# Game-based learning environments: Designing the collaborative learning processes

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**ABSTRACT**

The importance of Collaborative Games in education has been described in different scientific studies. However, designing a collaborative activity is not an easy task; it needs understanding and analyzing collaborative learning processes requiring a fine-grained sequential analysis of the group interaction in the context of learning goals. Several researchers in the area of collaborative work have considered the quality of the group outcome as a success criterion. Nevertheless, recent findings are giving more importance to the quality of the collaboration process itself. This paper presents a set of patterns that includes aspects of the design of collaborative game, as well as of the evaluating and monitoring process. Also we describe a Collaborative Game design using these set of patterns as a method, which can be used in analyzing the interaction processes in a Collaborative Game Based Learning environment (CGBL).

**Keywords:** Design Patterns. Collaborative Learning. CSCL. Game Based Learning.

## Ambientes de aprendizagem baseados em jogos: projetando os processos de aprendizagem colaborativa

**RESUMO**

A importância dos Jogos Colaborativos na educação tem sido descrita em diferentes estudos científicos. No entanto, projetar uma atividade colaborativa não é uma tarefa fácil; ela exige compreensão e análise de processos de aprendizagem colaborativa que requerem uma análise sequencial detalhada da interação do grupo no contexto das metas de aprendizagem. Vários pesquisadores na área de trabalho colaborativo consideraram a qualidade do resultado do grupo como um critério de sucesso. No entanto, descobertas recentes dão mais importância para a qualidade do próprio processo de colaboração. Este trabalho apresenta um conjunto de padrões que inclui aspectos do design do jogo colaborativo, bem como dos processos de avaliação e monitoramento. Também descrevemos um projeto de Jogo Colaborativo usando este conjunto de padrões como

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um método, o qual pode ser usado na análise dos processos de interação em um ambiente de aprendizagem baseada em jogos colaborativos (CGBL).

**Palavras-chave:** Padrões de design. Aprendizagem colaborativa. CSCL. Aprendizagem baseada em jogo.

## INTRODUCTION

Recent years have seen a rise in learning with Game Based Learning Environments (PRENSKY, 2001), especially in online multiplayer games. Although not designed for educational purposes but ludic, the use of commercial games like World of Warcraft (WOW) open up a world of possibilities in education today (CHANG, 2008; CORNELIUSSEN; RETTBERG, 2008; GOLUB, 2010; DUCHENEAU, 2010; PIRIUS; CREEL, 2010; BAINBRIDGE, 2010), such as: students collaborating and discussing ideas, possible solutions, connecting with other students around the world, on topics of study, immersing students in a learning experience that allows them to grapple with a problem, gaining higher-order thinking skills from pursuing the solution, among others. This new way of learning offers new opportunities to use collaborative tools, allowing the students to co-construct knowledge efficiently. However, it is often difficult for users to know how to use these tools effectively, especially because the interactions take place in a social context (HADWIN, 2010). Validating a Collaborative Learning process requires to define a collaboration process that allows instructional designers to monitor it and evaluate it. It has been agreed upon that before the collaborative learning be stated effective, it must follow certain guidelines. Besides, certain roles must be defined in the group of apprentices. However, the definition of these guidelines and roles will not guarantee that the learning will be achieved in the most efficient manner. It is necessary to define an outline of collaboration which permits the instructor to know when and how to intervene in order to improve the collaborative learning process (SANCHO; FERNÁNDEZ-MANJÓN; FUENTES-FERNÁNDEZ, 2008). So, it is important to mention that how and when to intervene is just as important as how to evaluate. It is very difficult to realize these aspects in an efficient manner, especially if they are managed in a manual way, taking into account the facilitator must cooperate with other groups of apprentices in the same class at the same time. Fortunately, the use of computer tools allows situations that would otherwise be impossible in the real world. For instance, the tracking of the students' movements could be reviewed with the objective of improving the strategies to solve problems. In order to evaluate the effectiveness of a group we can monitor and observe the interaction between the group members while working together. The observation will allow the teacher to obtain an understanding of the quality of the interactions between every member and the process of accomplishment of their task (RICHARDS; DEVRIES, 2011). Using the computer model we intend to develop, the teacher will not only be able to observe the interactions between the participants but also s/he will be able to intervene whenever s/he feels it is necessary. The development of computer environments where the interaction sequences can be analyzed could determine, for example, when a student

is failing within the group, allowing analyze this situation. If the collaboration process is improved, the quality and quantity of topics learned by the group will be increased (MARTY; CARRON, 2011).

In this paper, we describe a set of patterns as a recurring solution to the collaboration problem. Patterns help developers to communicate architectural knowledge, help people to learn a new design paradigm or architectural style, and help new developers to ignore traps and pitfalls that have traditionally been learned only by costly experience. Persico et al. (2009) have developed 3 Design Patterns (DP) instances that have been developed and fine-tuned by a community of practice consisting of researchers, instructional designers and tutors with the aim of supporting monitoring and evaluation of Computer Supported Collaborative Learning (CSCL) interactions. The Patterns described provide examples of solutions to the problem of getting useful information about what is happening during the learning process or at the end of it. So, we define a set of patterns that provide guidelines to design the necessary evaluation mechanisms for supporting the collaborative learning processes in Game Based Learning Environments.

