Towards a Framework Definition to Increase Collaboration and Achieve Group Cognition

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Abstract. Computer Supported Collaborative Learning - CSCL is an area that focuses on how people can learn together with the computers help, it is also one of the most promising innovations to improve teaching and learning with the modern information technologies and communication help. The CSCL describes a situation in which it is expected that interaction particular forms will occur, which will produce learning mechanisms that possibly generate the planned achievement, but that there is no total guarantee that these situations will be presented effectively. For this reason, this scheme is difficult to achieve if several aspects that can really guarantee this interaction kind are considered. In addition to considering that working collaboratively is not an easy task; it is necessary to structure activities, design applications, analyze additional factors that allow achieving the planned objective, however, up to this time, there are some methodologies for the collaborative applications built that focus mainly on supporting the activity execution, leaving aside, that with these applications to achieve the group cognition through the collaborative knowledge build. As part of our previous research, we have identified that it is necessary and important to have strategies set to achieve collaboration and group cognition when participating in a collaborative learning activity. This article shows the proposal and the advances towards the framework definition that allows the collaboration increase and the group cognition construction, through the strategies centralization that allows achieving learning and collaboration.

Keywords: Computer Supported Collaborative Learning
Collaborative learning · Group cognition · Collaborative activities
Framework · Strategies

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1 Introduction

Today, most important decisions in organizations are made by groups who are experts in specific topics that contribute to this process and in the complex problems solution. Furthermore, the fast growth of information and communication technologies are generating new forms of work and modifying different practices in people's daily lives, in this transformation there is a progressive trend towards collaboration to achieve a common objective, where the work is organized into groups and each member interacts with the rest to obtain a better productivity [1]. Education has not been foreign to these advances and it is for this reason that one of its basic requirements in the present and future, is to prepare students to participate in networks [2]. However, working collaboratively is not an easy task; it is necessary to structure activities, design applications, analyze additional factors to achieve that objective [3]. Therefore, there is a need to define a framework that support collaborative learning activities, where these activities are designed and structured in order to ensure true collaboration and also to achieve group cognition (defined by Gerry Stahl in [4]), which is conceived as a sum of individual heads facts, rather than as a positive cognitive phenomenon of their own, which allows going beyond obtaining individual learning. It can structure activities that ensure these actions requiring approaches that must be strategically executed; it is not enough to encourage a student's group and a teacher to develop a task together to achieve a common objective, collaborative learning is more effective if participants work in well-designed scenarios [5]. As part of our research process, we have identified that it is necessary and important to have strategies set to achieve collaboration and group cognition when participating in a collaborative learning activity. This article shows the proposal and the advances towards the framework definition that allows the collaboration increasing and the group cognition construction, through the centralization of strategies that allow achieving learning and collaboration. This document is structured as follows: Sect. 2 describes the problem statement, Sect. 3 defines the proposal and Sect. 4 shows the project progress until this moment.

2 Problem Statement

Traditionally, the teaching of a topic has followed the information transmission model, where the teacher selects a learning topic, organizes it in a course and transmits it to the student in a one-way flow. The student in this model becomes a passive element, receiver of this information. For which, a new teaching-learning scheme arises, called Collaborative Learning, in which students learn by interacting and structuring their own knowledge, with the tutor guidance [6]. This model allows for the opportunity to share skills and competences in common to contrast ideas and viewpoints, wonder, question, pose challenges, discuss them, solve problems together reaching consensus and negotiate between different members. In this way and to facilitate these activities, having available technological tools within a collaborative activity can result in achieving a better performance in the task performed, that is why the concept of Computer Supported Collaborative Learning - CSCL, which is an area that focuses on how people can learn together with the computers help, is also one of the most promising innovations to

improve teaching and learning with the help of modern information and communication technologies [7]. Collaborative learning describes a situation in which interaction in particular forms are expected to occur, which will produce learning mechanisms, possibly producing the planned accomplishment, but there is no total guarantee that these situations will be presented effectively. For this reason, this scheme is difficult to achieve, but different aspects that can really guarantee this interactions type are considered [2] and therefore it is necessary to consider a framework that allows the collaborative learning process, through the increase of collaboration and to achieve group cognition.

