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Effective management of work groups through the behavioural roles applied in higher education students

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ABSTRACT

One of the most in-demand skills for engineers is working effectively in a team. However, divergences inside the group often lead to the unsuccessful progress of the task. Therefore, creating a methodology that allows overcoming this obstacle and promotes successful teamwork seems fundamental. In this work, we present a novel questionnaire that we have designed and implemented to form balanced work teams based on the behaviour and personality of the group members. Concretely, the roles selected were Leader, Collaborative, Thoughtful and Creative. The role assignment was performed using a questionary and applied to different subjects and degrees. The role of Leader was predominant, but when analysing the group mates' opinions, a relevant decrease was observed, indicating that the students answered the questionary as a leader but did not show leadership capacities. The second role majority was Collaborator, and Creative and Thoughtful roles obtained the fewest percentages. Finally, the academic results of different courses and the students' feedback experience have been analysed, getting an upbeat assessment of the new methodology for forming groups, and it has also been observed an improvement in the average marks of the subjects.

1. Introduction

Teamwork is the top desired professional skill by employers in the 21st century, yet it is observed that most engineering graduates lack these skills (Zhang et al., 2020). Teamwork is not a simple combination of actions by a few members, but it is when all the members join together to form one block, which has its own goal and mission above the members' individual goals (Mahmood et al., 2017). Many factors affect the success of teamwork: group composition, lack of creativity, mastery or indifference of teammates, little or even absence of lead, personality classes and, most relevant, the conflicts related to an unequal effort and contribution by the members of the team to the task (Aranzabal et al., 2022). Therefore, the teacher's method of forming work groups is crucial to promote this skill and its adequate student development (Anson and Goodman, 2014). Typically, the workgroups are created following three pathways: alphabetical order, random selection or formation by the students. Alphabetical order or random selection is easy for the teacher, and all groups exhibit the same opportunities to carry out the task successfully or to fail it (Vasquez et al., 2020). The formation of groups by students is based on their friendship, geographical proximity, similar class schedule or the selection of a classmate due to their best academic marks. In this way, the group is unbalanced in skills, and aptitude against group work, increasing the probability of failure compared with the formation of groups randomly (Aranzabal et al., 2022; Loughry et al., 2014). Moreover, in both types of team formation, the level of participation is sometimes different, involving the student failing to achieve the work in group skill (Witt et al., 2019). Therefore, these methodologies do not consider the skills of each student and how these can help carry out the task optimally, achieve better learning results and improve marks.

Different ways of forming teamwork have been studied over years of research (Garrido and Garine, 2014). Concretely, a widely used team-forming method to develop this skill is based on classification by students' roles (Aritzeta et al., 2007; Driskell et al., 2017; Manning et al., 2006; Rahmani et al., 2021), and the Belbin role theory is the most accepted worldwide (Aranzabal et al., 2022; Belbin, 2011; Fekry et al., 2019; Meslec and Curşeu, 2015; Storch de Gracia et al., 2017). Belbin proposed the categorisation of individual behaviour within the team into nine roles: Plant, Monitor Evaluator and Specialist (roles oriented to thinking and solving problems); Coordinator, Teamworker and Resource Investigator (people-oriented roles); Shaper, Implementer, Completer and Finisher (action-oriented roles) (Aranzabal et al., 2022). However,

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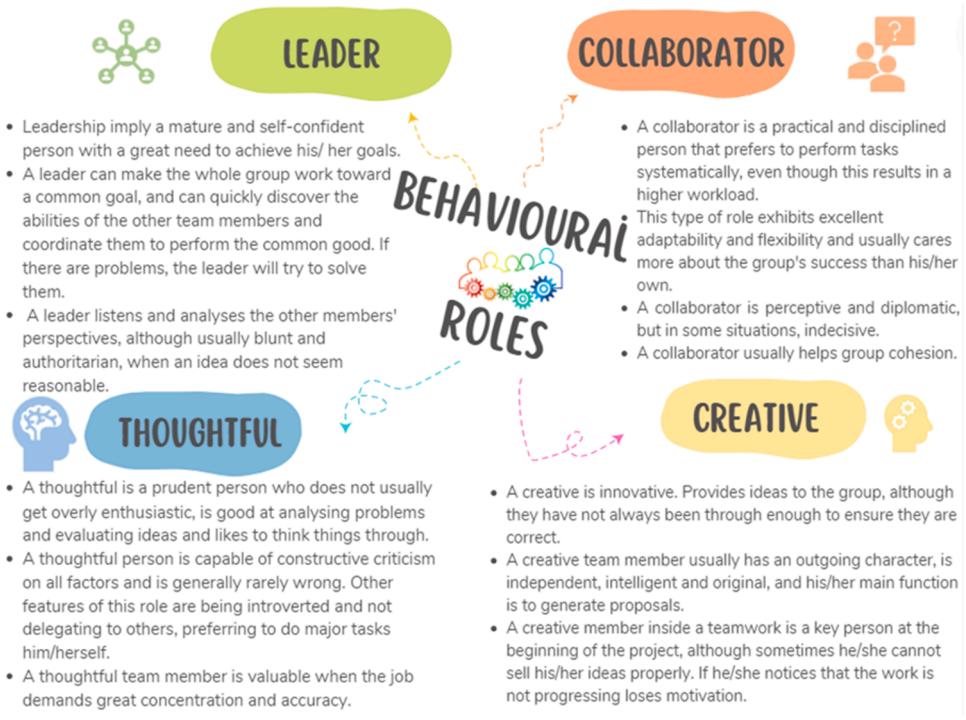

