

# A Fuzzy Measure of Satisfaction for University Education as a Key for Employment<sup>1</sup>

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**Summary:** In this paper, we propose a fuzzy approach to measure the degree of satisfaction of graduates on the suitability of university education for working purposes. The indicators proposed come from two factors: the importance attributed to six aspects of university education and the quality of the service perceived by graduates. We use these indices to evaluate the first results of a telephone survey on a sample group of graduates at the University of Foggia. Using factor analysis, we show that all the aspects of university education can be summarised in just one dimension.

**Keywords:** Fuzzy indicators, Customer satisfaction, Graduates, University of Foggia.

## 1. Introduction

The evaluation of *customer satisfaction* implies the collection of one or more marks allotted to a service by its users. The allotment of these scores requires subjective evaluations, which may be thought of as values on an ideal continuum and may be suitably summarised.

In this paper, we propose a *fuzzy* method to measure the satisfaction of graduates for their university education in terms of preparation for the labour market. Thus, we evaluate *ex post* the university education in order to improve the formative offer according to labour market needs.

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<sup>1</sup> This paper is the result of the joint research of the two authors. C. Crocetta was responsible for the final editing of Sections from 1 to 4, 6 and 7, whereas G. Delvecchio was responsible for Sections 3 and 5.

Indeed, the didactic autonomy of universities imposes serious thoughts about the objectives and contents of the educational pathways through which the competences develop.

## 2. The survey

The University of Foggia has recently started the monitoring of placement and satisfaction of its graduates with respect to the effectiveness of the education received for preparing their insertion into work.

We will use the database formed through the integration of the data available in the archives of Student secretariat of the University of Foggia and that obtained from an *ad hoc* telephone survey.

Because of some difficulties in interviewing graduates by telephone (some of them graduated seven years before), we had to undergo some limitations in the data collection design. The initial purpose was to contact all graduates of the University of Foggia. We made up to seven attempts to contact the students at different hours before considering them unreachable. We carried out the 2,133 interviews from April 28th to May 26<sup>th</sup>, 2003. The percentage of completed interviews reached the 72.9% of the eligible population.

The questionnaire is composed of four parts: the first one is dedicated to graduates who worked before graduation, the second to those who are still seeking employment, the third to current or past professional experiences and the last to graduate satisfaction with services received, considering both the job searching and professional experiences.

In this paper, we will focus on the evaluation of graduate satisfaction with respect to the services received.

In order to measure the importance that each person assigns to the different aspects of university education and the quality of the teaching offered by each faculty, the interviewees were asked to give a score from 0 to 100 to both, importance and quality of service, with respect to the following aspects:

- basic teaching,
- specialist teaching,
- practical activity (practice, laboratories, job placement, etc.),
- use of equipment for improving expertise and research,
- *forma mentis*,
- methods and techniques learned during the course.

The answers to this part of the questionnaire required particular commitment from the interviewees because many interviewees found it difficult to answer the questions properly and required the interviewer to explain the exact meaning of questions. We chose a 0-100 scale in order to have a wide range of scores, thus providing greater accuracy without using decimal numbers.

It is not possible to carry out mathematical operations between values assigned to the importance and the quality to obtain a satisfaction index, because they are inconsistent between themselves and with satisfaction. For this reason, to summarise the two (quality and importance) scores, it is inappropriate to use the arithmetic mean. In the following (Section 3), we propose to estimate this value with a model-free fuzzy approach.

### 3. The fuzzy approach

In order to identify a fuzzy system it is to be chosen (Dubois & Prade, 1980; Bualoti *et al.*, 1999; Delvecchio, 2002):

- the type of system, and the way to activate fuzzy subsets (see Section 3.1),
- the *memberships* associated to the measures entering the system (Section 3.2),
- the *memberships* associated to the measures leaving the system (Section 3.3),
- the input-output association rules (Section 3.4),
- the type of defuzzifier (Section 3.5).

#### 3.1 The fuzzy system used

In the fuzzy logic, the units (importance attributed, quality perceived and index of satisfaction with respect to six aspects of university education) are divided into fuzzy subsets.

