# Assignment of Groups for the Execution of a Collaborative Work Using Emerging Algorithms

Dunia Inés Jara-Roa[1(✉)], María-Soledad Ramírez-Montoya[2(✉)], Marcos Cabezas G.[3(✉)], and Luis Barba-Guamán[1(✉)]

[1] Universidad Técnica Particular de Loja, San Cayetano Alto, Loja, Ecuador
{dijara,lrbarba}@utpl.edu.ec
[2] Tecnologico de Monterrey, Avda. Garza Sada 2501 Sur. Col Tec. Monterrey, Monterrey, Mexico
solramirez@tec.mx
[3] Universidad de Salamanca, Paseo de Canalejas 169, 37008 Salamanca, Spain
mcabezasgo@usal.es

**Abstract.** In educational institutions collaborative work is used as a strategy to enhance active learning. One of the organizational tasks that is in charge of the teacher is the assignment of groups. Hence the purpose of this article, which is to show how emerging algorithms with their self-organization characteristics, can be used in group formation to carry out a collaborative task. Showing that performance and small groups do not necessarily go hand in hand. The methodology used is a case study and the sample corresponds to 62 students of the subject of Artificial Intelligence of Distance Modality of the Universidad Técnica Particular de Loja, in the academic period April-August/2018, to whom a dichotomous 16-item survey was applied based on the three phases of the Zimmerman self-regulated learning cycle. Among the remarkable results, we can mention that the synergy of individual regulation known as socially shared regulation influenced the execution of the collaborative task. Likewise, the cohesion of a group is not a determining variable to achieve meaningful learning since the less cohesion the greater regulation of socially shared learning. The contribution of the present study is given in the field of Computer Supported Cooperative Learning (CSCL) to alleviate one of the administrative tasks of teachers "Group Assignment", which can be replicated in classroom learning environments or in any of the variations of e-learning.

**Keywords:** Emerging algorithms · Self-regulation · Group assignment

## 1 Introduction

Society is a set of living beings that relate to each other in order to achieve an objective; to keep it in balance, it is essential that standards of organization and behavior are established. Societies within the animal kingdom show to us like human beings how working together leads to better results than individual work. One of them is the ant


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society. In these societies the communication is carried out by means of a chemical called pheromone that is a chemical signal deposited in the soil that informs the physiological state, reproductive, social, age, sex and even the possible relationship with the issuer [1].

Optimization based on ant colonies constitutes a metaheuristic, with the understanding that metaheuristics allows us to find the best solution, in the shortest time, to optimization problems [2]. The metaheuristics of ant colonies are inspired by the behavior of ants to find the shortest paths between food sources and anthill [3]. Ants move between food sources and the anthill following the pheromone trail, if there is no trace, they move randomly; the choice that ants make between the different paths to follow, constitutes a probabilistic decision biased by the amount of pheromone, The stronger the trail, the greater the probability of choosing it [4].

Among other features of the nonlinear model present in ants, according to [5] are:

- The idea of fork;
- The basic interaction scheme;
- Synchronization of activities;
- The size of the colonies.

The characteristics indicated are fundamental for the emergent behavior of the ants; therefore, they constitute a fundamental part of the theory of emerging systems. The term emergency, in its basic definition, is applicable to those properties of a complex system that arise from a certain level of complexity [6]. The emerging models of the ant colony are: food search, division of labor, recruitment (nest migration), organization of the environment (nest building, etc.), aggregation (graveyard, breeding classification), and transportation of objects.

Given the nature of the article, the aggregation model (graveyard, offspring classification) is described, "Aggregation processes have a relevant role in the emergence of cooperation processes and assignment of tasks in the colonies. The phenomenon of aggregation is of particular interest, because it is a prerequisite for the development of other forms of cooperation in an insect society. […] but really how do these patterns arise? For example, ants initiate the formation of such patterns by modulating the emission of an attraction signal" [7]. As indicated [8] in the aggregation phenomenon, two dynamics arise: (a) animals are grouped, despite the heterogeneity of the environment, and (b) the group of animals regulates their activities, through social inter-attractions. The metaheuristics of the ant colony aggregation model uses a stochastic scheme, nondeterministic, it plans a process of grouping elements, in which elements that are different from those of their neighbors are or should be isolated by what has been applied to the assignment of work groups for the execution of a collaborative task, where students who have heterogeneous characteristics are removed to form a community of students with similar characteristics considering self-regulation as a differentiating element, those results showed the efficiency of the formation of homogeneous groups for the accomplishment of collaborative tasks.

The sociocultural school, within the theoretical perspectives of the constructivist pedagogical model, argues that when learning one of the most important elements is the socialization of experiences and knowledge. Therefore, one of the best ways to learn

is to do it together with others [9], one of the main elements to achieve the effectiveness of computer-assisted collaborative learning - CSCL- is collaboration, but this is not spontaneous, it occurs through motivation and fundamentally the sense of belonging to the group. [10] indicate that collaboration is a process in which the learning context, personality, experience, prior knowledge and learning skills of individual students are interrelated. However, learning is a personal and dynamic process, when the human being needs to learn something new, it is necessary to define the objectives to be achieved and it is through the motivation and monitoring of the cognitive processes that regulates their learning, this process is called learning self-regulation. It is understood that self-regulation is "the control that the subject performs on her thoughts, actions, emotions and motivation through personal strategies to achieve the objectives she has established" [11]. Likewise, [12] mentions that self-regulation is a "process formed by self-generated thoughts, emotions and actions that are planned and cyclically adapted to achieve personal goals." Self-regulation or regulation of learning allows the student to be the protagonist of her own learning, for this, commitment, reflexive knowledge, responsibility, and above all motivation are required. It is a process that requires coordination and regulation of activities [13]. Socially shared regulation can contribute to the learning achievements of groups if activated at the right time and place [14].

