Software Tool to Support the Improvement of the Collaborative Learning Process

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Abstract. Computer supported collaborative learning brings together the same characteristics and qualities of traditional learning, and includes benefits at the level of interaction and collective learning, as well as the inclusion of a motivating element associated with technology, which allows monitoring more detailed, incorporate an activities record, guide, evaluate and observe the process that is executing in a collaborative activity. However, one of its main problems are caused by a lack of software tools to guarantee effective collaboration, to support the monitoring and evaluation of the process in each of its phases (Pre-Process, Process and Post-Process), and provide a compendium of mechanisms that allow the execution of a collaborative activity and increase collaboration among participants. In this paper, the MEPAC (Monitoreo y Evaluación del Proceso de Aprendizaje Colaborativo) software tool is presented to support the improvement of the collaborative learning process in each of its phases, through the integration of monitoring and evaluation. The evaluation of the MEPAC usefulness, applicability and complexity through a case study, allowed us to conclude that the development of collaborative learning activities is suitable, using monitoring and evaluation mechanisms, thus improving the collaboration between participants.

Keywords: Computer supported collaborative learning · Monitoring and evaluation mechanisms · Improve collaborative learning process · Collaborative software tool · Case study

1 Introduction

The human being by nature is a social being who needs others to achieve their survival. Taking into account this concept, investigations such as Johnson et al. [1], have shown that in education it is also necessary that there is an appropriate collaboration between people so that the learning of a particular subject is easier to understand and assimilate. Collaborative learning is defined as "a set of instructional methods for the application in small groups and mixed skills development (personal and social learning and

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development), where each of the group member is responsible for both their learning and of the group remaining members [2]", and a collaborative activity consists in "the development of a group task with a single final goal, exchanging ideas and materials, a tasks subdivision and group rewards. In summary, students working in groups who exchange ideas, ask questions, everybody listen and understand the answers, help each other before asking the tutor for help [3]". Due to in the collaborative learning process are immersed several elements that are essential for its realization and to obtain better results of collaboration and learning, is necessary to have a technological tool that allows centralizing the needs of the teacher and the student, in addition can give as result to achieve better performance. However, one of its main problems is the lack of software tools to allow guarantee an effective collaboration, that support the monitoring and evaluation of the process in each of its phases (Pre-Process, Process and Post-Process), and provide a compendium of mechanisms that will allow execute a collaborative activity and increase the collaboration between the participants, searching to provide a software tool that allows covering all the previous elements and characteristics, MEPAC is born as a tool that provides support elements for the execution of the collaborative learning process. This article is structured as follows: related works, which show some similar tools to support the collaborative learning process, MEPAC tool, which describes the tool characteristics, using MEPAC - study case, the section that shows the study case development to validate the tool, and finally the concluding section.

2 Related Works

Ramirez et al. [4] present a guide for the design of computer supported collaborative learning activities called CSCoLAD, which provides a design mechanism throughout all the collaborative learning process and defines a web tool to support the design of collaborative activities. Hernández et al. [5] present COLLAGE, a high level tool based on collaborative learning flow patterns for the design of activities, which represents the best practices that are used repeatedly in structuring the of activities flow allowing the reuse and patterns customization, in order to be effective and adapted to the needs of a particular learning situation. Chacón [6] proposes a method that allows the structuring of collaborative activities, to stimulate the incorporation of technology efficiently in the teaching and learning processes, using Web 2.0 tools to design and develop collaborative activities. Collazos et al. [7] design the tools: Chase the Cheese, MemoNet, ColorWay, CollabPet, to evaluate the process and collaboration degree, that allow to understand some of the most common problems that occur in the execution of a collaborative activity. DEGREE (Distance Learning Environment for Group Experiences) [8], supports the realization of a variety of learning tasks by small groups of students, allowing for various methods of collaboration. On the other hand, ColaboQuim [9] is a tool to support collaborative learning in chemistry, which searches to support the teaching of the chemical molecules construction, through the creation of material, execution and collaborative activities evaluation; also incorporates several positive interdependencies, and has a monitoring module. In Lovos et al. [10] present a customized environment that integrates teaching paradigms: Problem-Based Learning (PBL)

