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An assessment of behavioral variables implied in teamwork: an experience with engineering students of Zaragoza University

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This paper presents a study of behavioral variables implied in the working dynamics of student groups undertaking their first project. The study has been carried out in two phases. During the first phase, the participants have answered a survey of open questions regarding their own behavior and that of their teammates, questions related to: the quality of their work as a team; their individual contribution to teamwork; and their perception of what they have learned after taking part in the experience. Analysis of the answers through the inter-judge consensus method has been the basis for developing a questionnaire of closed questions, which has constituted the second phase of the study. The procedure followed for developing the questionnaire and the results obtained after handing it to 92 students guarantee its validity and reliability for measuring and assessing the behavioral variables implied in how such groups work. The study concludes with the prospects for using such a tool, in order to support the work of student groups throughout the course.

Keywords: behavior; project management; questionnaire; teamwork

1. Introduction

One of the initial recommendations included in the convergence process for the European Higher Education Area is the adoption of active learning methodologies by students. Among such methodologies, approaches such as the following stand out: cooperative learning (Felder and Brent 2007), problem-based learning (Graaff and Kolmos 2003), or experiential learning (Kolb 1984), in which the student is no longer a passive element and assumes a more active role in the learning process, usually involving the performance of work within a team.

In this context, it is necessary, on the one hand, to provide the students with certain skills that will allow them to perform effectively and cope with the situations arising from that kind of work (Oakley *et al.* 2004) and, on the other, to monitor how performance as a group affects the quality of the results obtained.

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Starting from this premise, we present the experience taking place in the subject of project management of the Industrial Engineering Master degree at Zaragoza University, where groups of five and six students have been able to address the need put forward by a real client, through completion of a project (Cano *et al.* 2006). Davidovitch *et al.* (2006) noted that in order to prepare the students for a real project environment there is a need to practice in the "real world" of project management.

Evaluation of the student group in this academic year is related to the quality of the project they have developed. Although there is agreement among the teachers group regarding the quality standards to be met by the work of the students, it does happen on occasion that students differ in their perception of such standards. This becomes clear in aspects such as the varying importance attached by students and teachers to the satisfaction shown by the client with the work performed.

Within this framework, the teachers become interested in identifying and measuring those variables that reveal the perceptions of students regarding aspects of how their groups work the quality of their performance, and the relation between both. Concern with learning about the ideal conditions for teamwork in an academic environment has driven several groups of teachers to carry out studies with this goal in mind (Brewer and Mendelson 2003, Tonso 2006, Oakley *et al.* 2007). Additionally, teamwork has been identified as one of the most important employability skills (Markes 2006) and one of the skills used in industry (Pascail 2006, Korhonen-Yrjänheikki *et al.* 2007).

For this purpose, a questionnaire has been devised as an instrument for the assessment of this set of variables of a technical and behavioral nature. Developing the questionnaire has required an interdisciplinary approach, and therefore a research team made up of teachers of the subject and psychologists was formed.

The aim in putting this questionnaire together has been the benefit of relying on a useful tool for teaching, making it possible to analyze, assess, and improve learning by the students. According to Prince *et al.* (2007), doing research on teaching and integrating successful innovations into classroom practice clearly has the potential to improve teaching and learning. In order to meet such goals, the questionnaire should guarantee the psychometric properties featured by an adequate measuring tool.

Next, we move on to the approach for project management teaching that has developed at Zaragoza University.

2. The Project Management Course at the University of Zaragoza

The training scheme part of this course has been based on the performance, in groups of 5/6 students, of a project for a real client. Such clients are usually SMEs, non-governmental organizations (NGOs), small town councils, etc. The usual scope of these works involves preparing a project management plan, which is handed to the client for them to implement if they consider it beneficial. In some cases, however, the students become involved in reaching the goals set by their project. Typical examples of the commissions undertaken are extensions and relocations of companies, organizing a variety of events (sport, social, cultural, artistic, etc.), preparing proposals for financing the activities of NGOs, and the like (Cano *et al.* 2008).

For a student group with no previous experience, carrying out a real project for a client involves an interesting challenge. So, the course is set within a fictitious consulting company where students work in groups, under the mentoring of their teachers. The teachers offer students the usual services of a Project Management Office (mentoring, time control, progress reports, psychological support and training, lectures, conferences, and seminars).