Currently, there are methodologies for the application's design that support the collaborative learning process, some of them are: CIAM [8] (Collaborative Interactive Applications Methodology), which is a methodological approach for the user interfaces development in groupware applications, Rodríguez et al. [9], define a methodology for the user interfaces design in collaborative applications from computing independent models, furthermore, AMENITIES [10] (A Methodology for aNalysis and desIgn of cooperaTIve systEmS), is a methodology focused on the system initial modeling using the user viewpoint and considering aspects related to the group (group cognition, relations between users, dynamic groups, social aspects representation, etc.), among other methodologies that focus mainly on design, leaving aside, to seek that with these applications the shared group cognition is achieved through the collaborative knowledge construction, defined by Gerry Stahl in [4], which emphasizes the support for interactions between the students themselves, with a teacher playing a role more facilitating than instructive. Furthermore, the group knowledge build implies the construction or subsequent some knowledge artifact development type. Meaning, students are not simply socializing and exchanging their reactions or personal opinions on the subject, but they could be developing a theory, model, diagnosis, concept map, mathematical proof or presentation. To achieve this group cognition, and a collaboration between the participants, it is proposed to have strategies to achieve this objective, such as: monitoring and evaluation of the participants interaction of the activity, gamification, or in the games creation, content adaptation, among other strategies to achieve this cognition and the necessary collaboration, and through a framework all these aspects are taken into account for the creation of the applications that support the proposed objectives achievement.

To achieve the above, it is necessary to analyze the problems presently present, one of the main collaborative learning problems is that in many situations it has been believed that having the technological infrastructure guarantees effective collaboration [11], but for this it is necessary to go beyond that to have a class practices set, laboratories and the respective technological tools. A deeper approach must be taken to ensure collaboration among the work teams, and also a common and egalitarian learning through some external factors analysis such as: people group, activities and technological infrastructure [12], furthermore to considering the monitoring and evaluation of the learning process by the teacher, who must be in continuous attention that the collaboration is carried out. In the same way, keep track of the interaction aspects such as technology, communication, the activity members, among others, and their relationship with the collaborative activity. The interaction ability is one of the elements that predominates in how students will develop collaborative activities, which is why

Johnson et al. [2] determine that: "it is necessary to focus more on the interaction and learning process than on the results". Furthermore, most researches on collaborative learning indicates positive effects on the participants individual learning, an increase in the group knowledge and/or the organization and an improvement in the skills to construct and generate knowledge [4, 13]. However, technological development is still very focused on individual learning models, providing few tools for collaborative knowledge management processes. Therefore, it is especially important to construct knowledge that must be generated in the process of conducting a computer-assisted collaborative activity, which allows the group cognition achievement, considering that in order to obtain learning, the usual internet environments do not work, which do not allow a true knowledge build and do not allow to link ideas, modify contributions, etc. According to Gros [14] to date, most virtual learning platforms do not facilitate the knowledge construction, "they allow an information exchange and discussion, but they are not designed to favor the knowledge construction process." For the knowledge construction are needed environments that allow ideas to arise and enter the path of continuous improvement, in such a way in community there is a shared responsibility to give life to ideas, improve them, etc. It is necessary, a shared work environment for the knowledge construction.

Taking into account the above, it is proposed to define a conceptual model that contains different strategies types, which is supported by a framework for increasing collaboration and achieving group cognition. In this way, the following research question arises: How to improve the collaborative learning process promoting collaboration and achieving group cognition among collaborative activity participants?

3 Proposal

To understand this proposal better, it is necessary to define some terms that will be important to clarify:

- Group: the focus is not on individual learning, but learning in and by small groups of students.
- Cognition: the group activity is not one of working, but of constructing new understanding and meaning within contexts of instruction and learning.
- Computer support: the learning does not take place in isolation, but with support by computer-based tools, functionality, micro-worlds, media and networks.
- Building: the concern is not with the transmission of known facts, but with the construction of personally meaningful knowledge.
- Collaborative: the interaction of participants is not competitive or accidental, but involves systematic efforts to work and learn together.
- Knowledge: the orientation is not to drill and practice of specific elementary facts or procedural skills, but to discussion, debate, argumentation and deep understanding.