and computer supported collaborative learning (CSCL). It has a collaborative learning environment in virtual teaching situations, through tools that provide synchronous and asynchronous services that are very useful in teaching - learning supported by computer. Rodríguez et al. [11] present MILLENNIUM, a prototype of a software tool that validates the integration model of the individual and collaborative environments, this prototype works under two types of environments and the users can exchange whenever they wish. Habi-Pro (Programming Habits): is a client-server application to develop good programming habits, is a collaborative learning system, synchronous, distributed in which students learn to understand and debug programs, develop good styles and also it can solve problems in a collaborative way [12]. Martinez et al. [13] define a way of evaluating interactions by capturing events and processing them, to model the interaction state, from a program that delineates the content of the interactions to store and evaluate them in computational terms in a generic way. The previous works offer tools to help the computer supported collaborative learning, but none of these provides a complete support in all phases (Pre-Process, Process and Post-Process), much less the possibility of executing a collaborative activity by the students, that is monitored and evaluated through mechanisms that help this process. Characteristics and elements that the MEPAC tool considers in its definition, being this the main contribution that the tool has respect to those previously mentioned.

3 MEPAC Tool

To check the usefulness of the conceptual model presented in [14], which considers the activities, subactivities, roles, guides, mechanisms and artifacts necessary to support the collaborative learning process in each of its phases (Pre-process, Process and Post- process), it was necessary to design and implement a software tool called MEPAC (by its initials in Spanish "Monitoreo y Evaluación del Proceso de Aprendizaje Colaborativo") tool defined by the reuse of the functionality provided by Moodle [15].

The MEPAC construction was based on the incorporation of plugins, to perform the monitoring and activities evaluation of the collaborative learning process, and embedded PHP code for the creation of forms that allowed manage the phases of the process by the teacher. MEPAC also has guides and support manuals for the teacher and the student, which allow to reach the objective of the collaborative activity and in this way, improve the process and increase the collaboration between the participants. To see the structure of MEPAC see Fig. 1.

According to the structure defined by MEPAC showed in the Fig. 1, each part of the software tool contributes to the objective of it uses in the collaborative learning process, which seeks to increase collaboration among the participants through the interaction monitoring and evaluation, each element is explained below:

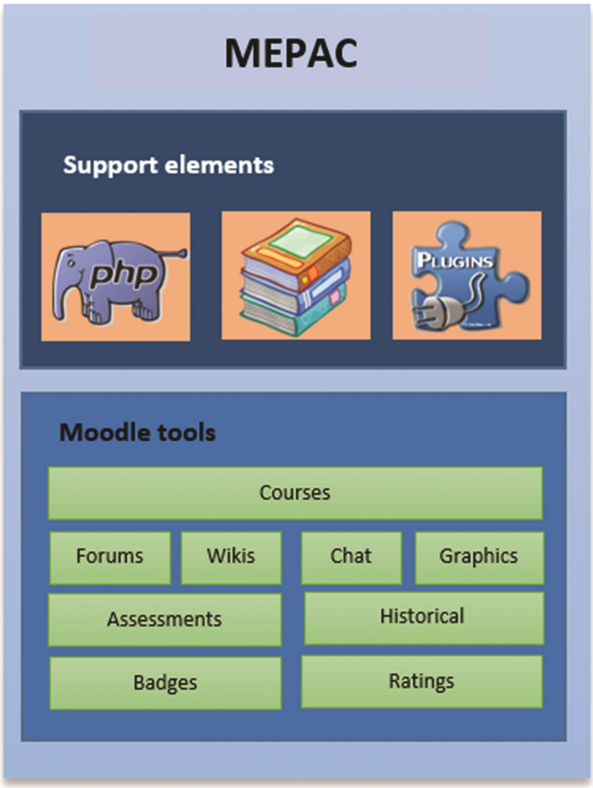

Fig. 1. MEPAC structure.