We will indicate a low importance subset with  $\mathbf{IA}_L$ , a medium with  $\mathbf{IA}_M$ , a high with  $\mathbf{IA}_H$ , and a very high one with  $\mathbf{IA}_{VH}$ . The analogous subsets associated to the perceived quality is denoted with  $\mathbf{Q}_L$ ,  $\mathbf{Q}_M$ ,  $\mathbf{Q}_H$ ,  $\mathbf{Q}_{VH}$ , and those associated to the index of satisfaction with *ten* subsets  $\mathbf{I}_1$ ,  $\mathbf{I}_2$ , ...,  $\mathbf{I}_{10}$ . Our fuzzy system is based on a method of fuzzy inference known as “Mamdani”<sup>2</sup>. The basic idea is to incorporate the experience of the researcher who designs the system<sup>3</sup>.

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<sup>2</sup> The main methods of fuzzy inference are those of Mamdani and Sugeno. The former (Mamdani & Assilian, 1975) is the most popular: it has the advantages of being intuitive and adaptable to human inputs. The latter (Sugeno, 1985) can be used to model any inference system in which the membership functions in output are linear or constant: it has the advantages of being computationally efficient, of working well with linear techniques or techniques of optimisation and adaptation, and of adapting well to mathematical analysis.

<sup>3</sup> «Fuzzy systems allow us to construct systems in the ordinary language. To supply some fuzzy systems the common sense contained in the heads and maybe in the language of Cro-Magnon and Neanderthal man was sufficient» (Kosko, 1995).

We have to establish the membership functions and the matrices of rules: i.e. the matrices that associate the value of the index (Section 3.4) to a particular combination of importance and quality. From a set of linguistic rules that describe the system, we obtain an algorithm (i.e. a system of fuzzy rules) whose words are defined as *fuzzy sets*.

The main advantages of this approach are the possibility of making feasible the knowledge based on empirical rules and on intuition, and also that of not requiring a process model (Kosko, 1995).

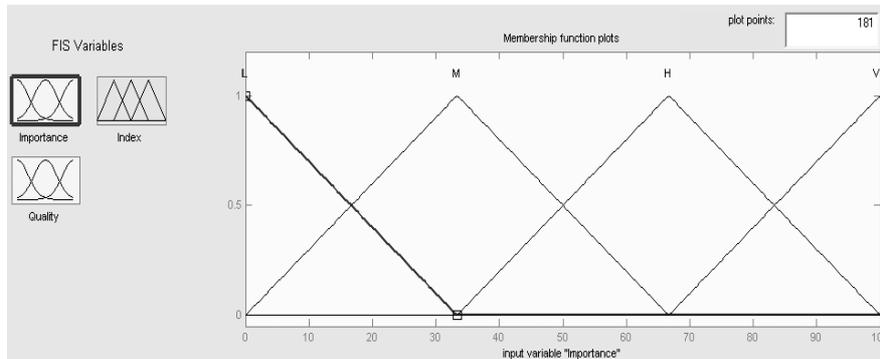
We applied the *correlation minimum encoding rule*, i.e., the fuzzy subset  $A'$  of a general fuzzy set  $A$ , activated by a determined value  $x_0$  of the non fuzzy variable  $x$ , is obtained from  $H$  by cutting the upper part at  $\mu_H(x_0)$ , where  $\mu_H(x)$  is the *membership function* of the input data associated to  $H$  (Kosko, 1992).

### 3.2 Memberships associated to the data entering the system

To define the functions that describe the degree of membership of input data to the fuzzy subsets we chose – for the sake of simplicity – triangular functions distributed in  $[0, 100]$ .

In Figure 1, we visualise the *memberships* associated to importance. The ‘low’ fuzzy subset is associated to the membership constituted by the triangle of vertices  $(0, 0)$ ,  $(0, 1)$ ,  $(33.3, 0)$ ; the ‘medium’ one is associated to the membership made up of the triangle of vertices  $(0,0)$ ,  $(33.3, 1)$ ,  $(66.6, 0)$ , and so on<sup>4</sup>.

The quality issue is represented with similar memberships.



**Figure 1.** Representation of memberships associated to educational importance in our fuzzy system, as visualised in the implemented software.

<sup>4</sup> The elements are not attributed to an ordinal class, because each element will belong to the four *fuzzy* subsets at the same time, but with a different degree of membership.

### 3.3 Memberships associated to data leaving the system

In Figure 2, we represent the memberships and their visualisation associated to the index of satisfaction (Mathworks, 1999). In this case, too, we decided to use the triangular type of membership for each of the ten *fuzzy* classes.

