INTERNATIONAL JOURNAL FOR KNOWLEDGE, SCIENCE AND TECHNOLOGY

CONTENTS

Multiple table factor analysis applied to the higher education competences

Cristina M. López-Caro, Amaia Lafuente-Ruiz de Sabando, Miren Artaraz-Miñón,
Miguel Á. Peña-Cerezo, and Iván Iturricastillo-Plazaola

Abstract— Due to the recent implantation of the Bologna process, the definition of competences in Higher Education is an important matter that deserves special attention and requires a detailed analysis. For that reason, we study the importance given to several competences for the professional activity and the degree to which these competences have been achieved through the received education. The answers include also competences observed in two periods of time given by individuals of multiple characteristics. In this context and in order to obtain synthesized results, we propose the use of Multiple Table Factor Analysis. Through this analysis, individuals are described by several groups, showing the most important variability factors of the individuals and allowing the analysis of the common structure of the different data tables.

The obtained results will allow us finding out the existence or absence of a common structure in the answers of the various data tables, knowing which competences have similar answer structure in the groups of variables, as well as characterizing those answers through the individuals.

Keywords— Competences, Business Administration and Management Degree, Higher Education, Multiple Table Factor Analysis.

I. INTRODUCTION

THE introduction of an educational system based on competences is a difficult task where sometimes there are doubts about their correct definition and application. This study consists in an exploratory factorial analysis of several developed competences and illustrates the employment of multivariate methods to obtain interesting results in the educative field. Through this study we try to observe the degree of fit between the importance given (IG) to a skill for professional practice (by Graduates), their degree of development (DD) during their training at the Center and its evolution along two periods of time. Therefore, the objective of the study is twofold:

1. To observe the existence of common structures of answers concerning IG and DD in each one of the competences.

2. To observe the existence of common structures of answers concerning both IG and DD in 2009 and 2011.

We use a factorial approach that shows the main factors of variability and describes individuals. From this perspective, a Principal Component Analysis (PCA) seemed to fit well to the data table [1]. However, as the variables are structured into distinct groups, we consider Multiple Factor Analysis (MFA) is more suitable to be applied.

This method developed by [2]-[3], and described by [4], makes evident the existence of common factors on the different analyzed groups, as well as specific factors on some groups. Therefore, the MFA provides similar indicators to the rest of factorial analysis and graphics that allow us to study [5]:

- Relationships between groups of variables and measure their similarity degree
- Relationships between variables of different groups
- Similarities between individuals studied along different variable groups

The results are expected to give a guidance to improve the adjustment between the importance given to skills and the opinion about the development of them. This should be supported by the identification of the skills that offer the greatest discrepancies and information about the characteristics of individuals.

The rest of the paper is organised as follows: Section II describes the data, Section III specifies the most general aspects of methodology, Section IV sets out the results of the analyses and finally, Section V summarises the conclusions.

II. DATA

The data used in this study come from a survey through which Graduates of the Business School of Vitoria-Gasteiz, through a Likert scale ranged between 1 (very low) and 5 (very high), express the importance they give to the grade skills for professional practice and the degree to which they feel they have been developed by the Center either in 2009 and in 2011. The following Table 1 shows the twelve skills developed by the Center and an identifier that helps their inclusion in the analysis.

Table 1: Name of the variables (skills) active in the analysis

Skills	Identifier
1. Accepting responsibility to manage and run a business or organization	ACCEPT
2. Understanding of business organizations as open systems interacting with their environment	UNDERS
3. Solve problems and take decisions under uncertainty	SOLVE
4. Contribute to finding the optimum answers to the questions of efficiency, management and resources allocation	CONTR
5. Demonstrate initiative and ability to learn and adapt to new situations	INICIAT
6. Identify and anticipate opportunities and threats	IDENT
7. Knowing how to find, identify, analyze and summarize critically to make useful decisions	KNOW
8. Develop, deliver and present any report with clarity and coherence	DEVEL
9. Understand the organization, plan the actions, implement the planned activities, and evaluate the results	PLAN
10. Ability for teamworking, showing responsibility towards the commitments made	TEAM
11. Being committed to the sustainable economic, social and environmental development	COMMIT
12. Demonstrate motivation for quality, for well doing	MOTIV

On the other hand, in order to study the profile of the respondents, the questionnaire includes qualitative and quantitative variables like sex, year in which they began their studies, reasons to choose these studies, reason to choose the Center, whether he has worked or not, current course, language of the studies, and so on. Those variables will be included in the analysis by way of illustration, as they are don't take active part of it.

