

Assessing the individual acquisition of teamwork competence by exploring students' instant messaging tools use: The WhatsApp case study

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Abstract: Nowadays, working in groups is very usual and popular in most professional environments. Thus students, as potential workers, need to acquire teamwork competence in their educational institutions. However, when the students are working in groups, it is easy assessing their final result but not so much evaluating how each of them, individually, is developing teamwork competence. In this sense, there are several methodologies, and those with better results are the ones that explore students' interactions in learning platforms when developing the activity/project. Taking into account the latter, students' interactions do not only happen in a learning platform but also using other tools such as instant messaging tools. This paper explores the possibility to assess the use of instant messaging tools for the acquisition of teamwork competence, and specifically, it presents a case study about the use of WhatsApp. From the results, we can conclude that the students prefer to use Instant Messaging Tools in teamwork activities than other interaction tools as forums; and that the employment of those tools has a positive impact in students' grades.

Keywords: Teamwork competencies, instant messaging, Mobile Devices, WhatsApp, Students' Interactions.

1 Introduction

One of the main aims of educational institutions is to prepare students to succeed in the world of work. Currently, companies and institutions develop their activities in a technological and changing context, so they need flexible professionals, ready to use the technology, who work together towards a common goal. This means that their workers must develop competencies to "survive" in this competitive landscape. They have to achieve competencies such as critical thinking, problem-solving, computational thinking, time planning or teamwork [1-3].

This paper is specially focused on these competencies' acquisition and specifically on teamwork competence (TWC) development. TWC is highly demanded by the industry and therefore a key competence in the educational systems [4]. TWC development is desirable because: 1) as we have already mentioned, in companies it is very common to work in teams, so future workers need to know how to do it properly [5]; and 2) TWC contributes to improve students' learning because they will interact with peers, which implies sharing knowledge and information that later will lead to the definition of solutions in a cooperative way [6,7]. In fact, the Bologna process considers it one of the key competencies to be acquired by the students in Higher Education [8].

Given these reasons, TWC has grown in importance in learning programs both formal and non-formal learning contexts. Many experts, tools and resources are being employed to facilitate the competence acquisition. With all this support, the development of team or group activities is affordable at all learning levels, but what is not easy is the evaluation of the competence acquisition. In this sense, the most common position is to assess the final result of the students' group activity. In this way it is possible to evaluate first if the students have been able to address a problem, develop a project or complete an activity as a group; and secondly to grade the result. However, this is not enough and the process and each student contribution should be evaluated as well to assess the individual acquisition of teamwork [9]. This requires methodologies and/or tools that explore the shreds of evidence of the individual contributions during the overall process. Some possible approaches are [10]:

- Event-based techniques, which were proposed as a way to evaluate complex simulation scenarios [11,12]. This case is based on facing students with simulated critical events that require the development of teamwork competencies to be solved. These approaches have been shown to be successful, but they cannot be easily used in all the

different educational contexts, usually, they are applied in very concrete scenarios and with a limited number of students;

- Observation, that is, tracking what students are doing to assess them by using a scale (e.g.: Behaviorally Anchored Rating Scales BARS [13] or Communication and Teamwork Skills (CATS) [14]) that grades team behavior issues. This approach works well but it is constrained by the number of students and the educational context where the activity takes place. For example, it is easy to assess 20 students that only work together in a class, but not so much 150 that work in the class but also beyond the educational institution;
- Peer and self-assessment approach. In this case, the students should rate their peers and their own work while they are solving a task, project or activity as a group. It is a good technique but the results are not always objective and can be biased by different issues such as the context, the relationship with peers, etc. Some samples of experiments and instruments to apply these approaches can be seen in [15-17];
- Analysis of shreds of evidence in IT-based learning tools. In this case, the idea is to analyze the students' interactions recorded in their Learning Management Systems (LMS) or in other tools they use to learn. This analysis requires the use of heuristics, rubrics or the application of algorithms to obtain knowledge of the individual acquisition of TWC. These methodologies are not limited by the number of students or the context but should be adapted to the technologies or tools used. A sample of this approaches is the Comprehensive Training Model of Teamwork Competence (CTMTC) [18,19].