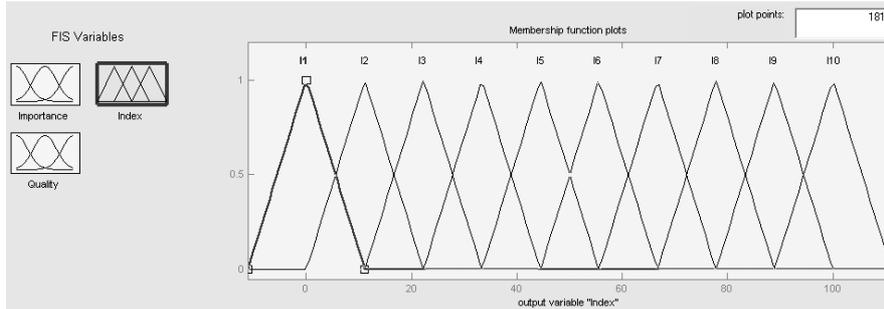


Figure 2. Representation of memberships associated to the index

### 3.4 Rules of input/output association

In the fuzzy approach, even the input/output rules of association are based on the operator’s experience. For instance, in the case of a risk deriving from two concurring sources, a popular model is multiplicative: i.e. the total risk equals to the product of the risks of the two components (Fiorentini & Romano, 1995; Delvecchio, 2002).

However, the rules for the definition of importance and the quality of the labour market and to the education received from the university cannot be mathematical, but psychological. To define the rules, we used the opinion of a group of experts composed of a job psychologist, an anthropologist and two social statisticians<sup>5</sup> who agreed on the following criteria (Table 1):

Table 1. Matrix of rules constructed with expert opinions.

Perceived quality	Attributed importance			
	$IA_L$	$IA_M$	$IA_H$	$IA_{VH}$
$Q_L$	$I_4$	$I_3$	$I_2$	$I_1$
$Q_M$	$I_4$	$I_4$	$I_5$	$I_5$
$Q_H$	$I_4$	$I_5$	$I_7$	$I_8$
$Q_{VH}$	$I_4$	$I_6$	$I_9$	$I_{10}$

<sup>5</sup> We express our thanks to professors Amelia De Lucia; Francesco Delvecchio, Giancarlo Tanucci and Ernesto Toma who collaborated to define the rules.

- the scores given to the importance of the aspects of the university education are independent of those assigned to the perception of quality;
- satisfaction is maximum when the highest level is attributed both to importance and quality;
- the bottom of satisfaction is when the quality is at the lowest level and the importance given to this aspect is highest;
- the satisfaction cannot decrease if the perceived quality increases, whatever the importance attributed.

### 3.5 The defuzzifier

The method chosen for defuzzifying (Cammarata, 1994) assumes as output the abscissa of the barycentre of the area subtended by the function that describes the fuzzy set output (the method is thus named *centroid*<sup>6</sup>).

In Figure 3, we describe an example of activation of rules relative to an aspect of university education, whose importance score is 10, quality score is 80, and satisfaction index is 41.9. Each row reports the three memberships (importance, quality, index of satisfaction) of the 16 rules described in Table 2. At the bottom right (under the sixteenth rule in the third column of the index of satisfaction) there is the output subset (obtained by “consolidating” the subsets in the third column, and outputting 16 rules), and the value of the index (the abscissa of the barycentre of the subtended area).

Let us consider, for instance, rule n. 7: if the importance is medium and the quality is high, then the index is  $I_5$ . The seventh row of Figure 3 shows diagrams of the three triangular memberships of medium importance, of high quality and of index  $I_5$ . The values in abscissa 10 and 80, by “activating” the subsets, determine the cutting of those triangular membership functions, thus generating some trapezoidal memberships (first and second diagram). The memberships of the output subset (third diagram) is obtained by cutting the respective triangular function of the  $I_5$  index near the lower height of the previous two trapezoidal memberships that regard importance and quality (rule of *correlation minimum encoding*, see Section 3.1).