However, personal differences between the members may arise, derived from the very dynamics of teamwork. To deal with such problems, two seminars are offered in order to develop the collaborative skills of the students. In the first of these, "Causes of Failure in Projects," the teachers present the experience gathered throughout the years regarding the most significant problems perceived in student groups taking the same subject, as well as the sort of attitude and behavior that will help prevent such problems. The performance of this seminar relies on students from previous years relating their own experiences during the course. The second seminar, "Conflict Management," is offered by a teacher from the Psychology and Sociology Department, and by means of a series of role-plays, students represent the most common conflict situations that may arise in teamwork, and strategies to deal with them are proposed. Additionally, a subject related to human aspects in project management is included in the program offered to the students. These actions are combined with guided reflection in topics such as coordination among the groups.

In the following chapter, we explain the methodology followed to develop the questionnaire mentioned previously.

3. Method

3.1. *Participants*

The groups participating in this study are the following.

- In the first assessment phase, a group of 21 students participated, of which 15 were males (71.43%), and 6 females (28.57%). This group, of which the components were selected randomly, represents 14% of the total 149 students registered for the subject that year. The first assessment phase relied on the six teachers responsible for the projects subject.
- In the second assessment phase, a group of 92 students participated, with an average age of 23.73 and a standard deviation of 1.46 years. Among them, 68 were males (73.9%) and 24 females (26.1%). This group makes up 74.19% of the total 124 students registered.

3.2. *Procedure for developing the questionnaire*

Development of the assessment questionnaire was carried out in two phases.

During the first phase (2005–06 term), the teacher group, considering the theoretical basis of the subject's teaching plan and the bodies of knowledge of the main International Project Management Associations (Caupin *et al.* 2006) and Project Management Institute (2004), selected and defined a set of 10 variables (see Section 2.3.), which they considered key indicators of teaching practices and their assessment. With the aim of defining and measuring these variables, a questionnaire was developed involving two different answering criteria: in the first place, the evaluation of each variable was made by means of a subjective scale from 0 (most negative, substandard) to 10 (most positive, excellent); secondly, indicating the reason or reasons for the said numerical evaluation. The content analysis of the information yielded by the student group was carried out through the inter-judge consensus method (Glaser and Strauss 1967, López-Araguren 2001), in which three teachers specifically trained for the task participated. The results of this analysis led to the identification of the content categories of the different variables (items), which in turn became the basis for the development of a new instrument, now consisting of closed questions.

During the second assessment phase (2006–07 term), the students taking part answered the questions of this second instrument, this time responding both to the variables globally and to each of the items by means of the ordinal scale of 10 intervals described before.

3.3. *Features of the questionnaire*

The questionnaire "retrospective assessment of teamwork" comprises 10 scales concerning the variables of the object of study of this research project. The variables or constructs assessed are as follows.

1. Perceived quality of the work performed.
2. Quality of performance as a project group.
3. Quality of technical/individual contributions in a project group.
4. Quality of individual contributions as member of a project group.
5. Teamwork competence in a project group.
6. Work motivation in a project group.
7. Satisfaction with work in a project group.
8. Advice for improving the quality of the work performed.
9. Advice for improving teamwork.
10. Proposals for improving individual work in a project group.

The first seven variables are defined by a single item with an answer format in an ordinal "continuous classification" scale of 10 intervals, from 0 (most negative, substandard) to 10 (most positive, excellent). In addition, the variables or scales 1, 2, 3, 4, 8, 9, and 10 are made up of a set of items, each of them with an answer format identical to the previous one. These items are taken from the content analysis of the open answers given by the students during the first phase of the questionnaire development process.

At the beginning of the questionnaire, information was gathered from the student on the following variables: age, sex, year in which studies were begun for the degree, role within the group (coordinator, secretary, or other), and preliminary evaluation that the teacher group, hereafter "rating obtained by the work," had given to the project at the end of each presentation made by the students, according to the following:

- Good: for those with final rating between 8 and 10 (on a scale from 0 to 10).
- Improvable: for work with rating between 5 and 8.
- Unsatisfactory: for work with rating lesser than 5.