Next section briefly describes the collaborative frameworks that intend to be a guideline for the implementation of Collaborative Game Based Learning Environments (CGBL). Then, we describe an example of Game-Based environment that we have developed. In this work, we focus on two aspects: the monitoring of the collaborative activity, where the teacher applies his/her own strategies in order to monitor the collaborative activity; the adaptation of the game according to the learners' profiles. We illustrate these two issues through two experiments carried out in the PIRATE ISLAND environments. The teacher will not only be able to observe the interactions between the participants but also s/he will be able to intervene whenever s/he feels it is necessary. The development of computer environments where the interaction sequences can be analyzed could determine, for example, when a student is failing within the group, allowing analyze this situation. If the collaboration process is improved, the quality and quantity of topics learned by the group will be increased.

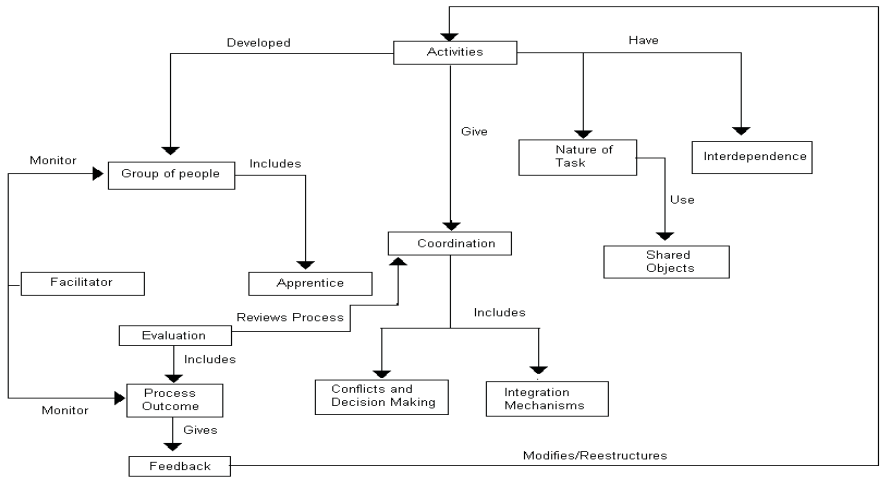
## THE PROPOSED MODEL

Considering the processes of collaborative learning depend on time factors, several conditions have been investigated such as the composition of the group, individual pre-requisites, characteristics of the task at hand, and the context of collaboration. However, it has been discovered that these conditions do not have simple effects on learning results, but rather interact with others in complex ways, and therefore it is necessary to pay special attention to the interaction aspects, i.e., a careful observation of the collaborative activity. Thus, it is important not only to consider the design of the structure of the collaborative space, the sum of activities that define the collaborative task, but also to understand the process of collaboration that takes place when developing

a collaborative activity. One way to understand this process is through the modelling and the evaluation of itself.

In order to improve the process of collaboration it is first necessary to evaluate this process with a certain degree of accuracy so that different learning processes taken on by diverse groups of apprentices can be contrasted (DEL BLANCO et al., 2012). Based on this premise, next sections present a system of patterns which includes aspects of the design of collaborative activities, as well as of the evaluating and monitoring process. These patterns characterize the most common situations when collaborative learning activities are used. Thirteen patterns compose the analysis pattern's system (Figure 1): activities, group of apprentices, facilitator, apprentice, positive interdependence, nature of the task, shared objects, coordination, integration, conflicts and making decisions, evaluation, process outcome, and feedback (Table 1).

FIGURE 1 – Monitoring and evaluation for collaborative applications pattern.




Source: The research.

TABLE 1 – Collaborative design patterns and its main characteristics.