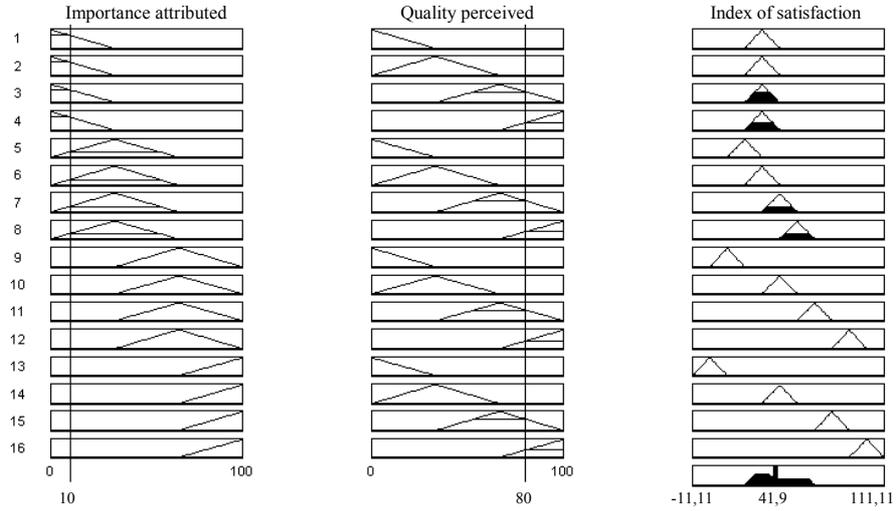
The global satisfaction index is the arithmetical mean of the *fuzzy* indices derived for the six aspects of university education analysed.

In Figure 4, we show how the index of satisfaction constructed with our fuzzy technique is connected to importance and the perceived quality. The relationship is not linear and when the perceived quality is low, the index of sat-

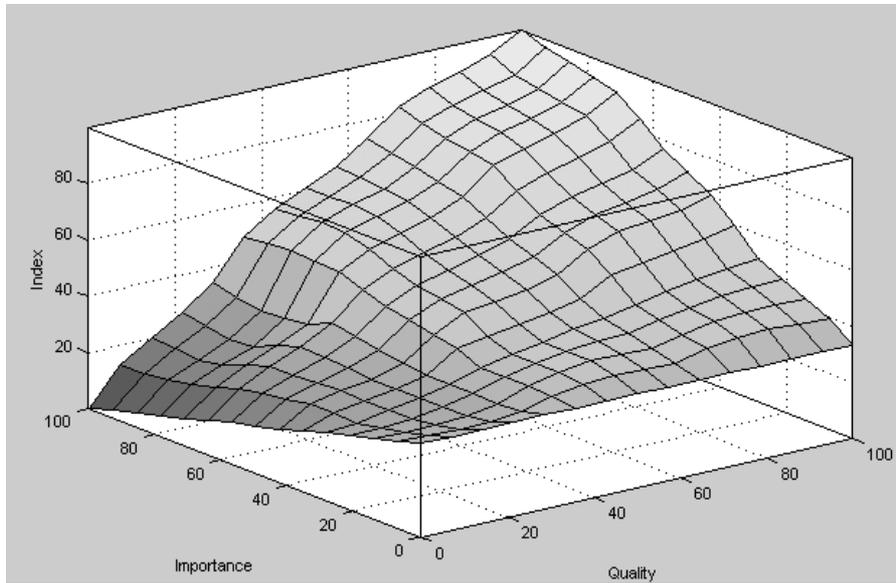
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<sup>6</sup> This method (which must not be confused with the cluster analysis one), is popular because it does not fail with several maxima or a maximum limit, and it considers the information of the output set (Cammarata, 1994; Kosko, 1995). According to Kosko, in the FAM (Fuzzy Associative Memory) technique, this method is appropriate because «we feel or perceive the centre of mass».

isfaction decreases with increases of importance; however, when quality is high, the index increases with increases of importance.



**Figure 3.** Example of activation of the rules in a fuzzy scheme (the score of the importance is 10, see the abscissa of the first column, and the perceived quality is 80, see the abscissa for the second column).