In the case of the preset work, given the drawbacks presented by the other methodologies, we decided to use the latter approach. Specifically, we considered CTMTC [19]. It is a flexible methodology adapted from the popular project management stages defined by IPMA, the International Project Management Association [20]. The students will follow the phases defined in CTMTC methodology to develop a project or a learning activity as teams. CTMTC is going to evaluate the students' learning shreds of evidence obtained from: 1) the completion of the stages (the definition of the team, the mission and the objective, the distribution of work, the work schedule, the work development and the outcomes obtained from the process); 2) team members' collaboration to create a common knowledge; and 3) the team outcomes and the interaction of their members in IT tools when producing them. Tools such as Wikis, Forums, Cloud Storage Devices, etc. [19].

This methodology has two main strengths. On the one hand, as the students are using the technology and leaving shreds of evidence of their interaction, the teachers or coordinators of the learning activity can track what they are doing in every stage of the project development. Moreover, they can know how each individual member of the team is collaborating in

the project development and how the project is progressing in each moment [21]. On the other hand, it is very flexible, there are a lot of shreds of evidence of the methodology success and how easily it can be adapted to different contexts [9,21-26].

However, CTMTC also has drawbacks. During these experiments the students have been asked about the methodology. Regarding the main disadvantages that they found, students agreed that they will change the tools employed to interact with peers. In most of the experiments, this tool was the LMS forum, in these cases the forum provided by Moodle. That is an asynchronous tool with a lot of functionalities commonly used in most LMS courses with different aims [27]. Students argued that they do not interact with their peers with this kind of tool and the conversations could seem to have not sense and look artificial, instead of them they prefer instant messaging (IM) tools such as Telegram, Snapchat, WhatsApp or even SMS [28].

These tools are very popular because: 1) they make possible a synchronous interaction between peers (including text, images, video or voice exchanging), that is, they are a communication way [29]; and 2) they can be installed easily in almost any smartphone.

This popularity is shown by statistics such as the number of IM accounts that in 2019 was around 7.0 billion [30]; or the number of users of the most popular IM tools in 2019:

Whatsapp with 1,6 billion users, Facebook Messenger with 1.3 billion users, WeChat with 1.1 users, QQMobile with 0.8 billion users or other with less accounts as SnapChat or Telegram [31]. Moreover, IM users state that they prefer to employ them as a communication channel instead of other such as phone calls or email [32,33], which justify why the students prefer them as a real interaction tool when developing the projects.

This means that we could apply IM tools, but this first requires to study the impact they could have in the educational process and how they are applied. Regarding the first issue, the use of IM tools has been associated with several positive effects such as: that IM tools enhance the communication of the educational process stakeholders [34-39], facilitating their collaboration and their knowledge exchange and increasing their sense of presence and ubiquity [39,40]. However, the application of IM in education is not always positive because these type of apps and the device where they are installed can be a distraction source for students [41,42].

Regarding the possible application of IM there are two main trends, those focused on the use of IM as a communication channel [40] and those that employ them to gather and analyze shreds of evidence about students interactions [43]. However, the analysis carried out does not address TWC assessment.

Given this background, the main aim of this work is to facilitate students in using an instant messaging tool to interact with peers while applying CTMTC during project development. The interactions will be gathered and analyzed in order to assess the individual acquisition of the TWC.

The rest of the paper is structured as follows: section 2 describes the tool developed and the architecture to integrate it in to the LMS. Section 3 presents a case study. Section 4 is devoted to show the results of such experiment that are discussed in Section 5. Finally, Section 6 includes some conclusions.

2 The technological solution

In order to check how IM tools can be integrated into a learning context, we have modified the framework proposed in [22] as a proof of concept. The result of the framework adaptation is shown in Figure 1. It is possible to distinguish two main components:

- The LMS, as the place where the students carry out part of the formal learning activities, and that is employed to publish the results and gather students' interactions while applying the CTMTC methodology. In this case, we used Moodle because it is quite popular all over the world [45-47] and because it is the LMS that uses the university where the case study is developed. Figure 1. shows the Moodle packages employed during the proof of concept. One of them is a plugin implemented to gather and parse the students WhatsApp conversations. This component was described in [44]. It allows the teacher to instantiate a WhatsApp activity. In this activity, each group of students should upload its conversations and include the correspondence between WhatsApp contact ID and the national IDs used in the LMS.

The plugin will parse the file and store the information gathered as logs in a new table included in the LMS database, this is why the plugin should use the LMS core.

