

# Monitoring Indicators for CTMTC: Comprehensive Training Model of the Teamwork Competence in Engineering Domain

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### Abstract

This paper proofs three initial hypotheses in relation with the teamwork competence. Firstly, the new university students access to the University without enough knowledge about teamwork competence because they have not been trained or evaluated in this competence. This justifies the use of our Comprehensive Training Model of the Teamwork Competence (CTMTC) method, which allows individualized training and assessment of teamwork competence in all the stages, including the outcome of this teamwork too. Secondly, the realised fieldwork for obtaining indicators that allow evaluate the required effort in order to use CTMTC, focusing on aspects of monitoring (formative evaluation) and outcomes (summative evaluation) and also the enormous effort in time for the teachers to carry it out, are shown. Thirdly, the final evaluation grades obtained by the teams and by their individual members, with the CTMTC method, justify the need of applying that personalized evaluation method and the search of technological tools, such as learning analytics, to help its implementation.

**Keywords:** Teamwork; Competences; Learning Analytics; White-box testing

## 1. INTRODUCTION

Teamwork is one of the most commonly required competencies that employees ask for (see [1-3]), as well as being an educational dexterity that is widely used in teaching processes of any educational level. The teamwork competency (hereafter the TWC) is one that is included in the majority of teaching syllabi for university subjects; being a learning objective for all university studies in Europe.

Nevertheless, the implementation of teamwork in an academic environment is normally carried out by means of the “black-box testing” model [4] (similar idea to the method of software testing). This means, that normally instead of evaluating the TWC itself, only the result obtained from the work is evaluated, based on the quality of it once completed. In this case, the students are left to develop the TWC simply by being exposed to or immersed in a team.

On the other hand, another reason why the “black-box testing” model is normally used in universities is to recognise that students gain admission to university degree studies with the acquired TWC, given that they are used to carrying out teamwork in a non-university learning context. In this article, we present the study undertaken regarding the acquiring of the teamwork competency in a non-university learning context, with which we demonstrate that students reach university without the TWC skills themselves and without having been evaluated by teaching staff.

There are currently research studies and models in which methodologies have been developed in order to create and evaluate the TWC (in addition to the result itself). In this sense, our research team developed the model known as Comprehensive Training Model of the Teamwork Competence (hereafter the CTMTC) ([5]) which allows a strategy to be carried out that is based on the “white-box testing”. This means, it involves a model that consists of three layers: the conceptual layer, which structures and describes the dimensions of the operative TWC in the context of education, in addition to the methodological and technological layers, which cover the procedure and resources in order to carry out a continual monitoring of the teamwork. Educational evaluations can therefore be produced in order to guarantee both the teamwork competency being acquired and the quality of the result. [6].

Throughout the work process [7], a table of factors is included that increase the efficiency of the group (equal distribution of the work, organization of the projects, etc.) and therefore it can be demonstrated that our method creates and evaluates aspects that have been demonstrated to be useful in order to increase the efficiency of the group.

The application of “white-box testing” methods is highly effective in the development of the TWC, however they require a great amount of effort on behalf of the teaching staff. Subsequently, their application is practically relegated to those subjects in which all of the assessment criteria are attributed to teamwork. Obviously, if the TWC represents a small part of the overall grade given for the subject, it is to be expected that both the teachers and students dedicate time and effort that correspond with the part attributable to the overall grade; and of course, if this is the case, to carry out an assessment of the teamwork to determine if it is effective and influential or not for the teaching staff with common methods

The widespread use of the “white-box testing” methods can become a reality thanks to ‘Learning Analytics’, the objective of which is to analyse the data that is produced on behalf of the student in the learning processes. This data is used to understand and optimize the learning process in the environment in which it takes place [8].

The problem is not having data available, as this can be gathered from the learning management system used, but rather distinguishing which of the data is relevant and deciding how to use it so that it helps with the decision making. As is supported by G. Siemens [9], the objectives of analysing the activity of trainees should be to address the problems that are important for the teachers. In this sense, the work that we present provides an identification of relevant data which, after being managed and processed by a Learning Analytics system, will allow the process of decision making, both for the educational evaluation (monitoring of the TWC) to be carried out and the overall evaluation (result of the work and the TWC). The benefit of using technology to carry out the monitoring of the TWC is demonstrated, and not only in terms of collaborative and communicative aspects that are particularly fundamental in teamwork [10].