| Pattern | Characteristics |
|---|---|
| ***1. Activities* Pattern** | |
| Defining the CSCL *activities*, it is necessary to specify the group of people, the required conditions of collaboration, the nature of the activity, the type, and the mechanisms that provide positive interdependences and coordination. | **Problem:** Not all the activities executed by the group are CSCL activities.<br><br>**Context:** In collaborative environments, diverse activities are proposed so students can achieve the desired results, that is, acquire knowledge through the development of a collaborative task.<br><br>**Description:** The designed activities specify the work the members of the group must perform during the collaborative task. Such activities can be designed with methods that promote a collaborative learning environment using computer tools, such as the environment proposed by Gallardo et al. (2002).<br><br>**Solution:** Plan the activities in order for the students to change from an individual perspective to a group one. That is, move the group of students from an exploration and analysis scheme to a scheme of sharing information, discussion and consensus. The activity must be designed so that the only way to solve it is through the collaboration of all the members of the group. Therefore, its design has to imply elements that will guarantee positive interdependence and good collaboration schemes. It is necessary to specify and clearly define the activity, describing its nature, type, people in charge, and desirable conditions of collaboration. Ideally, the designed activities, as mentioned by Dillenbourg (1999), should generate interaction patterns that activate cognitive mechanisms. It is important to mention that we cannot directly influence these cognitive mechanisms, but we can create situations or activities that promote valuable interactions. |
| ***2. Group of Apprentices* Pattern** | |
| The roles inside the collaborative learning groups must be carefully defined. | **Problem:** Being a member of a group is not sufficient to promote good learning interactions.<br><br>**Context:** In CSCL activities, groups of people are associated to the functions undertaken to execute a particular activity.<br><br>**Description:** Specify the roles of the participants in a collaborative activity. It is important to differentiate the role of the Facilitator and that of the Apprentices. What needs to be done in this component is to analyze how to define or identify effective mechanisms that can help in the selection and distribution of the work teams. The importance of the definition of roles in collaborative environments resides in that different users possess different levels of knowledge, as well as access to different information sources. Each member or the group, be it Facilitator or Apprentice acquires certain knowledge about a determined domain starting from the different perspectives as the collaborative process develops. In order to achieve an effective collaboration, it is necessary that the roles of both the Facilitators and Apprentices change.<br><br>**Solution:** For the collaborative activity to be successful, it is essential to clearly define the tasks to be undertaken by each one of the members of the activity. It is necessary to define coordination policies in order to provide different interface mechanisms to each type of user for effective decision making. In a Collaborative scenario, although the phrase team cognition suggests something that happens inside people's heads, teams are very much situated in the real world, and there are a number of activities that have to happen out in that world for teams to be able to think and work together. This is not just spoken communication. Depending on the circumstances, effective team cognition includes activities such as using environmental cues to establish a common ground of understanding, seeing who is around and what they are doing, monitoring the state of artifacts in a shared work setting, noticing other people's gestures and what they are referring to, and so on. Awareness is knowledge created through interaction between an agent and its environment—in simple terms, "knowing what is going on". Specific awareness mechanisms must be specified for each type of actor of the activity (GUTWIN; GREENBERG, 2004). The function of these mechanisms is to provide the necessary information about the development of the activity and about the performance of each member making it possible to intervene if necessary. Another important aspect that needs to be considered is in regards to the characteristics of the group that participates in the collaborative activity. The group's heterogeneity covers several independent variables such as: size of the group, gender and group members' differences. The size specifies the number of participants within a collaborative activity. Generally speaking, the smaller the group, the more each member talks and less chance there is that someone will be left out. Also, smaller groups require less group management skills and can usually come to decisions faster. Gender, specify the male/female group composition. Some studies have found important the influence of this factor within a collaborative learning process (AUTHORS, 2002). |

| Pattern | Characteristics |
|---|---|
| ***3. Facilitator* pattern** | |
| The facilitator plays a key role in the collaborative learning activity. The whole learning activity depends on this person. | **Problem:** In a collaborative learning context, someone is responsible for the success of the activities<br><br>**Context:** The facilitator plays a key role in the design and execution of collaborative learning activities. He/she must structure the activities and must be able to monitor the group process.<br><br>**Description:** The facilitator is the person in charge of: defining the initial work conditions, planning the activity and their objectives, defining the conditions of success, among others. In general, the facilitator is the one who creates interesting learning environments and activities that link the new information to the previous knowledge providing opportunities for the collaborative work and offering the apprentices a variety of real tasks. The facilitator must have the ability to determine when and how to intervene.<br><br>**Solution:** For an effective decision making process inside the groups, it is essential to define coordination policies. Making effective the collaborative learning process requires to follow certain guidelines and define certain roles inside the group (AUTHORS, 2001). However the sole definition of these guidelines and roles do not guarantee that the learning will be done in the most efficient way. It is necessary to define a collaboration scheme that allows the instructor to know when and how to intervene in order to improve the collaboration process. The facilitator is responsible to define the groups and the roles. He/she is also responsible of monitoring and evaluating the group process, encouraging types of interaction that influence the individual learning, and the development of collaborative skills, such as to give and receive, help and obtain feedback, and identify and solve conflicts and disagreements. That is why the facilitator must have access to all the shared objects in the activities of those that are participating. The type of help provided by the facilitator must not be the solution of a particular problem, but to provide mechanisms that encourage the creation of an ideal state of collaboration inside the groups and among groups. |
| ***4. Apprentice* pattern** | |
| The apprentice is the most important element in the collaborative learning activity. The whole learning activity is centered on a group of apprentices. | **Problem:** In a collaborative learning context, someone must obtain certain knowledge or some kind of skill**.**<br><br>**Context:** The apprentice is the person who must be subject to interact with other students in order to acquire the knowledge the collaborative activity proposes.<br><br>**Description:** The apprentice has a key role in the development of the collaborative activity. He/she is responsible for the completion of the activities that will achieve the goals and for the solving of the problems define by the Facilitator. His/her main objective is the cooperative gathering of knowledge about a problematic situation.<br><br>**Solution:** The different roles of the apprentices must be specified during the collaborative activity. Each group member must be assigned a role, which can actually be executed. The roles must not be fixed; the roles of the apprentices must be rotated while the activity is ongoing because the exchange of roles is very positive in collaborative learning activities. |