Taking into account that MEPAC reuses some elements of Moodle, which is defined as: a software designed to help teachers create high quality online courses and virtual learning environments. One of the main Moodle characteristics over other systems is that it is done on basis of the constructivist social pedagogy, where communication has a relevant space in the way of the knowledge construction, the goal being to generate an experience of enriching learning [16]. MEPAC takes Moodle tools and elements to execute a collaborative activity, elements such as:

- The courses, are pages or areas where teachers can present their resources and activities to the students, showing the necessary material and information. The courses are used to carry out collaborative activities, to upload information and for students to have spaces to upload their documents, find their grades and communicate with the teacher.
- The roles allow getting into the platform as “teacher” or “student”, each having an identification with user and password. In addition to having a user profile to manage their information.

- Activities, which refer to a characteristics group in a course, usually an activity is something that a student does, that interacts with other students or with the teacher. Among the activities are:
  - Tasks: allow teachers to rate and comment on uploaded files and tasks created online and offline. They allow managing the hours and dates of delivery.
  - Election: with which the teacher creates questions and specifies a variety of multiple choice answers.
  - Exam: allows the teacher designs and assembles exams, which according to the activity can be automatically qualified or through feedback to show the correct answers.
  - Predefined survey: allows to collect student's data, to help the teachers to know their students and to analyze about the teaching. In addition to being used to gather information on teacher and student satisfaction about the software tool and the activities developed.
- Chat, allows students to have a synchronous discussion in real time, as well as involving the teacher when required. The teacher can also intervene in the talks to get the activities focus.
- Forum, created to allow students to have asynchronous discussions and request information at the teacher.
- Wikis, are a collection of web pages where any user adds or edits necessary information, used to deliver the final activities, where each student must give their contribution and build the final delivery to the teacher.
- Private messages, used by teachers and students, to send and receive private messages necessary for activities, as well as receiving notifications about tasks, forums discussions, etc.

MEPAC has functionalities that are taken from Moodle, but its contribution and difference are the following elements that are used mainly for the monitoring and evaluation of the collaborative learning process, and searching improvement it. In addition to taking into account each of the process phases (Pre-Process, Pro-cess and Post-Process):

To MEPAC also were added Moodle plugins that are not specified in the basic version, but they were installed to manage the collaborative activities:

- The grading book, each course has its own grading book, which is accessible to teachers and course's students, in addition to allowing look the progress of the activities defined by the teachers, upcoming activities and qualifying activities. This with the purpose of the teacher can verify how students work and does required movements when there is work recharge or vice versa.
- Activity ending, an action that allows the teacher to officially mark as finished, manually or automatically according to criteria specified at the beginning of the course. In addition to allowing students to see their progress during the course until it is finalized.
- Badges, are awarded manually or by using the end of activities configurations in a course and it is a way to motivate students. It is awarded at different course stages for different levels of activities progress.

- Reminder, added so that the teachers remember those activities that must qualify and of which they need to give a feedback, this in order to be in continuous contact with the students.
- Groups, allows assigning students to a group, to have a teacher management of all groups created for the collaborative activity and analyze their activities.

MEPAC also has the addition of PHP code for the creation of forms that allow the teacher to perform the three collaborative learning process phases (Pre-Process, Process, Post-Process). By means of these elements the teacher registers activities information, where at the end of the registration a PDF file is generated that must be taken for the activity monitoring and evaluation to be carried out:

- A first form for the Pre-process phase, in where fields related to the planning, management, coordination and definition of the collaborative activity are registered.
- A second form for the Process phase, where fields recorded about the collaboration activity execution as a way of achieving the teaching objectives, depending on the student's interaction with their peers and with learning resources.
- The last form referring to the Post-process phase, where information registers about the assessment individually and collective to verify the level of knowledge acquired by the students in the activity carried out, as well as information about the activity ending with feedback required.