**Figure 4.** Representation of the index of satisfaction, obtained with fuzzy rules, according to the importance attributed and the quality perceived

**Table 2.** Average (M) and coefficient of variation (CV) of the scores assigned to importance, quality and index of satisfaction

Aspects of university education	Importance attributed		Quality perceived		Index of satisfaction	
	M	CV	M	CV	M	CV
1. Basic teaching	75.4	27.3	64.0	31.6	66.8	27.7
2. Specialised teachings	73.1	30.5	61.1	35.8	64.0	30.9
3. Practical activities (practice, labs, job placement)	76.5	34.8	49.2	53.8	53.8	44.5
4. Use of equipment for expertise & research	74.5	35.9	47.6	54.8	52.8	44.6
5. Forma mentis	77.8	26.5	67.4	32.5	69.9	28.9
6. Methods and techniques	72.6	30.5	58.3	37.3	61.5	32.3
Global index of satisfaction					62.9	24.2

For low values of importance, satisfaction does not change with changes of quality, whereas when importance is high, satisfaction increases rapidly with the increase of quality perception.

#### 4. Index of satisfaction

Following the methodology described above, we computed – for each respondent – six indices of satisfaction for the university education. In Table 2, we show the means and the coefficients of variation of the six aspects.

On average, the importance of the different aspects rated higher than the perceived quality. The global index of satisfaction indicates that graduates are reasonably satisfied (62.9).

The interviewees attribute great importance to *forma mentis*, practical activity and basic teaching. This opinion is popular among researchers, considering the fact that the coefficients of variation of the fifth and first aspect are significantly lower than the others. The index of satisfaction regarding practical activity, however, shows a great variability.

Therefore, according to the interviewees, the university should give basic knowledge and integrate it with practical activities (such as internship, labs, and job placement) in order to prepare graduates to face the problems of working life. In general, graduates at Foggia University prefer less specialised courses.

The relations between the scores attributed to importance and to the perceived quality, for the six aspects, are evident in the correlation matrices (Table 3). All the values of these matrices are positive, and this indicates that there is a general agreement between all the variables. The only exceptions are practical activities and use of equipment for which there is a stronger linear relation both as regards to the importance attributed ( $r=0.75$ ) and the perceived quality ( $r=0.69$ ).

**Table 3.** Correlation matrices between the scores regarding the importance attributed and the quality perceived for six aspects of university education.

<i>Importance attributed to the aspects of university education</i>	Aspects					
	1	2	3	4	5	6
1. Basic teaching	1.00	0.52	0.31	0.29	0.43	0.43
2. Specialised teachings		1.00	0.48	0.45	0.45	0.50
3. Practical activities			1.00	0.75	0.48	0.55
4. Use of equipment				1.00	0.51	0.56
5. Forma mentis					1.00	0.63
6. Methods and techniques						1.00

<i>Quality perceived attributed to the aspects of the education</i>	Aspects					
	1	2	3	4	5	6
1. Basic teaching	1.00	0.55	0.34	0.27	0.38	0.41
2. Specialised teachings		1.00	0.48	0.38	0.39	0.47
3. Practical activities			1.00	0.69	0.34	0.48
4. Use of equipment				1.00	0.32	0.45
5. Forma mentis					1.00	0.54
6. Methods and techniques						1.00

**Table 4.** Correlation and partial correlation coefficients between the scores regarding the importance attributed, quality perceived and index of satisfaction.

Aspects of the university education	Correlation coefficients between			Partial correlation coefficients between	
	importance and quality	importance and satisf. index	quality and satisf. index	Importance and satisfaction index   quality	Quality and satisf. index   importance
1. Basic teaching	0.46	0.67	0.94	0.78	0.96
2. Specialised teaching	0.46	0.61	0.95	0.63	0.95
3. Practical activity	0.34	0.41	0.97	0.33	0.96
4. Use of equipment	0.35	0.39	0.97	0.21	0.96
5. Forma mentis	0.51	0.63	0.97	0.64	0.97
6. Methods& techniques	0.39	0.53	0.96	0.59	0.96

Let us now verify if there is a relation between satisfaction index, importance attributed and perceived quality (Table 4).

The correlation coefficients between attributed importance and perceived quality for the different aspects vary between 0.34 and 0.51. The most correlated are those regarding the *forma mentis* and the basic and specialised subjects. The correlation between importance and quality for practical activities, use of equipment and methodology taught is less intense.



and a similar agreement exists between the use of equipments for providing expertise and practical activities.

The link between the fundamental aspects of education, such as *formamentis* and basic teaching, with practical activity and the use of equipment is rather weak. Instead, the satisfaction index is positively correlated with all the educational aspects.