III. METHODOLOGY

This paper presents a factorial method called Multiple Factor Analysis which is adequate to the treatment of tables in which all individuals are described by several groups of variables. The study is structured around two types of tables:

1. The first type contains the set of variables observed in the same period which are divided into two groups: the importance given (IG) on the one hand, and the degree of development (DD) on the other.

2. The second type of table contains the same variable observed in two distinct periods. Thus, groups are defined through a time variable. It is important to note that the same individuals have not been interviewed over two years. Therefore, the analysis will not be referred to the same individuals.

Table 2: Data tables.
Table 2.1

2011	IC		DD	
	C1 C2... C12		C1 C2... C12	
I	X_{11} X_{12}... X_{112}		Y_{11} Y_{12}... Y_{112}	
N	X_{21} X_{22}... X_{212}		Y_{21} Y_{22}... Y_{212}	
D	. .		. .	
I	. .		. .	
V	. .		. .	
I				
D				
U				
A				
L				
S	X_{n1} X_{n2}... X_{n12}		Y_{n1} Y_{n2}... Y_{n12}	

Table 2.2.1

2009/ 2011	IC (2009)		IC (2011)	
	C1 C2... C12		C1 C2... C12	
I	Z_{11} Z_{12}... Z_{112}		X_{11} X_{12}... X_{112}	
N	Z_{21} Z_{22}... Z_{212}		X_{21} X_{22}... X_{212}	
D	. .		. .	
I	. .		. .	
V	. .		. .	
I				
D				
U				
A				
L				
S	Z_{m1} Z_{m2}... Z_{m12}		X_{m1} X_{m2}... X_{m12}	

Table 2.2.2

2009/ 2011	DD (2009)		DD (2011)	
	C1 C2... C12		C1 C2... C12	
I	R_{11} R_{12}... R_{112}		Y_{11} Y_{12}... Y_{112}	
N	R_{21} R_{22}... R_{212}		Y_{21} Y_{22}... Y_{212}	
D	. .		. .	
I	. .		. .	
V	. .		. .	
I				
D				
U				
A				
L				
S	R_{m1} R_{m2}... R_{m12}		Y_{m1} Y_{m2}... Y_{m12}	

Where X_{ij} is the response of each individual to the importance given to each of the twelve skills in 2011, Y_{ij} is the response to the degree of development in 2011, Z_{ij} is the response to the importance given to skills in 2009, and R_{ij} is the response to the degree of development in 2009.

The aim of the MFA is, as in any factorial analysis, to identify the main factors of variability of individuals, being them described in a balanced way by the different groups of variables. To this end, the common structure of the different data tables under study is analyzed, showing which items are heterogeneous, i.e., those that behave differently from the rest. Such analysis makes possible to identify not only the structural difference between IG and

DD at a general level, but also to identify what skills are the cause of such discrepancies between IG and DD.

Each group of variables is associated with a partial cloud of individuals, through which we get the so-called partial factors. The MFA provides as many representations of each individual in each axis as groups of variables involved in the analysis are. This set of representations form a global cloud which can be considered decomposed into different groups and each group includes all representations of each individual. The Huygens decomposition proves that the inertia of the global cloud is equal to the addition of intra-inertias (inside the groups) and intra-inertia (between groups). The relation between inter-inertia and the total one will represent the similarity between the measurements of groups of variables. The closer to one this relationship is, the more similar these groups will be [6].

We are willing to examine the existence of common structures to all or part of the partial clouds, reflected in minimum intra-inertia or, expressed another way, maximum inter-inertia. The MFA provides an overlapped representation of these partial clouds projecting them on the axes of a global analysis of all groups. Every partial point next to each other reflects a weak intra-inertia, and therefore, these individuals illustrate a common structure between the analyzed tables. However, all individuals whose partial points are far away from each other, indicate a high intra-inertia and, therefore, they will be exceptions to the common structure we are trying to find [6].