Another important element that we employed from the LMS is the Web Service Layer. The integration of a new tool into the platform is not easy, which is why we have defined a LA tool that obtains the data from Moodle and to do so use the web service layer, that will gather the data from Moodle database by accessing to the LMS Core.

- The other main component is this LA Tool. It should represent the information about students' interactions in WhatsApp. In order to do so the LA tool will show the shreds of evidence recorded of the learning activities with different levels of detail:
 - General detail. It includes general information about the number of messages, groups, and students involved. It also provides information about each group (messages, students, multimedia messages and long messages). Figure 3. shows a sample of the tool;
 - Group detail (Figure 2). Describes the stats for the group and its members. First provides aggregated data from the group, number of students, messages, average number, number of multimedia messages, average characters of group message and use of long messages. Then, it includes the list of the group students with the number of messages of each of them, the average number of characters and the number of messages with more than 140 characters.

With this implementation of the tool as a proof of concept we carried out a case study described in the next section.

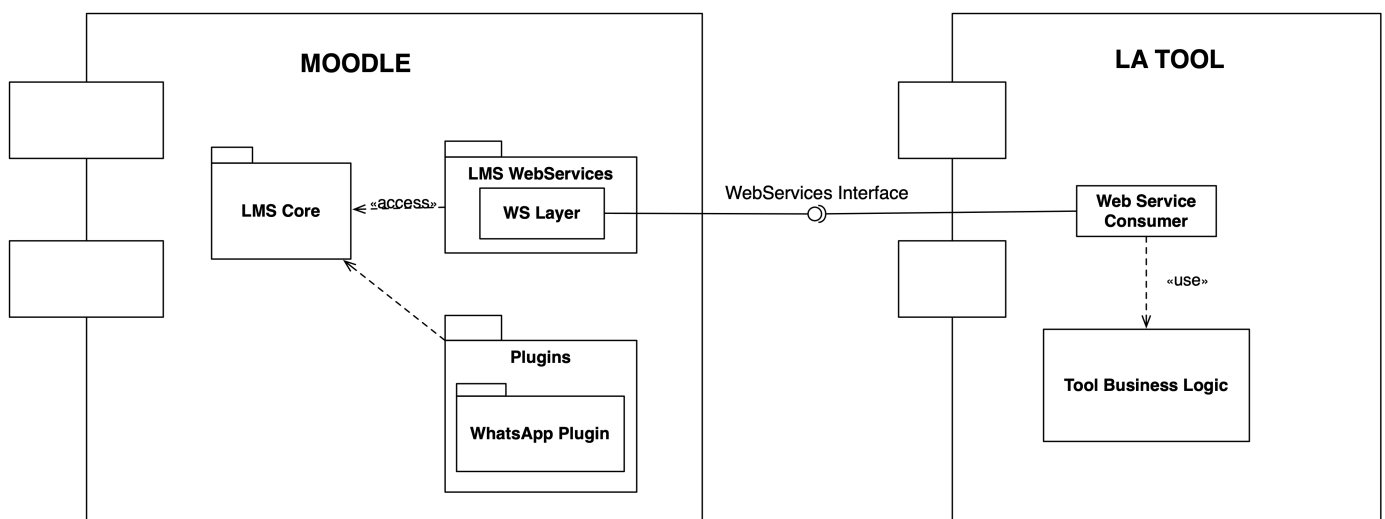


Fig 1. Technological framework adapted from [22].