Fig. 1. Definition of four different behavioural roles: Leader, Collaborator, Thoughtful and Creative.

the Belbin method could imply that a student would have to develop more than one role in a work team, even 2 or 3, being confirmed that if the group is less than five people, all the skills proposed by Belbin are not covered (Bullen and Wood, 2006). In addition, it should be noted that if this method is applied in the first or second year of higher education and due to the lower maturity of the students, the high number of proposed roles will tend to confuse them more than cause learning benefits and the proper development of the competence to work within a team.

On the other hand, CATME is a based-web software tool (www.https://info.catme.org/) that surveys students about criteria that instructors want to use when creating teams and uses a max-min heuristic to determine team assignments based on distribution criteria specified by the professor (Garrido and Garine, 2014; Layton et al., 2010; Mahmood et al., 2017). The Team-Maker offers a list of criteria that professors can choose when forming teams relating to skills, knowledge, attitudes, and constraints, such as schedule, gender, race, discipline, leadership preferences, prerequisite courses or software skills. These are presented to students as questions in a Team-Maker Survey. Instructors can also write their own questions and choose the weights for each criterion. Previous studies have verified how the use of CATME tool in creating teams increases teamwork effectiveness and leads to higher individual and self-accountability. However, this Team-Maker tool requires a previous thorough study by the professor, supervision, and active involvement in resolving conflict and re-assigning teams (Mahmood et al., 2017).

Based on the above, a novel questionnaire to form teamwork considering the predominant and innate behavioural roles of students has been created in the present study. The effectiveness of the proposed methodology to form balanced teams has been tested in various academic activities of engineering degrees. Concretely four behavioural roles have been selected: Leader, Collaborative, Thoughtful and Creative. Compared to other published methods of team formation, the main advantage is that the questionary created for the role assignment is easy for professors and students, free and available online. Moreover, it can be expected that the lower number of roles selected lead to more balanced groups and the students can maximise their abilities to benefit themselves, the group and the proposed task. In addition, the students were surveyed about the methodology used, and the academic results of both the subject and the training activity were compared to previous courses in which the teacher randomly formed the groups.

2. Methodology

2.1. Role questionary design and application

The role questionary was configured using Microsoft Excel software to classify the student within a specific role. In this study, it was decided to use a low number of types of roles in order not to complicate the questions necessary to classify the students. Specifically, four different behavioural roles were created: Leader, Collaborator, Thoughtful and Creative. The characteristics of each role were defined considering those published in the literature (Aranzabal et al., 2022; Belbin, 2011; Kyprianidou et al., 2012; Storch de Gracia et al., 2017), and their final definitions are summarised in Fig. 1.

Once the roles were established, it was necessary to formulate a series of questions that allowed the classification of the participants into a specific role depending on the obtained answers. For this, ten questions were prepared for each type of role by the professors of the studied subjects, considering the definitions shown in Fig. 1. These questions were also reviewed by other group of professors from the Chemical and Environmental Technology Department of the Rey Carlos Juan University who performed the test and gave their feedback. Questions are shown in Table 1, distinguished by colours. The students completed the questionary, answering each question with an "x". If the person disagrees, it subtracts 1 point from the final score of the role to which the question belongs. The total score is not modified if the student neither agrees nor disagrees. Finally, if he agrees, one point is added to the score of the corresponding role.

The questions were shown in random order concerning the roles to which they belonged so as not to generate bias. After all the questions were answered, the total sum of the points and the corresponding percentage obtained was calculated for each role, and the students were assigned their specific role. Thus, once the questionary was finished, the role with the highest percentage was shown to the student. At this moment, the explanation of the main features of each role was

Table 1
Questions outlined for the different types of roles (Leader-green; Collaborator-orange; Thoughtful-blue; Creative-yellow).