## **2. CONTEXT**

This research has been undertaken by the Polytechnic University of Madrid (hereafter the UPM) with the participation of 304 students from different university degrees and 82 students from the University of Zaragoza (hereafter the UNIZAR). In total, 55 work groups have participated in the UPM and 22 groups in UNIZAR made up of six students and four respectively, for whom data has been gathered and a monitoring process carried out.

The starting premise is to recognise that the TWC is important from a social and professional point of view and the hypotheses or objectives to be demonstrated for this investigation are as follows:

- Hypothesis 1: “Students start university studies without having been taught or evaluated in the TWC”
- Hypothesis 2: “The “white-box testing” education of the TWC requires a large investment in terms of time”
- Hypothesis 3: “The development and evaluation of the TWC needs its educational process to be of the “white-box testing” type”.

It is important to demonstrate hypothesis 1, given that a large number of university teaching staff expect students to have already acquired the TWC, as a result of having carried out teamwork in their previous educational stages. Therefore, it means that it is not specifically necessary to teach the TWC as part of the learning program. As is outlined in hypothesis 2, carrying out a daily supervision of each work group requires an educational and evaluation model, but this would require the teaching staff to be very dedicated, in order to oversee both the monitoring process and the educational evaluation and overall assessment. With regard to hypothesis 3, the CTMTC method allows the TWC to be taught by means of the “white-box testing” format and the results of the evaluation for the experience justify the need to apply this method.

In the following sections of this work, we will present the results that are demonstrated for each one of these hypothesis.

## **3. HYPOTHESIS 1: STUDENTS START UNIVERSITY STUDIES WITHOUT HAVING BEEN TAUGHT OR EVALUATED IN THE TWC**

It is therefore very important to identify relevant data for teamwork carried out by the students for their analysis and decision making processes, in such a way that the effort required in the TWC learning process is minimised. In this section we describe the methods used in order to carry out the study concerning the extent to which the TWC is acquired, as well as the research undertaken in order to obtain the indicators.

In order to demonstrate that students start university studies without having been taught or evaluated in the TWC, a survey was compiled with direct questions about the aspects of the TWC, as well as other indicators. Those indicators should allow us to determine whether techniques have been used to carry out teamwork and if they have been evaluated by their teachers. Below, the size of the sample and the structure of the survey are indicated, in order to finalise the results that serve to support the hypothesis.

### 3.1 SIZE OF THE SAMPLE

295 of the 304 students participating in the experience in the UPM and 65 of the 82 students participating in UNIZAR, answered the survey questions. So the sample size is 360.

### 3.2 STRUCTURE OF THE SURVEY

The survey contains two kind of questions:

- Questions in order to obtain the basic profile of the students: demographic, university student and their experience with academic teamworks.
- Questions about the phases and aspects of teamwork, that is, the phases of the CTMTC model: Mission and Objectives, Planning, Execution and Presentation [5]. We highlight the questions focused on the second phase (Planning) and the third phase (Execution).

The majority of the second kind of questions are formed according to a seven-point Likert scaling response. The scaling used meant: 1- never, 2-rarely (less than 20%), 3-sometimes (between 20% and 40%), 4- half the time (between 40% and 60%), 5-quite often (between 60% and 80%), 6-very often (more than 80%) and 7-always.

The structure of this part of the survey focuses on three main types of aspects:

- **Basic tasks** associated with a teamwork competency (e.g. planning). Likert type questions.
- **Indicators** of the competency:
  - **Execution** of the activity that represents the competency considered: Likert type question.
  - **Evaluation** of the competency, evidence used and the time it is carried out. Likert type questions, open and multiple choice, respectively.

### 3.3 RESULTS OF THE SURVEY

#### 3.3.1 Survey question about academic teamwork previously undertaken.

From the answers to the questions concerning how many works they have undertaken throughout their studies prior to university, the following percentages are deduced: 2% answer that they have not undertaken any, 40% have undertaken between 1 and 5 works and 57% have undertaken more than 5 works.

#### 3.3.2 Survey questions associated with the planning phase.

We will look at some of the results from the survey questions concerning the planning skill and with the indicator for carrying out and evaluating the activity that represents the said skill, the map of responsibilities.

