

Quantitative Methods in Higher Education: a typology of representations

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Abstract

It is often concluded that higher levels of self-confidence in pupils in relation to their ability to interact with mathematics, associated to the perception of the latter's greater utility contributed for pupils making positive representations of this discipline. One of the objectives of this article is to inspect if in the university context this linear trend is maintained in the relation between the two dimensions – affective and instrumental – which structure the representations of the disciplines of quantitative methods. A second objective consists in observing how students from different courses (from different scientific areas) create their representations about these disciplines. A questionnaire was applied to a sample of students from a university institution. The definition of patterns of representations was done through the use of Multiple Correspondence Analysis (MCA), and Categorical Regression (Catreg) was employed to identify explaining factors in the students' profile. The results show that the space of the representations of quantitative methods in a university context is marked by heterogeneity, with a complexity that goes beyond this linear trend in the relation between the utility dimension and the affective dimension. Another conclusion is about the untenability of the thesis that points (at least in a non-university context) to the feminization of the lack of self-esteem and self-confidence to deal with disciplines from this scientific area. A further conclusion is that a course culture seems to exist, insofar as the courses tend to reflect a predominant pattern of representations of the quantitative methods.

Keywords

Representations of quantitative methods - Typology of representations - Multiple Correspondence Analysis (MCA) - Categorical Regression (Catreg)

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The fact that the economic progress of current societies is closely linked to their technological development contributes strongly to an ever-increasing importance of the competences in areas such as mathematics. This phenomenon, associated to the persistent school failure observed in this discipline, has worried educators and governments in many countries, and also in Portugal where the rates of failure in mathematics continued to show alarming values.

In research, the failure in mathematics has appeared equally in many studies, namely, in the areas of the Sciences of Education and Psychology, which have also dealt with the issue of the relation between the representations about mathematics and students' performance (with emphasis on those of the pre-college level), arguing the importance of specific factors in the structure of this relation.

One of the hypotheses that have been analyzed points to the sense of self-confidence of the students with respect to their capacity to obtain good results in mathematics, along with their perception of the usefulness of this discipline, as a decisive influence on their performance, wherein higher levels of self-confidence and perception of usefulness are associated to better results.

Along with the identification of the structuring factors in students' representations of mathematics, the present study also investigates the relationships between some individual characteristics such as gender and age.

One of the objectives of this article is to expand the analysis of some of these hypotheses to the segment of university students, having as a background the disciplines of the scientific area of quantitative methods¹. We focus on exploring the representations that students build about these disciplines in a university institute marked by the diversity of scientific areas, but in which the transversality of the disciplines of quantitative methods (QM) is a constant². With the purpose of identifying the multiple features this articulation can assume, we placed particular emphasis – and this is undoubtedly an essential aspect – on the

articulation of the affective and instrumental dimensions in structuring the representations made by these students.

A second objective relates to the perception of how is it that students, from courses in different scientific areas³, generate their representations regarding these disciplines. Can we speak of a group dynamics, in the sense that within each course one can witness a socialization that triggers the sharing of similar representations?

In answering these questions we seek to contribute to the understanding of the interaction of university students with the disciplines of QM, particularly through their representations, with the purpose of enhancing the pedagogical intervention in groups that may exhibit greater problems in interacting with these disciplines.

Factors in the social and individual relationships with mathematics

Under the perspective that the relationship between practices and representations is continuous and iterative, it is legitimate to think that also at the level of learning and of performing in disciplines such as mathematics, social representations play an important role. This is the meaning of many studies that have explored the outlines of this relationship, despite being referred to the pre-university context. Authors such as Haladyna; Shaughnessy; Shaughnessy (1983); Schoenfeld (1988; 1989); Kloosterman (1994; 1996); Mcleod (1985; 1992); and Reyes (1984), among others, have already demonstrated amply the importance of variables

1. We regard as disciplines of the scientific area of quantitative methods (QM) all disciplines taught by the Department of Quantitative Methods of the university under study, such as: Mathematics, Statistics, Quantitative Methods, Data Analysis, Linear Algebra, Forecasting Methods, Time Series, Econometrics, Macro-econometrics.

2. At the university studied all courses analyzed have in their curricula one or more disciplines from the scientific area of QM.

3. Anthropology, Economics, Computer Engineering, Telecommunications and Computer Engineering, Finances, Management, Human Resources Management, Management and Industrial Engineering, History, Computer Sciences and Management, Marketing, Social and Organizational Psychology, Sociology and Sociology and Planning.

from the affective domain to the practices and, consequently, to the construction of representations about mathematics.

Haladyna, Shaughnessy and Shaughnessy (1983) starting from the hypothesis that a positive attitude can be an important school result in itself, but that it can also be positively related to performance and increase the bias toward the option for courses with a strong mathematical component, have developed an analysis model in which the wider issue of pupil motivation (which includes variables such as the importance given to the matter under study, the self-confidence in one's capacity to learn, and fatalism) appears associated to the practices.

Those authors have concluded that pupils' self-confidence in their ability to obtain good results in mathematics, along with their perception of the importance of the discipline, have influenced decisively their performance, with higher levels of self-confidence and perception of usefulness being associated to better results.

Along with the importance of the affective dimension to the construction of social representations of mathematics, the usefulness attributed to it – as a component of the relationship established with the discipline and, consequently, as a structuring factor of representations – has been a topic analyzed in numerous studies (Fennema; Sherman, 1977; 1978; Kloosterman; Stage, 1992; Schoenfeld, 1989; Muis, 2004). In these studies it becomes clear not just the relevance of the perceived usefulness of mathematics, but also of its association to variables from the affective domain.