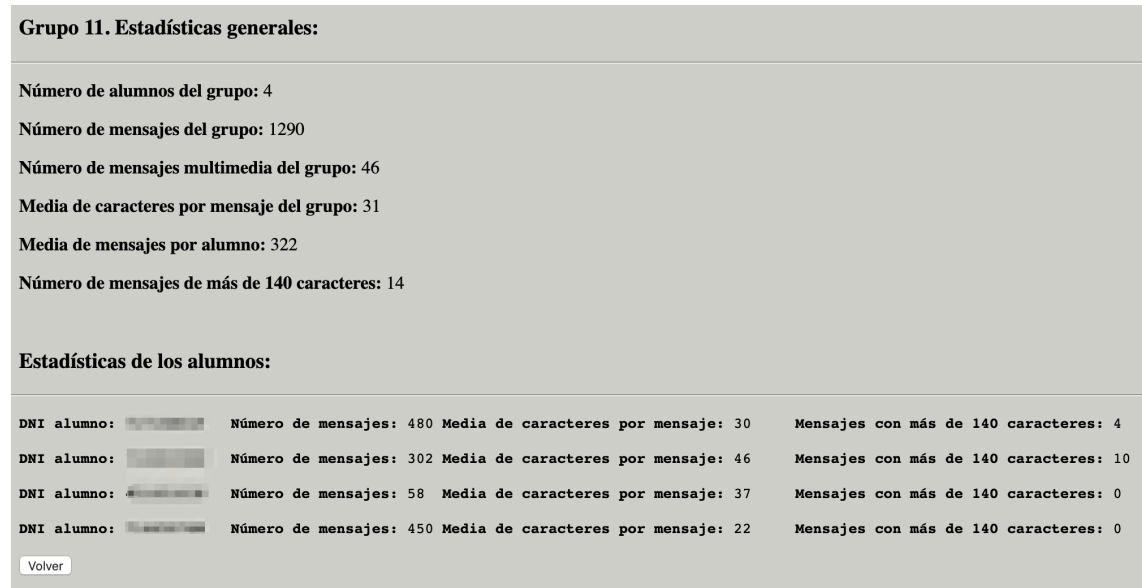


Fig 2. Detailed information of a group in the LA tool.

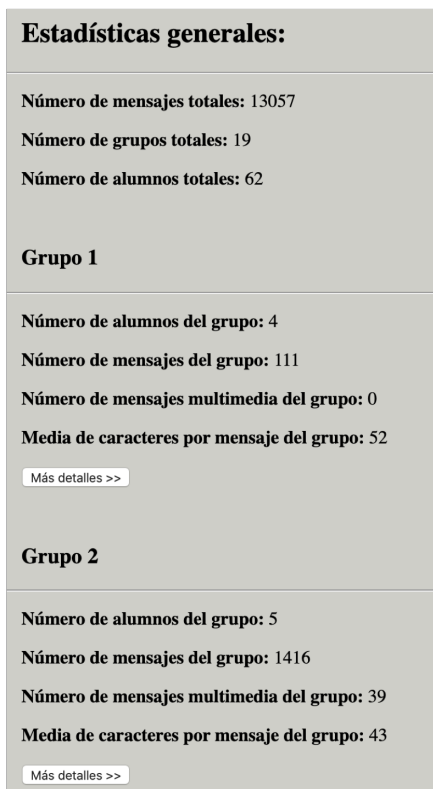


Fig 3. General information about the groups and the process.

3 The Case Study

In this section, we describe how the implementation has been employed in a Computer Science Bachelor Course of the University of León.

3.1. Context and Sample

This case study has been carried out in the Operating System (OS) subject, which is a second-year course subject with an enrolment between 100 and 130 students. It deals with the fundamentals of operating systems from a practical perspective. Although theoretical concepts are taught as lectures, most of the contents are developed as lab work. The subject assessment consists of the evaluation of theoretical/practical concepts through questionnaires (a 35% of the final grade) and two mandatory assignments to evaluate the practical part (65% of the grade). From the latter, the first assignment is individual and is weighted with 35% of the practical grade and the second (also called final assignment) is carried out by students' groups and accounts for the rest of the practical grade. Students should pass the theoretical and practical part separately to pass the subject.

For the case study, we decided to use the final assignment. We did this because the teachers have applied to it the CTMTC methodology during the last 5 years with good results and a good acceptance by the students [26]. This academic course the subject has 100 enrolled students and from them, only 84 delivered their final work, with a total of 24 students' groups of 3 or 4 students each.

3.2. Methodology

But how do those groups proceed? Until this year the students should address a project proposed by teachers in groups freely chosen of 3 or 4 members. Each group should name a team coordinator and develop the CTMTC phases. The partial results of those phases were published on Moodle Wiki and the interaction was carried out by using Moodle Forums. In addition, they can use tools to share content such as Google Drive, Dropbox or GitHub.

In this case, we apply the same methodology, but as the students claim that it would be better for them to use more realistic interaction tools, we employed WhatsApp. The use of WhatsApp was not mandatory, as the available options included to continue using forums, use the forums and WhatsApp and use only WhatsApp.

For those that decided to use the IM tool, the teacher defined an activity instance into Moodle where the students uploaded their WhatsApp conversations. The conversation was parsed with the information introduced by the students and the interactions were stored in the database.