MEPAC finally, has guides and support manuals for teachers and students, in order to facilitate the use of the elements provided by the software tool:

- Manual for the use of monitoring and evaluation mechanisms, created so that the teacher acquires knowledge of how it is the best way to use all the mechanisms proposed and obtain the benefit of necessary collaboration.
- Support material for students, guides for students to have in summary documents topics related to the activity and they can be support in the collaborative activities accomplishment.
- Process phase guide, a document generated by the teacher in the MEPAC tool, that is accessible to students, where the rules and concepts necessary for the collaborative activity execution are concentrated.

All of the elements aforementioned with their respective use, make up the structure of MEPAC and allowed to execute a process of collaborative learning, monitored and evaluated for the improvement of this.

4 Using MEPAC - Case Study

The MEPAC objective is to support the collaborative learning process phases in the classroom by means of the grouping of monitoring and evaluation mechanisms. To validate its usefulness, applicability and complexity in supporting the collaborative process improvement, it was necessary to apply the tool in a case study execution, which allowed to define the best way to use the monitoring and evaluation mechanisms, defined and presented in [17], which seek to increase collaboration in the activities carried out.

For the selection of the case study, was taken into account the case study guide defined by Runeson et al. [18], where the need to have an objective is defined; which for this project is defined as: verifying the level of usefulness, MEPAC applicability and complexity use in supporting collaborative learning through the application of monitoring and evaluation mechanisms in the undergraduate academic field. In addition, the definition of an analysis unit, which is defined for this project, as an academic environment within a process of collaborative learning. The primary information source is: the teacher who is the main person in charge of each process phases, in charge of applying the collaborative activities. According to the types of case studies defined by Benbasat et al. [19], the type for this project is holistic, due to it is considered an analysis unit with a research subject and a collaborative activity in a real case in undergraduate teaching.

The case study was developed in two undergraduate academic courses in the system engineering program, object-oriented programming of the Electronic Engineering and Telecommunications Faculty of the University of Cauca and databases modeling of the Corporación Universitaria Comfacauca – Unicomfacauca. Courses that were constituted by 16 students of the second and third semester, and 10 students of the fourth and fifth semester, respectively (See Fig. 2). For each of the previously mentioned courses, a collaborative activity was carried out, using the MEPAC tool, with the collaboration of teachers and students.

Fig. 2. Courses created for teachers and students

Guidelines for determining the MEPAC usefulness, applicability and complexity
For specifying the MEPAC tool utility, which is defined as the property by which the software tool acquires the condition of useful value to satisfy the improvement objectives proposed for the collaborative learning process, were managed as metrics: the software tool utility perception in the development of the activities by the students and by the teacher in the collaborative learning process, the students percentage who approve the developed activity, contrast the improvements made for each of the processes vs the opportunities of improvement found previously. In order to specify applicability, which is defined as the property by which MEPAC can be easily used to obtain favorable

improvement results for the collaborative learning process, metrics such as: the necessary effort by the teacher and by the student for the realization of the collaborative activity doing use of the tool. In order to specify the complexity, which is defined as the diversity of elements that compose a situation, which is interlaced and/or interconnected that contain additional information and hidden from the observer, the metrics were taken into account: the complexity perceived by the teacher to apply the monitoring and evaluation mechanisms during the collaborative activity, doing use of MEPAC, and the complexity perceived by the teacher when using it for the design, application and subsequent collaborative activity evaluation.

Taking into account the previous metrics, the guidelines that were established to calculate the utility are:

- The student's average range who consider MEPAC is a positive support for the course should be between 80% and 100%.
- The favorable responses' average range by the teacher to consider that MEPAC supports the activities of the collaborative learning process should be between 80% and 100%.
- The students' average range who pass the activity must be between 80% and 100%.
- The range of questions that have a positive impact on the improvement process obtained with MEPAC vs the improvement opportunities found previously, based on the teacher's perception, must be between level four and five (five being the degree of utility higher), and greater than or equal to 80%.