- **Basic tasks** associated with planning phase:

The wording of **Question 9** is: *From the day that you were informed of the work to be carried out and the members to participate in the teamwork, to the date on which the final result of the work was submitted, evaluate the extent to which you carried out each one of the following tasks, on a scale from 1 to 7:*

- a) Part of the work was assigned to each member of the team and a date for its completion was established.*
- b) A method was established in order to be used to monitor the progress of the work carried out by each member of the team.*
- c) The steps were identified that should be followed in order to carry out teamwork, before designating the tasks.*
- d) A calendar was created for the activities in which the result to be obtained in each activity should be included.*

The students perceive that they have carried out tasks characteristic of the TWC. For example, in question 9 in which they are asked about the basic tasks of planning, on average they answer that 'quite often' (5; maximum 7) have they carried out the designation of tasks (9a-5.3, 9c- 4.9); whilst only a scale of 3.5 is reached, on average, for tasks related with the monitoring of the planning (9b-3.6, 9d- 3.4). We have observed that these types of questions tend to be answered as a result of the mean values of the scale used, in our case close to 4; so in order to receive answers in more detail, more specific questions were asked, see [11].

- **Indicators** (execution and evaluation) of the planning skill. We call **Indicator B**: "Visible document that reflects the tasks and responsibilities".

About the **Execution** of the activity, if the students are used to make the type of document of indicator B.

The wording of **Question 13** is: *Have you ever made a map of responsibilities in any teamwork you have been involved in (a map of responsibilities is a document that reflects the tasks and responsibilities of each member and which is visible for the whole team)?*

About the **Evaluation** of the TWC, namely, the evidence used by the teacher to evaluate the planning skill and the time when it was carried out. The wordings of the three related questions are the following:

**Question 14.** *Did the teachers grade the creation of the said map of responsibilities?*

**Question 15.** *What information did the teacher use in order to grade the said map of responsibilities?*

**Question 16.** *If you have answered 1 (never) in question 14, do not answer this question. When did the teachers carry out the evaluation of the map of responsibilities? Options to answer: Before completing the final project; After completing the final project.*

Nevertheless, when specific indicators are asked about, like the map of responsibilities (indicator B) for the team in question 13, the distribution of the answers is clearly asymmetric in a way that the answers are mostly (51%) grouped into the first value, 1 (never). See the first row in the table 1.

In terms of the evaluation of the competency indicator, the teaching staff on the whole did not evaluate the execution of the indicator B (question 14, answer 1 - 82%, see the second row in the table 1) and which in the cases in which it was evaluated, for 65% of the answers they reflected that it was done after the final project was completed (question 16, see the results in the first row of the table 2)

### 3.3.3 Survey questions associated with the execution phase of the teamwork.

In this case, we consider the following three indicators, in which both the execution of tasks that support it and their evaluation on behalf of the teaching staff are considered. **Indicator C.** Resolve any doubts, ideas for improvements, etc. **Indicator D.** Monitoring and progress of the work. **Indicator E.** Making decisions by means of debates.

Alike the indicator B (see subsection 3.3.2), the survey contains similar questions related to those three new indicators. One question related to the execution and three questions related to the evaluation of every indicator. In table 1, five ratings are presented instead of the seven of the Likert scale for the questions, grouping the scales 2 and 3 into a single one (Rarely or Sometimes) and 5 and 6 (Quite often or Very often) and the following results are included:

- *Execution.* In a generic way, students carry out cooperative measures, the indicators C and E reach rather high percentages for the execution. The situation is different when they are asked about indicators that reflect the execution of specific tasks for teamwork, like B and D, for which we can confirm that they are not normally used, as almost 50% state that they have never carried out this type of task.
- *Evaluation of teamwork skill.* Having said that, both in the case of the cooperation indicators, C and E, that they say they normally use, as well as in the monitoring and planning indicators that they do not normally use, the teaching staff did not evaluate the said indicators or tasks associated with the TWC. It is sufficient to look at table 1 and read that the percentages for the option "Never", in the Evaluation row of all indicators, are greater than 80%

Not only was it made clear that the teaching staff had not evaluated the TWC, but rather that in addition, more than half of the students that answered the survey, indicated that at least once they had been evaluated in the skill but that evaluation was carried out after they had completed and submitted the work. See the second column of table 2.

Table 1. Distribution of the frequencies for the execution and evaluation of the indicators of the TWC

Table 2. Percentage of students evaluated in the TWC and time of their evaluation.

