

Collaborative learning in the teaching of statistics in psychology: An alternative to traditional teaching

Joan Guàrdia-Olmos¹, Montserrat Freixa-Blanxart², Jaume Turbany-Oset³,
Maribel Però-Cebollero⁴

Dept. de Metodologia de les Ciències del Comportament, Facultat de Psicologia.
Universitat de Barcelona. Barcelona, Spain. ¹Corresponding author. E-mails:
jguardia@ub.edu, montsefreixa@ub.edu, jturbany@ub.edu, mpero@ub.edu.

Abstract: This project tried to generate a learning strategy based on the cooperative work in the habitual students' activities of the Data analysis in psychology subject in order to improve the teaching in this subject. During the academic year 2004-2005, a strategy of cooperative learning was put into practice. We worked with a sample of 415 students of the University of Barcelona, 211 students carried out cooperative work and 204 students did individual work. The results showed the existence of a greater satisfaction with the work among the students who did it cooperatively than among those who did it individually.

Key Words: Cooperative learning, statistics, satisfaction.

1. Introduction

One of the main debates that arise in every university study is the analysis of drop-out and failure rates, and, at the same time, the essential reflection that it is necessary to generate in order to prepare the new european higher education system. These two facts are not unusual in our Data analysis in psychology subject. The last cohorts' academic results show that the subject, generally, presents a 20% rate of absence during the semester and that the rate of students who do not take the exam is 40% of the registered students, which may not be considered a promising result.

For some time now, several strategies are being implemented in order to approach these facts. The proposals are the following:

1. Several teaching publications have been created (Batista *et al.*, 1996; Sarrià, Guàrdia, & Freixa, 1999). The results improve slightly, but it does not involve a significant increase in the performance obtained.

2. Since the academic year 1999-2000, a free-choice course is organized previous to the Statistics subject (course 0) denominated *Fonaments matemàtics* (Mathematical fundamentals), which intends to level the uneven mathematical knowledge of the students who wish to improve their previous mathematical baggage.

3. We have put into practice computer-assisted teaching, especially with the use of a CD-ROM that deals with Descriptive statistics (Guillén *et al.*, 2001), or the use of the virtual space of the electronic dossiers of the subject where the students have at their disposal theoretical-practical support material to the teaching classes. The results (Peró, Turbany, Guàrdia and Freixa, 2002; Però, Turbany, *et al.*, 2004; and Però, Barrios, *et al.*, 2004) have shown, on the one

hand, that the use of remote technology brings about an increase in the students' level of satisfaction with it. On the other hand, as far as academic performance in the subject is concerned, there exist more satisfactory results.

4. We have tried to obtain predictive variables to estimate the profile of the student at risk of drop-out or failure, in order to try to profile our teaching much more (Barrios *et al.*; Guàrdia *et al.*, 2002; and Però, Guàrdia, Freixa, and Turbany, 2002). The results obtained with these projects present a weak relation between academic performance and the predictors usually employed, such as academic antecedents, the grade the student estimates to obtain in the subject and their level of satisfaction with different aspects related to the subject.

Other authors work in a different line from those presented here. Thus, Garfield (1993) or Potthast (1999) propose collaborative work between students for a greater involvement on their part in the Statistics subject and, consequently, in their active learning process, with the subsequent academic result that it brings about. In fact, some works show that collaborative work indeed succeeds in improving the students' academic performance (Graud, 1997; Magel, 1998; or Smith, 1998), and they even report a positive response from the students towards the proposed system (Smith, 1998; Syh-Jong, 2007). And some works use it in the teachers' training (Chaliès, Bertone, Flavier and Durand, 2008).

In any case, it was not until recently that the academic community started paying attention to the student as a learning person and not so much as a person who passes exams. For this reason, and along the line of the authors who propose the concept of collaborative work for an improvement of the learning of statistics, this teaching strategy was implemented among the students of the 2004-05 Data analysis in psychology subject in order to decrease the number of drop-outs and students not taking the exam in the statistics subject. Specifically, the idea involved substituting some of the traditional teaching classes for practical sessions carried out by the students in an environment of collaboration among themselves. On the other hand, this work plan goes along the line of what is proposed from the logic of the European Higher Education Area, in which the ECTS (European Credit Transfer System) credits must focus on the students' efforts to prepare the subject, where the teacher stops being *the source of information* to become *a facilitator of learning* (Garfield, 1993; or Javornik and Ivanus, 2008).