The proposal presented here (see Fig. 1), is based on the concepts defined by Stahl in [4] and was added it the strategies centralization, which will allow increasing collaboration and with the execution of these strategies can also achieve group cognition, for this, it is important to have a methodological framework where the guidelines,

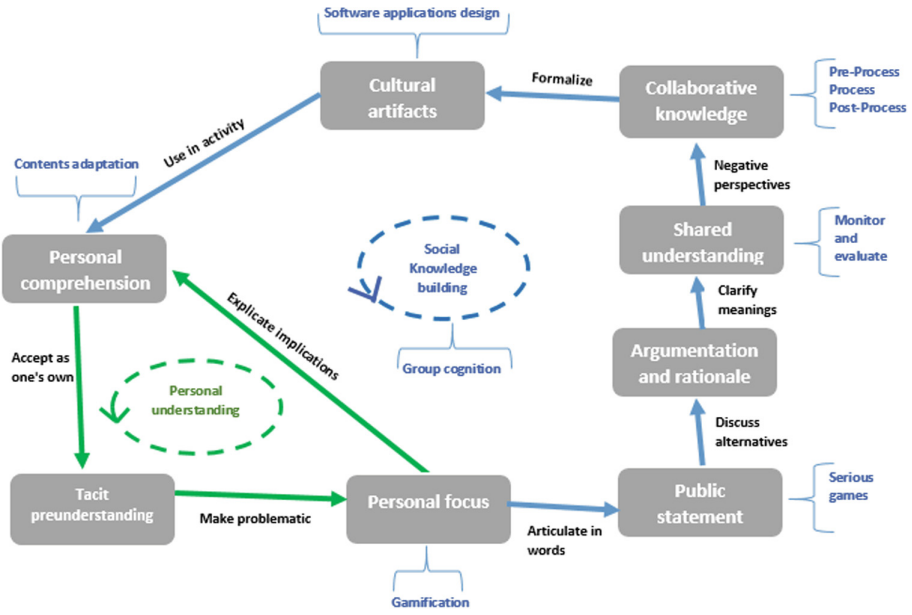

Fig. 1. Increase collaboration and achieve group cognition proposal in each phase

patterns, and other elements necessary are defined, regardless of the context in which a collaborative activity is carried out.

According to this proposal is an attempt to understand learning as a social process incorporating multiple distinguishable phases that constitute a cycle of personal and social collaborative knowledge building. This model of collaborative knowledge building incorporates insights from theories of understanding and learning within a simplistic schema in hopes of providing a useful conceptual framework for the computer supported collaborative learning, specifically collaborative knowledge-building environments with some strategies that can incorporate in activities and in the process carried out.

Considering this proposal, it is necessary to analyze first each part that composes it, in order to determine the shortcomings and determine the best elements that can give the best results. Initially, the collaboration problems will be analyzed, since the main search for cooperative knowledge work and collaborative learning according to Stahl [4], is the emergence of shared group cognition through effective collaborative knowledge building.

Collaboration. Collaborative success is hard to achieve and probably impossible to guarantee or even predict [15]. Computer-supported cooperative work (CSCW) and Computer supported cooperative learning (CSCL) represent concerted attempts to overcome some of the barriers to collaborative success, like the difficulty of everyone in a group effectively participating in the ideas development with all the other members, the complexity of keeping track of all the inter-connected contributions that have been offered, or the barriers to working with people who are geographically distant [16].

As appealing as the technological aids introduction for communication, computation and memory seem, they inevitably introduce new problems, changing the social interactions, tasks and physical environment. Accordingly, CSCW and CSCL study and design must take into careful consideration the social composition of groups, the collaborative activities and the technological supports.