The guidelines that have been established to determine applicability are:

- The average degree of applicability of MEPAC from the teacher's perception must be between four and five (five being the highest degree of applicability), which corresponds to having a percentage greater than or equal to 80%.
- The effort to develop a collaborative activity using MEPAC, taking into account the teacher and student time (for the 3 process phases), should be on average 10 to 12 h.

The patterns that have been established to determine complexity are:

- The complexity degree average in monitoring applicability and evaluation mechanisms, using MEPAC, obtained from the teacher's perception that it is between one and five (5 being the highest degree of complexity), must be less than 70%.
- The complexity degree average of the use of MEPAC for the execution of collaborative activities based on the teacher's perception of between one and five (5 being the highest degree of complexity) must be less than 70%.

4.1 Case Study

The case study began with the Pre-process phase, in which the teachers made use of the MEPAC tool, carrying out the collaborative activity design, through a guide, which defines a compendium of activities required to complete this phase (See Fig. 3), finally generating a PDF document containing the design of said activity. In the development of the Pre-process phase teachers spent an average of 40 min.

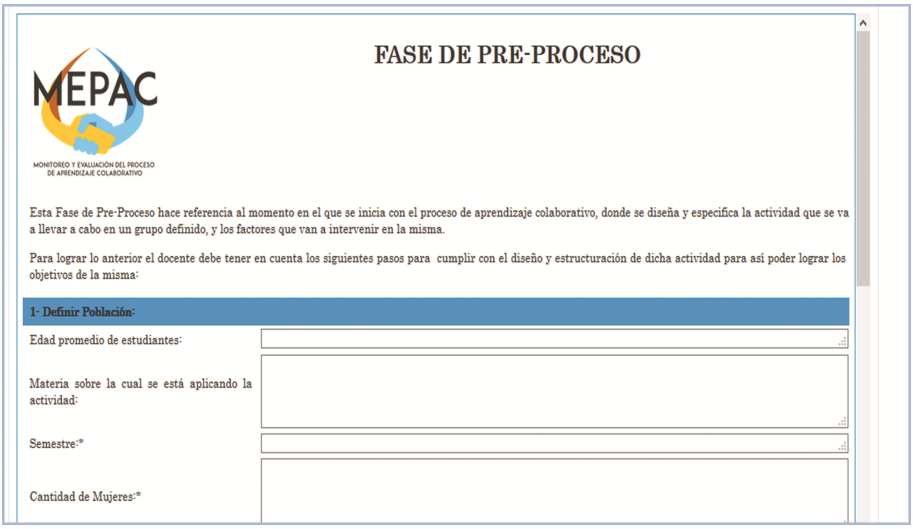

Fig. 3. Pre-process form

In the next session, the teachers were in charge of complete the form related to the phase of the Process, which takes into account defined activities for the application of the designed activity, which finally generates a new PDF file of this second phase.

