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A Way of Boosting Students' Interest in Statistics: Approach and Results

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Abstract
A common problem academic staff must face when imparting courses of quantitative subjects, and more specifically when doing so in most of the degrees on the field of social sciences in Spanish universities, is student's reticence of dealing with subjects requiring a good mathematical base.
This is the case of statistics, a subject with a huge potential in terms of its usefulness and applicability in almost all fields (social fields, humanities, health, science...), which should be acknowledged as such by students.
We believe a way to achieve this goal is to make statistics a friendlier subject for students' point of view. In order to get this, teachers shall reinvent if necessary their way of lecturing, by using the appropriate tools to arouse students' curiosity, turning this reluctance into a good predisposition.
With this in mind, an activity has been developed and implemented in the course of Statistical Inference, a subject being imparted in one of the many degrees from the social sciences branch in the Universitat de València. Its purpose is to encourage collaborative work so that the student, in a way similar to playing a game, gains and reinforces previously acquired inferential concepts. During this process they are not alone but groups of around 6 students are made. As it happens in basketball matches, these groups compete against each other, so that the group which correctly answers more questions is the winner of the activity and, as in any game or competition, a second and third position are considered. Nonetheless there is a common reward for all, as for a few hours they can enjoy the subject in a most different way, while becoming the core in which everyone try their best to come out on top.
Additionally, and in order to further develop fellowship between students, the composition of the groups is determined by the teacher in charge of this activity, and only a few minutes before it begins does it become public who the members of each team are. When deciding the members of each group, the teacher follows the heterogeneity criterion in a way such that students inside each group have a different degree of statistical knowledge and are therefore forced to work as a team in order to achieve the proposed objective.
Thus, in this paper the results of its use throughout various classes are evaluated, concluding a significantly positive effect on both the motivation and learning processes.

1. Introduction
For some years now university teaching staff of quantitative subjects in Spanish Universities suffers a problem of basis and aptitude of the students, as they access to the University with a rather precarious basis on mathematics and hence they show a negative predisposition towards quantitative subjects.
In addition to this, if we focus on the social sciences degrees this problem is emphasized, possibly due to pre-university preparation for students, which has given more weight to subjects from liberal arts education than those of a more quantitative type. As an example, if a student has completed a Bachelor's degree of social sciences only a basic course in mathematics has been completed, while the other subjects that make up the curriculum refer to literature, geography, philosophy, economics.

All the above is reflected clearly in the case of the teaching of statistics, a quantitative subject in which a good mathematical background is necessary.

Given that, as university professors, the power to make a change in the pre-university conditions of our students is not in our hands, we propose a series of changes in the way teaching quantitative subjects is made, so that greater involvement by the student is achieved, thus turning their initial reluctance into a good attitude toward learning.

Taking into account this idea, as well as the quantitative subject "Statistical Inference", a pedagogical experiment was carried out in a degree of the social sciences area from the University of Valencia. Basically, it consists in the formation of groups with five or six members each, in a way similar to that in a basket game, and making a review of the subject-matter addressed throughout the semester. The group activity is done after university teaching time and is voluntary. It is inspired by the good reception and results that a cultural TV program in “Televisión Española” (TVE) had in the 60-70 years, and therefore we have proceeded to replicate its mechanics while at the same time introducing a number of differences [1]. In brief, it should be noted that "Cesta y Puntos" program was produced by “Radio Televisión Española” (RTVE), it was released in 1965 and it stayed on the air until 1971, being retransmitted once a week with an approximate duration of 1 hour.

The objective of this game was for high school students from different schools of Spanish geography to compete among themselves, seeking victory and a prize consisting of personal awards for the winning students, as well as a reward for the Educational Centre of origin. To achieve this, students in each team must correctly answer a set of questions of all types (geography, history, literature, maths...). Two teams in each program faced each other, similarly as it is done in a basketball game. The composition of the teams was as follows: 2 forwards, 2 point guards, 1 center and 3 alternates.

The systematics of each program (game) can be summarized as follows:

- The presenter asked a question to the forwards. If their answer was not correct, the question was passed to the point guards, and if the also failed it was the center that tried to answer. If the center too got it wrong, then that would mean a "bounce" to the center of the other team, who had the opportunity to answer correctly and get the points for his team. Along this process the value of the right response decreased.
- During the encounter a table consisting of a crew chief and two referees (the so called table of referees) was responsible for timing the time available for each answer and resolve any doubts that may arise.
- Every time a question was answered correctly, following the parallel with basketball, a ball appeared on screen entering in the basket while the corresponding points were added to the score of the concerned team.
- When the match finished the team that achieved the highest score was declared the winner.

This program had very good welcome and received, in 1968, the Ondas Award for "Best Cultural Program".