The MFA provides global measures of relationship between groups based on the RV coefficient of Y [2]. This coefficient is obtained from the linear correlation coefficients between any two variables. Its value ranges between 0 (there is no correlation between the variables of the two considered groups) and 1. This measure is completed with Lg coefficients which measure the dimensionality (number of factors of considerable inertia) of each group. These coefficients take 0 value when there is no relation between groups and they don't have upper limit.

In short, for the case of quantitative variables, the MFA is a weighted Principal Component Analysis (PCA) of the global data table where each variable is weighted by the inverse of the square root of the first eigenvalue obtained in the PCA of each of the partial tables.

IV. RESULTS

A. Multiple Table Factor Analysis in one period of time.

A.1. First results (Graduates)

Tables 3 and 4 show the variability of variables in the first five axes. We can observe that the variability in the first axe is smaller in group 2 than in group 1 (51.32 percentage of projected inertia for group 1 and 39.46 percentage of projected inertia for group 2). Likewise, projected variability in the remaining three last factors of

group 2 is appreciably higher than in group 1. Latter on we will observe the implications of the existing difference in variability.

Table 3: Group 1: First five eigenvalues and PCA inertia percentages

Number	Eigenvalue	Percentage	Accumulated percentage
1	6.15	**51.20**	51.32
2	1.77	**14.81**	66.13
3	0.97	8.16	74.29
4	0.79	6.62	80.90
5	0.57	4.83	85.73

Table 4: Group 2: First five eigenvalues and PCA inertia percentages

Number	Eigenvalue	Percentage	Accumulated Percentage
1	4.73	**39.46**	39.46
2	1.30	**10.87**	50.33
3	1.19	**9.97**	60.30
4	1.05	**8.79**	69.09
5	1.01	**8.44**	77.53

In Table 5 we present the correlation between the partial factors of the two groups of variables, IG and DD:

Table 5: Correlations between the projections of the partial axes (Gr1 and Gr2) on the axes of the global analysis

Correlations	Global Analysis Factors				
Partial axes	1	2	3	4	5
Gr 1 (IG)	**0.82**	**0.64**	**0.89**	0.53	0.57
Gr 2 (DD)	**0.79**	**0.74**	**0.87**	**0.95**	**0.94**

Table 6: Contributions of the groups to the formation of the global axes (global factors)

	Contributions				
FAC	1	2	3	4	5
Gr 1 (IC)	**52.8**	**43.5**	**53.1**	17.4	20.1
Gr 2 (DD)	**47.2**	**56.5**	**46.9**	**82.6**	**79.9**

The first three axes are affected by both groups in a very similar way. However, although the reality of the second group is reflected significantly in the five axes, the last two are more remarkable (0.95 and 0.94). Summarizing, we may say that the first component of the MFA is a "common factor" to the two sets of variables. The high correlation coefficients values indicate that the projections of both clouds are almost homotheties of the projection of the global cloud (that can be considered as an "average" of these projections). Therefore it can be said that there is a direction of dispersion almost analogous in both clouds.

The second and the third component is also a "common factor" to both groups of variables (0.64, 0.74). However, as the correlation of the axes with the projection of the clouds defined by the IG variables is lower in the fourth and the fifth axes, 0.53 and 0.57 respectively, we could say that these are dimensions that result only in the DD of skills. This is corroborated by the projected variability in

the last factors observed in Table 4.

Therefore, the correlations allow us to prove the existence of a common factor for all or some of the groups. When this common direction exists, is interesting to measure and to compare its importance in the different groups. The importance of a factor in a group is measured by the accumulated inertia of the variables of the group over this factor, also called weight of the factor in the group.

Since the two groups contribute similarly to the formation of the first three global axes, Table 6 shows almost the same. However, to the formation of the fourth and the fifth axes contributes mainly the second group. Therefore, apart from the last two factors, the first three factors have the same interpretation for all groups.

Table 7: Ratios Inter-Inertia/Total Inertia

FAC	1	2	3	4	5
Graduates	0.64	0.48	**0.77**	0.58	0.59

Table 8: RV coefficients of relations between groups

RV Coef. (Graduates)	1 (IG)	2 (DD)
1 (IG)	1.000	
2 (DD)	**0.031**	1.000

None of the principal components (factors) is closely related to each group and therefore they are not a very important direction of inertia for each one. This is because groups of variables present a multidimensional reality, where there are other major components that collect for the variability. All groups, therefore, are "rich", i.e. involve at least some variables (correlation between IG and the DD of skills) poorly correlated with each other. The "rich" groups affect more axes than the poorer ones.