## 5. Graduate satisfaction

Because the University of Foggia was only recently established, it seemed appropriate to investigate whether the indices of satisfaction vary according to study course, year of degree achievement, graduation mark, and employment position (Tables 6 and 7).

**Table 6.** Average scores of the importance attributed to six aspects of university education, by faculty, year of graduation, final graduation mark and current working position.

<i>Faculty, year at grad., classes of grade and working position</i>	<i>Aspects of university education</i>					
	Basic teaching	Specialist teaching	Practical activity	Use of equipment	Formamentis	Methods & techniques
<i>Faculty</i>						
Agriculture	81.3	80.8	79.4	79.0	82.2	79.1
Economics	74.7	73.2	73.6	71.2	76.9	72.1
Law	75.2	71.8	77.0	75.7	77.5	71.6
Medicine and Surgery	75.9	78.2	85.3	78.9	84.1	79.3
<i>Solar year at graduation</i>						
Until 1995	79.2	74.1	83.4	88.8	87.3	79.4
1996	79.0	76.0	78.0	70.0	81.0	75.0
1997	78.0	75.0	79.0	76.0	81.0	74.0
1998	79.0	75.0	80.0	76.0	82.0	77.0
1999	78.0	76.0	77.0	76.0	80.0	75.0
2000	75.0	73.0	75.0	75.0	77.0	73.0
2001	75.0	72.0	74.0	74.0	76.0	71.0
2002	74.0	73.0	78.0	75.0	76.0	70.0
2003	69.0	66.0	69.0	66.0	72.0	70.0
<i>Final graduation mark</i>						
66 – 99	66.6	64.7	66.7	64.8	69.6	64.7
100 – 105	75.3	73.3	75.2	72.1	77.2	72.3
106 - 110 L	79.3	75.8	78.7	76.6	81.1	74.9
<i>Current working position</i>						
Employed	78.6	75.3	76.5	75.0	79.8	73.9
Not employed	72.3	71.0	76.4	74.1	75.9	71.3
University of Foggia	75.4	73.1	76.5	74.5	77.8	72.6

**Table 7.** Average scores of the quality attributed to six aspects of university education, by faculty, year of graduation, final graduation mark and current work position.

Faculty, year of grad., classes of grade and working position	Aspects of the formation at university					
	Basic teaching	Specialist teaching	Practical activity	Use of equipment	Forma mentis	Methods & techniques
<i>Faculty</i>						
Agriculture	68.2	66.0	53.1	49.9	67.2	62.0
Economics	63.6	59.8	47.5	45.0	67.3	59.0
Law	63.8	61.2	50.2	50.3	67.4	57.5
Medicine and Surgery	65.2	64.5	49.7	44.6	68.7	57.9
<i>Solar year at graduation</i>						
Until 1995	75.7	67.2	54.8	56.5	76.7	65.2
1996	64.1	62.2	55.2	45.6	66.7	59.0
1997	62.8	61.2	49.8	47.3	67.2	57.0
1998	66.0	59.7	50.2	47.4	70.7	58.4
1999	66.1	60.4	49.5	49.9	68.7	59.1
2000	63.6	60.6	47.2	47.9	68.0	59.0
2001	63.9	61.3	49.0	49.1	65.9	57.4
2002	62.3	61.7	47.5	45.1	65.3	56.7
2003	62.1	61.2	51.8	45.9	67.2	61.3
<i>Final graduation mark</i>						
66 – 99	61.6	59.2	48.1	49.2	66.3	58.3
100 – 105	63.5	60.4	48.3	46.2	66.9	57.7
106 - 110 L	67.9	64.2	51.2	47.6	69.5	59.2
<i>Current working position</i>						
Employed	65.4	61.6	49.5	47.8	68.5	59.2
Not employed	62.6	60.7	48.9	47.4	66.3	57.4
University of Foggia	64.0	61.1	49.2	47.6	67.4	58.3

It is evident that the opinions of graduates about the importance they attribute to education always exceed the quality they feel with it. In particular, the difference between those opinions (attributed importance and perceived quality) is generally greater for the aspects regarding the use of equipment and practical activity but lower for basic and specialist teaching.