During the term object of the study, none of the works was considered unsatisfactory by the teachers.

3.4. *Reliability and validity of the questionnaire*

Regarding the psychometric properties of tests, the design of the development process itself must aim particularly at guaranteeing and analyzing its reliability and validity.

Reliability refers to the degree to which measurements are relatively free of random error. Reliability, understood as "internal consistency," can be estimated using Cronbach's α coefficient.

In all the scales of this questionnaire made up of items (scales nos 1, 2, 3, 4, 8, 9, and 10), internal consistency may be considered good, since, in every case, the values of Cronbach's coefficient exceed 0.7 (Nunnally 1978).

Validity can be defined as "the degree to which the test measures what it is intended to measure" (Anastasi and Urbina 1997). Presently, the most commonly used model for establishing validity is that offered by the combined assessment of the validity of the content, construct, and criteria (Sartori and Pasini 2006).

Content validity refers to the existence of a sample of questions in the test representing content, the relevant skills, or behaviors of the area of interest; that is, if the items of the test are pertinent, exhaustive, relevant, and representative of the construct, we intend to measure.

In this questionnaire, content validity is endorsed by the identification and content analysis process of the variables object of the study, by means of the opinions of a representative group of "experts" (the students themselves).

Construct validity refers to the notion that a test must measure what it has been devised to measure. This type of validity is usually determined using factor analysis techniques and structural equations. In order to check construct validity, what was studied in the first place was the discrimination of the items of the scales numbered 1, 2, 3, 4, 8, 9, and 10 of the questionnaire, performing the "item-total correlation" analysis in each of the previous scales with the aim of assessing the integration of each item within the scale as a whole. The criterion employed for inclusion of an item has been to obtain a correlation index of 0.25 or higher (Nunnally and Berstein 1995). One last criterion for inclusion of items in the questionnaire was determined when performing exploratory factor analyses in order to check the factorial structure of each of the scales, on verifying communalities (the % of variance of an item explaining the factorial model made up by the remaining items), following the criterion of excluding an item from the model whenever a value of <0.3 was obtained. The result of the preceding analyses makes it possible to establish the structure and content of the scales and items of the final questionnaire (Lidón *et al.* 2007).

Finally, the criteria of a test are valid if it is useful in predicting a person's behavior in a specific situation. The results obtained (to be discussed in the following section) regarding the criteria variable "rating obtained by the work," which amounts to a measurement of the "success" met with by each project group, are an indicator of the predictive validity of this questionnaire.

4. Results

4.1. *Relation between the variables "rating obtained by the work" and "perceived quality of the work performed"*

As has been noted, the teachers of the course carried out an evaluation of the projects, using a three-tier classification: unsatisfactory, improvable, and good work. As has been mentioned above, none of the works presented during the term object of the study was marked as "unsatisfactory," and therefore, the grading of the projects may be considered dichotomic for all practical purposes. On the other hand, the students of the course graded the quality of their work as they perceived it, on a scale of 0 (very low) to 10 (very high).

In order to study the relation between these two variables, the choice was made to dichotomize the second, taking as criterion the value of the median (Mdn = 8). When studying the relation between the two variables, a statistically significant positive correlation was observed between rating obtained by the work and quality as perceived by students regarding their final work ($\phi = 0.397$, $p < 0.001$).

Such a result seems to support the idea that the criterion used by the teachers in assessing the work agrees with the individual appreciation of its quality of the students themselves.

4.2. *Relation between the variables "rating obtained by the work" and "quality of performance as a project group"*

Throughout previous terms, teachers have observed that aspects such as lack of coordination or faulty teamwork were among the most frequent causes of faulty work (Cano *et al.* 2006).

It was decided to study the perception of the teachers with the student group of the 2006–07 term. To that end, the non-parametric Mann–Whitney test was used to analyze the possible differences between the evaluations of "quality of performance as a project group" of students marked as "improvable" (i) *vs*. the group of students whose work had been rated as "good" (g).

Those analyses reflected that the students who had obtained higher ratings perceived a better quality of performance as a group when compared with those with lower ratings ($U = 551$, $p < 0.05$; $\mathrm{Mdn_i} = 7$, $\mathrm{RI_i} = 2$; $\mathrm{Mdn_g} = 8$, $\mathrm{RI_g} = 2$).