This research is framed within a project in which the different catalan universities in which the psychology major is taught participate: *Universitat de Barcelona* (UB), *Universitat Autònoma de Barcelona* (UAB), *Universitat Rovira i Virgili* (URV), *Universitat de Girona* (UdG) and *Universitat Ramon Llull* (URL). The first exploitations of the research (Guàrdia, Freixa, *et al.*, 2005; and Guàrdia, Però, *et al.*, 2005) do not show an effect of this strategy on the improvement of academic performance, although they do show an effect on the percentage of students who end up handing in their work.

Given that in Smith's work (1998), besides observing an improvement of academic performance, a positive response by the students was observed towards the implementation of this kind of strategy, the aim of the current project focuses on carrying out an analysis of the students' satisfaction with this teaching strategy as well as with different aspects related to the teaching of this

subject globally, taking as a source the data collected among the students of the *Universitat de Barcelona*.

2. Method

2.1. Participants

We worked with two subject registration groups from the morning shift (n= 211) to apply the experience of optional collaborative work (practice exercises to do in class in little groups). Aiming to have a control group, we took into account two other registration groups (n= 204) from the same shift and same teachers as the two groups from the collaborative experience. In these last two groups, work was optional and individual, and it consisted of resolving a series of questions asked from a scientific article published on a specialized journal.

Moreover, during the last teaching week of the subject (from December 20 to 22, 2004) a survey was given to the students who were in the classroom at that moment. The number of students who answered the survey was 215, from which 109 were registered in the two groups in which the optional collaborative work was implemented, whereas the other 106 were registered in the two groups in which the optional individual work was carried out.

2.2. Materials

The satisfaction questionnaire handed out on the last teaching week of the subject collected information on sociodemographic data, on the use the students had done of the materials at their disposal in the electronic dossiers of the subject, their level of satisfaction with those, as well as their level of satisfaction with different aspects related to the teaching of the subject. This last part of the questionnaire is formed by a total of 23 statements assessed on a 1 (*totally disagree*) to 7 (*totally agree*) Likert-type scale.

2.3. Procedure

For each of the collaborative work sessions, different material was prepared for each group where the students had to work in class. This material basically consisted of a general situation which the students had to approach and answer specific statements referring to their data. In this optional pilot test, we decided to carry out this kind of practical activity limited to the three lessons of the initial program of the subject (Descriptive statistics, Chi square test and Mean comparison test). In order to assess the work, the task carried out in each group had to be handed in at the end of the class. In order to encourage the students, these exercises meant a percentage of the final grade of the subject (15%). In the case of the optional individual work, the students could hand their answers in up to the subject's final exam and assessment of it like for the collaborative work students, it also meant 15% of the final grade of the subject.

2.4. Data analysis

In order to determine whether the sample of students who answered the questionnaire was equivalent –regarding academic performance in the subject– to the sample of students registered in the four groups studied, we obtained the z-statistic for the comparison of two observed proportions. Moreover, for the sample of students who had answered the questionnaire, we carried out the

comparison –between the students who did collaborative or individual work– in different demographic variables, academic antecedents and grade obtained on the final exam and on their own work, using the z-statistic for the comparison of two observed proportions or the *Student's t*-test for independent groups, according to the nature of the variable (qualitative or quantitative in scale of reason).

In order to answer the objective formulated on the present project – satisfaction with the type of collaborative work and different aspects related to the teaching of the subject–, a double analysis was made. An initial analysis consisted of the comparison, statement by statement, between the collaborative work group and the individual work group using the non-parametric Mann-Whitney U-test, given the nature of the measuring scale used in the 23 statements that assess the students' satisfaction with different aspects related to the teaching of the subject using a 1 (*totally disagree*) to 7 (*totally agree*) Likert-type scale. A second level of analysis consisted of reducing the dimensionality of the 23 statements by applying an exploratory factorial analysis according to the model of principal components and varimax rotation. The students' grades were generated in each of the factors obtained from the regression method. These grades were later compared between the two groups studied using the *Student's t*-test for independent groups.