The trend captured here goes in the direction of a greater perceived utility of mathematics being associated to more positive representations of the discipline. The perception that students have of its usefulness can range from one extreme of not attributing any importance to the other extreme of regarding it as fundamental to their personal and professional future. If for some of them it has no practical relevance whatsoever to their lives, for others its usefulness and importance are

beyond discussion, be it at the level of short-term objectives – namely, to obtain a good grade at the end of the year or to carry on with studies in a given scientific field – be it for their personal fulfillment or professional future.

Thus, in this study about the representations of the QM by university students, apart from the factors that referred to affective relationship with the disciplines from this scientific area, we could not leave out the indicators that measure the usefulness perceived by students in terms of its usefulness for their personal, school, and professional future. Particularly when we note that we are dealing with a group whose proximity to the exercise of a profession takes on special urgency.

If students expect to obtain in the future professional advantages as a result of competences acquired in the study of disciplines of QM, we should expect, for instance, that their position with respect to the study and to the image they build about them would be different from what would happen if they did not foresee any surplus value in the learning effort. In other words, the usefulness each person attributes to the acquisition of knowledge in this scientific area will very likely determine their predisposition toward interaction with these disciplines and, specifically, their own application in their learning.

In addition to factors of affective and instrumental domains, several authors called attention to the importance of the relationship between representations and individual characteristics, such as gender (Fennema; Sherman, 1978; Stage; Kloosterman, 1995; Kilpatrick; Silver, 2000; Fennema, 2000), age (Fredrick; Mishler; Hogan, 1984; Walker; Plata, 2000) and self-confidence (Schoenfeld, 1985; 1989; Reyes, 1984; McLeod, 1992; Kloosterman *et al.*, 1996).

Fennema and Sherman (1978), Fennema (1990; 2000) under the framework of the issue of the differences between genders in the learning of mathematics, relate them with a few affective variables, concluding that boys' self-confidence with respect to capacity to learn was significantly higher than that of girls', it being also observed

that the stereotype of mathematics as a masculine field was more strongly rooted among boys.

Fredrick, Mishler and Hogan (1984) and Walker and Plata (2000) also reached the same conclusion. According to them, although age seems to be a factor of no great relevance, and in spite of the possibility of detecting a slight tendency for older students to derive more satisfaction from the study of mathematics and to attribute more usefulness to it, in what concerns gender it is possible to observe that girls tend to have more negative representations of mathematics and to be less self-reliant than boys.

This brief systematization intends to show the need to consider in the analysis of social representations we made – albeit transposed to the university milieu and to a wider set of disciplines, all of the same scientific field – a larger group of variables to allow the assessment of pupils' perception as to their own abilities, their self-confidence, the usefulness and importance attributed to the disciplines of the area of the QM, as well as some characteristics of an individual nature, namely, gender and age. Considering the possible influences of these various factors, now with focus on the university field, we have sought in the present article to give answers to the following questions:

- What is the relation of the students from a higher education institution with the disciplines of the area of the QM (mathematics, statistics, data analysis, econometrics, operational research...) under the affective and instrumental dimensions?
- What types of representations of the QM are defined from the relationship between the two dimensions?
- What individual profiles are associated to the different types of representations?

Methodology

Sampling

This study emerges from within the wider theme of the relationship between representations

and performance, and its novelty resides in: 1) the target population chosen for the study (university students), since in most investigations the object of analysis is the pre-university levels; and 2) the classifications of these students according to a typology of social representations of the QM based on the interaction between indicators of the affective and instrumental domains.

The target population in this study is composed of students from various undergraduate courses in a Lisbon university whose curriculum includes disciplines from the scientific field of QM. The sample was constructed through a process of multistage sampling, so as to encompass students from various school years, courses, and shifts. In the cases of the courses in which there is more than one class per year of curriculum, we selected randomly one class from each year. In the courses with day shifts and night shifts and when there was more than one class, we also selected randomly one class per shift per year of curriculum.

After selecting the classes, a questionnaire was applied in the classroom to all students present. Data gathering took place in the first semester of 2005, comprising a sample of 1269 students which spanned the existing diversity in the institution in terms of courses, school years, shifts, ages and professional situation.

The ages in the sample range between 16 and 69 years, and the average age was 23.3 years. The majority of the students were female (56.4%), coming from families with high levels of schooling (30.8% with higher education and 23.4% with secondary education), attending the day courses (83.5%), and non-working (73.6%), which obviously reflects the profile of the student population of the institute.

Indicators

Different aspects are present in the process of social construction of the representations of the QM: i) those linked to the way in which students relates affectively with the discipline; ii) those derived from expectations and convictions about the direct

or indirect benefits that might accrue from this kind of knowledge; and iii) those that reflect students' self-confidence. Table 1 systematizes the specific contents and indicators associated to these different aspects, and that will allow their operation.

One of the indicators of the affective relationship maintained with the disciplines of QM is the feeling about them. Students were asked that, from a list of several words, to choose the one that better defined their feelings towards the disciplines of this scientific area. Still within the context of the affective dimension, they were asked to indicate their degree of agreement (in a six-point scale) with several statements, and the degree of importance (in a ten-point scale) they attributed to these disciplines in their professional future.

Preserving the individuality of each of these dimensions – affective and instrumental – as structuring factors in the system of representations of the QM, we want above all to explore the relational multidimensionality that characterizes this or any other system of representations. The complexity sustained by the inter-relationships between the multiple indicators that define these dimensions implies

that we must preserve the multidimensionality of a structural type, both in the conceptual approach and in their analytical exploration. With the precise purpose of managing efficiently the analysis of the relational configuration that characterizes the system of representations we have chosen the Multiple Correspondence Analysis. It is a method of multivariate analysis adequate to deal with multiple indicators, especially those of a qualitative nature (as those described in Table 1), and that allows structural analyses.