## 4. HYPOTHESIS 2 "THE "WHITE-BOX TESTING" METHOD OF THE TWC REQUIRES A LARGE INVESTMENT IN TERMS OF TIME"

The teaching plan in the TWC was structured using the phases of the CTMTC model [5]: mission and objectives, planning, execution and presentation. It included material with descriptions of each phase, examples and recommendations, and the related activities. Next, the activities needed in order to carry out the individual monitoring are shown for the CTMTC method, showing some of the differences in the application of the CTMTC model in each university (which shows its flexibility), and which leads us to the same confirmation of the hypothesis.

At the **UNIZAR** the field work was carried out with 22 work groups, consisting of 3 or 4 students. Two groups did not complete the designated work. The deadline for completing the teamwork was 6 weeks, the subject matter was chosen by the work group and from four options offered by the teacher and the weight designated to the work with respect to the final grade of the subject was 10%.

The grade obtained by the students for the teamwork was distributed in the following way: 15% for the participation in the decision making processes (individual grade), 15% for the planning of the execution (joint grade), 40% for the quality of the work result (joint grade), 15% for what they have learnt (individual grade) and 15% for the peer evaluation (individual grade). As a result, the grade given specifically for the teamwork competency is 45%, the result of adding the first two 15% to that of the peer evaluation.

The participation in the decision making process was evaluated by means of their involvement in the forums that were created for such a purpose. Some of the threads were designated expressly as part of the teaching process of the TWC and others arose spontaneously.

In terms of the planning of the work to be carried out, it was assessed that the team would have created a teamwork schedule in which the different work tasks were clearly defined, which were assigned to one or various team mates and which were published in one of the private places (wiki or file depository) for the team of the Moodle course activated for such a purpose. See [12].

For the evaluation in pairs, the students were asked to reflect on the contribution of the other team members, and that of themselves as well, in terms of the work carried out. This reflection was guided by the questions of a survey created ad hoc. The responses obtained were used in order to obtain the corresponding grade.

Global data of the process: forums, with 164 threads and 615 messages, 20 wikis and 64 files and a formative evaluation during the execution phase of the work plan. Disaggregated data on the phases of teamwork are:

- Phase 1. *Decision making: selecting the work to be undertaken and designating the team coordinator.* Forum phase 1 (160 messages) and Wiki team (21).
- Phase 2. *Planning: construction and publication of the work calendar, indicating the tasks assigned and the members of the team responsible for them.* Forum phase 2 (310 messages) and Wiki team (20).
- Phase 3. *Monitoring the work plan.* Forum phase 3 (101 messages) and file depository of the team (20 folders).
- Phase 4. *Conclusion of the work.* Forum phase 4 (44 messages).

The magnitude of the effort made in the monitoring process (progress of the work by means of forums, of the wiki and of the repository of the team) and evaluation can be deduced from the number of messages.

In the **UPM** the field work was carried out with 55 work groups, consisting of 6 students on average, and the deadline to complete the teamwork was 3 months, the subject matter was chosen by the work group and the weight designated to the work with respect to the final grade for the subject was 20%. The grade obtained by the students for the teamwork was distributed in three parts of equal value: 1/3 for the planning, execution and participation (individual grade), 1/3 for the analysis and synthesis skills (individual grade) and 1/3 for the quality of the work result (joint grade).

The tasks for the planning, execution and participation were undertaken using forums. On the whole, different threads were used for the different phases of the teamwork. By means of these threads the TWC as individuals and a group was evaluated: the effectiveness (cooperation, propositions, measures demonstrating knowledge, messages of motivation and debates), responsibility (common knowledge, involvement in all of the threads, assuming responsibilities), leadership, planning, organisation and monitoring.

The evaluation of the analysis and synthesis skills was carried out by means of the analysis of documents created and of references used by each member of the work team. The tool used was Dropbox. The result of the work was captured in a wiki created by the group and in a presentation (both the result of the work as well as the resources used during the execution of the teamwork). Based on the wiki, the quality of the work, its use and brainstorming was evaluated.

With respect to the investment in time on behalf of the teaching staff, the following data can be deduced: 7 forums, 4,000 messages, 55 wikis, 600 documents, 500 threads. A “white-box testing” educational method of the TWC requires that at the very least an educational evaluation of each team is carried out (in our case there were two) and an overall evaluation. In addition, taking into account that the grade had to be individual, a monitoring of each student is necessary.