nº	Questions: Leader - green; Collaborator - orange; Thoughtful - blue; Creative - yellow
1	I can be relied on to perform any task assigned to me.
2	Sometimes I find difficult to adequately express the new ideas that I have.
3	My objectivity makes difficult for me to quickly join the enthusiasm of my co-workers.
4	Although not everyone agrees, I would perform any task that needs to be done.
5	I have the ability to influence the other members of the group.
6	Generating ideas is one of my main characteristics.
7	I work well with any type of person
8	I'm not afraid to challenge others' points of view and show my own.
9	I am able to have a strong influence on decisions.
10	I can be counted on to contribute with something original.
11	Sometimes, due to my objectivity, I discourage my colleagues.
12	I gain satisfaction in a job when it requires the use of my imagination.
13	I am able to get people to agree on what the priorities are.
14	I am able to find arguments against little contrasted ideas.
15	I have no problem withdrawing a suggestion if it benefits the group.
16	Sometimes I lose concentration by turning over ideas that occur to me.
17	I prefer to do the main tasks by myself.
18	I find difficult to carry out my tasks if they have not been made clear enough beforehand.
19	I am able to reorganize the team if I see no progress.
20	I prefer to carry out systematic tasks that do not require much thought even if it means more work.
21	I easily detect which task is more suitable for each member of the group.
22	I like to be very exact in the tasks I do, even if it means dedicating more time to it.
23	I like to push for actions that ensure no time is wasted.
24	Sometimes I come up with ideas quickly without making sure they are correct.
25	I am not a very creative person, I prefer to be assigned tasks.
26	Sometimes my perfectionism is not welcomed by my co-workers.
27	I have a tendency to talk a lot when starting a new topic.
28	I find difficult to lead because I am easily influenced by the group environment.
29	I prefer to avoid the obvious and open lines that have not been explored.
30	Sometimes I am powerful and authoritative when dealing with important issues.
31	I am able to see the point of view of my colleagues and put myself in their place.
32	I get bored if the work we are doing is not stimulating.
33	I like to analyze all possible alternatives and choose the one that best suits the work to be done.
34	I am always prepared to be clear in expressing my opinions
35	I find difficult to express my point of view when there are more powerful people present.
36	I am a perfectionist with the work I do.
37	I am quick to think of new ideas and possible developments.
38	I worry when at the end of a meeting there are unresolved issues.
39	Sometimes I waste time by thinking too much about a task
40	I am aware of what I cannot do myself and I ask others for their collaboration.

displayed, and the students pointed out whether their agreed or not with the result obtained. It is necessary to consider that the students were assigned with a role that, in most cases, they only presented in majority and not 100%. However, even though it was tried to create groups with a representative of those assigned to each role, the percentage that each student contributed to the group from the rest of the roles was also taken into account in such a way that representation of each role in each of the groups was as similar as possible.

At the beginning of this work, it was intended to use a previously published questionnaire and carry out this work based on the classification obtained. However, the authors couldn't find any open questionnaire already published that could be used, so this questionnaire was developed so that, in addition to carrying out the current study, it could serve as a tool for open use by other educational institutions. The Excel file for the download of the questionnaire can be found at the following link: https://github.com/miguelsomer/RolesTeam/releases/tag/RoleTeam.

2.2. Questionnaire implementation for the creation of work groups

The implementation of the questionary to assign a behavioural role to each student was applied in the 2021/2022 academic course during the first weeks of the academic semester. For this, the questionnaire was sent to the students enrolled in the different subjects involved in this study, and they were informed of the need to complete it to be included in the workgroups for various formation activities. The issues involved in the study were: Air Pollution Treatment Techniques (from now on APTT) of the Environmental Engineering Degree (6 ECTS, 6th semester), Hydraulic and Pneumatic Machines (HNM) of the Mechanical Engineering Degree (4.5 ECTS, 5th semester), and Graphic Expression (GE) of the Industrial Organisation Engineering degree (6 ECTS, 2nd semester). They all belong to the Chemical Engineering Area of the School of Experimental Sciences of Rey Juan Carlos University (Móstoles, Madrid, Spain). The number of participants involved in the study was 58 for APTT, 46 for HNM and 55 for GE, totalling 159 students.

Regarding the distribution of the students in the groups, there is no clear answer as to how many members of a workgroup should have a university degree. It depends on several factors, such as the project to be

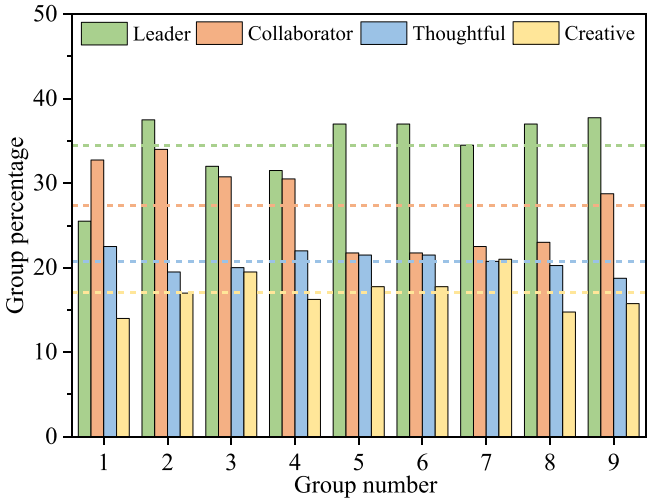

Fig. 2. Percentage of each role in each of the groups formed in the APTT subject and average obtained for all groups (dashed line).

Table 2
Detailed information about the activities developed in each subject.

Subject	Activity type	Details	Evaluation method	Duration
APTT	Laboratory experiments	Experiments related to absorption and adsorption phenomena and the use of cyclones for air particles removal	Laboratory report	20 h
HNM	Laboratory experiments	Experiments related to the operation of hydraulic pumps and turbines	Laboratory report	16 h
	Theoretical work	Identification of hydraulic and pneumatic equipment of a real installation	Theoretical report	20 h
GE	Theoretical work	Design of a logistics centre using AutoCAD software	Oral presentation	30 h

Table 3
Survey carried out for the students about their point of view on the management of work groups employing behavioural roles.