After identifying and defining the various types of representations, they were regressed in accordance with a series of factors considered important to explain the differentiation detected. To such end, and given the categorical nature of many of the variables, Categorical Regression was used (via optimal scaling).

Representations of the quantitative methods: perceived usefulness and affective relationship

With respect to the feelings manifested towards the disciplines of QM (Table 2), need and interest are the more frequent ones (21.0%

Table 1: Dimensions of analysis: contents and indicators.

Dimensions	Contents	Indicators	Categories
Affective	Affective relationship with disciplines of the QM area	Feelings displayed towards the QM disciplines	Sympathy, incomprehension, obligation, interest, boredom, acceptance, need, challenge
	Importance of success in the disciplines of the QM area as a form of personal fulfillment	Importance of having good grades in QM to: Please oneself Be considered a good student	Six-point scale: 1 = disagree completely 6 = agree completely
	Perception of abilities in the disciplines of QM (self-esteem)	Self-evaluation as to: Level of knowledge Confidence regarding QM Difficulty regarding QM Easiness regarding QM Anguish regarding QM	Bad student, average student, good student. Six-point scale: 1 = disagree completely 6 = agree completely
Instrumental	View of usefulness of QM disciplines	Level of agreement regarding the importance of having good grades in QM in order to: The final grade in the course Follow the intended area of specialization Getting a job	Six-point scale: 1 = disagree completely 6 = agree completely
	Importance of QM in terms of professional future	QM is an essential tool for future job	Ten-point scale: 1 = no importance 10 = very important

Source: QM in higher education, 2005.

and 20.4%, respectively)⁴. With lower values we find incomprehension, sympathy, and boredom. Although half of the students (46%) present choices that point to a markedly passive stance – need, obligation, and acceptance – towards these disciplines, one third (35.5%) associate with these disciplines feelings such as interest and challenge.

Table 2: Feelings towards QM disciplines.

Feelings	N	%
Need	267	21.0
Interest	259	20.4
Challenge	191	15.1
Obligation	163	12.8
Acceptance	152	12.0
Incomprehension	103	8.1
Sympathy	76	6.0
Boredom	58	4.6
Total	1269	100.0

Source: QM in higher education, 2005.

This oscillation between feelings that suggest that we may be facing some students more passive and others more pro-active with respect to the management of the affections in the relationship with the QM is reinforced by the (average) levels of agreement regarding the assessment of self-esteem (Graph 1). If, on one hand, they do not tend to feel

at ease ($M=2.4$), on the other hand they do not feel uncomfortable nor anguished ($M=2.8$).

The association between the self-assessment indicators (Table 3) display moderate, although statistically significant, correlations⁵. It was possible to see that, as expected, the safer the students feel about this disciplines, the more at ease they are ($R=0.510$, $p<0.01$) and less uncomfortable ($R= -0.537$, $p<0.01$).

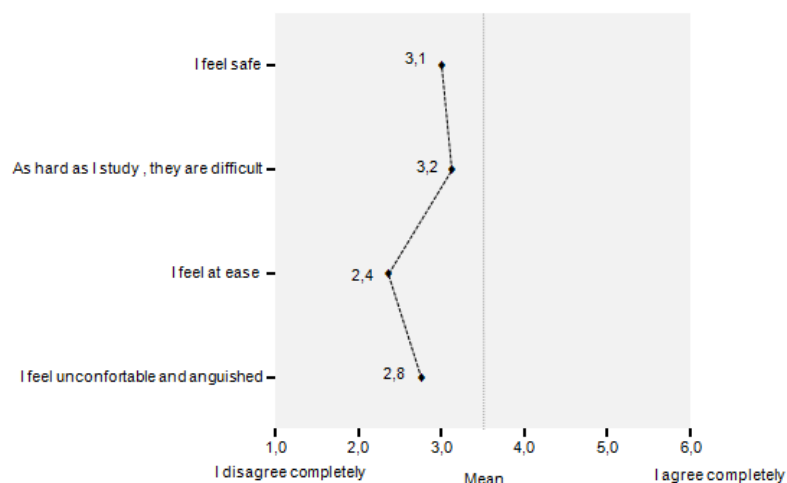
From among the various possible reasons for a good result at the disciplines of QM, all of them seem to be somewhat important, as can be seen by the average values presented in Graph 2 (all are above the central point of the scale). Nevertheless, a good grade by the end of the course in the reason that stands out with an average value of 4.2, with the remaining reasons averaging similar values (between 3.6 and 3.9).

As observed by Fennema and Sherman (1977; 1978), Fennema (2000), Schoenfeld (1989), Kloosterman and Stage, (1992), Muis (2004), in other segments of teaching, students of higher education also attributed importance to the disciplines of QM in what regards their usefulness, particularly in terms of the fulfillment

4. Some of the feelings that appear in the initial list were eventually disregarded in the analysis because of their low frequency.

5. It should be noted that a maximum level of significance of 5% was used.

Graph 1: Affective relationship towards QM.



Source: QM in higher education, 2005.

Table 3: Affective relationship towards QM (correlations).

	As hard as I study, they are difficult	I feel at ease	I feel uncomfortable and anguished
I feel safe	-0.483*	0.510*	-0.537*
As hard as I study, they are difficult		-0.360*	0.543*
I feel at ease			-0.426*

* $p < 0.01$ (1-tailed)

Source: QM in higher education, 2005.

Table 4: Importance of a good result in the QM (correlations).