| Pattern | Characteristics |
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| ***5. Positive interdependence* pattern** | |
| Positive interdependence is the heart of collaborative activities. These interdependences define the collaboration process and transform group work into teamwork. | **Problem:** In a collaborative learning activity just putting people around the activity does not imply a collaboration activity among people; it is necessary to structure the activity incorporating elements like positive interdependence.<br><br>**Context:** Positive interdependences are a fundamental aspect in the Collaborative Learning scenarios, unfortunately there is a lack of support in order to determine the best way to include them in those kinds of scenarios.<br><br>**Description:** As Johnson et al. (1993) mention, the essence of a cooperative group is the development and maintenance of positive interdependence among team members. Being a member of a group is not sufficient to promote higher achievement; there has to exist positive interdependence among all the group members. It is a key feature that has been emphasized by scholars concerned primarily with promoting students' academic achievement and cognitive development.<br><br>**Solution:** Design activities that permit to foster different kinds of positive interdependencies among members of the group (AUTHORS, 2003). High positive interdependence within a cooperative group means the group members feel personally responsible for contributing their efforts to accomplish the group goals. They are also aware there are negative consequences when failing to do one's own part. Johnson et. al, have defined 9 types of positives interdependencies (goal, role, outside enemy, resource, identity, reward, fantasy, task, environmental). Some recommended activities are:<br><br>➢ Using only one piece of paper or just one set of materials for the group giving each member a separate job or role, giving all group members the same reward or giving each person only part of the information.<br><br>➢ Redirect instructor-directed questions posed by individual students back to the students' team.<br><br>➢ Have teams that seek help from other teams before asking it to the instructor.<br><br>➢ Let the last team receiving help provide it to the next team requesting support.<br><br>➢ Have group members that consistently use team responses (e.g., all teammates raise their hands before the instructor responds; teammates that provide a choral response to instructor-posed questions; all teammates sign their names on completed group tasks)<br><br>➢ Let students consistently use team language in the classroom ("we" and "our" vs. "I" "me" or "mine"), among others. |
| ***6. Nature of the task* pattern** | |
| The characteristics of the task in some way define the degree of interaction that can exist among the group members**.** | **Problem:** In a collaborative learning activity the lack of information about the objectives, the rules and the collaboration environment can result in that a given task not be properly undertaken.<br><br>**Context:** In a computer supported collaborative learning environment, the purpose of the proposed tasks must be that a group undertakes them as a collaborative effort.<br><br>**Description:** Specifies the characteristics of the collaborative activity. The characteristics of the task in some way define the degree of interaction that can exist among the group members. The collective development of an activity requires the integration of all participants, and therefore, it is necessary that the apprentices be very aware of the steps that are needed to be followed to achieve the objectives and of their role within this process.<br><br>**Solution:** When defining the nature of the task, the following aspects must be taken into consideration: (a) Period of collaboration: Specify the time interval in which the collaborative activity will occur. The interval can be specified in minutes, hours, days, weeks, months or years. (b) Setting of collaboration: It is the place where the collaborative activity will be held. It may be the classroom, workplace, home, etc. (c) Type of activity: Specify the type of activity that will be performed by the members of the group in order to solve a problematic situation. Examples are: puzzle solving, editing a newspaper, writing a letter, etc. (d) Rules: Specify the rules of the group activity. These rules permit to mediate the subject-community relationship, and refer to the explicit and implicit regulations, norms and conventions that constrain actions and interactions within the activity system. These rules permit review boundaries and guidelines of the group activity, and according to Collazos et al. (2002), these rules correspond to one of the indicators of collaborative learning process. (e) Nature of Collaborators: Specify the types of interaction that occur. For example, three types of interaction can occur in a certain case: Peer to peer interaction, Teacher-student interaction and Student-computer interaction. (f) Goals: There are activities performed by the group corresponding to the main goal, and activities performed by every member of the group, corresponding to the partial goals. One of the most commonly heard objections to having students work in groups is that some group members will end up doing all the work and all the learning. This can occur because some students try to avoid working or because others want to do everything. Thus, encouraging everyone in the group to participate is a real concern. All people should feel they are individually accountable for the success of the group. (g) Conditions of collaboration: Specify the kind of mediation. It could be physically co-present or computer-mediated. |