Mark with an x the opinion that best fits	Yes	No
Do you consider that the formation of groups by roles has been effective in the experimental development of laboratory practices and/or work in group?		
Do you consider that the formation of groups by roles has been effective in carrying out the laboratory practices and/or and/or work in group reports?		
Do you think that your role working group has worked better than those formed following traditional methods?		
Do you find this way of making group interesting?		
Do you consider the established roles are correct (leader, collaborator, thoughtful and creative?		
Would you recommend carrying out the formation of groups by roles for all the subjects that imply formation activities with work groups?		

carried out, the amount of time available, and the ability of each student to work in a group. Some experts suggest that an optimal workgroup can have between 3 and 7 people. A smaller group may be more efficient and less prone to conflict but may have less diversity of perspectives. A larger group may include more ideas and viewpoints but may be more challenging to manage and coordinate (Kozlowski, 2018). Hackman discusses the factors that contribute to team effectiveness, including team

Fig. 3. Stages followed in carrying out the development of effective management of work groups through behavioural roles.

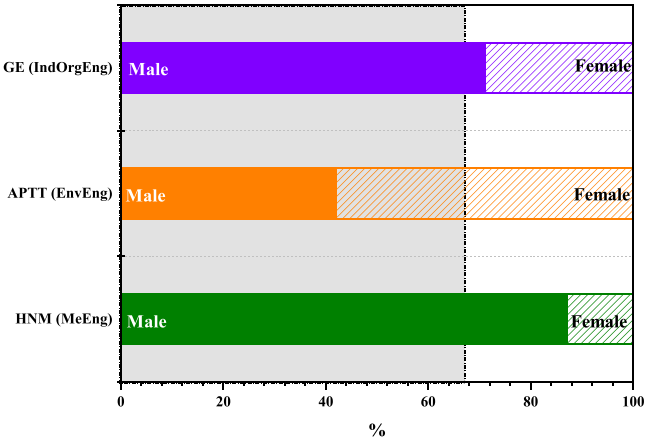

Fig. 4. Gender distribution related to the type of engineering degree.

size. He suggests that "teams with three to nine members are often the most effective" (Hackman, 2004). On the other hand, Kerr et al. examine research on the relationship between group size and group performance. They conclude that "small groups (3–5 members) tend to perform better than larger groups (6–10 members)" (Kerr and Tindale, 2004). Considering that, according to these authors, it is best to carry out small workgroups and also the experience of previous courses, the working groups were made up of 4 members, also allowing to coincide with the reduced number of roles proposed in the present work.

Therefore, once each student completed the questionnaire, the percentage for each role was calculated, and work groups of 4 members were created, trying to have one student with each type of role per group, although it was not possible in all cases. Thus, not only was the majority role obtained for each student considered but the groups were created in such a way that the total percentage of each type of role was as

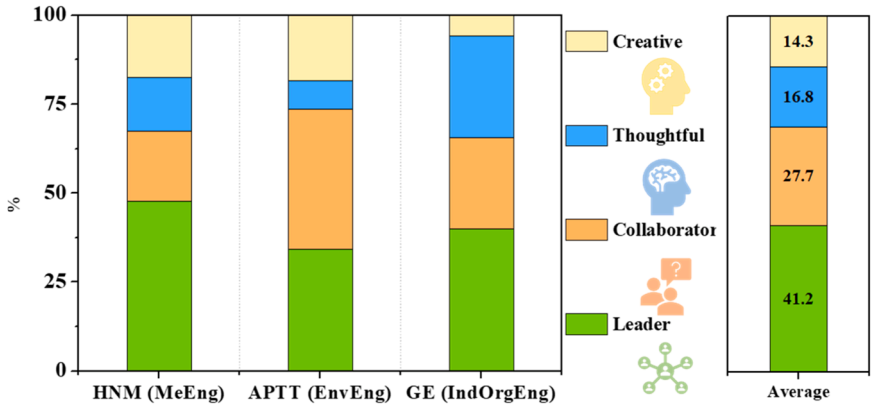

Fig. 5. Behavioural roles distribution obtained in the questionary for students enrolled in different subjects and engineering degrees.

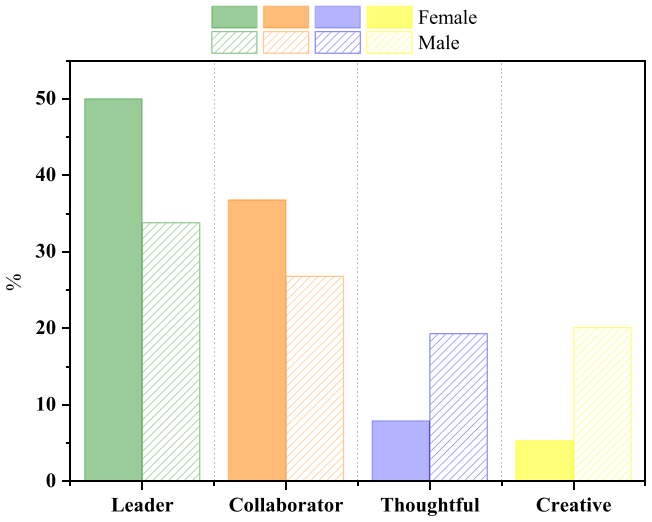

Fig. 6. Behavioural roles distribution per gender (obtained in the questionary for students).