	Prepare for the intended scientific area	Having a good grade by the end of the degree course	Please myself	To be considered a good student
To find the job I want	0.623*	0.405*	0.401*	0.313*
Prepare for the intended scientific area		0.332*	0.416*	0.283*
Having a good grade by the end of the degree course			0.463*	0.403*
Please myself				0.519*

* $p < 0.01$

Source: QM in higher education, 2005.

of more immediate objectives such as having a good grade at the end of the degree course.

With respect to the association of the various aspects deemed important for having good grades in disciplines of QM (Table 4) we can highlight the relation between preparation for the scientific area and getting the intended job ($R=0.623$, $p<0.01$). It is also important to notice the existence of positive correlations and of average intensity between aspects that relates the dimensions of usefulness and affective such as for example having a good grade at the end of the degree course and pleasing myself ($R=0.463$, $p<0.01$).

In Graph 3 we can see the importance attributed by the students to the disciplines of QM as tools for their professional future. The larger concentration of answers is observed at the highest points of the scale (almost 50% between seven and eight points), leading us to suppose that the competences they acquire through them are regarded by these students as very important for their professional future. The importance attributed to these disciplines in achieving short-term objectives was already

clear, and now it also becomes evident that QM disciplines are strongly felt as essential tools for a future job.

Representations of quantitative methods:

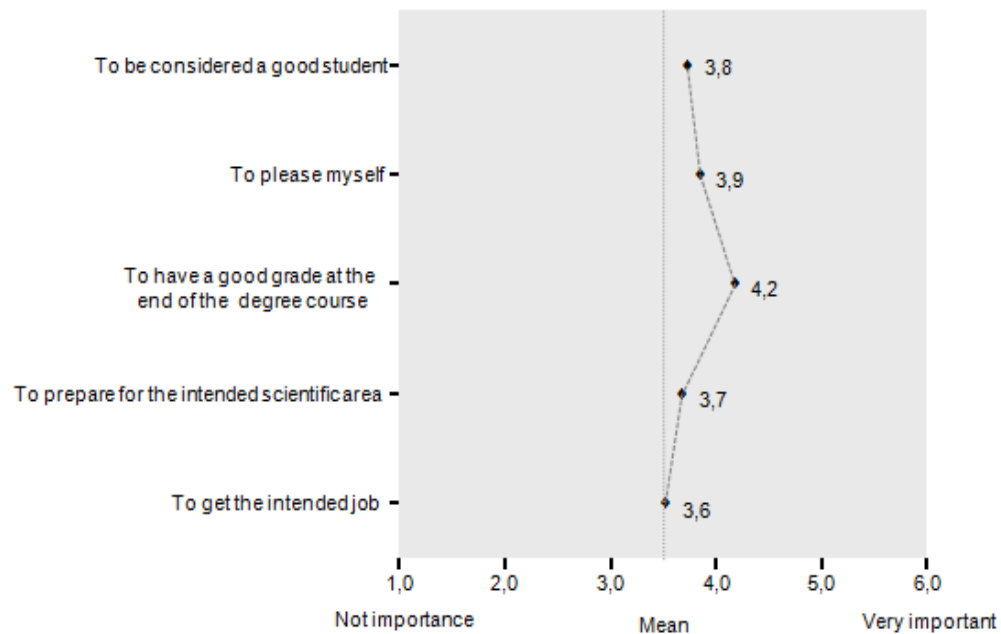
identification of distinct profiles

In order to identify patterns of representations of the QM among university students we conducted a Multiple Correspondence Analysis (MCA). To such end, we explored associations between multiples variables (Table 5), selecting two dimensions as structuring axes of the space of representations.

As we can see from the mapping shown in Graph 4, the variables that point to affective relationship with the QM contributed decisively to structure dimension 1, whereas the variables that stand out in dimension 2 are those related to the usefulness of the knowledges acquired in these disciplines. The results of the MCA indicate therefore that we are dealing with two dimensions quantitatively and substantially consistent.

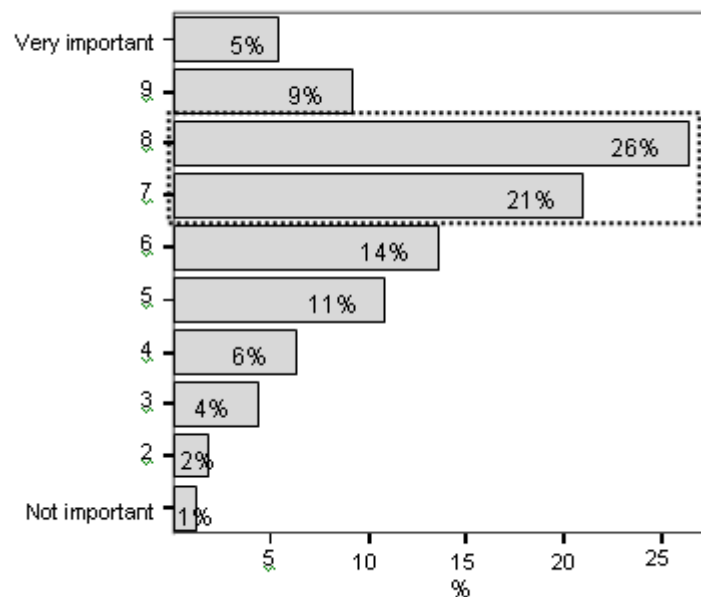
Analyzing the relative positions of the multiple categories in the various indicators in

Graph 2: Importance of a good result in the QM.



Source: QM in higher education, 2005.

Graph 3: Importance of QM for professional future.



Source: QM in higher education, 2005.

Table 5: Indicators for the definition of the representations of the QM.