| Pattern | Characteristics |
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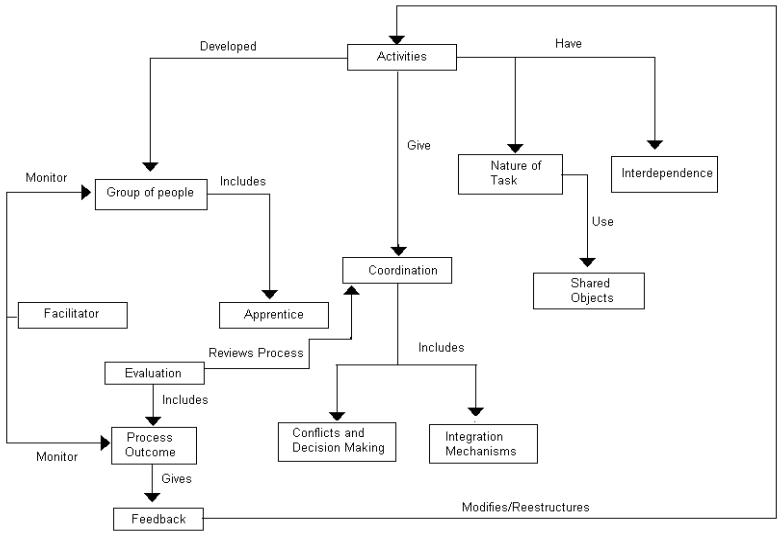
| ***7. Shared Objects* pattern** | |
| Shared objects represent the space where the participants exchange information and represent any important element in CSCL scenarios. | **Problem:** In a collaborative learning activity it is very important to understand the activities the other members of the group are performing. This aspect in many cases is considered as the group awareness.<br><br>**Context:** Collaborative learning environments allow students to work together, sharing virtual spaces where to interact.<br><br>**Description:** Shared objects represent the space where the participants exchange information. These environments cannot reproduce all the actions that take place in a space of face-to-face interaction. That is why collaborative learning environments must provide the means to facilitate the necessary information for effective decision making in a problematic situation. Awareness is a concept related to the mechanisms that guarantee that people can understand or be aware of the process itself and of the interaction among all the participants of a given activity.<br><br>**Solution:** The notion of what is going on within the group as a whole represents a true collaborative learning concept. Thus, it is necessary to provide a representation of the group members within the working space, so all of the group can have the following information:<br>• Where are the other members of the group?<br>• What are the other members doing to complete the task?<br>• What have the other members done?<br>• What will the other members do to solve the task?<br><br>This representation can be graphic, an icon or through elements of virtual reality. Another element that can be included is the perception in regards to the learning being done by each of the group members. |
| ***8. Coordination* pattern** | |
| In a collaborative setting it is important to define mechanisms to organize the work that must be performed among the group members. | **Problem:** In collaborative learning environments, that have an educational objective, coordination must serve as help to define the types of work, allowing all members to have access to the shared knowledge or carry out the collaborative activities.<br><br>**Context:** Coordination is a term used to describe a number of actions or mechanisms available in a shared environment, whose objective is to manage the interdependence among the participants.<br><br>**Description:** Coordination is related to the support, the definition and the execution of the group and individual tasks. In defining the tasks, procedure rules are established. In executing the tasks, assistance is required not only in terms of instruments but also regarding information and concepts. There are many cooperative systems that provide guidelines for the structuring of social interactions within the context of shared spaces (FARNHAM et al., 2000).<br><br>**Solution:** The environment must allow the establishment of rules of cooperation and of procedures among the individuals, guaranteeing that all participants share the knowledge or are committed to the collaborative task. The environment must provide assistance to the participants in the sense that to develop a task also implies to acquire, share or work in the construction of some type of knowledge. According to Johnson & Lenz (1991), another aspect of the coordination has to do with in the ways of maintaining the group stimulated, such mechanisms that incentive participation and communication. Guidelines must be provided that serve as help mechanisms and which directly observe the actions that are taking place within the group; analyzing and interpreting actions, messages and all kinds of situations that happen with the idea of providing the necessary information for adequate decision making. |
| ***9. Integration* pattern** | |
| In a collaborative setting it is important to define mechanisms to provide cohesiveness aspects to the work performed among group members. | **Problem:** In collaborative learning environments non integrated groups do not fully reach their objectives.<br><br>**Context:** The means used by the individuals to integrate into a group will characterize their relationship. In integrated groups, people tend to act in a coordinated way.<br><br>**Description:** Integration can be measured by the degree of cohesion to operate in a coordinated way. The first step for the integration and establishment of common goals is a mutual understanding among all group members. An integrated group is one in which its members are committed to work and feel responsible for the group.<br><br>**Solution:** To provide mechanisms that facilitate understanding of the group's objectives and the means to keep participants of the collaborative activity informed of the objectives of each activity and their responsibility towards it. |