3. Results

Given that the objective of the present project was to differentially analyze (students who did collaborative work *versus* students who did individual work) the students' level of satisfaction with different aspects related to the teaching of the subject and this information was only available from the students who had taken the questionnaire and not from the total number of students registered in the studied groups, a first analysis consisted of determining the equivalence in academic performance between the students who had taken the questionnaire and the students registered in the studied groups. As can be observed on table 1, the comparison of the percentage of students who pass the subject, percentage of students who take the exam and percentage of students who hand in their work is equal if studied on students registered or on students who took the questionnaire. In both cases there are no differences between the students who did collaborative work and those who did individual work in the percentage of those who pass the subject or who take the exam. There *are* differences, though, in the percentage of students who hand in their work: it is higher in the case of those who did collaborative work in both samples. However, in the collaborative work group, the percentage of students who took the exam is higher among those who answered the questionnaire than among those registered (table 2). The same thing happens as far as handing their work in is concerned, although this effect also occurs in the case of the students who only did individual work (table 2). This aspect may be attributed to the fact that the students who answered the questionnaire present a higher fidelization of the subject.

Given that from the latter analyses it can be inferred that the students who answered the questionnaire behave similarly to the total of students registered in the registration groups studied, it has been considered appropriate to consider this sample of the students who answered the questionnaire characteristic of the students registered in the four groups studied and, therefore, to carry out the

current work with the group of students who answered the questionnaire. On tables 3 and 4, we display the comparison of the students who did collaborative work and those who did individual work in demographic and academic antecedent variables. As can be observed on these two tables, there are no statistically significant differences between the two groups in any of the assessed variables. From this, it can be inferred that the results above the student level of satisfaction are not influenced by these variables and, therefore, they are not deemed necessary to carry out any control in the main analysis of the present project.

Variable	Registered students				Students who answered the questionnaire			
	C.W.	I.W.	Comparison of proportions		C.W.	I.W.	Comparison of proportions	
	%	%	z	p	%	%	z	p
Pass subject	73.46%	67.65%	1.30	.194	82.56%	75.47%	1.28	.201
Take exam	77.73%	74.02%	0.88	.378	88.99%	83.02%	1.26	.206
Hand in own work	81.04%	37.75%	8.99	< .001	95.40%	53.77%	7.04	< .001

Table 1. Comparison of proportions between the collaborative work (C.W.) and the individual work (I.W.) students in the academic performance in the subject, differentiating between those registered in the subject and those who answered the survey.

Variable	Collaborative work				Individual work			
	Registered	Questionnaire	Comparison of proportions		Registered	Questionnaire	Comparison of proportions	
	%	%	z	p	%	%	z	p
Pass subject	73.46%	82.57%	1.82	.068	67.64%	75.47%	1.43	.153
Take exam	77.73%	88.99%	2.46	.014	74.02%	83.02%	1.79	.074
Hand in own work	81.04%	95.41%	3.50	< .001	37.74%	53.77%	2.70	.007

Table 2. Comparison of proportions between the registered students and those who answered the survey in the academic performance in the subject, differentiating between those who did collaborative work and those who did individual work.

Variable	C.W.	I.W.	Comparison of proportions	
	%	%	z	p
Sex: Female	85.32%	89.62%	0.95	.341
Access route: LOGSE (New Bachelor)	76.15%	83.02%	1.25	.212
Branch of high school education: social LOGSE	44.86%	43.81%	0.15	.878
Psychology as first option	87.16%	83.96%	0.67	.505
Having taken Statistics in previous studies	45.87%	40.57%	0.79	.432
Having taken <i>Fonaments matemàtics (Mathematical fundamentals)</i>	49.07%	44.34%	0.69	.488
Being repeating the subject	18.35%	23.58%	0.94	.345

Table 3. Comparison of proportions for the collaborative work (C.W.) and individual work (I.W.) students in their academic antecedents.

Variable	Group	n	Mean	t	p
Age	C.W.	109	19.51	0.69	.489
	I.W.	104	19.84		
University access grade	C.W.	105	6.89	1.09	.278
	I.W.	104	6.78		
Exam grade	C.W.	97	6.46	1.38	.169
	I.W.	88	6.77		
Own work grade	C.W.	104	1.57	0.77	.443
	I.W.	57	1.54		

Table 4. *Student's t-test* for independent groups for the comparison between the collaborative work (C.W.) and individual work (I.W.) groups.

As can be observed on table 5, on seven out of the 23 statements, there exist statistically significant differences between the students who did their work collaboratively and those who did it individually. The application of Bonferroni correction don't modify specially the significance (alpha of .002 for each contrast). Hence, the students who did their work collaboratively assess the following statements better than those who did it individually: *The classroom's lighting, temperature and ventilation conditions are appropriate* ($z = 4.23, p < .001$), *The student's own work was useful to me in order to learn the different lessons explained in class* ($z = 4.34, p < .001$) and *I am satisfied with the way the student's own work has been programmed/carried out* ($z = 5.86, p < .001$); whereas the students who did their work individually assess the following statements better than the collaborative work students: *The theory teacher seems to master the subject content* ($z = 2.95, p = .003$), *The teacher used the examples properly* ($z = 3.58, p = .003$), *The theory teacher has been available for consultations* ($z = 4.29, p < .001$), and *The teacher generates a participative and trustful atmosphere in class* ($z = 2.95, p = .003$).