Table 8 shows an overall positive opinion (provided by the global satisfaction index *I*) for all the faculties. The most satisfied graduates seem to be those of the Agriculture Faculty, whereas those of the other faculties are slightly more critical. Obviously, the judgement expressed for the aspects of university education varies according to faculty: for graduates in Agriculture the highest satisfaction level refers to basic teaching, whereas for graduates in Medicine and Surgery, Law and Economics the most important aspect is *forma mentis*.

Graduates of almost all the faculties are unsatisfied with their practical training and expertise for the labour market, thus requesting a greater commitment of the University management to take care of it.

**Table 8.** Indices of satisfaction regarding the 6 aspects of university education considered and index of global satisfaction, by faculty, year of graduation, working position and final graduation grade.

<i>Faculty, year of grad., classes of grade and working position</i>	<i>Indices of satisfaction</i>						
	<i>I1</i> Basic teaching	<i>I2</i> Specialised teaching	<i>I3</i> Practical activities	<i>I4</i> Use of equipment	<i>I5</i> Forma mentis	<i>I6</i> Methods & techn.	<i>I</i> Global index
<i>Faculties</i>							
Agriculture	72.2	70.0	58.5	55.3	71.2	67.0	65.7
Economics	66.5	63.0	52.1	50.3	69.7	62.5	62.7
Law	66.5	63.7	54.2	55.3	69.7	60.2	62.9
Medicine and Surgery	68.0	68.4	55.4	50.5	71.5	62.0	62.7
<i>Year of Graduation</i>							
Up to 1995	76.3	70.2	56.2	59.4	79.9	68.0	69.5
1996	67.8	64.8	59.6	51.3	71.0	61.7	63.0
1997	66.7	64.8	54.3	53.3	70.8	61.7	63.9
1998	68.9	63.6	55.6	53.4	73.4	62.6	64.4
1999	69.2	64.1	54.5	55.1	71.3	62.5	64.3
2000	66.6	63.4	52.8	53.2	70.0	61.6	62.8
2001	66.8	64.2	53.2	54.4	68.6	60.8	62.6
2002	64.9	64.3	52.0	50.1	67.8	59.6	61.4
2003	63.6	61.8	54.2	49.4	68.1	62.7	61.5
<i>Final graduation grade</i>							
66 - 99	63.7	61.7	52.4	54.2	68.2	60.4	61.6
100 - 105	66.5	63.3	53.1	51.6	69.5	60.9	62.6
106 - 110 L	71.0	67.3	55.7	52.6	72.2	63.3	65.0
<i>Curr. working position</i>							
Employed	69.0	64.9	54.1	53.2	71.3	62.7	64.0
Not Employed	64.8	63.1	53.5	52.4	68.5	60.3	61.9
University of Foggia	66.8	64.0	53.8	52.8	69.9	61.5	62.9

In Table 8, by observing the distribution of the *satisfaction indices* as regards year of graduation, some interesting regularity and some even more eloquent peculiarities can be observed.

We have to specify that some people who graduated at Foggia University in first years after its foundation transferred from other universities, and had the opportunity of using equipment and the organisation of other long established universities. The unexpected positive opinions expressed by these graduates on various aspects of university education can be easily understood. In the first years, the family-like environment resulting from the small number of students and the relaxed relation with lecturers may have positively influenced the students.

The global satisfaction index assumes higher values for graduates of the first years and decreases during the last ones. The less theoretical aspects of

university education (*use of equipment and practical activity*) always differ from the others. However, considering the evolution of these scores in time, it is inevitable to ask why the significant investments made to equip the young University of Foggia with adequate structures did not affect the evaluation of those who graduated in the last years.

Of course, as the refreshers increased the intrinsic validity of the teaching and the presence of adequate structures increased their importance, graduates became more demanding, and evaluative scores lowered. The evaluation was good until the University obtained its independence from the University of Bari in 1999.

The final graduation marks had also influenced the students' opinions: those who have achieved a better university education were more positively oriented on all aspects, the only exception being training on the use of equipment. This confirms that the lower the opportunity of using university resources, the lower the educational performances.

The only aspects that even graduates with the best marks evaluate insufficiently are those regarding practical activity and use of equipment.

Finally, employed graduates express more positive opinions than the unemployed ones on all the aspects of University education. Also between these two categories, there is little discrepancy of evaluation regarding practical activities and use of equipment.