The use of WhatsApp affects the traditional way of assessing the work in the CTMTC methodology. It consists of a formative and summative assessment. Summative assessment is based on the results of the work while the formative assessment in the partial group results and in the interaction. Part of both assessments requires exploring students' interactions and, in this case, it happens not only in the LMS but in WhatsApp, so the nature of the interaction is not the same.

This requires changing the rubric defined for evaluation as published in [25]. This rubric has two parts, one devoted to the group shreds of evidence (mostly based on the Wiki results) and another related to individual shreds of evidence (specially forum interactions). In this case, the original rubric attends to several issues such as responsibility and engagement (related to the student participation), tracking what the other students have done (related to students forums visualization), discussion (how the students participate and give feedback to their peers) and leadership (related with who starts the threads, who gives feedback or who makes decisions). Some of the items were thought for the forum shreds of evidence and are not valid for WhatsApp so that part of the rubric has been adapted as shown in Table 1. Tracking cannot be included because it is not possible to register if the students have read or not the WhatsApp messages, the other items have also been adapted.

Table 1. CTMTC Rubric – Part for Individual work

INDIVIDUAL WORK – CTMTC RUBRIC	
Responsibility and engagement	<p>Is the student participating actively in all discussions?</p> <ul style="list-style-type: none"> • Are the number of messages similar to the average number in their team (+/- a 20%)? • Average characters under their peers (- 20%)
Discussion	<p>Are team members commenting and giving suggestions to help their peers?</p> <ul style="list-style-type: none"> • Do they answer the different discussions? • Do they have more long messages than short messages?
Leadership	<ul style="list-style-type: none"> • Who starts discussions? • Who is solving problems? • Who is making decisions?

It is necessary to take into account what we understand by short and long messages and by starting a discussion. For the first issue we maintain for the proof the same number of characters that we employed in the forums, which is 140 characters. Regarding the beginning of the discussions we have considered that a message posted within a period of 4 hours during the day can be an answer to other and 8 hours at night. That is, if a message is out of these hours range it is a new conversation. The case study will serve us to test this to assessment parameters.

3.3. Case study evaluation

Regarding the experiment evaluation we followed a mixed approach [45] which takes into account both quantitative and qualitative data. The quantitative data is based on average grades comparison between those that do not use WhatsApp, those that use it and those that use both. Qualitative data is obtained from a questionnaire that gathers students' perceptions about CTMTC methodology with some open questions about the improvement introduced by including WhatsApp and questions about how easy to use is the tool to import WhatsApp conversations. The form is available here: <https://forms.gle/PdURAbrqGiPpdAjz6>.

4 Results

The results obtained from the case study as described above are analyzed quantitatively and qualitatively. Table 2 shows the number of students, average grade (of individual work) and standard deviation, depending on if they have used WhatsApp, Forums or both during the development of the final assignment. It should be pointed out that to be evaluated individually the students should previously pass a test, so not all the team members have been evaluated, something that also happened in previous CTMTC applications when using forums.

Table 2. Results for each tool choice

	WhatsApp (G1)	Forums (G2)	Both (G3)
Number	64	16	6
Average Grade	8.90	6.92	8.2
Standard Deviation	1.21	1.66	0.98
Average WhatsApp Messages	210.95	-	188.66

Regarding the WhatsApp users, we should point out that we had 15141 messages, from 70 users (those that only use WhatsApp and those that use both this tool and the forums), which means 216,3 messages per student, although we should mention that groups of students that later do not deliver the program have less collaboration than the others. In

addition, we can attend to the number of long messages, which is only 393, a 2% of the total interactions.

The next step is to compare the average grades of the students that use WhatsApp with last edition students (2018/2019) in which they used forums. This requires analyzing the normality and homoscedasticity of the sample. In this case, as the sample involves more than 50 values, we have used the Kolmogorov-Smirnov test. In this test we check the null hypothesis that data distribution is normal, and obtained a value of 0.516, which is greater than 0.05. We can accept the null hypothesis, but we apply the Lilliefors correction and obtained 0.09 which is greater than 0.05 so we can say that the sample has a normal distribution. We have applied a Fisher homoscedasticity test to check the difference in variances with a value of 0.26 greater than 0.05 so there are not differences in variance. Given these two values, we applied a parametric test to compare average values, a T-test. In this case, the null hypothesis is that both groups have similar average values and there are not significant differences. We obtained from the test a t-value of 4.885 value and a p-value of 5.963e-06 which is lower than 0.05 so we reject the null hypothesis and we can argue that there are significant differences in the average grade when using WhatsApp and when using Forums in CTMTC.