According to Stahl [4], the promise of globally networked computers to usher in a new age of universal learning and of the sharing of human knowledge remains a distant dream; the software and social practices needed yet to be conceived, designed and adopted. To support online collaboration, the technology and culture have to be re-configured to meet bewildering constraints set. Above all, this requires understanding how digital technology can mediate human collaboration. The idea with this proposal includes efforts to design software prototypes featuring specific collaboration support functionality, to analyze empirical instances of collaboration and to theorize about the issues, phenomena and concepts involved today in supporting collaborative knowledge building.

To Gros [17] states that software applications involved in the management of collaborative knowledge must comply to a greater or lesser extent with two technical characteristics: (a) facilitate the collaborative work of the users involved in the knowledge management process and (b) provide tools for the collaborative generation of knowledge as well as establishing tools that provide greater emphasis on the knowledge structures generation. Knowledge management software is characterized by allowing the learning of the participants through mechanisms of integration, administration and distribution of knowledge. In addition to consider that computer support can help us to transcend the limits of individual cognition. It can facilitate the formation of small groups engaged in deep knowledge building, construct forms of group cognition that exceed what the group members could achieve as individuals [4]. Analyzing all of the above, it is necessary to bear in mind that generating a true collaboration in an activity using a software application is not an easy task, for which several aspects must be consider, such as social, cultural, different strategies and designing well the activity that really helps in this collaboration.

Group cognition. According to Stahl [4], group cognition is achieved through the collaborative knowledge construction. As a collaborative knowledge building, the emphasis is placed on the support for interactions between the students themselves, with a teacher playing a role more facilitating than instructive, in addition to the construction or subsequent development of some knowledge artifact type. The students are not simply socializing and exchanging their personal reactions or opinions about the subject matter, but might be developing a theory, model, diagnosis, conceptual map, mathematical proof or presentation. For this reason, it is harder to understand how a small group of people collaborating online can think and learn as a group. Group cognition is conceived as a facts sum of the individual heads, rather than as a positive cognitive phenomenon of its own. An alternative conceptualization is to see group cognition as an emergent quality of the interaction of individual cognitive processes. Emerging the important question: How does a group build its collective knowledge through a software application?

Previously [18] it was thought that collaborative knowledge building consisted only of forming a group, facilitating interaction among the multiple personal perspectives brought together, and then encouraging the negotiation of shared knowledge. But when a software application was used in this process resulted in disappointing levels of knowledge building.

With this evidence we see the need to do some additional questions and try to solve them with the research that will be carried out with this proposal: Can technology help groups to build knowledge? Can computer networks bring people together in global knowledge-building communities and support the interaction of their ideas in ways that help to transform the opinions of individuals into the groups knowledge? With this questions is necessary to think that the software should support cooperative work and collaborative learning; it should be assessed at the group level and it should be designed to foster group cognition, which will be the pillars of this proposal.

There is an evolution and previous research of the group cognition concept present in [4], which helps to understand the concept presented here and the objective that is sought with the framework of application design that it wants to achieve with this proposal:

- Mediated Cognition [19]: Vygotsky's work from the 1920's and 1930's only became available in English 50 years later, when it proposed a radically different view of cognition and learning as socially and collaboratively mediated.
- Distributed Cognition: This alternative developed by a number of writers (e.g., Suchman [20], Winograd [21], Pea [22], Hutchins [23]) also stressed the importance of not viewing the mind as isolated from artifacts and other people.
- Situated Learning [24]: Lave's work applied the situated perspective to learning, showing how learning can be viewed as a community process.
- Knowledge building [25]: Scardamalia and Bereiter developed the notion of community learning with a model of collaborative knowledge building in computer-supported classrooms.
- Meaning making [26]: Koschmann argued for re-conceptualizing knowledge building as meaning making, drawing upon theories of conversation analysis and ethnomethodology.
- Group Cognition: To arrive at a group cognition theory by pushing this progression a bit further with the help of a series of software implementation studies, empirical analyses of interaction and theoretical reflections on knowledge building.