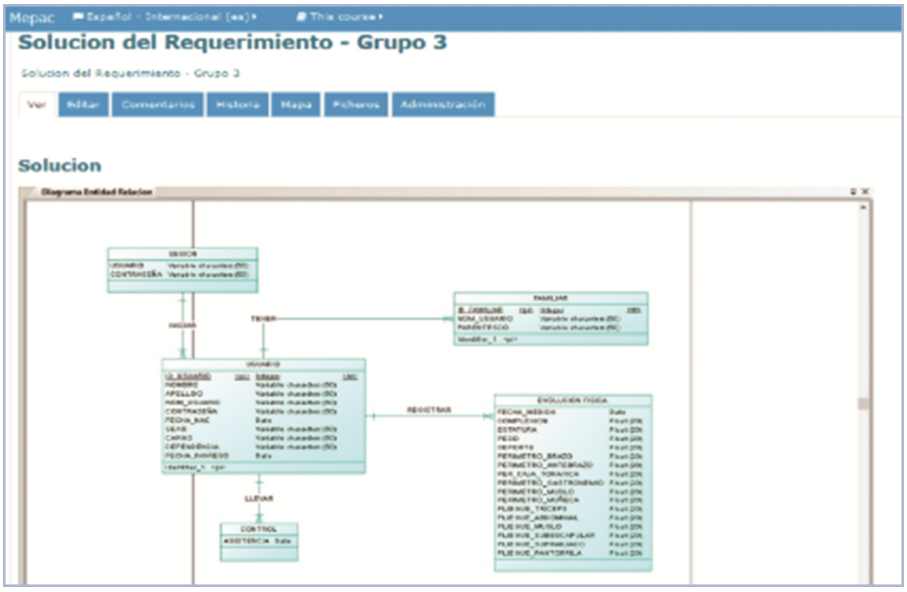

Fig. 4. Wikis creation and use

Subsequently, the teachers apply the collaborative activity using MEPAC, using the guide generated in the previous phase. For the application of the collaborative activities, groups of 3 students were organized. The time of average execution of activities used by students was one and a half hours.

MEPAC, in addition to providing the monitoring and evaluation mechanisms defined in [17] of the activities carried out, which allowed the teachers to intervene at appropriate times, always seeking to increase collaboration between the groups to achieve the proposed objective, for example, the use of forums, wikis that helped in the activities execution, monitoring and evaluation, as well as it was shown in the structure of the tool and can be seen in the Fig. 4.

The additional elements that were used for the activities monitoring and evaluation were executed to increase the collaboration and to make the students learn and achieve the proposed objectives, some of the elements used can be seen in Fig. 5.

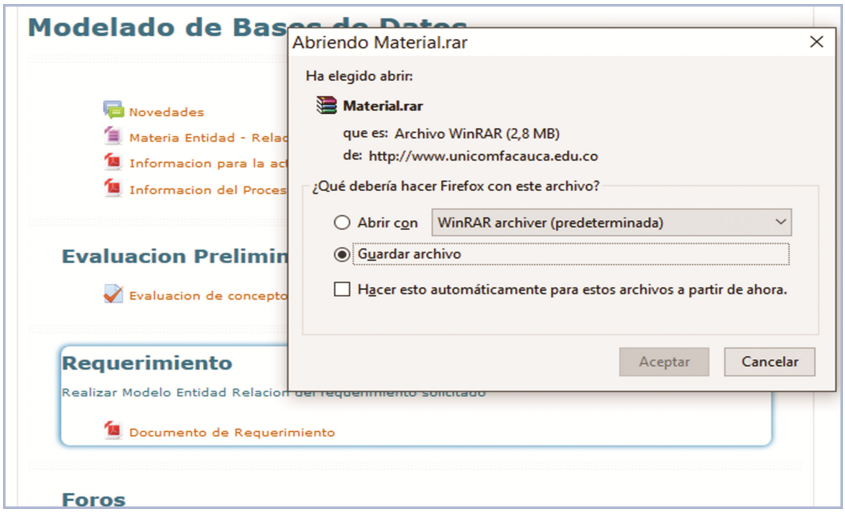

Fig. 5. Student and teacher manuals about collaborative activity

After executing the activity with the students, the teachers were in charge of completing the form for the Post-Process phase, spending in its definition half an hour, in this phase, a new PDF guide to the activities of closing and feedback of the executed activity.

Results

Taking into account the guidelines for determining the MEPAC usefulness, applicability and completeness, the following results were obtained, which were taken from both teacher and student satisfaction surveys and from MEPAC records (the values are on average, in the two courses on which the collaborative activity was applied):

- The percentage of students who defined MEPAC as positive support for the course was 88.2%.