| Pattern | Characteristics |
|---|---|
| ***10. Conflicts and making-decisions* pattern** | |
| Conflicts are very important in CSCL scenarios in order to assimilate the shared knowledge within a group. | **Problem:** In the context of collaborative learning environments, a negotiation is an auxiliary mechanism related to the Coordination that forces apprentices to make decisions about the execution of some tasks, which in turn forces them to elaborate a solution for a proposed problem, thus promoting learning.<br><br>**Context:** During the collaborative learning sessions, conflicts may arise among the group members, creating problems in the execution of the tasks.<br><br>**Description:** Negotiating implies discussing and deciding. In this type of interaction, people express their opinion and allow the others to accept it. This process implies several cognitive mechanisms such as inference, logic, deduction, etc. The decision making process requires defining and analyzing different alternative solutions proposed by the group members, identifying a number of possible alternatives for the execution of a collaborative work. This process is important not just for the cognitive development of the apprentices, but also for the acquisition of social skills. Conflicts or disagreements arise from different perspectives that bring about verbal interactions in order to resolve the conflict. Social factors can help the group find a solution. There is a greater possibility of this happening due to differences than because of the need for a solution to an intense conflict. The verbal interactions generated during the resolution are what promote learning.<br><br>**Solution:** Stahl says that collaboration requires divergence (stating of ideas) and convergence (negotiation, synthesis, and consensus). That is why the model must be flexible to allow negotiating mechanisms where the participants can communicate and participate in the making of decisions.<br><br>*Communication.* Define mechanisms to support communication among members of the group, such as chat boxes, messages boxes, etc. Delvin and Rosemberg (1996) emphasized the importance of communication in individual knowledge and cooperative practices such as sign language with hands in face-to-face communication. The participants of a work group must communicate in order to accomplish tasks that are independent, incompletely described or requiring negotiation. It is important to define mechanisms where students have the opportunity to understand what they have heard, read and also to express themselves in relevant tasks. The idea is not simply to provide mechanisms for communication, but also for negotiation. Negotiation is an essential component of collaboration. Through negotiation of knowledge, a group of knowledge workers or collaborative apprentices determine what knowledge they must build and accept as a group (STAHL, 2002).<br><br>*Participation.* The idea is to define scenarios, where members of the group have the same opportunities to participate in order to solve the problematic situation. The complexity of the activities must be designed in a way that the work performed by every member of the group at least must be the same. It is important to notice that just because one person in the group is talking or performing any activity, does not mean that each member of the group has the same chances to talk and to intervene in order to solve the problematic situation. Kagan (1992) have defined equal participation as one of the principles which are key to the structural approach to cooperative learning. |
| ***11. Evaluation* pattern** | |
| The evaluation must function as an instrument that gives possibility to the teacher to analyze in a critical way the collaborative activity. Also, must provide the possibility to detect the main weakness of a certain group, in order to define some mechanisms to support them. | **Problem:** There are a growing number of experiences in qualitative evaluation in CSCL environments (WASSIN et al., 2000). However, there are some open-end questions regarding the application of qualitative methodologies in the evaluation of real situations. The first one is the high cost that these methods imply which can make it impossible for teachers to apply who are already very busy with their present classroom activities. Additionally, it has become necessary to adapt qualitative methods to new space-time situations and computer-aided interactive ways that appear while using CSCL environments.<br><br>**Context:** Evaluation in collaborative learning involves a number of actions organized with the purpose of obtaining information about the knowledge acquired by the apprentices.<br><br>**Description:** Evaluation in collaborative learning involves a number of actions organized with the purpose of obtaining information about the knowledge acquired by the apprentices.<br><br>**Solution:** In a collaborative learning environment, it is necessary to record all of the activities that occur within the group when solving a problematic situation. All the mechanisms that allow the recording of all the activities should be provide, so that they can be reconstructed after performing an in-depth analysis of messages, actions and all kinds of events that have occurred. Basically, every collaborative application must save and share the data obtained by the users. Besides, the collaborative applications need to provide with a way to visualize the information due to different points of view that can be had of the same data by different kinds of users. The teacher can determine what kind of data he needs to evaluate a particular aspect of this collaborative process. That is why it is necessary to provide with an object of information for each object of data. This meta-object should have certain features or information such as date of creation of the object, the name of the examiner, the name of participants, addressee, sender of messages, text of shared message, time of the delivery, and actions carried out indicating which object performed a particular event. |

| Pattern | Characteristics |
|---|---|
| ***12. Process Outcome* pattern** | |
| A collaborative learning process is typically composed of several tasks that must be developed by the cognitive mediator or facilitator. | **Problem:** In a collaborative activity a series of steps occur in order to reach the final goal.<br><br>**Context:** In order to understand the collaborative process, it is necessary to define, show and evaluate it.<br><br>**Description:** A collaborative learning process is typically composed of several tasks that must be developed by the cognitive mediator or facilitator, and by the group of apprentices, defining naturally two categories of tasks. In order to evaluate the cooperative learning process, we divide it into three phases according to its temporal execution: *pre-process, in-process and post-process* (AUTHORS, 2002). Thus, pre-process tasks are mainly coordination and strategy definition activities and post-process tasks are mainly work evaluation activities. Both phases, pre-process and post-process, will be accompli-shed entirely by the facilitator. The group members will perform the tasks concerning the in-process phase, to a large extent. It is here where the interactions of cooperative work processes take place. Thus, our interest concentrates in the evaluation of this stage. In order to specify this division, we present the structure of a cooperative learning activity identified by Johnson & Johnson (1998).<br><br>**Solution:** A group of indicators have been defined that allow the evaluation, to some degree, of the collaborative process (AUTHORS, 2002). These indicators are the following: (a) *Applying Strategies*: the first indicator tries to capture the ability of the group members to generate, communicate and consistently apply a strategy to jointly solve the problem; (b) *Intra-group Cooperation*: this indicator corresponds to the application of collaborative strategies previously defined during the process of group work; (c) *Success criteria review*: this indicator measures the degree of involvement of the group members in reviewing boundaries, guidelines and roles during the group activity; (d) *Monitoring*: this indicator is understood as a regulatory activity. The objective of this indicator is to oversee if the group maintains the chosen strategies to solve the problem, keeping focused on the goals and the success criteria; (e) *Performance:* measures the quality of the proposed solution in terms of Quality, Time and Work. That is why it is necessary to provide with as many elements and needed information as possible to enable the accurate evaluation of the collaborative process, based on the indicators mentioned above. |
| ***13. Feedback* pattern** | |
| All the collaborative activities require receive information about the work performed. | **Problem:** In a collaborative activity it is necessary to define mechanism that permit to understand the activities performed.<br><br>**Context:** In a collaborative learning environment the feedback that is given is essential for the success of a collaborative activity.<br><br>**Description:** Feedback allows one to identify the weak points of each group with intention to improve them. After analyzing the collaborative process, some of the most important weaknesses in a work group can be determined in order to improve them, establishing new mechanism that involve developing new collaborative activities that enable to focus specifically on the weakness in a group.<br><br>**Solution:** In a collaborative learning environment all the necessary means should be provided so that the people evaluating can determine accurately how and when to intervene. Once the collaborative process analysis has been done, the environment should provide the information needed about the weak points of the group. Underlying nearly all-collaborative learning experiences is a distinctive set of assumptions about what teaching is what learning is, and what the nature of knowledge is. Perhaps the most pivotal of these is the assumption that knowledge is created through interaction, not transferred from teacher to student. Hence, it typically –and logically– follows that instructional activity must begin with students' current levels of background knowledge, experience, and understanding. It also follows that the teachers' role is to create a context in which learners can make the material their own through an active process of discovery. Consequently, this model includes two aspects: the participation of the teacher during the collaborative learning process, and the inclusion of a strategy that generates conflicts among members of the group. Figure 2 depicts the model of the pattern presenting the relationship among different patterns we have proposed. |