Regarding the qualitative analysis of the data, we have explored the text answers to the open questions related to the methodology and the use of WhatsApp. In order to do this, we grouped students' responses following a proximity criterion for Q1 (the advantages of using the methodology), Q2 (the drawbacks found), Q3 (other tools employed) and Q4 (the advantages of using WhatsApp and IM tools instead of forums when developing teamwork). The results are combined and shown in a matrix (Table 2) as suggested by authors such as [46]. The table shows a sample of 20 students out of the 70 that answer the questionnaire, the first 20 answers.

In addition to such data we obtained from the questionnaire that 100% of the students found the importation of WhatsApp conversation tool easy to use.

5 Discussion

After the case study, regarding the quantitative data it is possible to see several interesting issues.

First of all, regarding the number of messages, it is not possible to know if the number is normal, high or low, because we cannot compare it with forums. What can be seen is that the number of messages is higher than the possible messages in forums, but they are also shorter in length. This makes necessary to adapt the rubric applied in the methodology, more concretely the number of characters of a long message, which in the case of WhatsApp will be 40 characters according to previous studies [47,48].

Beyond the number of messages, we can also study how many students decide to use each tool. Although the use of WhatsApp in the methodology is optional, 64 students (out of the 86 that deliver the assignment) have used it as the only

interaction tool, that is a 74%, percentage that reaches 79% if we include those that use both WhatsApp and the Forums (G3). This means that if they can choose, they prefer to use this IM tools.

It is also interesting to attend to the average grade obtained in the individual acquisition of the TWC. Grades are high but especially good for G1 students, with 8.9 over 10 vs 6.9 over 10 of G2 students. This fact can also be observed when comparing the grades of students using WhatsApp (G1 and G3) with students from previous editions of the subject (in which forums were the only choice as an interactive tool). We have carried out statistical analysis showing that there is a significant difference in grades between these two groups, which means that grades are better using WhatsApp. This can be related to the increase of motivation because of using familiar tools [49], a fact that is usually linked with obtaining better grades [50].

Also, regarding grades, we should point out that G3 students, that is, those who use both WhatsApp and forums, have worse grades than students only using WhatsApp. This may be explained by the distribution of their attention between these two tools, which means that they need to employ more or less the same time than G1 students in WhatsApp (something supported by the low difference in average messages between G1 and G3 groups) and some more in the forums.

We have also analyzed the perspective of the students about the methodology as we also did in other applications of CTMTC such as [25,26]. The results of the advantages are similar. Students consider that the methodology facilitates them in managing the projects and improving issues such as planning, work distribution, setting of deadlines, tracking their work and peers' work, etc. This is linked with the development of what is understood as teamwork behavior [17], as a necessary step to the acquisition of the so demanded TWC. One difference from previous applications is that 14 answers, that is, 20% of the students, pointed out communication as an advantage, something that was not common in previous applications of the approach where the use of the forums was one of the main drawbacks of our approach. Another positive issue was that only 1 over 70 answers considers that CTMTC has not advantages, which is 1.4% over the total answers. In previous experiences, the results were worse.

Regarding the disadvantages, several students stated that in their opinion CTMTC application has none. The rest described several, some of them focused on issues related with project management such as the completion of tasks, the difficulty of working with peers, that the grade does not depend on the work of the student but on the group, the time they need to devote to the methodology, etc. This is normal, students are in the second year of the degree, and have never participated in project-based learning approaches.

Regarding the additional tools used, the most common are Google Drive (to share content), Discord (for voice discussion) and GitHub (as control version system). In this case, they have not employed other IM Tools.