- The 80% of the answered questions by teachers are at a high level of positive impact to consider that MEPAC supports the collaborative learning process activities.
- The student's percentage who approved the collaborative activity is 90.2%.
- The 89% of the answered questions by teachers are at a high level of positive impact on the improvement process obtained with MEPAC vs the improvement opportunities previously encountered.
- The teachers' survey allowed to determine that their perception about the applicability of MEPAC in the collaborative learning process, it is defined by 60% of the questions answered that are at a high level of ease of application.
- The effort involved in developing a collaborative activity using MEPAC (taking into account the teacher and the student time in the 3 process phases) averaged 14 h, in the different stages:
  - Training on collaborative activities, external factors involved in these activities, as well as training teachers on the correct use of monitoring and evaluation mechanisms
  - Design of material for collaborative activity.
  - Analysis of results obtained from the activity and feedback to students.
- In the teachers' survey, according to their complexity degree perception in the monitoring applicability and evaluation mechanisms, using MEPAC, the 80% of the questions answered are at a high level of application complexity.
- The complexity degree average of the MEPAC use tool for the execution of collaborative activities based on the perception of teachers is 68% of the questions answered, which are at an average level of complexity of application.

Analysis of results

According to the obtained data in the case study, it can be considered that:

- The results show that, since the application of MEPAC, the percentage of students who approve the activities is high, consolidating this tool as useful mechanisms to increase the good performance of the students in the collaborative learning process. In addition, students perceived that the tool provided to them was a support for the development of their activities and for the growth of collaboration. Also, from the teacher perspective it is possible to classify MEPAC as useful taking into account the positive impact that was generated on the process carried out from the activities carried out.
- With regard to the utility of MEPAC and the monitoring and evaluation mechanisms that are present in the tool, all the levels established in the guidelines are met, in order to conclude that it is useful for carrying out an improvement process regarding the increase of collaboration between the participants in this context and to take advantage of each one of the activities that are carried out.
- From the teachers' perceptions regarding the applicability of MEPAC in an academic collaborative learning process, the results show that the tool is not classified as easily applicable but it provides mechanisms for its application in this context. In addition to determining that to meet all stages requires a great effort in terms of time per person, from which it can be assumed that the greatest effort is necessary at the beginning (at the time that the teacher and students should appropriate concepts of the tool and

work collaboratively), an effort that can be overcome in the long term, with feasible results for teachers and students.

- The results obtained from the metric to calculate the complexity show that, from the teacher perception, to apply monitoring and evaluation mechanisms, the complexity is high, which may be due to the teacher's lack of knowledge in the development of activities of collaborative learning, and in the execution of each phases. In the case where the teacher repeats the tool use and its mechanisms, the complexity may diminish, since experience is acquired and in later uses it is not necessary to read and interpret the manuals and guides that accompany the tool and its mechanisms. And the complexity to use MEPAC, is average according to the teacher perception, since, it follows the same Moodle guidelines, for the activities in the education context.
- The results concerning the collaborative learning process improvement through the use of MEPAC were published in [20], which establishes a set of metrics to measure the improvement and cooperation implemented in collaborative activities. The results obtained in [20] allow us to compare the values before the improvement (with those case studies where monitoring and evaluation were not applied) vs the results obtained in the indicators and metrics after the improvement, from which we can conclude that the collaboration is increased through the use of MEPAC monitoring and evaluation mechanisms.

Conclusions

This article presents the MEPAC software tool that supports the collaborative learning process in each of its phases, in addition to its monitoring and evaluation, because it considers elements such as: wikis, chat, forums, manuals, guides, forms, management activities and evaluations, which are necessary and strategic to increase the collaboration between the students who carry out an activity.

According to the results obtained through the case study development it can be concluded that MEPAC is useful, applicable and moderately complex, which can facilitate its use in the collaborative activities development, providing strategies to facilitate communication and joint work between students regardless of whether of their geographical location.

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