Source: The research.

FIGURE 2 – Monitoring and Evaluation for Collaborative Applications Pattern.




Source: The research.

In the following section we present how we have applied the set of design patters for monitoring and evaluation the collaborative learning process in a multiuser virtual environment (MUVE) called “PIRATE Island”.

## CASE STUDY: PIRATE ISLAND ENVIRONMENT

The game is called Pirate Island (GONZALES et al., 2011). The game is developed on Unity Framework with a web interface. The main objective is to learn healthy behaviors collaboratively with other players. The player can design their own avatars according their preferences (Figure 3). The main objective is collaborating to overcome together the different challenges in an island. Users must manage different resources; help other game characters, different design strategies while learning healthy behaviors. To perform these actions, the game provides to the users some tools such as chat with emotional emoticons to communicate the different users, a map to explore with real time user information (with different colors), a navigation window to observe the other users’ actions and group inventory to share and use different resources and items (Figure 4). The chat system offers the possibility of using emoticons and sounds to complete the semantic of the written message. The monitoring tool offers the possibility of analyzes the different messages and actions from the users and offer information to the facilitators to facilitate their work. Thanks to this information the facilitators can modify the challenges, analyze the learning process, evaluate or resolve any conflicts between users (Figure 5).

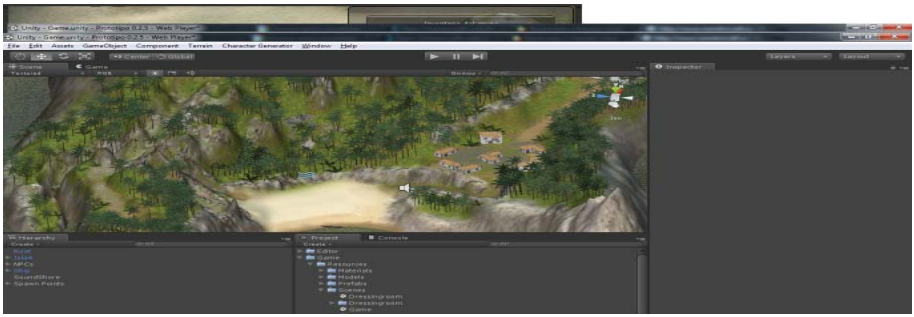
FIGURE 3 – Avatar customization in PIRATE ISLAND.


Source: The research.

FIGURE 4 – Emotional information on chat, global map and planning and collaborative resources management.


Source: The research.

FIGURE 5 – Game inspector to analyze and modify the dynamics of the game according to the players' actions.



Source: The research.

Using the Patterns previously described, the game is characterized by:

- *Pattern 1. Activities:* The screen has four well-defined areas: game, communication chat, map and resources (Figure 4). Each player is identified with an avatar and name which appear on the screen. In addition, the avatar and their teammates should achieve different items and food to overcome the challenges.
- *Pattern 2. Group of Apprentices:* This game is played by more than four persons selected in a random way.
- *Pattern 3. Facilitator:* There is a person who is in charge of the activity design and will be the responsible of the monitoring and evaluation of the activity. Also, Facilitator is an avatar within the virtual game world. Users can interact with Facilitator.
- *Pattern 4. Apprentice:* The participants in a team must reach a goal by satisfying subgoals/challenges in each of the game stages. Each player is identified with an avatar image and name. Roles are switched during the collaborative activity if user change the planning and perform the task in a freeway.
- *Pattern 5. Positive Interdependences:* There is a Positive Resource Interdependence, because in the game each member needs to share his/her part of the story to complete the information to achieve the goal. Also a positive Fantasy interdependence appears due to group members can choose how to solve and how to interact with the other video game characters. They then need to use language to accomplish goals in their imaginary situations.
- *Pattern 6. Nature of the Task:* (1) Period of collaboration: it is expected that the one activity will be performed in a session of 45 min - 1 hour. (2) Settings: The game is played in a distributed fashion, with communication allowed through a chat tool. (3) Type of activity: Problem-solving. (4) Rules: Planning and manage resources to overcome the challenges. The discussion is intended to internalize and assimilate in an appropriate way what is being done. (5) Nature

of collaborators: peer-to-peer interaction. (6) Goals: User must to overcome different challenges related with manage different resources and related with healthy living. They need to discover information, share and combine items and search the best way to reach the game and didactic objectives. (7) Conditions of collaboration: Computer-mediated collaboration.