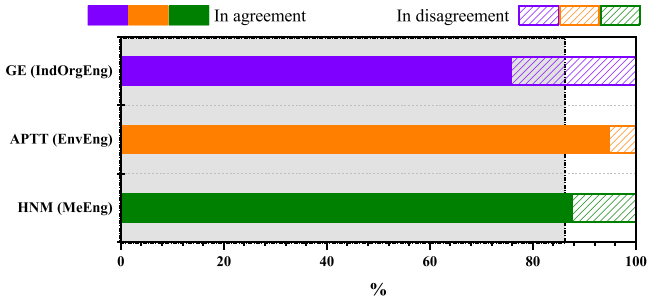

Fig. 7. Students' point of view about the role assigned by the questionnaire.

balanced as possible and similar to the rest of the groups formed. Usually, the students do not obtain 100% of the principal role, but they also get a certain percentage of the rest of the roles. Fig. 2 represents, as an example, the percentage of each of the roles obtained for the different groups created in APTT subject. It can be seen how, following what was explained above, the percentage of each type of role within the groups was very similar in all of them with maximum deviations from the average of 11.9%, 18.4%, 5.9% and 13.0% for leader, Collaborator, thoughtful and creative respectively. It is noteworthy that even though not all the roles had an equal distribution within each group (from average values of 17% for creative to an average of 34% for the leader), all groups did have homogeneous distributions with representation of all roles.

The work groups formed using this methodology served to work on the experimental practices of the subject of APTT and HNM in which, after carrying out laboratory experiments, a group report had to be drawn up for evaluation. On the other hand, in the HNM and GE subjects, work groups were created to develop works related to the contents of the subject. In this case, the team must also perform a report following the teacher's instruction. These activities were carried out and evaluated similarly in the three academic years, and more detailed information about them is shown in Table 2.

2.3. Analysis of data collection and students survey

Once the academic year was over, all the data was collected to verify the effectiveness of the group management method by behavioural roles. For this, all the students' views in the surveys were compiled, the marks obtained in the formation activities evaluated, and the final average mark of the subject for each student (between 1 and 10, being the last one the maximum mark). To complete the study, a final survey was carried out to find out the students' opinions and degree of satisfaction with the methodology used. The questions asked are shown in Table 3, in which the students answered with "yes" or "no". Moreover, students' general points of view on the new methodology applied under study were also collected employing a rating scale from 1 to 10, the last one being the best valuation. On the other hand, to check whether the role obtained by each student corresponded with the aptitudes performed in the team, the students were also asked about the role of the rest of the members of their group. Therefore, there are two different roles, one personal and individual per student, and the other based on their classmates' perception of that student's work. Moreover, it was possible to analyse the influence of gender and the type of student related to the engineering degree above the role and the marks. Lastly, the improvement obtained by applying this methodology was also estimated compared to previous courses in which the work groups were carried out randomly.

As a summary of the methodology carried out in this analysis of behavioural roles for managing work groups, Fig. 3 shows the chronological steps carried out throughout the academic year.

3. Results

3.1. Analysis of the behavioural role assigned by the questionary

Before beginning with the analysis of the behavioural roles assigned to the students by this novel questionnaire, a comparison of the distribution of females and males has been carried out according to the engineering degree in which they are enrolled. The results are summarised

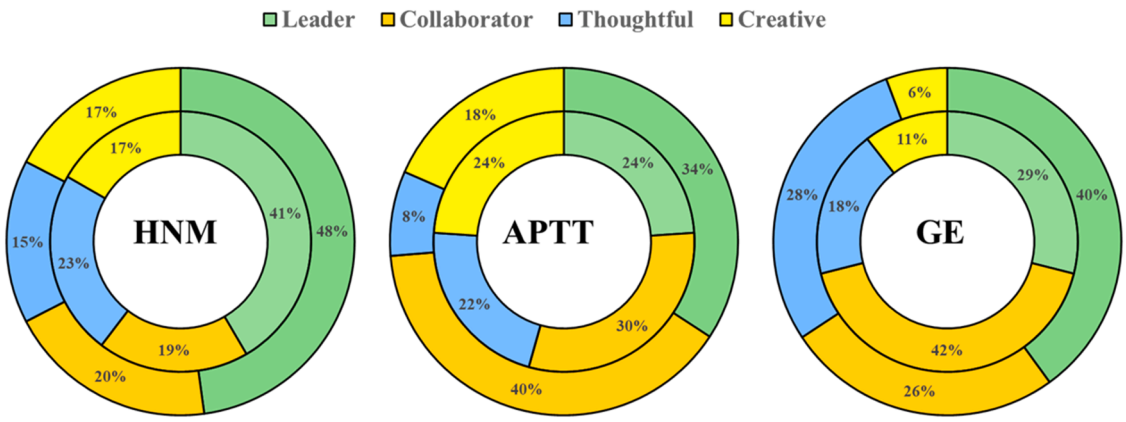

Fig. 8. Roles distribution assigned by the teammates (internal graph), compared with those given by the questionary (external graph) for every subject.