Strategies. The "collaborative learning activities" do not directly engage in the construction of collaborative knowledge, but focus on activities that are expected to lead to this [14]. Therefore, the knowledge construction that should be generated in the process of performing a computer-assisted collaborative activity is of particular importance, consider that in order to obtain learning, the usual internet environments are not useful: chats, forums, wikis, which do not allow a true knowledge build and do not allow to link ideas, modify contributions, etc. That is why it is necessary to look for strategies that achieve this knowledge build to achieve group cognition. Some possible strategies have been analyzed, such as:

To monitor and evaluate. Monitoring and evaluating of the existing process, Collazos et al. in [27] they pose: for a collaboration process to be effective, certain guidelines must be followed and some roles must be defined, so that the only definition of these guidelines and roles does not guarantee that learning will be carried out in the most efficient. It is necessary to define a collaboration scheme, where the instructor knows when and how to intervene with the objective of improving the collaboration process. For this reason, it is important not only to consider the structural design of the collaboration space, the activities set that define the collaborative task, variables that can influence collaboration (group composition, gender, etc.), use of various interaction devices, but it is also important to understand the collaborative process that occurs when developing a collaborative activity considering all these aspects. One way of understanding this process is through modeling, monitoring and evaluating it [12].

According to [2] the availability of monitoring mechanisms for participants within a group activity can be very useful to identify people with low participation or groups with an unbalanced distribution of tasks. This identification process, in turn, will allow the activity coordinator to intervene when it deems appropriate and in this way to improve the collaborative process; the availability of computer tools can give more accurate data about the people performance. Therefore, one way to evaluate the group's effectiveness is to monitor, observe and evaluate the interactions among the group members. This allows the activity coordinator and the other participants to obtain an understanding of the quality of the interactions between each member of the respective groups and their progress in the task development [28, 29].

Gamification. Consists in the use of mechanic, elements and game design techniques in the context that are not games to involve users and solve problems. Some of the gamification benefits are: activates the motivation for learning, there is a constant feedback, allows a more meaningful learning generating a greater retention in the memory to be more attractive, creates a commitment for learning and linking the student with the content and with the tasks themselves, and also generates competitiveness as well as collaboration [30].

Gamification can be a powerful strategy that promotes learning among people and a change in behavior, therefore gamification in the academic field can even create a healthy dependence state [31]. Looking for a change in the user's attitude without the need to use coercion or deception, using game elements that call the attention to the user. Several studies [32] support the idea of gamification and indicate that through games you can achieve a change in attitude in a person's behavior. These benefits are intended to serve as a strategy to achieve group cognition, and increase collaboration among the participants of a collaborative activity.

Serious games. Games designed and developed primarily for a purpose or educational finality, above entertainment [33–35], using the game characteristics to generate motivation and immersive learning experiences [36]. Serious games have a convergence between the technological, the playful and the educational or formative, but with an emphasis on the latter. In addition, they allow the multiple intuitive developments, accessible training environments for educational and training purposes [37]. Several studies [38–43] have proposed methodologies for the serious games' design, but there are no any oriented to achieve group cognition and the search for an increase in

collaboration. That is why the serious games benefits can be adopted to achieve the objectives that are to be achieved in this proposal.

Contents adaptation. It is the possibility to adapt the contents and strategies methodologies to the individual characteristics of the activity participants [44]. In this sense, the computer-supported training facilitates the realization of an adjustment of the virtual environments to the different cognitive types that the students use during their formative process. These are defined as those cognitive, affective and physiological traits that serve as relatively stable indicators of how participants in an activity perceive, interact and respond to their learning environments. From this definition we can deduce that cognitive styles are relatively stable traits, although susceptible to changes and improvements, adaptable to different situations; and that if they are taken into accounting, students can learn more effectively, in such a way that a software environment adapted to the cognitive type will generate better learning results [45]. Being the content adaptation a good strategy to be applied in software applications to obtain what is desired in the collaborative activities participants.