The result points to the fact that adequate teamwork is an essential feature for the end result of work.

4.3. *Factors influencing the variable "perceived quality of the work performed"*

In order to study the variables implied in "perceived quality of the work performed" (scale no. 1 of the questionnaire) the relation between the general evaluation of this variable and each of the specific contents or items that make up this scale was analyzed (Table 1).

What can be learned from these results is that all items of the scale "perceived quality of the work performed" show a statistically significant positive relation with it.

In order to gain a deeper knowledge of this relation, the influence of the evaluation of each item on that of the variable "perceived quality of the work performed" was studied. The ordinal regression analysis performed shows good adjustment of the model ($\chi 2 = 222,097$, $p < 0.01$), allowing for explanation of 83.5% of cases (students, in this instance).

4.4. *Factors influencing the variable "quality of performance as a project group"*

As in the case described before, the relation between the specific contents of the variable "quality of performance as a project group" and its general evaluation was studied. The results are shown in Table 2.

All items, except "the members of the group had worked together before" have a statistically significant relation with the variable "quality of performance as a project group". Noteworthy are the negative relations existing between the items "time allocation for the work has been uneven

Table 1. Analysis of the relation between the "perceived quality of the work performed" and the items of this scale.

Items related with the variable "perceived quality of the work performed"	r_s	p
All aspects of the project have been considered in great detail	0.682	0.000
All members of the group showed a good predisposition for the work	0.315	0.002
Tasks have been distributed according to the knowledge and skills of each member	0.213	0.035
The group has functioned in an adequate, coordinated way	0.377	0.000
The most has been made of the project	0.609	0.000
The project has been an original one	0.221	0.029
The expected results/objectives have been achieved	0.645	0.000
The project has been well planned	0.606	0.000
The client's satisfaction has been sought	0.263	0.009
The members of the group have made a great effort	0.391	0.000
The client is satisfied	0.398	0.000
Work has concluded successfully	0.357	0.001
The objectives have been fulfilled	0.569	0.000
The project had great scope	0.321	0.001
The project is useful for the client	0.496	0.000
All initial problems have been solved	0.364	0.000
Everything necessary to develop the project without difficulty is included	0.471	0.000
The results of the project are interesting	0.558	0.000

Table 2. Analysis of the relation between "quality of the Performance as a Project Group" and the items of this scale.

Items related with the variable "quality of the performance as a project group"	r_s	p
All members of the group had a clear idea of what was to be done	0.480	0.000
The group was united by a common goal	0.624	0.000
There has been a pleasant working environment	0.550	0.000
Time allocation for the work has been uneven throughout the project	−0.376	0.000
There have been differences among members	−0.438	0.000
Communication within the group has been good.	0.598	0.000
Work has been performed as a team	0.634	0.000
Timetable incompatibility has been solved	0.399	0.000
All members of the group have worked hard	0.647	0.000
All members of the group have worked well	0.664	0.000
Each member of the group had a clearly defined role	0.408	0.000
The work has brought the group together on a personal level	0.450	0.000
A positive attitude has prevailed in the group	0.741	0.000
The members of the group had worked together before	0.127	0.226
The meetings held led to steady work	0.502	0.000
Although hard in the beginning, day by day things improved	0.424	0.000
The group has held together even in moments of difficulty	0.490	0.000
There has been even distribution of tasks	0.458	0.000
All members of the group have fulfilled their part	0.597	0.000
Coordination within the group has been good	0.672	0.000
Before the group was formed, its members were friends	0.220	0.000

throughout the project" and "There have been differences among members" and the variable. In the groups where such problems arose, evaluation of the variable "quality of performance as a project group" has been worse. Therefore, preventing such situations will result in better work as a group and, consequently, in better results, as has been stated before.

As in the case of Section 3.3, in order to gain a deeper knowledge of this relation, the influence of the evaluation of each item on that of the variable "quality of performance as a project group" was studied. The ordinal regression analysis performed, excluding those items that showed no statistically significant correlations, shows good adjustment of the model ($\chi 2 = 299, 013$, $p < 0.01$), allowing for explanation of 73.3% of cases. **Q4**

4.5. *Lessons learned by the students*

In the questionnaire, students are asked what they would change given the chance to begin work all over again, in order to improve its quality, as well as that of teamwork.