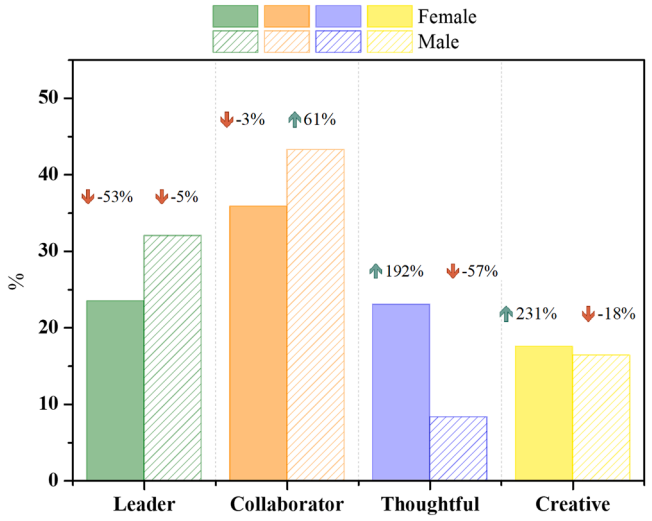

Fig. 9. Roles per gender assigned by the teammate (final) and variation of the results of the first test.

Table 4
Survey carried out for the students about the management work groups employing behavioural roles.

Survey about point of view of students over the applied methodology	% Yes	% No
Do you consider that the formation of groups by roles has been effective in the experimental development of laboratory practices and/or work in group?	90	10
Do you consider that the formation of groups by roles has been effective in carrying out the laboratory practices and/or and/or work in group reports?	82	18
Do you think that your role working group has worked better than those formed following traditional methods?	75	25
Do you find this way of making group interesting?	85	15
Do you consider the established roles are correct (leader, collaborator, thoughtful and creative?	79	21
Would you recommend carrying out the formation of groups by roles for all the subjects that imply formation activities with work groups?	74	26

in Fig. 4, in which it can be observed that the Degree in Environmental Engineering is the one with the highest number of female students and Mechanical Engineering the least, followed by the Industrial Organization Engineering Degree. This fact can be attributed to the professional opportunities of each degree. A Mechanical Engineer is more associated

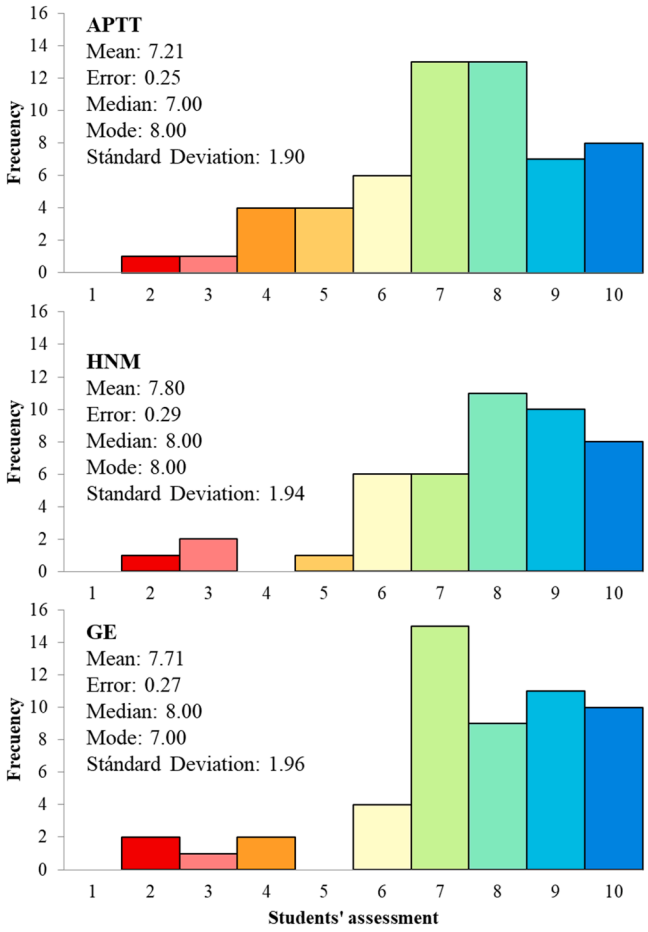

Fig. 10. Histogram of students' assessment of this methodology.

with the design and manufacture of industrial machinery (Patange and Jobaliya, 2022) and is something that, in general, is usually not motivating for a woman when she chooses the type of engineering to study. Instead, an environmental engineer who analyses environmental problems and considers the contributions of various fields of knowledge, such as chemistry, physics, biology, geology, sociology or economics, is generally more attractive to females (Rathburn, 2023). It is important to highlight as the percentage of females in Environmental Engineering is higher than the average of three degrees evaluated in the present study (see the grey shading in Fig. 4), concretely the women students reach almost 70% in environmental engineering versus the average with

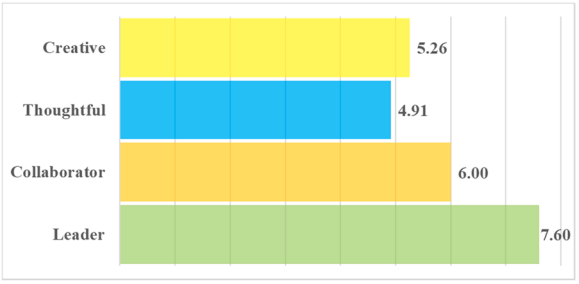

Fig. 11. Students' average subject marks based on the roles obtained in the role assignment questionnaire.

values about 30%.