Variables	Categories
Feelings towards the QM	Sympathy, obligation, interest, incomprehension, boredom, acceptance, necessity, challenge
Confidence with respect to the QM	Not confident, confident, very confident
Difficulty towards the QM	Not difficult, difficult, very difficult
Easiness towards the QM	Not at ease, at ease, totally at ease
Anguish towards the QM	Not anguished, anguished, very anguished
Level of knowledge of the QM	Good, average, bad
QM as essential tool for future job Importance of good grades in QM to get a job Importance of good grades in QM for the intended field of specialization Importance of having good grades in QM for a good average in the course Importance of having good grades in QM to please oneself Importance of having good grades in QM to be considered a good student	Not important, important, very important

Note: For purposes of MCA, indicators first measure in a 6 or 10 point scale were recode into a scale with less points.

Source: QM in higher education, 2005.

the two dimensions (Graph 5), we can capture the differentiation caused by each one of them. Thus, in dimension 1 we can emphasize the disposition of the feelings followed by the ordering of the level of knowledge of QM, in which the more negative feelings are associated to a poor self-evaluation of knowledges, in opposition to positive feelings and a good self-evaluation.

In dimension 2 we must note the opposition between the categories that point to a large importance of having good grades in the disciplines of QM to attain personal and professional objectives in the short and medium terms, and those that point to an average position or to not attributing importance to good results in these disciplines.

The combined analysis of the two dimensions allowed us to identify the topological configuration of the space of social representations of QM, and to observe different combinations, thereby indicating that we are dealing with a space in which distinct representations coexists. As the picture shows, we have essentially four configurations whose specificity derives from the articulation of feelings – positive in some cases and negative in others – with the importance attributed –

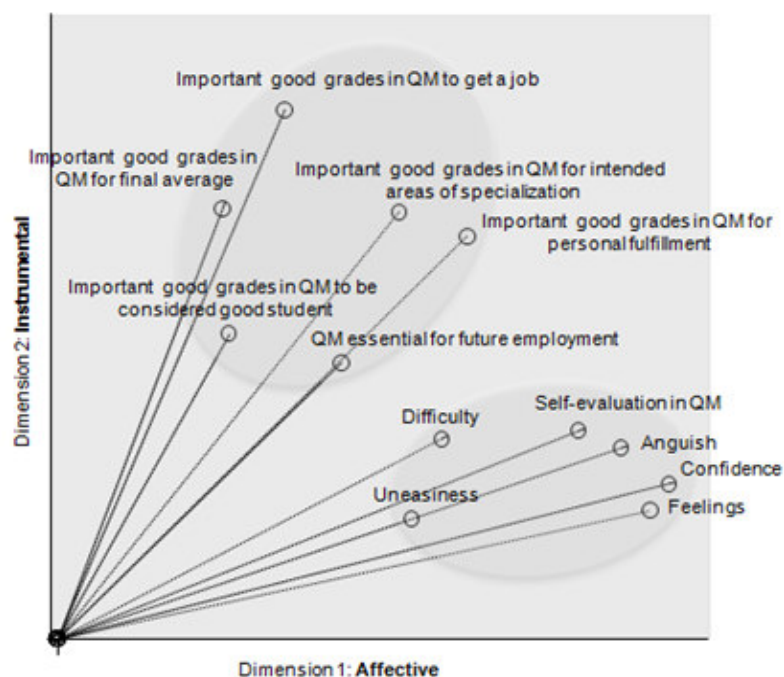
with higher or lower intensity – or even not attributed to the disciplines of QM.

We can see (1st quadrant) a privileged association between positive feelings – sympathy, challenge, and interest, with easiness, little anguish and little difficulty in these disciplines, also being worth noting the closeness with the category confident. In terms of the knowledge of QM we have a group with a high self-evaluation. With respect to the instrumental dimension, we observe the association with categories that point to the importance of quantitative methods to personal success and professional future.

In the neighborhood (2nd quadrant), but sharing negative feelings such as boredom, and relatively close to the feeling of obligation, we have another configuration. In this case, the results obtained in the QM are regarded as important neither for personal success nor for personal and professional future. This is clearly the pattern that reflects the strongest pessimism and disbelief.

Also marked by negative feelings, there is another group (3rd quadrant) for which the QM seem to generate much anguish, incomprehension, insecurity, and also great learning difficulty. This negativity is reinforced

Graph 4: Relationship between indicators (measures of discrimination).



Source: QM in higher education, 2005.

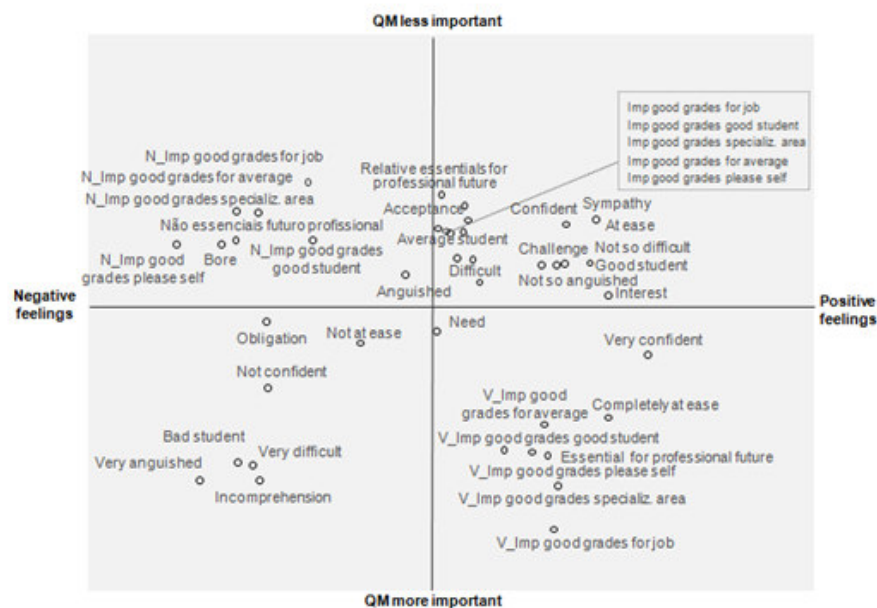
by the self-evaluation expressed by the individuals: they regard themselves as bad students. The negative feelings they nurture towards these disciplines notwithstanding, and with respect to the importance the latter have in the personal and professional formation, we can observe on the basis of their position regarding dimension 2 ($\text{dim } 2 < 0$) that we are dealing here with individuals that at the same time attribute them much importance.