As analyzed above, we can determine that collaborative success is difficult to achieve and probably difficult to guarantee or even predict. Concerted attempts have been made to overcome some of the barriers to collaborative success, such as the difficulty of everyone in a group that effectively participates in the ideas development with all the other members, the keeping track complexity of all the interconnected contributions that have been offered, or barriers to work with people who are geographically distant. As attractive as the technological aids introduction for communication, computing and memory, they inevitably introduce new problems, changing social interactions, tasks and the physical environment. That is why it is necessary to create conditions that are probably favorable for the interactions type we want to study. One is to create student's groups who will work well together, who get along and understand each other and contribute a healthy combination of different skills. We must also carefully design the activities that will be carried out and the contents that are lent for the development and deployment of the understanding through collaborative interactions, activities that will not be solved by an individual, but that the group can chew together in the interaction online. In addition, the technology provided to the groups must be easy to use from the beginning, while meeting the communication and representation needs of the activities.

Objectives. With the above strategies and some others that can be analyzed in the research process of the proposal presented, it is intended to generate a framework that contain the necessary elements to support these strategies that increase collaboration and generate group cognition among the participants of a collaborative learning activity.

To achieve the above, it is necessary to follow the objectives: (a) To specify and characterize the learning collaborative process elements that allow to increase collaboration and achieve group cognition; (b) To select and use a methodology for modeling the framework that contains the learning collaborative process elements that allow increases collaboration and achieves group cognition; (c) To evaluate the framework in a collaborative learning environment and to validate the framework with experts to determine the completeness and ease of use in its application.

Hypothesis. Some initial hypotheses, which can be defined from what has been analyzed until now:

- The framework definition with strategies for the increase of collaboration and the consecution of group cognition allows the collaborative learning process improvement in the activity participants.
- A student's group working in a computer-assisted collaborative activity can, sometimes and under favorable conditions build a collaborative knowledge and a shared meaning that exceeds the knowledge of the individual members of the group.
- Educational activities can be designed to encourage and structure effective collaborative learning by presenting problems that require a shared deep understanding.
- Members of collaborative groups can internalize group knowledge as their own individual knowledge and can express it through persistent artifacts.
- Group cognition and collaboration achieved in a computer-assisted collaborative learning activity are achieved through the interaction of students and the application of well-defined strategies.

4 Project Progress

The collaborative learning process is divided into three phases [46]: Pre Process, Process and Post Process, in which we have done previous work on how to increase collaboration in the collaborative learning activity development in the Process phase (was collected the studies carried out in [47]) through the monitoring and evaluation use of the process and that generates evidence of the need to apply other strategies types to achieve such collaboration and generate group cognition, through the software applications design that accomplish these objectives. In this previous work, it was possible to conclude that to increase collaboration, it is not enough to deliver an activity and a software tool. To achieve true collaborative processes, it is necessary to structure the activities, analyze the type of people that make up the groups, the external factors that can affect the collaborative work and have a tool designed for the use of control, monitoring and evaluation mechanisms activity; so that collaboration is promoted and is not simply an individual work activity and furthermore it was defined that having a software tool that contains a compendium of mechanisms that allow to evaluate and monitor collaborative learning by the teacher, is of great help so that it can generate better results of collaboration between the students who participate in the same, so that are of great benefit and allowing an active collaboration and a common and egalitarian learning.

With this evidence that collaboration can be achieved through the strategy application (in this case, monitoring and evaluation) in the students who participate in a collaborative activity, where it sees the need to define a framework that allows the design of applications software that also achieve collaboration, group cognition, through the definition of another kind of strategies that allow these objectives, regardless of the context where you want to use this applications type.

Currently, the project is in the literature search stage to determine related works and conceptual bases that generate a solid justification and clearly define the problem planning and can establish its hypothesis, furthermore the initial steps for specifying and characterize the learning collaborative process elements that allow to increase collaboration and achieve group cognition.

5 Initial Conclusion

With the previous research, we found that the collaborative learning is a complex process and the same like to obtain the collaboration and the group learning, for that reason in this work are presented the advances towards the definition of a framework to increase collaboration and achieve group cognition. As an initial result, we have identified some elements that the framework should consider like part of its content and its structure for trying to improve the collaborative learning process with the group cognition elements. With the advance of our research process, we hope to improve the proposal in its components that need to consider both in its theoretical foundation and in its several constructs.

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