- *Pattern 7. Shared Objects:* The user's interface has many elements showing awareness: the avatars' icon, score bars, map or items. The need to collect objects on the way means the players of a team must reach a goal by satisfying sub goals in each of the game's stages. If a person is not able to pass his/her goals, then it will be impossible to continue and thus the whole group will not reach the goal.
- *Pattern 8. Coordination:* The group members must fulfill a partial goal that is accomplished when every one of them "solves" his/her own challenges and complete his/her part of the story before passing to another stage.
- *Pattern 9. Integration:* The user's interface has many elements showing awareness: the avatar's' icon, score bars, items or maps (Figure 4).
- *Pattern 10. Conflict and making-decision:* The game provides a chat to planning and realizes the negotiation. It is a discussion environment. Chat offer emoticons and sound to complete the semantic of the messages.
- *Pattern 11. Evaluation:* The game implemented a structured chat-style user interface through which the group conversation is held. The application records every message sent by any member of the group. Along with each message, it records the time of occurrence, sender, addressee, location and emotional information when the message was sent. The tool also registers the start and finish game time, the time spent in the area, scores and goals (Figure 4).
- *Pattern 12. Outcomes:* Use of strategies, intra-group cooperation, checking the success criteria, monitoring and the ability of providing help.
- *Pattern 13. Feedback:* The indicators we have developed permit evaluators to identify some weakness in the collaboration process in order to design strategies to better support it. Is also possible to observe the individual contributions of every member in any group and permit a more specific analysis of collaborative interaction.

## CONCLUSIONS AND FURTHER WORK

Understanding the collaborative process of learning in groups is an interesting research field. In the case of collaborative activities, performing a task well implies not only having the skills to execute the task, but also collaborating well with teammates to do it. This complexity offers opportunities to develop tools and techniques for improving collaboration. One way to evaluate the effectiveness of a group is through monitoring

and observing the interaction between their members while working. In order to achieve predefined collaborative learning objectives it is necessary to design a group process that allows to monitor it and to evaluate it. It is also necessary to understand how the apprentices work and they learn. If the group work process is improved, the quality and quantity of the group learning will be increased. In this paper we try to describe mechanisms for supporting the design of collaborative learning activities, and to show a set of appropriate elements for the development of educative frameworks based on games, especially environments that support monitoring and evaluation of collaboration processes.

Several conditions regarding group work have been investigated, such as the composition of the group, individual pre-requisites, characteristics of the task at hand, and the context of collaboration. However, it has been discovered that these conditions do not have simple effects on learning results, but rather interact with others in complex ways. It is necessary to pay special attention to these interaction aspects –I.e., to carefully observe the collaborative activity. Thus, it is important not only to consider the design of the structure of the collaborative environment and the sum of activities that define the collaborative task, but also to understand the process of collaboration that takes place when developing a collaborative activity. One way to understand this process is through modeling it. On the other hand, one of the most important aspects in evaluating a collaborative learning process is defining clear criteria for evaluating such process. An improvement in the collaboration process should provide higher quality about the learned knowledge. Based on this premise, this paper presents a set of patterns that include aspects related to designing collaborative learning activities, as well as for evaluating and monitoring such processes.

Thanks to recent tools developed, such as the Multi User Virtual Environment (MUVE) “PIRATE ISLAND”, and our experience testing it, there are some factors that increase the interactive experience and the effectiveness as collaborative tools. These factors are the role of the user and mechanisms of communication in the video game. These factors make us to study the need for include new patterns to complete de collaborative and interactive experience.

Role is indicated to offer a mechanism to create their own avatars according their preferences. These avatars are conditioned with a number of features and characteristics that identify their skills within virtual game world (what and how they can do the actions). This pattern helps to promote better ways of planning and strategy in the collaborative process. Communication offer information of how the users share the ideas and opinions between them. Face to face communication is not only by words. The factors of intonation and gesture complete the meaning of words and ideas that are transmitted through them. Written communication should be enhanced to supply these needs. Some solutions could be the use of emoticons which help to increase empathy for users and different sounds for complementing and contextualize the messages. Furthermore, the use of these techniques helps analyzing the messages transmitted and the monitoring of user actions.

Current work focuses on validate these new patterns and their relationships with other presented patterns. In addition, we are conducting an exhaustive analysis on how

the use of certain patterns in the collaborative process varies due to cultural influences and emotional and provoke different experiences that affect the effectiveness of the collaborative process through a User Centered Development Process (UCDP).

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