One last group the combines positive feelings with the recognition of the high importance of the disciplines of QM in the acquisition of competences in the personal and professional spheres is defined in the 4th quadrant. We see here the clear articulation of the maximal usefulness with the positive representations of the QM. In this case, the disciplines of QM are characterized by their unleashing of feelings of easiness and security. In terms of self-evaluation their position indicates that this is a group of students that see themselves as good students.

It is therefore evident that the representations of university students in the present study are not intrinsically homogeneous. On the contrary, we found several configurations whose specificity ensues precisely from the articulation between the negative and positive feelings towards the disciplines of QM with the different levels of importance they can have in personal and professional success.

Beyond the presence of combinations that reflect a tendency to the existence of what we could call a linear positive relationship between the dimension of usefulness and the affective one, the results of the MCA also bring forth the presence of a combination in which negative feelings coexist with the recognition of the usefulness of the disciplines of QM. This means that even if it means smaller self-confidence, these students still recognize the usefulness of these disciplines. What is the profile of these and of other students that share the various patterns of representations is a question we also contemplated in our study.

Graph 5: Topological configuration in the space of representations.



Key: N_imp – Not important; Imp – Important; V_imp – Very important.
Source: QM in higher education, 2005.

Typology of the social representations of quantitative methods

Having identified in the MCA plane different configurations in the social representations of the disciplines of the QM, and before we analyze the profile of the students that share each type, we proceed to introduce the formalization of the typology. To such end, we conducted a Cluster Analysis taking as a reference the two structuring dimensions of the space of representations defined through the MCA.

Graph 6 depicts the projection of the four types⁶, making quite clear the correspondence between the topological configuration and the typology obtained insofar as the four types have in general a position almost at the center of the sub-clouds that represent each one of the four configurations of representations.

We thus find a group that we called the disbelievers because, in addition to nurturing

negative feelings towards these disciplines, they do not see in them any importance and are in this respect different from the pragmatics. In spite of sharing negative feelings, they are still aware of the fact that they have to learn and work with these disciplines because they are important to acquire some competences, particularly to the exercise of the profession.

With positive feelings we have the confident and the convinced students. The former are individuals confident of their knowledge, of the importance of these disciplines, and from this confidence also issues the easiness with which they deal with them. The convinced not only manifest positive feelings, but also attribute great importance to them. They definitely feel very confident about their success.

It is worth noting that from the four types of students interviewed at this university

6. The solution of four groups suggested by the observation of the MCA plane was confirmed by a Hierarchical Cluster Analysis, after which the final definition was made through the k-average method, thereby optimizing the partition into four groups (for more technical details see Carvalho, 2004).

Table 6: Differentiation factors of the types of representations of the QM (categorical regression).

Predictive variables	Beta	Semi-partial correlation	Relative importance (Pratt coefficient)
Gender	0.089*	0.086	0.105
Age	n.s.	0.005	-0.001
Mother's instruction	n.s.	-0.008	-0.001
Father's instruction	n.s.	-0.025	0.000
Course	0.272*	0.255	0.729
Year of course	0.129*	0.128	0.159
Shift	n.a.	-0.011	0.009
R ² adj.		0.109	F (19,1196) = 7.690**

Note: Beta – standardized regression coefficients; n. s. non significant

* $p < 0.01$ ** $p < 0.001$

Source: QM in higher education, 2005.

institution the types of representations more favorable to the disciplines of QM predominate. The confident and the convinced are preponderant (38.5% and 27.1%, respectively). Truth be said, and as active participants both of these students' learning processes and of the continuing restructuring of some of the disciplines of this scientific area, we should add that this favorable attitude derives to some extent from the efforts made to simultaneously defuse drama and enhance students' commitment.

Students' profiles in the space of representations of quantitative methods

Once the typology of social representations of the QM was defined, it became important to learn the student profile associated to each type. Were there determinant factors in the structuring of the different configurations of representations? The investigation developed in a non university context points specifically to the influence of students gender and age.

In order to do that we made a regression of the four types of representations in terms of variables more directly related to socio-demographic features of the students – such as gender, age, and parents' level of education – and of variables that contribute to the definition of their profile as students of that university institution – course attended, year in