The exploratory factorial analysis' factorial weight matrix is shown on table 6. As can be observed, four factors have been obtained that explain the 56.34% of the total variability. According to the factorial weights, it could be thought that the first factor is related to different aspects related to the teaching staff, the second factor is related to the structuration of the subject's electronic dossier materials and forum, the third factor is related to the practice material and the student's own work for the subject and, finally, the fourth factor is related to organizing aspects of the subject (classroom condition, time assigned to the subject's lessons, assessment system, coordination between teachers, etc.). The reliability as internal consistency is good for the three first factors but no for the last one. For the total scale the coefficient alpha is .860, which informs about a good reliability following the standard criteria.

There exist statistically significant differences between the two groups studied (collaborative work and individual work) in three of the four factors obtained from the exploratory factorial analysis. On the first factor, the teaching staff, the score is statistically higher among the students who did their work individually than among those who did it collaboratively ($t = 3.75, p = .001$), where the effect size measure is .302, which indicates a moderate intensity of the difference. In the other two factors, practice and student's own work, and organizing aspects, the differences occur in the opposite way, that is, the score is higher among the students who did their work collaboratively ($t = 2.13, p = .035$).

and $t = 2.03$, $p = .045$ respectively), where the difference of intensity is moderate in both cases (.177 and .169 respectively).

Statements	Rank mean		Mann-Whitney U	
	C.W.	I.W.	z	p
The classroom's lighting, temperature and ventilation conditions are appropriate.	124.72	89.95	4.23	< .001
The time assigned to the different lessons of the subject is sufficient.	107.88	107.12	0.09	.926
The assessment system of the subject is known and adjusted to the program.	106.93	108.08	0.15	.884
The practice dossier is useful for the students.	103.61	111.54	1.02	.307
The bibliography recommended is useful to prepare the subject.	92.10	98.19	0.79	.433
The theory teacher seems to master the content of the subject.	97.85	117.52	2.95	.003
The practice teacher seems to master the content of the subject.	114.43	99.36	1.84	.065
The teachers teach in a motivating way.	105.87	109.20	0.42	.676
The teachers attract the students' interest in the subject.	108.72	107.26	0.18	.858
The teacher used the examples properly.	93.66	121.60	3.58	< .001
The theory teacher was available for consultations.	91.25	124.37	4.29	< .001
The teacher generates a participative and trustful atmosphere in class.	96.05	119.39	2.95	.003
There was sufficient coordination between the theory teacher and the practice teacher.	108.00	108.00	0.001	.99
The student's own work was useful to me in order to learn the different lessons explained in class.	120.29	85.00	4.34	< .001
I am satisfied with the way the student's own work was programmed/carried out.	128.21	80.18	5.86	< .001
The general organization of the electronic dossiers of the subject is appropriate.	102.82	112.26	1.20	.231
The organization of the material presented in the electronic dossiers is appropriate.	102.55	113.60	1.39	.163
The organization of the questions and answers in the subject's forum is appropriate.	96.74	85.56	1.48	.139
The answer promptness to the contributions to the subject's forum is appropriate.	90.40	88.62	0.24	.812
The answers given on the subject's forum are appropriate.	89.38	86.67	0.37	.714
The knowledge acquired is important for the rest of the major.	105.15	105.86	0.09	.929
The knowledge acquired is important for professional life.	109.94	103.06	0.84	.400
In general, the subject deserves a favorable assessment.	106.73	108.29	0.20	.844

Table 5. Non-parametric Mann-Whitney U test for the comparison of the assessment on the part of the students of statements related to different aspects of the teaching of the subject.