The closest ratio to one is in the third axis of variability, reflecting that the reality explained by this factor is quite common to both groups. As both groups have a quite distinct behaviour, the ratios for the five axes of variability (Table 7) do not have values close to one. On the other hand, the portion of information offered by the five factorial axes is quite similar, i.e. the information is distributed and is not exclusive of a few factors.

The RV coefficient matrix of relationships between groups (Table 8) highlights again the lack of similarity between both groups with an RV coefficient of correlation between groups of 0.031.

And now we present in the next table the Lg relation coefficients between groups.

Table 9: Lg relation coefficients betweeen groups

Lg relation coef. (Graduates)	1 (IG)	2 (DD)
1 (IG)	**1.148**	
2 (DD)	0.195	**1.295**

After the study of the main diagonal of the Lg matrix, we observe similar coefficients which show the existence of a similar multidimensionality in both groups. This last result joint with the Inter Inertia/Total Inertia Ratios show that the answers of both groups of variables are explained by the five factors extracted and in the case of

the second group, fourth and fifth factors capture more relevant aspects.

In conclusion, the initial indicators show that the two analyzed groups (IG and DD) evaluated in 2011 for Graduates, present a quite different structure, which reveals that there are significant changes in the level of IG and the perceived DD of skills.

In our case, the objective of the School is to obtain highly correlated variables, i.e. which move in the same direction. So, for example, if the student gives great importance to a skill, it is deemed to have been developed successfully, and vice versa. So the School looks for groups with similar structure.

A.2. Results of the partial analysis
a. Analysis of the variable-points cloud

Regarding the collective of Graduates, and looking at Figure 1, we see that in the first axis all the skills are positively correlated in pairs. Therefore, in general, there is a correspondence between the IG and the DD of these skills. This first axis is a reference axis where all the variables of both groups are in one side of axis 1.

The second axis opposes the assessments about the importance given to the skills KNOW_1, DEVEL_1 and COMMIT_1 (located on the negative side of factor 2) with the assessments on the degree of development of skills CONTR_2, PLAN_2 and TEAM_2 (located on the positive side of factor 2).

Thus, there is a significant group of individuals that respond in the same sense to KNOW_1, DEVEL_1 and COMMIT_1 variables in one hand and CONTR_2, PLAN_2 and TEAM_2 in the other hand. These variables have a similar structure between the answers of a great number of individuals, therefore these are variables to take into account.

Figure 1: Graphical representation of the cloud of points in the skills space and partial axis
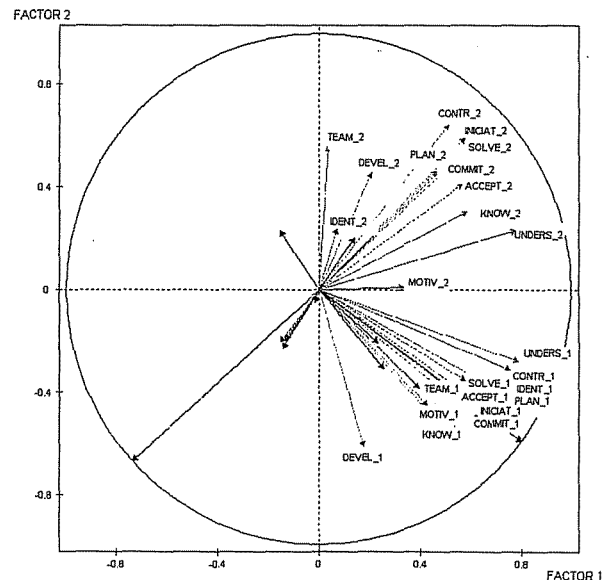
As we said before, fourth and fifth factors contribute to the formation of group 2, i.e. the perceived development

of the competences. The variables of group 2 more related with the fourth and the fifth factor are SOLVE_2, DEVEL_2 and TEAM_2 in one hand, and ACCEPT_2, IDENT_2 and COMMIT_2 in the other hand respectively.