Thus, for the activity implemented in the University, similar rules were applied, though some differences from the game show must be pointed. For example:

- The questions refer only to the content of the subject (in this case "Statistical Inference").
- The teacher is the one who decides the composition of each team, in order to guarantee as much heterogeneity as possible among the members of the group, by combining students with a different level of performance in the subject, and thus forcing them to collaborate to win.
- The teacher plays the presenter, that is, he/she is the one who poses the questions.
- The role of the "table of referees" in the competition is conducted by assistant teachers of the subject.
- The prize is that, once passed the course, final grades of the members from the winning team will be increased up to a maximum of one point.

It can therefore be concluded that the referred activity can be extrapolated to any other discipline (as it would be enough to adapt the questions to the subject).

2. Objectives

Considering the good results obtained in any class in the activity [2][3][4][5], the objective we intend is to assess the outcome of the activity over three consecutive classes (2005-2011, 2006-2012 and 2007-2013), that is to extend previous studies and add in this case the continuous evaluation score, so that some questions that will arise later can be answered.

To do this we note that the course "Statistical Inference" was evaluated as follows: 30% of the grade corresponds to the continuous evaluation (CE) and the remaining 70% to the score obtained in the final test (FT). So considering that the proposed activity is carried out after university teaching, yet before the FT, we will consider the results for both the students who took part and for those who did not. Detection of better results for those who participated would validate the use of the proposed tool as a means of boosting students' interest in the aforementioned subject.

Specifically we will try to answer the following questions:

1st -. Did students who participated in the activity obtain, on average, higher scores in the FT, in comparison with those who didn't participate?

2nd -. Is there, o average, a significant difference in the results of the CE between all those students who participated in the group activity and those who did not, in favor of the first? This question is important to determine whether it can be accepted that students getting better CE grades are more motivated and would more likely participate.

3rd -. If the answers to the two questions previously posed are positive it would be interesting to analyze whether there is a positive and significant correlation between the marks obtained in the CE and in the FT. If not, the factor "attendance to the activity" could be considered as a determinant of better results in the FT.

3. Results

As indicated above, the results of three consecutive classes (2005-2011, 2006-2012 and 2007-2013) are analyzed. Thus, considering for each academic year the two clusters formed by students who didn't participate in the activity (NOT) and those who did (YES), the mean and the Pearson coefficient of variation for grades in the continuous evaluation (CEG, scored on 3) and final test (FTG, scored out of 10) are obtained for each case. The results can be seen in the following table:

Table 1. NEC and NEF Parameters

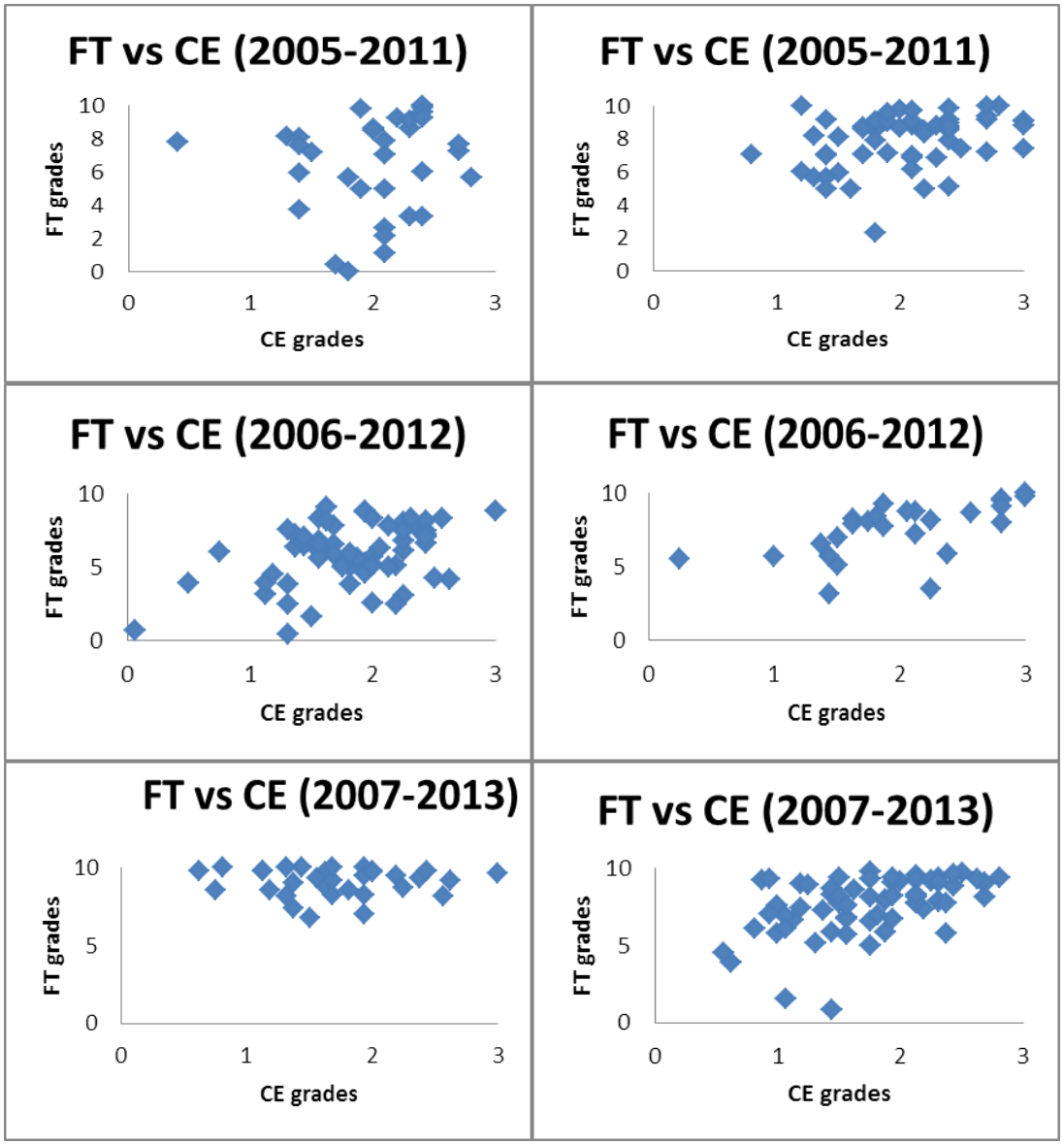
	FTG				CEG			
	MEAN		COEF. VARIATION		MEAN		COEF. VARIATION	
	NOT	YES	NOT	YES	NOT	YES	NOT	YES
Class 2005-2011	6'40606	8'05416	0'44517	0'19680	1'58503	2'03607	0'32768	0'24485
Class 2006-2012	5'86672	7'49596	0'35139	0'24516	1'76231	2'00240	0'31589	0'32856
Class 2007-2013	7'63515	9'06133	0'23188	0'09759	1'59821	2'34570	0'42557	0'23380