Table 3. Students' perception about the use of CTMTC and WhatsApp (truncated to the first 20 students opinions)

	<i>Advantages</i>	<i>Drawbacks</i>	<i>Tools</i>	<i>WhatsApp</i>
S1	Easy to deliver and finish work	None	No	To use a daily life tool
S2	Easy to learn to work as a team	Needs to be clarified from the beginning	Discord	More comfortable
S3	Projects are easily addressed	Peers that do not work	No	Quick and efficient
S4	Facilitate project management and task completion	Restrictive	No	Natural and straightforward
S5	Organize the work of each team member	It is not easy to reach agreements with my peers	Discord	Simpler
S6	Track project progress	None	No	More interactive
S7	Good for teamwork development	It is complex	Google Drive, Github and Discord	That I use it commonly
S8	Tasks distribution	None	No	Easier communication
S9	Facilitates work distribution	Does not include voice discussions analysis	Google Drive	Immediate and popular
S10	Collaboration among team members	Agreed in schedule and planning	Github	Straightforward
S11	Fair evaluation of each team member work	Does not include video discussion analysis	Skype	More comfortable
S12	Improves communication	None	No	More direct and better interaction
S13	Common way to address the projects	The use of forums and wikis	No	Integrated in our daily life
S14	Work as a team	Submission is more complex	Discord	Facilitates tracking work
S15	Facilitates coordination and communication	Boring to follow all phases	Google Drive	Not so boring as forums
S16	Improves team planning and communication	Allow forums in addition of WhatsApp	Discord	Better interaction
S17	Support team management and project progress	None	Google Drive, Discord, Skype, Github	Faster interaction
S18	Improves planning	Peers availability to work	No	Faster communication
S19	Supports the work management and the publication of the results	Time necessary to address the work	Discord and Codeshare	Real communication
S20	Supports team member communication	Forums, we have used WhatsApp	Discord and Github	Familiar to us

Finally, we gathered students' opinions about the use of WhatsApp as an interactive tool when applying CTMTC methodology. The results show that they feel comfortable with the employment of this tool because they use it in their daily life, and for them is quicker than checking the forums or their emails to see if someone posted something and that it is quite straightforward. In any case, they prefer to use a synchronous tool than an asynchronous one.

In order to conclude the discussion, it is important to clarify that the experiment has only been carried out with one class and that students were allowed choosing the interaction tool to use, so probably some of the feedback can be biased by this. It will be interesting for future research to repeat the experiment and force students to use only WhatsApp.

6 Conclusion

TWC acquisition is a key issue in our current educational systems, so a lot of efforts are being devoted to facilitate it. Subjects at different educational levels are applying methodologies such as Project-based Learning or Problem-based Learning, that require students working in groups and help developing TWC. However, a critical issue is to assess competence acquisition and specially how it is acquired individually.

CTMTC is a flexible methodology that facilitates this work but it has an important drawback, as it is necessary to gather students' interactions during the process and in most cases, the easiest and most affordable strategy is to use the LMS forums. Although these are very powerful asynchronous

tools, students consider that using them during teamwork development does not show the real interactions between team members. In order to address this problem, we proposed the application of IM Tools in CTMTC methodology, defined a tool to import WhatsApp Messages as a proof of concept and test it in a subject instead of the traditional forums.

From this case study we have reached several conclusions: 1) CTMTC is flexible enough to include any kind of tool, but depending on the tool and taking into account the nature of IM Tools, some adaptations are needed, for instance, the adaption in the rubric or in what is understood as a long message; 2) Students prefer to use an IM Tool as WhatsApp rather than forums, because for them these tools show real conversations and because it is what they use during their daily life; 3) The use of IM Tools is associated to an improvement in students' grade, which could be caused by the increase of student motivation, but we can only assert it in the context of the presented case study; 4) Project Management should be introduced early in education and in this way students would be more used to the tasks and methods of such approaches.

As future research lines, it is clear that is necessary to test the tool in other contexts, with more students of different backgrounds and courses. Also, it is interesting to compare results when the students have the possibility to choose the interaction tool vs when they cannot. Moreover, it would be desirable to check the methodology with other IM tools beyond WhatsApp.

Following this work, it is clear that the application of IM tools in methodologies that assess the individual acquisition of TWC is possible and desirable in order to increase students' satisfaction and performance.

Ethical Statements

The research study is part of the RoboSTEAM project which has been approved by the University of León ethical committee. The research has been conducted according to ethical standards.

Participant consent was obtained prior to undertaking this study. Students volunteered on an individual basis and indicated their agreement to participate in the study by a consent form. All students were informed that their participation was completely voluntary, that they can cancel their consent when they decide it and that all collected information would be anonymous and confidential.

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