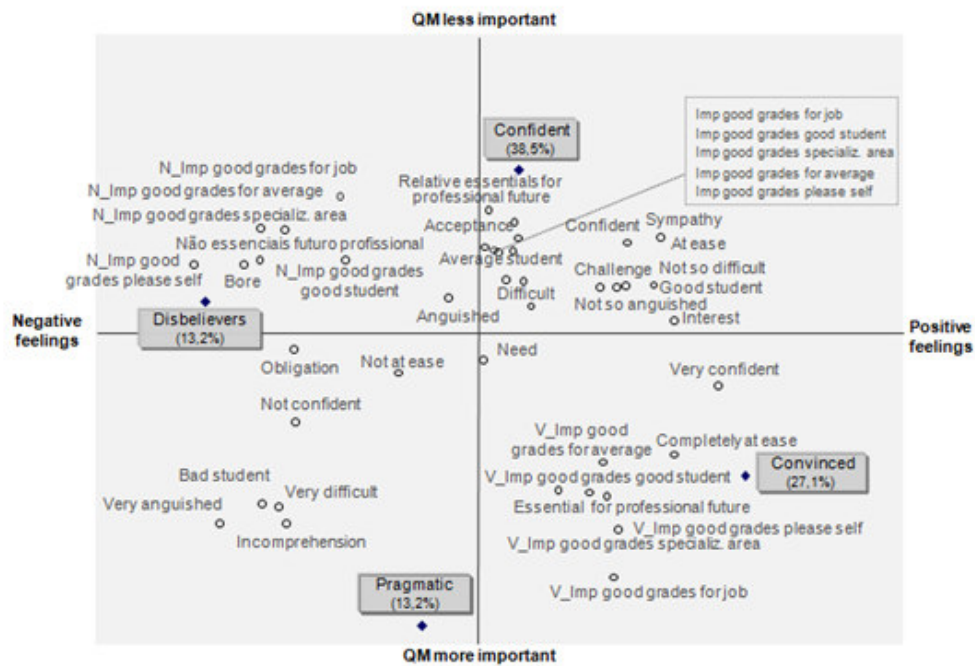
the course (at the time of the study) and shift. Categorical Regression (via optimal scaling) allowed us to conclude that only gender, year in the course and course attended have significant effect (Table 6), with the course attended being the factor with the highest relative importance (Pratt coefficient=0.729) to explain the variation of the types of representation of the QM (after transformation).

The idea that age is a factor of little importance (Fredrick; Mishler; Hogan, 1984; Walker; Plata, 2000) is therefore resumed in this university context which, given the presence of two shifts (day and night), is characterized by strong age diversity.

Once we have known the variables analytically pertinent to explain the variability of representations, we proceed to identify the determinant features of the students' profiles, and for that we conducted another MCA, this time with a supplementary projection of the variables that appeared as significant: gender, course, and year in the course (Graph 7).

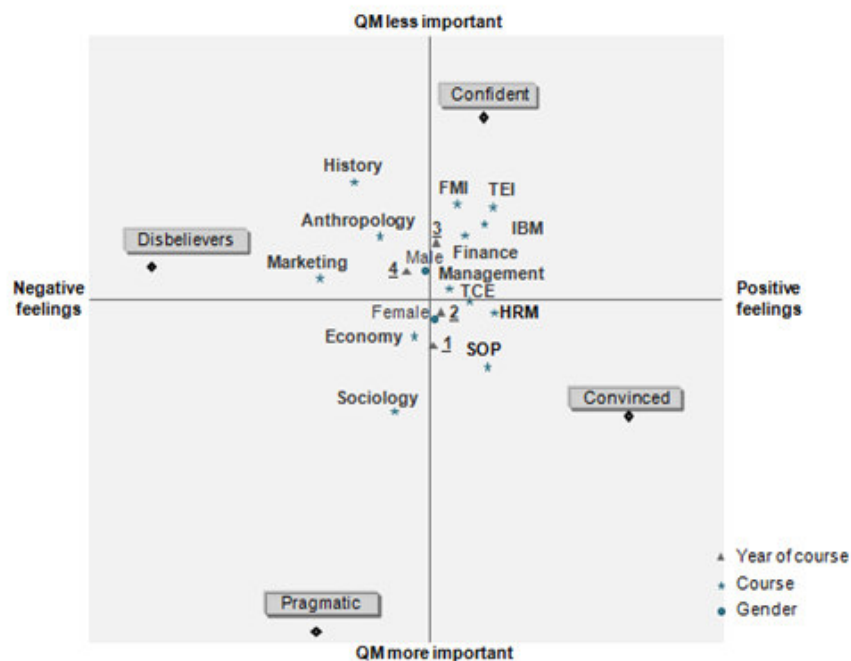
Gender has been pointed out throughout the years as a potential differentiating factor (Fennema; Sherman, 1978; Stage; Kloosterman, 1995; Kilpatrick; Silver, 2000; Fennema, 2000), either in terms of representations and at the level of the performance, where habitually female students tend to display less self-confidence and more negative representations, a trend that does not seem to obtain in the case of these university students.

Graph 6: Projection of types in the space of social representations of the QM.



Source: QM in higher education, 2005.

Graph 7: Students profiles in the space of social representations of the QM.



Source: QM in higher education, 2005.

As we can see in Graph 7, female students questioned in this study are more pragmatic and convinced. Their position with respect to the affective dimension – as is also the case of male students – reflects in this case the inexistence of association. Within this university context, we could therefore conclude for the untenability of the thesis that female students have lower self-esteem and more negative representations. If in the affective dimension the sharing of negative feelings versus positive feelings thus not distinguishes between genders, some differences shall be found between the profiles in the instrumentality of the QM disciplines. Those differences go along the lines of considering these disciplines as very important, both in achieving short term objectives, and in their professional future.

With respect to the year in the course, and despite the fact that, as it happens with gender, it is a factor of relatively small importance within the global variability (Pratt coefficient = 0.159), we can still see that students from the first two years, in particular, position themselves between the pragmatic and the convinced, whereas those more advanced in their courses (third and fourth years⁷) are among the disbelievers and the confident. The latter are those who have had up to that point more QM disciplines, a reason why their answers already show this knowledge of reality. While on the one hand we have self-confidence and confidence allied to the attribution of importance to these disciplines, on the other hand we observed those who have no expectations about the benefits these disciplines can (still) bring, where such disbelief is reinforced by the negativity of the feelings.