In terms of the data from the forums used for the monitoring of the TWC, as well as for the educational evaluation, it was as follows: number of threads, name of the threads, application of rules to the threads, type of threads, creating a summary of each thread, person that starts the thread, person that closes the thread, dates the threads were started and ended, involvement in the threads by each participant, period in which members were involved in the thread with respect to its end date, type of involvement, total number of messages per thread and per forum.

The effort made by the teaching staff in this monitoring process, in the progress of the work by means of the forums and Dropbox, meant an average amount of time of 10 minutes per student and revision, in addition to approximately 15 minutes per group and revision to write the report. In total, 3 hours and 45 minutes were needed per group, which equates to an investment in terms of time of 206.25 hours for the 55 groups. The supervision time needs to be added to that for the result of the work, which, on average, was 15 minutes for each wiki. As a result, the part that requires the greatest amount of weight designated to it is in the monitoring, supervision and individual evaluation of each member of the group. This data confirms the hypothesis with respect to the effort that is required in order to follow a “white-box testing” method.

Once the educational process was finished and the final grade for the learning of each student was attained, two studies were carried out concerning the said grades, which helped to somewhat demonstrate the validity of hypothesis 3. More specifically, we chose to use two criteria: the comparison of the joint grades for the groups (average of its members), and the analysis of the internal difference of the grades of the members of the group.

Firstly, the data, of the figures which contain the team grades, are presented.

**Data obtained for UNIZAR:** in Figure 1 the average grades (range from 0 to 100) are presented for the teams, ordered from lowest to highest.

Fig 1. Average grades (0 to 100) obtained by the teams in UNIZAR

**Data obtained for UPM:** the average grades (range from 0 to 100) for the 53 teams, that completed the work designated to them, are shown on two consecutive graphs: Figure 2 and Figure 3. The first graph contains the average grades less than or equal to 60 and the second one shows those between 60 and 100.

Fig 2. First part of average grades (0 to 60) obtained by the teams in UPM

Fig 3. Second part of average grades (60 to 100) obtained by the teams in UPM

Secondly, we can observe the variability between groups of both Universities. As a result, we judge the appropriateness of carrying out a study concerning the variance that supports the idea that there are differences between the average grades of the different teams. In both cases, the  $p$ -value of the analysis of the variance (ANOVA) is  $2 \times 10^{-16}$ , then it can be rejected the null hypothesis: “the average calculated for the grades of the teams are the same”, with a level of significance greater than 99%. This means, we can recognise that not all of the average grades are the same.

Lastly, the variability of the grades within each group can be viewed by means of the studentized residuals (differences between the average grade of the group and that of each member).

Suppose that a grade within a team is defined as atypical grade if it has a studentized error lower than -2.01 or greater than 2.01 (probability of 95%) in the UNIZAR case or which have a studentized error lower than -1.96 or greater than 1.96 (probability of 95%) in the UPM case. Then there are three teams (22, 25 and 32) or fourteen teams (G01, G06, G11, G14, G22, G29, G31, G34, G36, G38, G43, G54, G55 and G60), respectively, in which the educational/evaluation method has detected a significant difference in the performance within the team.

Somewhat less restrictive would be to consider as atypical grades those that produce an absolute error greater than 1.6775 (probability of 90%) for UNIZAR teams, or greater than 1.645 (probability of 90%) for UPM teams. In this case, we add another four (4, 6, 9 and 26) or another three teams (G13, G16 and G21), respectively, with notable differences in the performance. In summary, in the most moderate case, three UNIZAR teams out of twenty (15%) can be considered as heterogeneous/varied, or even in a broader sense, seven teams out of twenty (35%) can be considered that way. See Figure 4. And, in the most moderate case, fourteen UPM teams out of fifty three (26.4%) can be considered as heterogeneous/varied, or even in a broader sense, seventeen teams (32.1%) can be considered that way. See Figure 5, the group 38 has been excluded due to it containing a member that was extremely atypical ( $r_{student} = -9.38$ ), as it therefore prevents us from seeing the rest of the variations with sufficient clarity.