According to these distributions, it is possible to conclude that it is difficult to achieve a gender balance in these subjects.

The questionnaires carried out by the students to assign them a behavioural role were analysed, and the results are presented in Fig. 5, in which the percentages of the four types of roles have been summarised according to the Engineering Degree in which the students were enrolled, and the average values have also been included. It can be observed that the role with the highest percentage, including the average of all students, is that of Leader. This result could be due in some way to two factors. On the one hand, the role of Leader can be highly regarded by society, and therefore it is the role that some students would like to show rather than what they really are. On the other hand, this majority of students with the role of leader may be due to the positive effect in which the characteristic questions of this role are raised. According the different grades, among the students of the Environmental Engineering Degree, the role of Collaborator stands out, which can be attributed to the students' character in the field of sustainability and environment, which tends to be the one that can move the furthest from the engineering concept. On the other hand, it also highlights the variability in the distribution of roles of the Industrial Organization Engineering Degree. This fact can be directly related to the subject included in this study being from the second semester of the degree, and it may imply a lower degree of maturity of the students, influencing the answers provided by the student in the questionnaire. The students do not yet have their role completely defined because they have just started their higher studies. On the other hand, the most remarkable leadership is in the mechanical engineering students, whose distribution for the rest of the roles is relatively homogeneous. Considering the average of all the engineering students included in the study, the order of roles would be: leader > collaborator > thoughtful > creative, confirming the tendency to leadership for these future engineers (Aranzabal et al., 2022; Storch de Gracia et al., 2017). On the other hand, the Creative and Thoughtful roles are the least developed in all students, regardless of grade, which can be related to the training deficit in solving and innovating engineering problems (Storch de Gracia et al., 2017). These skills are necessary to improve their future success as workers in engineering companies and will be developed in the subjects of the last years of the engineering degree.

Clear rank order differences in male and female roles are apparent, and to clarify this, Fig. 6 shows the distribution of the roles by gender obtained for the engineering students included in this study. It can be verified that women stand out in leadership. One related aspect outside this study's scope is a generational change and the role of females in recent decades. It is possible to find in the literature that women now feel safe and know the importance and relevance of their role in any proposed field of work (Martínez-Rosales et al., 2021; Samuelson et al., 2019). Although the percentage of leaders is lower for males, it stands out that in both genders, the Leader presents a higher rate, followed closely by the Collaborator role. Usually, education and learning in engineering encourage students' orientation to results and specific skills such as "apply" and "experience", i.e., work systematically. This is a clear characteristic of the collaborative role (Fig. 1), which could justify that many students fall into this role of Collaborator (Storch de Gracia et al., 2017).

Fig. 7 summarises the result of the students' point of view about the role assigned by the questionnaire and their perception of themselves. The success of the novel questionnaire proposed in this work can be verified because in all the engineering degrees evaluated, a percentage greater than 70% agrees with the assigned role. Furthermore, it is noteworthy that in the case of students coming from environmental and mechanical engineering careers, values above 80% were obtained, which can be associated with their greater maturity as they are more advanced in their academic development.

3.2. *Analysis of the role assigned by the teammates and evaluation of questionary success*

In the present study, a survey was carried out to analyse the role assigned by the teammate once the work in the group was finished, i.e., the personal point of view about the behaviour of their group colleagues and the role that they considered prevailing in each one. Fig. 8 shows the role assigned by the teammates (internal graph) compared with those obtained by the first questionnaire. It is relevant to aim that both results agree reasonably well. Among all the roles, it is possible to find higher differences in the leadership one; concretely, there is a significant decrease (from 48% to 41% in HNM, 34–24% in APTT, and 40–29% in GE). According to the subsequent perception of their teammates, this decrease is distributed among the rest of the roles homogeneously. This deviation can be attributed to the typology of the group activity. For example, students spend much time in HNM or APTT laboratory practices and can better know each partner's role. However, in the case of the GE subject, the activity is a report employing Autocad software, and the student can perform at the university and from home. Because of that, the student does not know each partner's role deeply. Moreover, in the GE subject, the discrepancy between roles could be explained by its students' lower degree of maturity because they are in the second semester of the engineering degree, as has been commented on in previous

Table 5
Average marks and statistics parameters achieved in formation activities for the last three academic courses.