Source: own calculations

It follows from the observation of the *Table 1* that, for the three classes, those who participated in the activity have obtained, on average, higher grades in the CE and the FT, also showing less dispersion for all classes except the 2nd class for CES, in which case the difference between the two clusters is quite small (0'32856 versus 0'31589).

To answer the third question posed in the objectives, scatter plots of CEG vs FTG for both participants and not participants, and for the three classes, are drawn (not participants on the left and participants on the right):

Figure 1. Scatterplots (FE vs CE)



Source: own calculations

By looking at *Figure 1* it can be observed that no apparent clear relationship exists between the variables considered (FTG and CEG). In order to quantify this, the correlation coefficients between FTG and CEG have been obtained. Values for each case can be found in *Table 2*:

Table 2. Correlation between FTG and CEG

	Correlation coefficient between FTG and CEG

	NOT	YES
Class 2005-2011	0’086417338	0’324594791
Class 2006-2012	0’405614168	0’605276399
Class 2007-2013	0’480045130	0’449741681

Source: own calculations

Because values for the correlation coefficients cannot be considered significantly high (except, perhaps, for the participants of the 2nd class), it seems that good results in the CE cannot fully explain good results in the FTG, and therefore attendance to the group activity can be considered decisive in the improvement of students’ performance.

4. Conclusions

Recall that the proposed objective was to validate the use of a group activity. To do this we had to justify their use in response to the good results obtained in a quantitative subject (specifically "Statistical Inference") taught in a degree in the social sciences area at the University of Valencia.
Data used correspond to the grades on the continuous evaluation (CE) and the final test (FT) of three consecutive classes of such degree, concluding that:

- Students who participated in the activity obtained, on average, higher grades on the final exam (FTG) in the three classes. Specifically: 8'05 vs 6'4 for the first, 7'49 vs 5'87 for second one and 9'06 vs 7.64 for the third one . Furthermore the means for the three groups of participants are more representative, as they show lower Pearson coefficients of variation.
- Something similar happens if we consider the continuous evaluation grades (CEG), i.e. 2'04 vs 1'59 for first class, 2 vs 1'76 for the second one and 2'35 vs 1'6 for the third one (note that the values for these grades are smaller because the highest possible score in CE is 3). Dispersion is also lower for the clusters of participants in the first and third classes, and in the second class is almost the same for both.
- As for the possible existence of a significant positive correlation between the CEG and the FTG, neither the corresponding dispersion diagrams nor the value of the correlation coefficients (lower than 0.5 for all three groups of students who did not participate, and between 0.3 and 0.45 for those who did in the first and third class) allow us to accept this, and so the factor "attendance to the activity" could be the determinant of improvement in the FTG, and can therefore be considered a tool that enhances students’ interest and academic performance.

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