Fig 4. Residual values of the grades obtained by the team members in UNIZAR

Fig 5. Residual values of the grades obtained by the team members in UPM

As a result, this method of evaluation and learning for the competency in teams leads to different individual grades. It is observed that the majority of the teams are homogeneous (65% and 68% respectively), given that all of their members obtain similar grades. However, the method that has been followed has been able to detect that there are teams (35% or 32%) in which the performance of some of its members has been notably greater or lower than that of the rest of the members.

## 5. CONCLUSIONS

The students have carried out teamwork in their studies prior to going to university, however they do not use the techniques that are characteristic of the TWC; in particular they have not developed skills that are required in order to monitor their individual responsibilities or those of the progress of the work.

It has been demonstrated that the teaching staff did not evaluate any of their skills in terms of teamwork, not even the skills that students normally carry out spontaneously, like how they help each other out. The lack of a form of evaluation

reinforces that students do not practise these skills. Similarly, on the few times when teachers do carry out an evaluation, they do so, on the whole, after the work has been completed and submitted. In conclusion, students start university studies without having been taught or evaluated in the TWC. The methods based on “black-box testing” prevail, in which only the result is evaluated and once the teamwork activity has been completed. Therefore, we can confirm hypothesis 1.

With regard to the effort made by the teaching staff, it is also clear, based on the volume of information created by the students and the monitoring work and educational evaluation needed in order to channel the development of the competency. Hypothesis 2 is thus demonstrated.

The results referring to the grades demonstrate the effectiveness of the CTMTC method for the learning of the teamwork competency and for its subsequent individual evaluation based on the group activities. In fact, on the one hand, almost 84% of the groups of both experiences obtain an average grade that is greater than the central value of the spread of the grades (see the data in figures 1, 2 and 3). Furthermore, it has been confirmed by means of the analysis of the variance that there are significant differences between the grades obtained by the teams. On the other hand, 32% (UPM) and 35 % (UNIZAR) of the groups (see figures 4 and 5) have had important variations in the grade of its members, meaning that it can be concluded that giving the same grade to the whole team does not reflect the development of the competency of its members. Therefore, it is necessary to use a “white-box testing” type method that allows the measures and achievements of each member of a team to be distinguished. Hypothesis 3 is thus demonstrated.

Therefore, the “white-box testing” methods like the CTMTC are effective, but not productive, meaning that the efficiency of the said methods would need to be improved. The TWC can be evaluated by means of the organisation of the forums, the threads, the involvement in the threads and the content that is created temporarily by each member of the team. The analysis of such data is therefore viable, by means of the Learning Analytics techniques and this research team is working on it.

The said analysis would increase the effectiveness and the efficiency of the CTMTC. It would allow a reduction in the time needed by teaching staff to carry out a monitoring process and an educational evaluation of the individual teamwork competency. A Learning Analytics system would provide the analysis of the evidence data during the making process of the teamwork. It would help the teaching staff to make decisions in relation with the training, evaluation and accreditation of the TWC. Such as the supervision (to identify those individuals that are not developing the competency and the evolution of the teamwork with respect to the anticipated planning), teaching evaluation (to carry out measures depending on the evolution of the teamwork like the involvement of each member) and an overall evaluation (to assess to what extent the individual competency is acquired and the planning of the teamwork).

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**Á. Fidalgo-Blanco** is responsible for educational innovation of the UNESCO Chair in University Management and Policy and Director of the Laboratory for Innovation in Information Technology at the Polytechnic University of Madrid. He has actively participated as principal investigator in R&D, both national and international. He has been the organiser of many seminars and conferences for many years and he is currently the president of the organiser committee of the International Conference of Learning, Innovation and Competitiveness (CINAIC, Spanish abbreviation). He is an active researcher in educational innovation, knowledge management and educational technologies and educational communities from the social networks, having generated as a result of both publications and information products.

**D. Leris** is Professor of Applied Mathematics in the School of Engineering and Architecture and member of the Quality Evaluation Board of Electrical Engineering Degree at the University of Zaragoza, Spain. She is actively involved in the Research and Innovation Group in Training supported by Information and Communication Technology (GIDTIC for its Spanish abbreviation). Her current research interests focus on teamwork competency, team training, long-life learning and mathematical competencies training. She coordinates or participates in research and innovation projects from national, local or university funds. She has experience and expertise in the field of adaptive courses in LMS Moodle with multi-conditionals.