	HNM_Prac (MecEng)				APTT_Prac (EnvEng)		
	Main	Error	Standard Deviation		Main	Error	Standard Deviation
2019–20	7.50	0.138	0.93	2019–20	7.63	0.125	0.84
2020–21	8.08	0.076	0.57	2020–21	7.45	0.093	0.69
2021–22	8.43	0.050	0.34	2021–22	7.80	0.066	0.49
	HNM_Work (MecEng)				GE_Work (IndOrgEng)		
	Main	Error	Standard Deviation		Main	Error	Standard Deviation
2019–20	8.80	0.114	0.77	2019–20	7.20	0.111	0.82
2020–21	7.95	0.096	0.65	2020–21	7.00	0.072	0.61
2021–22	9.05	0.075	0.50	2021–22	7.50	0.068	0.57

sections.

On the other hand, Fig. 9 summarises the students' thinking about the role that the rest of the classmates in their group have played during the activity. The figure also indicates the deviation of these values concerning the values obtained from the previous questionnaire, where each student obtained the type of role that seemed most appropriate for himself. It could be observed that the female sex exhibited a higher percentage of leaders in the initial questionnaire. However, there was a decrease of more than 50% when groupmates were granted the roles. This indicates that some students responded to the questions as if they were capable of leadership but could not demonstrate it in front of their peers. In the case of men, this decrease in the number of leaders was significantly lower, with a difference of around 5% between both values. On the other hand, the reflective and creative roles increased notably in the case of women, 192% and 231%, respectively. In the case of men, a notable increase could be seen in the collaborative role, with a 61% increase. It is noteworthy that a marked gender difference is observed in the role when the point of view of the peers is considered. This result had already been previously reported in other studies in the literature (Anderson and Sleap, 2004). Consequently, despite the evolution in the conception of women as workers in any professional field, it can be concluded that their allocation to leadership positions is less than that of men. It is necessary to point out that the number of male students enrolled in the subjects and grades evaluated is higher than that of women, and given that men may think that women are less leaders, a thoughtful and creative role has been assigned to female students.

3.3. Students' feedback experience and opinion

The proposed methodology's success in managing work groups per behavioural roles has been analysed based on the students' point of view. For this, they answered a final survey with yes or no about different relevant aspects to evaluate this new strategy to do the work teams. Table 4 shows the average percentages obtained by all the students. It can be observed that the opinion of the students is very positive on all the topics asked, and they consider employing this methodology in other subjects and training activities an excellent idea. In addition, to verify the students' point of view on the new methodology employed, a survey was also included using a rating scale from 1 to 10, the last one being the best valuation. Fig. 10 shows a histogram and the main statistics parameters of these results, observing that in the three subjects, the average value was higher than 7, with a low error and standard deviation, which allows us to conclude that the methodology was well-valued by the students.

3.4. Students' performance and comparison with previous academic courses

The different roles selected in this study to form working groups (Leader, Collaborator, Thoughtful and Creative) have been analysed based on the average academic success of the students of each type of role assigned by the initial questionnaire.

The results are shown in Fig. 11, representing the average mark of the subject corresponding to the different roles. Its score depends on a large number of factors, many of them related to reasons not evaluated inside the classroom. Notably, the leaders exhibit the highest score, followed by the collaborators, which agrees with the features of these roles described in the previous sections. Leadership implies a mature and self-confident person with a great need to achieve their goals, and a collaborator is a practical and disciplined person that prefers to perform tasks systematically, even though this results in a higher workload. On the contrary, those who get the worst grade are the Thoughtful ones with an average mark of just below five (minimum to overcome the subject), which can be attributed to their characteristics, features or abilities; concretely, they are not usually too enthusiastic, and it is valuable when the work requires a lot of concentration and precision. In addition, the group activities under study, and described in Table 2, require the development of other skills such as practice, dexterity, and collaboration, which are not characteristic of this role.

Finally, to evaluate the effect of this methodology under study, Table 5 shows the average grades obtained in the training activity for each subject, compared to those achieved during the two previous courses (2019/20 and 2020/21) in which the teacher randomly formed the work groups. It should be noted that in the 2019/2021 academic year, the pandemic made it difficult to carry out group activities, and many times it was replaced by individual or group activities carried out online. As a result, the error presented by these values, like the standard deviation, was higher. However, the methodology applied in the groups during the 2021–22 academic year allows us to observe a decrease in the standard deviation in all the activities evaluated.

Consequently, the comparison allows us to conclude the clear improvement regardless of the training activity (laboratory or group work) for all subjects; Specifically, the average grade increases by more than half a point. Therefore, it can be seen that a slight improvement in the qualification has been achieved, and the students highly value this team-building methodology.

4. Conclusions

This paper shows how a questionnaire has been designed and implemented to effectively manage work groups by behavioural roles in different subjects and engineering degrees at Rey Juan Carlos University. The questionnaire is simple and practical for teachers and students, which is an advantage for collecting objective results. The answering allowed assigning the student into a behavioural role, concretely, Leader, Collaborative, Thoughtful and Creative. The survey carried out confirms the high degree of satisfaction of most students. The results obtained show that the average of the subjects was better for the students with the Leader role, and those assigned to the Thoughtful one obtained the worst marks. Moreover, the improvement in the marks of the formation activities of each subject under study when the roles are employed to form the workgroup was verified. All these data confirm the effectiveness of the behavioural roles to form work groups rather than randomly, and it has been confirmed that most of the team members improve their learning.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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