The course is the factor that within the present model appears to be quantitatively more influent (Pratt coefficient = 0.729) to explain the various types of representations in these university students. We can see by graph 7 that there are courses clearly associated with different representations, just as there are other

courses that are transversal to the majority of the types of representations. Sociology students are closer to the pragmatic. Our participative observation allows us to say that they tend to be students that, despite the fact that these disciplines are not the ones that most captivate them, are aware of their importance for their professional future. In spite of the level of difficulty they have, which leads them to repeat evaluations, their pragmatism does not falter.

In the same neighborhood we have the convinced, who come mainly from the course of Social and Organizational Psychology (SOP). They are effectively good students, and they are aware of that. They recognize these disciplines as playing a central role in their education, both for the recurrent use of competences – which they acquire by learning them – throughout the course, and for the importance they see in them to the exercise of their profession. Relatively close to the SOP students we find students from the Human Resources Management course (HRM).

We detected, associated to the confident students, a cluster including the courses of Finance, Management, and Industrial Engineering and Management (FMI), Computer Sciences and Management (IBM), and Telecommunications and Computer Engineering (TCE) that intersect the areas of Management and Information Technologies. These are courses in which the presence of QM disciplines is unquestionable, and students from these courses tend to deal with them without much pain. We should say that to gain access to these courses Mathematics is a mandatory discipline, something that to some extent makes students aware of the importance of this field of knowledge, causing them to share feelings such as challenge and interest, and even sympathy (recall the mapping shown in Graph 5).

The same thing does not occur with students from the Marketing course, which is

7. It should be noted that for this analysis fifth year students were not included, because they are in small number, which is explained by the fact that few courses have a five-year curriculum.

closer to the disbelievers. Many of these students, in addition to seeing the disciplines of QM as a bore, do not recognize in them any usefulness. History and Anthropology students also share (above all) the disbelief, but are still half way between disbelievers and confident. We could add, with respect to this relative ambivalence of representations shared by the History and Anthropology⁸ students, that it shows in the attitude they adopt as students, which impacts both in their learning and when we evaluate their performance.

With regard to the courses of Management, Economics, and Telecommunications and Computer Engineering we could say that students have an average profile, not being clearly associated to any one of the four types identified. In the context of this institution, these are, therefore, the more heterogeneous courses with respect to the representations they have of the QM disciplines.

From the analysis of the association of the course with the representations, we could systematize two aspects. There seems to exist a group culture (in this case, a course culture) in what concerns the sharing of representations, namely, of the QM. As shown before, and with the exception of Management, Economics, and Computer Engineering (as we have just mentioned), there are several courses in which a special association with a given type of representation can be observed, pointing to what we could call a superposition of a status quo.

However, when we move upwards in the hierarchy, in terms of the organization of the courses in scientific areas, it is also important to note that the three areas that run through this university institution – Social and Human Sciences (Sociology and Sociology and Planning, Social and Organizational Psychology, History and Anthropology), Management Sciences (Management, Human Resources Management, Management and Industrial Engineering, Finances, Economics and Marketing) and Sciences and Technologies of Information (IBM, TEI, and Telecommunica-

tions and Computer Engineering) follow the trend to multiplicity in sharing the representations. If belonging to a given course tends to reproduce the sharing of a certain type of representations, this dynamics does to prevail in the scientific area.

Conclusion

The combined analysis of the affective and instrumental dimensions allowed us to investigate the topological configuration of the space of social representations of the QM in a university context. It turned out to be a space marked by heterogeneity, in the sense that in it distinct representations coexist, and also by the prevalence of positive feelings.

The specificity of the different configurations of representations materializes in the articulation of feelings – negative in some cases, positive in others – with the levels of importance that students attribute to the disciplines of QM in what concerns the competences they acquire through them, and that they believe will contribute to their personal and professional success.

Although from the analysis of the patterns of representations it was clear that to in the university context we could also identify a “linear trend” in the relationship between the affective dimension and that of usefulness (that is to say, that to higher levels of the perception of the usefulness of these disciplines correspond higher levels of self-confidence and enjoyment of these subjects), the articulation between these two dimensions is not restricted to that. There is, in addition to this scenario, and still on the basis of the MCA results, a different configuration of representations, in which negative feelings coexist with the recognition of the usefulness of the disciplines of QM. This means that lower levels of self-confidence and enjoyment of these subjects

8. It should be noted that these two courses are the ones with the smallest number of disciplines from this area: only two at the time of the application of the questionnaire.

can indeed be also associated to high levels of perceived usefulness.

From the factors available to characterize the profiles of the students that share such distinct representations, we concluded that, in what concerns their insertion in the academic space, the most important were the course attended and the year of the course. For a more socio-demographic characterization of the students, gender was the only factor that appeared as significant.

With respect to the influence of this variable, the data revealed that both genders have the same position regarding the affective dimension. This made us conclude for the untenability of the thesis that points (at least in a non-university context) to the feminization of the lack of self-esteem and self-confidence in their abilities to deal with disciplines from this scientific area. What can also be concluded, and hence the significant influence, is that female

students present greater awareness in the sense of attributing higher levels of importance to the success in these disciplines and its return in terms of personal and professional future.

Lastly, and concerning the influence (the most significant one) of the course, we can lay down two conclusions. The evidence for what we called a course culture. As observed, courses tend in their vast majority to reflect a predominant pattern of representations of QM. It appears to be possible to conclude that the socialization among peers feeds the tendency for a more homogeneous culture regarding the representations of the QM. When we move to the observation at the level of the scientific area, it becomes clear the transversality of the patterns of representations, evidencing that the wider the amplitude of the scientific area, the more apparent the heterogeneity of the representations becomes, with the case of Social and Human Sciences being the most emblematic of them all.

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