Statements	F1	F2	F3	F4
The classrooms' lighting, temperature and ventilation conditions are appropriate.	-0.002	0.064	0.138	0.570
The time assigned to the different lessons of the subject is sufficient.	0.277	0.152	-0.074	0.537
The subject's assessment system is known and adjusted to the program.	0.268	0.398	0.064	0.426
The practice dossier is useful for the student.	0.340	0.278	0.405	0.170
The bibliography recommended is useful in order to prepare the subject.	0.003	-0.031	0.380	0.344
The theory teacher seems to master the content of the subject.	0.672	0.065	-0.035	-0.015
The practice teacher seems to master the content of the subject.	0.025	-0.090	0.009	0.722
The teachers teach in a motivating way.	0.793	0.025	0.199	0.127
The teachers attract the students' interest in the subject.	0.758	0.122	0.255	0.072
The teacher used the examples properly.	0.683	0.170	0.061	0.067
The theory teacher was available for consultations.	0.689	0.220	-0.086	0.206
The teacher generates a participative and trustful atmosphere in class.	0.751	-0.005	0.035	0.060
There was sufficient coordination between the theory teacher and the practice teacher.	0.231	0.090	0.082	0.635
The student's own work was useful to me in order to learn the different lessons explained in class.	-0.055	0.133	0.590	0.347
I am satisfied with the way the student's own work was programmed/carried out.	-0.180	0.175	0.538	0.422
The general organization of the subject's electronic dossiers is appropriate.	0.269	0.618	0.290	0.207
The organization of the material presented on the electronic dossiers is appropriate.	0.314	0.605	0.283	0.241
The organization of the questions and answers in the subject's forum is appropriate.	-0.012	0.870	0.051	0.036
The answer promptness to the contributions to the Forum is appropriate.	0.075	0.911	0.045	-0.033
The answers given on the subject's forum are appropriate.	0.117	0.908	0.046	-0.006
The knowledge acquired is important for the rest of the major.	0.260	0.074	0.774	-0.189
The knowledge acquired is important for professional life.	0.269	0.112	0.831	-0.068
In general, the subject deserves a favorable assessment.	0.626	0.131	0.401	0.134
Percentage of variance explained	18.42%	15.74%	11.84%	10.34%
Coefficient alpha for internal consistency	.869	.872	.746	.615
Varimax rotation method – convergence: 5 iterations				
Kaiser-Meyer-Olkin: .785				
Bartlett's sphericity Test: $\chi^2 = 1787.76$; g.l. = 153; p < .001				

Table 6. Exploratory factorial analysis' factorial weight matrix (n= 142).

4. Discussion

From a conceptual point of view, as was mentioned on the introduction, on previous projects from the present study (Guàrdia, Freixa, *et al.*, 2005; and Guàrdia, Però, *et al.*, 2005), there was no effect of the implementation of the collaborative work strategy on the improvement of the academic performance, which would be consistent with the works carried out by Graud (1997), Magel (1998) or Smith (1998). However, what this work actually pursued to study was the students' level of satisfaction with this type of strategy in the teaching of the subject and, as shown by the results obtained in the present work, it is observed that it is higher among the collaborative work students than among the individual work students, which would be consistent with the line developed by Smith (1998) or Syh-Jong (2007). In any case, despite the fact that the implementation of this strategy did not involve an improvement in the academic performance, there was a higher fidelization of the optional work among the students who did it collaboratively. One possible explanation to there not being an improvement in the academic performance could lie on the way this strategy was implemented. As was mentioned above, it was only used on three lessons from the subject's program, for which reason, it is considered that the best option for the upcoming academic years would be to implement it on all the lessons and, consequently, adding more collaborative work sessions while suppressing some of the teaching classes of the subject. This would be justified by the fact that the collaborative work students showed a higher level of satisfaction with it and a subjective perception of a better learning of the subject content than those who did individual work. This extension to the whole program of the subject would possibly involve an improvement in the academic performance, which has not been observed in this study and that other studies have shown (Graud, 1997; Magel, 1998; Smith, 1998; or Syh-Jong, 2007).

Moreover, and along the line of what was just mentioned above, we would like to emphasize that the assessment of the different aspects related to the teaching staff was higher among the students who carried out their work individually than among those who did it collectively. This may lead us to think that the students from the individual work group were more dependent on their teachers than those from the collaborative work group, given that these could resolve their doubts about different aspects of the subject among themselves in a formal academic space with no need to turn to their teachers

Finally, we would like to point out that this atmosphere of collaboration represents an involvement of the student in the work that means that these accommodate their work to their own characteristics. Thus, it is considered that this experience of promotion of the student's autonomous work in a cooperative way agrees with what is intended from the European Higher Education Area and, at the same time, it is believed that it means a greater involvement with the work world, since the psychologist must work collaboratively in interdisciplinary teams.

As a conclusion, we can say that the level of satisfaction is higher among the collaborative work students than among the individual work students. And, despite the fact that the implementation of the collaborative learning did not involve an improvement in the academic performance, there was a higher fidelization of the optional work among the students who did it collaboratively.

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