**M. L. Sein-Echaluce** is Director of Virtual Campus and Professor of Applied Mathematics in the School of Engineering and Architecture at University of Zaragoza, Spain. She is the main researcher of the Research and Innovation Group in Training supported by Information and Communication Technology (GIDTIC, Spanish abbreviation). She is the president of the scientific committee of the International Conference of Learning, Innovation and Competitiveness (CINAIC, Spanish abbreviation) and takes part in evaluation committees of the local calls of innovation projects and of the international conferences. Her research is currently focused on technologies applied to cooperative methodologies and the usage of Open Source LMS and other tools for online adaptive learning. She takes part in national projects with other research groups, in the organisation of events, in training activities for educational institutions and also in conferences and papers cooperating with Spanish and foreign researchers.

**F. García-Peñalvo** is researcher in GRIAL (research GRoup in InterAction and eLearning) and he belongs to the Research Institute for Educational Sciences at the University of Salamanca. His main research interests are related to online education.



Table 1. Distribution of the frequencies for the execution and evaluation of the indicators of the TWC

		Never	Rarely or Sometimes	Half of the time	Quite often or Very often	Always
<b>Indicator B.</b> <i>Visible document that reflects the tasks and responsibilities</i>	Execution	51%	20%	10%	16%	3%
	Evaluation	82%	7%	3%	7%	1%
<b>Indicator C.</b> <i>Resolve any doubts, ideas for improvements,...</i>	Execution	1%	8%	15%	58%	18%
	Evaluation	84%	5%	3%	7%	1%
<b>Indicator D.</b> <i>Monitoring and progress of the work</i>	Execution	47%	14%	14%	21%	4%
	Evaluation	83%	8%	2%	5%	2%
<b>Indicator E.</b> <i>Making decisions by means of debates</i>	Execution	8%	15%	15%	46%	16%
	Evaluation	83%	6%	4%	6%	1%

Table 2. Percentage of students evaluated in the TWC and time of their evaluation.

Indicator	At least evaluated at some point	Evaluated after completing the work
<b>B.</b> <i>Visible document that reflects the tasks and responsibilities</i>	18%	65%
<b>C.</b> <i>Resolve any doubts, ideas for improvements,...</i>	16%	60%
<b>D.</b> <i>Monitoring and progress of the work</i>	17%	49%
<b>E.</b> <i>Making decisions by means of debates</i>	17%	39%