Figure 2: Graphical representation of the cloud of points in the individuals space including illustrative variables
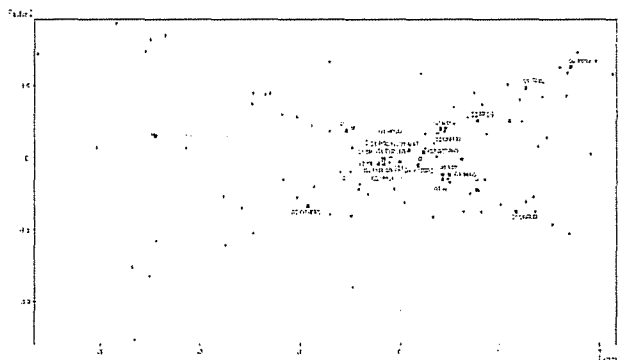
b. Analysis of the individual-points cloud.

The MFA allows the positioning of other elements called illustrative. These elements are point-individuals or point-variables that have not taken part in the analysis but as they have been projected on the axes determined by the active variables they are useful to characterize individuals. The additional illustrative variables included are: sex, reason for enrolment, reasons to choice the School and whether they have worked previously or not and so on.

Most of the illustrative variables are represented around the centre of gravity of the factorial plane which means that the majority of Graduates have these characteristics. Therefore they do not serve to distinguish between the answers given, i.e. to characterize the variability of individuals. Only the illustrative variables IMAG (good image), PROG (training program), UNPUBL (being a public university), SUBJ (subjects taught) and OTHER (other reasons), are distanced from the centre of gravity and characterize individuals and their responses.

Figure 1 shows how the first axis separates, on the right hand side, those individuals who give great importance to the skills, UNDERS_1, CONTR_1, INICIAT_1 and PLAN_1 and have considered that the skills UNDERS_2 and KNOW_2 have been developed, from those individuals on the left hand side that assess them with an opposite value. These individuals are those who had enrolled in the Center for its good image and for being a public university. Also, they chose these studies because they were attracted by the subjects taught (see Figure 2).

The second axis contrasts individuals who, on one side give great importance to the skills KNOW_1, DEVEL_1 and COMMIT_1 and consider that there is a small develop of the skills CONTR_2, PLAN_2 and TEAM_2, and vice versa. These individuals are characterized by choosing this Center because it is a public university (Figure 2).

A.2. Groups typology

As can be observed in Figure 3, supplementary variables are also represented by two groups: in one hand, group 3 is represented by qualitative variables sex, registration reason, center chose reason and if he/she had worked before, and in the other hand, group 4 is integrated by the only quantitative variable called age of beginning of college career.

Both active and supplementary groups are represented in a graphic that corresponds axis by axis to variables and individuals. The coordinate of a group in an axis is the accumulated inertia of the variables of a group in the correspondent MFA axis. The adjustment implies that coordinates of a group-point are included between 0 and 1.

Figure 3: Graphical representation of the cloud of the two active groups and the two illustrative groups
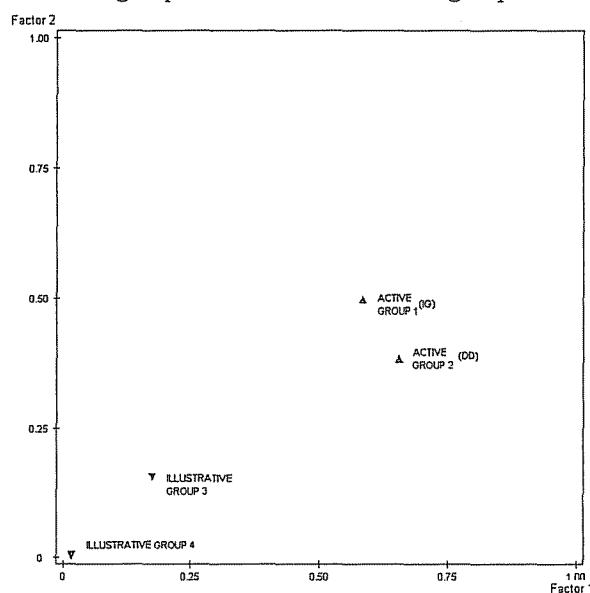
The coordinate of a group over an axis is the accumulated inertia of the variables of the group on the corresponding axis of the MFA. The weak coordinate of the two additional groups along both axes indicates that the illustrative variables that make up these groups are scarcely related to factors 1 and 2. Therefore, they give little information to characterize the responses to the groups of active variables. On the other hand, in Figure 3, the more similar the structures defined on the set of individuals are, the closer both groups will be. In our case, groups 1 and 2 are not close enough to say that groups have similar structures.