## 6. Factor analysis

By comparing the different indices of satisfaction, it emerges the existence of a latent structure influencing the different aspects considered.

To make this structure clear and minimise the number of evaluative dimensions, we applied a factor analysis on the index scores. Since there is only one eigenvalue greater than 1, we decided to retain the first factor alone, which explains 58.3% of the variability. In Table 9, we present the standardised factor loads and the communalities of each index of satisfaction, by faculty.

From the factor load analysis (Fabbris, 1997), we can see that practical aspects are juxtaposed to theoretical-methodological ones, and name the factorial axis *theory vs practice*.

The factorial loads of the Athenaeum all exceed 0.5 and are distributed in an almost uniform manner.

We can conclude that the university education quality, evaluated by the satisfaction indices, lead back to a single latent factor spanning from practical to the theoretical-speculative aspects.

Indeed, the factorial loadings regarding the faculties undergo only slight variations compared to the one obtained for the whole Athenaeum. The presence of a *theory-practice* factor is evident for all the faculties.

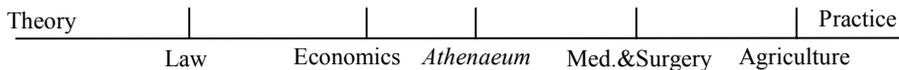
**Table 9.** Factor loadings and communalities of the satisfaction indices regarding university education, by faculty.

Aspects of university education	Faculties				University of Foggia
	Agriculture	Economics	Law	Medicine & surgery	
	Factor loadings				
1. Basic teaching	0.60	0.64	0.65	0.69	0.65
2. Specialist teaching	0.57	0.74	0.73	0.76	0.73
3. Practical activities	0.77	0.73	0.75	0.86	0.76
4. Use of equipment	0.73	0.66	0.71	0.80	0.70
5. <i>Forma mentis</i>	0.56	0.64	0.71	0.72	0.68
6. Methods & techniques	0.79	0.73	0.80	0.84	0.78
	Communalities				
1. Basic teaching	0.36	0.41	0.42	0.48	0.42
2. Specialist teaching	0.33	0.55	0.53	0.57	0.53
3. Practical activities	0.59	0.53	0.57	0.73	0.57
4. Use of equipment	0.53	0.44	0.51	0.64	0.49
5. <i>Forma mentis</i>	0.32	0.41	0.51	0.52	0.47
6. Methods & techniques	0.63	0.54	0.64	0.70	0.61

Nevertheless, some specifications are needed. For graduates in Agriculture there is a clear cut between theoretical aspects and practical ones and, in this case, the index of satisfaction regarding *forma mentis* has a lower factorial weight than the one regarding basic teaching.

For graduates in Economics, the factorial loads regarding specialist teaching assume an apparently anomalous position. Those related to the indices regarding methods and techniques, practical activities and specialist teaching almost coincide. This is reasonable if we consider that in this faculty, practical activities concern almost exclusively the specialist teaching.

The factor loads make it possible to position each faculty and the entire Athenaeum along a continuum (Figure 5). Even if the deviations are small, indicating a basic homogeneity between the considered faculties, we can see that the graduates in Law and Agriculture are at the extremes of the axis. We can conclude that the satisfaction of graduates in Agriculture is more influenced by their opinion on practical activities than it is for Law graduates.



**Figure 5.** Factorial weights regarding the theory-practice factor

## 7. Conclusions

Thanks to the *fuzzy* approach, we have summarised in a single index the scores attributed by the University of Foggia graduates on the importance and quality of education for employment and career purposes.

The index depends on the *fuzzy* rules provided by experts and thus has a high degree of subjectivity. Subjectivity is both the strength and weakness of the fuzzy method because, on the one hand, it allows the solution of complex problems with incomplete information, but, on the other, it does not guarantee objectivity of the results obtained.

Although fuzzy techniques have shown enormous progress in the last few years, applications in the field of customer satisfaction are few and there is a lack of specific methodological suggestions for this kind of application.

Our analysis has also pointed out that graduates express positive opinions on the quality of the education received, although there are some critical points.

The lowest graduate satisfaction was for the following aspects: use of equipment for specialisation and research, and practical activities (practical exercises, labs, work placement, etc.). The lack of space and adequate structures for research depend on the recent establishment of the Athenaeum. We hope these problems can be solved in the next few years.

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