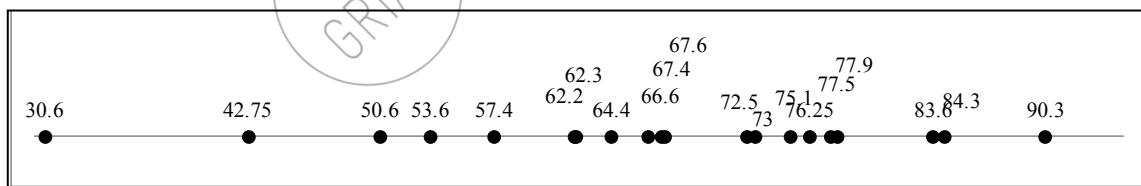


Fig 1. Average grades (0 to 100) obtained by the teams in UNIZAR

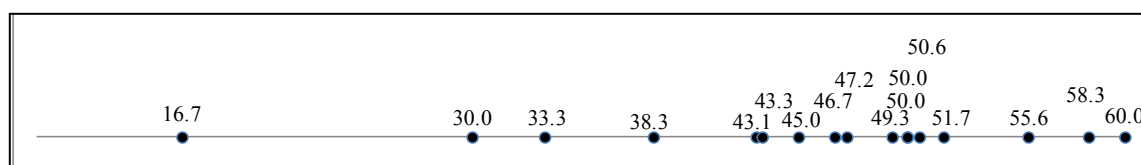


Fig 2. First part of average grades (0 to 60) obtained by the teams in UPM

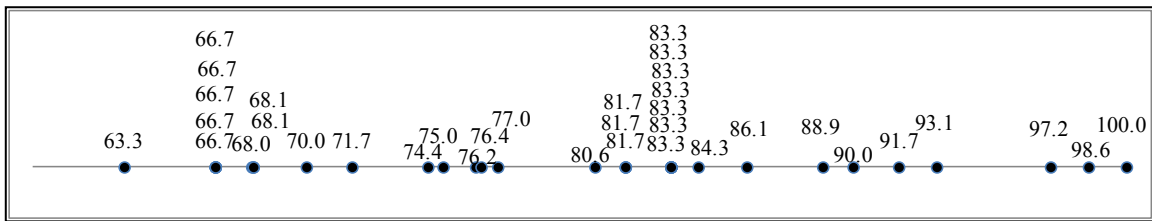


Fig 3. Second part of average grades (60 to 100) obtained by the teams in UPM

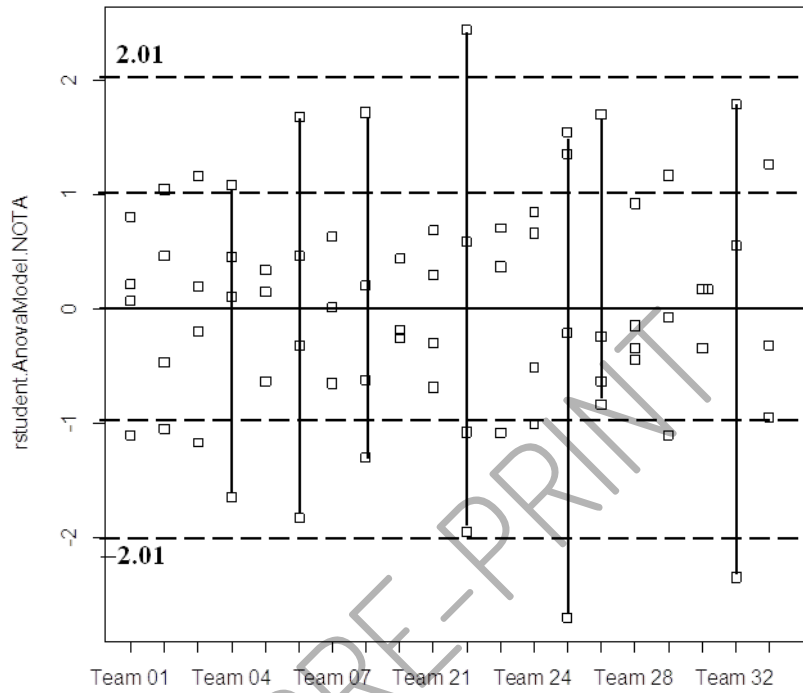


Fig 4. Residual values of the grades obtained by the team members in UNIZAR

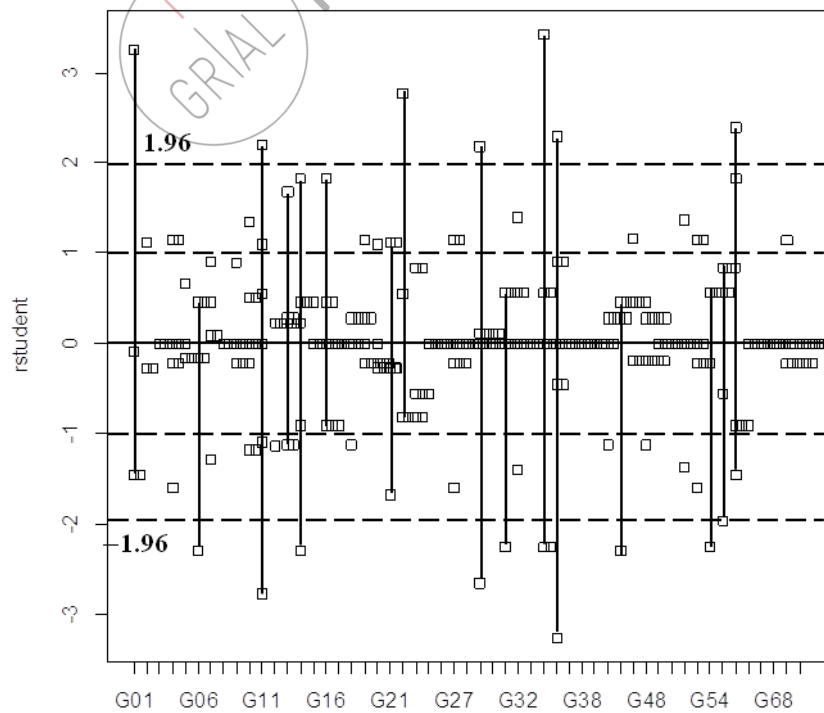


Fig 5. Residual values of the grades obtained by the team members in UPM