B. Multiple Table Factor Analysis in two time periods.

B.1.Time analysis of the Importance Given.

The conducted Multiple Table Analysis indicates that the structure or pattern of responses regarding the importance given to skills in the years 2009 and 2011, is different. On the other hand, the reality of these two years is multidimensional, which means that it is not explained only by one factor, but by the above mentioned five

factors.

Table 10: Ratio of Inter-Inertia/Total Inertia (Group 1 - 2009 / Group 2 - 2011)

FAC	1	2	3	4	5
	0.54	0.50	0.59	0.66	0.62

Table 11: RV coefficients of relationships between groups (Group 1 - 2009 / Group 2 - 2011)

	1	2	MFA
1	1.000		
2	**0.051**	1.000	

Table 12: Correlations between the projections of the partial axes (G1-2009 and G2-2011) on the axes of the global analysis

| Correlations	Global Analysis Factors				
Partial axes	1	2	3	4	5
G1 (IG-2009)	**0.72**	**0.73**	0.58	**0.83**	0.80
G2 (IG-2011)	**0.75**	**0.68**	**0.93**	**0.79**	**0.78**

After observing the obtained indicators, we conclude again that the structure of the analyzed groups is different.

b. Analysis of the variable-points cloud.

On the left hand side, axis 1 contrasts competences to whom individuals gave a certain importance level in 2009, to competences sited on the right hand side, to whom individuals, in 2011, gave a degree of importance opposite from the one gave in 2009.

Figure 4: Graphical representation of the cloud of points in the skills space and partial axis.
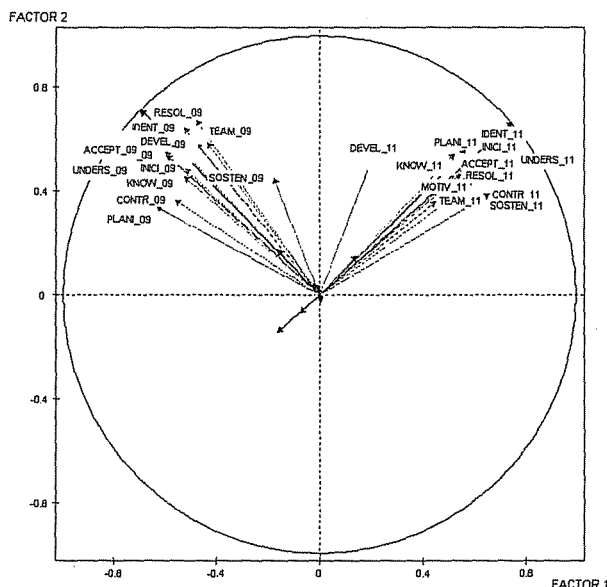
Variables that contribute most to the formation of the second axis correspond only with those of the group 1, that is, competences analyzed in 2009. Those competences are SOLVE_09, IDENT_09, DEVEL_09 and TEAM_09. Therefore, second axis contrasts those individuals that in 2009 gave some importance to the competences mentioned above from those who didn't give any importance.

Finally, third axis is exclusive of group 2, that is, of the

competences consulted in 2011. Competences that contribute more to formation of that axis are: ACCEPT_11, UNDERS_11, SOLVE_11, CONTR_11, TEAM_11, COMMIT_11 and MOTIV_11. This axis contrasts positive valuation of some individuals into the mentioned competences with those who don't give to them any importance.

B.2. Time Analysis of the Degree of Development.

It is worth to remark that with regard to the DD in 2009 and 2011, this group has much more similar structures than those obtained in previous analysis (see Table 13). In Figure 4 it can be seen how both groups are quite close from each other, therefore, their perception of the degree of development of skills in both years is similar.

In general, the rest of the aspects are similar to those that have been explained for the importance given in both years.