On the basis of that information, it was studied whether any difference existed between the lessons learned by the students, according to their evaluation of the variable "perceived quality of the work performed".

4.5.1. *Relation between evaluation of the variable "perceived quality of the work performed" and the items of the scale "advice for improving the quality of the work performed"*

To study this relation, Spearman's rank correlation coefficient was employed. From a list of 19 items, statistically significant relations were found only in 2, as reflected in Table 3.

A negative correlation is shown with the item "Greater degree of organization when contacting suppliers," that is, students whose valuation of the variable "perceived quality of the work performed" is lower tend to recommend a greater degree of organization when contacting suppliers.

Table 3. Analysis of the relation between valuation of the variable "perceived quality of the work performed" and the items of the scale "advice for improving the quality of the work performed".

Items	r_s	p
Greater degree of organization when contacting suppliers	−0.349	0.000
Would do the same	0.476	0.000

A positive correlation appears with the item "Would do the same," that is, students whose valuation of the variable "perceived quality of the work performed" is higher would do the same as they had done.

4.5.2. *Relation between evaluation of the variable "perceived quality of the work performed" and the items of the scale "advice for improving teamwork"*

To study this relation, Spearman's rank correlation coefficient was employed. From a list of 20 items, statistically significant relations were found in 5 of them, as reflected in Table 4.

In the first place, a negative correlation is observed with the item "Greater coordination," students whose evaluation of the variable "perceived quality of the work performed" is lower recommend a greater degree of coordination within the group.

Secondly, the positive correlations indicate that students whose evaluation of the variable "perceived quality of the work performed" is higher recommend: having clear ideas from the start; getting things done as soon as possible; having a good rapport within the group; holding more meetings.

What follows from these results is that the students who perceive a lower quality in their projects recommend aspects to do with improving functioning within the group. On the other hand, the advice of groups perceiving a higher quality in their projects has to do with specific points such as relations with suppliers, or getting things done as soon as possible, which are aspects more related to the development of the subject than with how the group works.

4.6. *Satisfaction of the students*

When studying the relation between valuation of the variables "satisfaction with work in a project group," "perceived quality of the work performed," and "quality of performance as a project group," a statistically significant correlation is observed between these three variables (Table 5).

The results point to how, by means of an improvement in one variable of the process such as "quality of performance as a project group," two result variables such as "satisfaction with work in a project group" and "perceived quality of the work performed" can be improved. This amounts to an opportunity for improvement in teaching, through control of the mentioned variable of the process.

Table 4. Analysis of the relation between evaluation of the variable "perceived quality of the work performed" and the items of the scale "advice for improving teamwork".

Items	r_s	p
Greater coordination	−0.317	0.001
Having clear ideas from the start	0.208	0.040
Trying to have everything ready as soon as possible	0.253	0.012
Good rapport within the group	0.206	0.043
Finding more time for meeting	−0.234	0.021

Table 5. Analysis of the relation between evaluation of the variables "satisfaction with work in a project group", "perceived quality of the work performed" and "quality of performance as a project group". Q5

		Quality of work	Quality of group performance
Quality of group performance	r_s	0.398**	–
Satisfaction	r_s	0.269**	0.342**

5. Conclusions

This article has presented the development process and the results obtained from a questionnaire aimed at measuring the relevant variables implied in freshman teamwork. The specific conclusions drawn are as follows.

- The psychometric properties of the questionnaire make it a valid and reliable measuring device.
- The results obtained show that the mentioned questionnaire is a valuable tool that can be employed for decision-making and advising teachers and students in an academic context, namely that of college learning. Therefore, throughout the 2007–08 term, this tool will be used to identify groups that perceive faulty teamwork, with the aim of facilitating preventive work on the part of the teachers.

The use of the questionnaire developed in this research as a measuring device is exclusively indicated for the specific subjects and context with which it has been carried out. In this sense, it is necessary to take the usefulness of assessment by means of this questionnaire further, both for the assessment of the student's learning process and the quality of teaching, as well as the effect of the teaching initiatives aimed at modifying these variables.

6. Notes on contributors

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