Table 13: Ratio Inter-Inertia/ Total Inertia (Group 1- 2009 / Group 2- 2011 - Graduates)

FAC	1	2	3	4	5
	0.57	0.48	0.62	0.69	0.53

Table 14: RV coefficients of relationships between groups (G1 - 2009 / G2 - 2011 - Graduates)

	1	2	MFA
1	1.000		
2	**0.079**	1.000	

Table 15: Correlations between the projections of the partial axes (G1 and G2) on the axes of the global analysis (Graduates)

Correlations	Global Analysis Factors				
Partial axes	1	2	3	4	5
Gr 1 (DD-2009)	**0.76**	**0.68**	**0.62**	0.75	0.34
Gr 2 (DD-2011)	**0.75**	**0.70**	**0.96**	**0.93**	**0.99**

Figure 5: Graphical representation of the cloud of the two active groups and the two illustrative groups (DD 2009/2011)
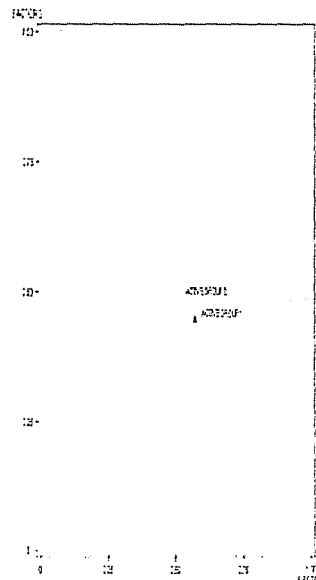
V. CONCLUSIONS

In general, it has been observed the existence of different answer standards both in the importance given and in the development degree of educational competences in one hand, and in answers given in 2009 and in 2011 in the other hand.

Every education center wants his former students to give certain importance to competences and consider that the center has been able to develop them adequately. Otherwise, it is important to know which the competences with higher discrepancies are.

Analysis done show a multidimensional reality, namely, that is explained by several factors. Last factors explain specifically the degree of development of the competences by the center, gathering a great variability of answers. Consequently, there is a group of individuals that in some competences and regarding the degree of development, answer in a very similar way and very differently from the rest.

Competences with a homogeneous pattern response which are significantly different from the rest and with higher discrepancies between the importance given and the development degree in one hand and between 2009 and 2011 years in the other hand are:

- Contribute to finding the optimum answers to the questions of efficiency, management and resources allocation
- Knowing how to find, identify, analyze and summarize critically to make useful decisions
- Develop, deliver and present any report with clarity and coherence
- Understand the organization, plan the actions, implement the planned activities, and evaluate the results
- Being committed to the sustainable economic, social and environmental development

Individuals that correspond with these answers and whom behaviour exceeds the average are: on the one side, a group of individuals that are characterized by enrolling in the Center because of its image and belonging to Public University as well as being attracted by the subjects taught, and on the other side, another group of individuals that chose this Center because it belongs to the Public University.

On the other side, competences that deserve special attention with regard to development degree are:

- Accepting responsibility to manage and run a business or organization.
- Identify and anticipate opportunities and threats.
- Ability for teamworking, showing responsibility towards the commitments made.

Finally, it is remarkable that in general, the collected responses on the degree of development in 2009 and in 2011 have much more similar structures than the rest and, therefore, individuals hold the same perceptions about the degree of development.

In later studies we will try to go further into the reasons that cause those discrepancies, and also into individual

profile. Likewise, is important to emphasize the usefulness of this kind of exploratory studies which enable us to know about the reality offered by data in a simplified manner.

REFERENCES

[1] Aluja, T. and Morineau, A., Aprender de los datos: El Análisis de Componentes Principales (Primera Edición), EUB, Spain, 1999.
[2] Escofier, B. and Pagés, J., "Análisis factoriales simples y múltiples. Objetivos, métodos e interpretación", Servicio Editorial de la Universidad del País Vasco, 1992..
[3] Escofier, B. and Pagés, J., L'analyse factorielle multiple: une m'ethode de comparaison de groupes de variables, in Diday, E. (ed): Data Analysis and Informatics III, Elsevier Science, Amsterdam, 41–56, Proccedings of the Third International Symposium on Data Analysis and Informatics, 1984.
[4] Lebart, L., Morineau, A. and Piron, M., Statistique exploratoire multidimensionnelle, Dunod, France, 1995.
[5] Abascal, E. and Landaluce, M.I., Análisis factorial múltiple como técnica de estudio de la estabilidad de los resultados de un análisis de componentes principales, Qüestiió, 1-2, 109-122, 2002.
[6] Landaluce, M.I., Fernández, K. and Modroño, J.I., "Reflexiones sobre el uso comparativo del Análisis Factorial Múltiple y de la metodología STATIS para el análisis de tablas múltiples". Methodologica, 7, 37-66, 1999.

Cristina López-Caro (M'07) This author became a Member of the University of the Basque Country (SPAIN) in 2007. She was born in Bilbao in 1974. She obtained her Bachelor in Economics and Business Degree at the University of the Basque Country in 1997, Advanced Studies in Statistic and Econometric methods and phD in Economy analysis and Public Economy at the UPV/EHU in 2009 with the title "Multivariate analysis applied to the automobile industry". Nowadays she is a Laboral Professor of Marketing at the Business School of Vitoria-Gasteiz, Department of Financial Economics (area of market research) at University of the Basque Country (UPV/EHU). Her fields of research are Structural Equation Models with latent variables and other measurement error models (multilevel data, latent growth curve models, latent growth mixture curve models...), Factor Analysis Models, Cluster analysis, Panel Data models...
She has worked in the Basque Institute of Statistics at the Basque Government with the survey of homeless. She has published (1) "Sales-advertising relationship: An application of Panel Data from the German Automobile Industry" (Prague Economic Papers – XV – 2006/1), (2) "La Satisfacción del Consumidor: Una aplicación de Análisis Factorial Confirmatorio a la Industria Automovilística Española" (Estadística Española – 47 (158)- 2005) (3) "Satisfacción cumulativa parcial y modelos de curvas latentes de primer y segundo orden. Una aplicación a la industria automovilística española" (Estadística Española – 53 (176) – 2011). Nowadays she is a member of a research group at the UPV/EHU in the Consumer Satisfaction field.

Miren Artaraz Miñón (M'94–SM'03) This author was born in 1970 in Vitoria-Gasteiz and achieved the Bachelor in Economics and Business Degree in UPV/EHU (Spain) in 1992. She became a Member (M) of UPV/EHU in 1994 and a Senior Member (SM) in 2003. She obtained Doctor Degree in 2011. Nowadays, she is the Director of Business School of Vitoria-Gasteiz, University of the Basque Country (UPV/EHU). Her principal research lines are sustainable environmental economy and educational innovation. She has published articles in Journals as Ciudad y Territorio, Ecosistemas and Residuos.
Dr. Artaraz has been prize-winner as Manager Woman in 2011. For more information, see: http://www.vc.ehu.es/mirenartaraz/

Miguel Á. Peña-Cerezo (M'97–SM'03) This author became a Member (M) of UPV/EHU (Spain) in 1997, and Senior Member (SM) in 2003. He was born in Bilbao in 1974. He obtained his Bachelor in Economics and Business Degree and the Actuarial Degree in UPV/EHU in 1997. He has been visiting scholar in ITESM (México). Since 2007 he is Assistant Manager of Quality and Teaching Innovation of the Business School of Vitoria-Gasteiz, University of the Basque Country (UPV/EHU). His research interests include financial markets, scientific methodology and educational innovation, and his research articles have been published in Global Journal of Business Research, EconoQuantum, Academia-Revista Latinoamericana de Administración, Revista de Economía (ICE), and so on. Also, he has collaborated in several projects with financial entities and others. He has been prizewinner of various national and international awards in economy, management and financial areas.
Prof. Peña-Cerezo belongs to European Academy of Management and Business Economics and is a reviewer of financial journals. More information in: http://www.ehu.es/miguelangel.pena

Iván Iturricastillo Plazaola (M'98–SM'11) This author was born in 1974 in Bergara, Gipuzkoa. He achieved the Bachelor in Economics and Business Degree and the Actuarial Degree in UPV/EHU (Spain) in 1997. He obtained the PhD in 2007. He became a Member (M) of UPV/EHU in 1998 and a Senior Member (SM) in 2011. Since 2008 till 2012 he has been the Academic Secretary and International Relationships Coordinator of the Business School of Vitoria-Gasteiz, University of the Basque Country (UPV/EHU). He is Member of the Basque Association of Actuaries since it has been segregated from the Spanish Institute of Actuaries, association to which he belonged until then. His research interests include financial and actuarial risks, social secutity and welfare, financial markets, scientific methodology and educational innovation. He has published articles in Journals as Analisis Financiero, Anales del Instituto de Actuarios (Anales) and so on. From 2010 on he has published and he has been interviewed frequently in various media as an expert economist.