The moment that each of the people is part of a group for the construction of knowledge is fundamental the capacity of regulation of the group known as socially shared regulation, that goes beyond the individual regulations, that is the regulation of learning exercised by the group; in other words, it is the synergy of individual regulations, where the group members act as a collective entity [15]. The regulation of socially shared learning refers to the processes through which the members of the group regulate their activity collectively [16]. This type of regulation reciprocally depends on interdependent or collectively shared regulations of processes, beliefs and knowledge available at the service of a shared or co-constructed result [17]. The regulation of socially shared learning supports to carry out, maintain and regulate productive collaboration processes leading to significant learning.

However, each of the members of the group must be aware of their cognitive, social, motivational and emotional aspects, identifying the way in which they learn alone, with others or from others. In the process of social regulation it is assumed that metacognitive processes must be systematically observed or measured in such a way that when the group of students perceive a discrepancy between where they are (individually or collectively) and where they pretend to be, an opportunity arises to strategically change thinking, feelings or actions […] it is argued that success in achieving CSCL depends on (a) self-regulation skills and strategies; (b) temporary assistance established among themselves to facilitate self-regulation competence within the group (co-regulation); and (c) collective learning regulation such as metacommunicative awareness, regulation of shared motivation, and successful coordination of strategies (shared regulation) [18].

Each member of the group has the responsibility to regulate her learning; likewise, each member of the group supports the other members of the group to regulate her own learning and the group regulates the learning processes in a continuous and productive way towards the achievement of the group objectives; for this to happen, it is important to know the individual and group strategies and goals. To this [16], they add that the shared

social regulation of learning has three basic principles: (1) increased student awareness of her own learning process and the one from others, (2) support in the learning process by performing her own tasks and/or the tasks from others, thus helping to share and interact, and (3) causing the acquisition and activation of regulatory processes.

For the realization of the virtual collaborative task, one of the organizational tasks that the teacher has, is the formation of groups. [19] indicate that a virtual group is a defined set of students (3 to 5 members) who work in an interdependent, coordinated and committed manner in a shared virtual environment to achieve a common goal. To this [20] they add that the groups must be heterogeneous and that "performance and small groups go hand by hand" (p. 9). For [21]; as well as for [22] there are three typical ways of organizing groups; like this: puzzle, star and chain; in the puzzle, the tasks are divided, it is established who does what and when? they decide which activities or aspects are divided, and appoint a person in charge to join the contributions and develop a unique product among the different contributions. In the star organization, each of the participants resolves the issue of collaborative work to later jointly develop a unique product. In the chain organization, one of the members of the group makes a partial, initial or final contribution of the task solution and puts it to the group's consideration, then together they ratify, rectify, aggregate, negotiate the task solution.

While [23] they mention that generally the learning groups are ad-hoc and that they are initially ineffective since they lack mutual trust in not knowing their competencies, these groups [24] are called low-familiarity groups or zero-history groups, in which dialogue, agreements, negotiation disagreements, and therefore the construction of knowledge is slower, in contrast to the groups of high level of familiarity where group norms, exploratory criteria, communication and social construction of knowledge occurs in less time. The group development models can be progressive, cyclic and non-sequential linear, the definition and stages can be observed in [25].

Groups usually have their own rules, [26] indicates that there are rules that are important to consider: "Expect that those who participate in the group have a good mood […]; the group coordinator must be aware of what the group technique marks […]; clearly define what the purpose is to carry out a specific technique […]; they need to be actively involved […]; once the technique is decided it must be respected […]; the techniques must be studied and its risks assessed in advance […]" (p. 5).

From the observation, there are several criteria for the organization of groups, but there is a lack of research in which reference is made to the results of learning processes with the assignment, conformation or distribution of groups, hence the hypothesis of the present research is: the use of emerging algorithms for the assignment of groups in the execution of a collaborative task, allows us to consider self-regulation as a differentiating element to produce better learning.

## 2 Materials and Methods

The research design is a case study in which the class of Artificial Intelligence was chosen included in the eighth cycle of the micro curriculum of the Computer Science Program of Distance Modality of the Universidad Técnica Particular Loja, in the academic period April-August/2018. The participants were 82 students from class A (50) and B (32) to

whom a 16-item dichotomous survey was developed in Suverymonkey. The survey was constructed based on the three phases of the self-regulated learning cycle of [12] that is: previous phase, completion phase and reflection phase (Table 1).

**Table 1.** Survey summary considering Zimmerman's self-regulated learning cycle

| Phases | Nro. items | Indicator |
|---|---|---|
| Previous phase | Two ítems | (Planning and time allocation) |
| Realization phase | Ten ítems | (Information search, regulation of actions towards goals, strategies to address the task, defense of their points of view, cognitive altruism, mental images, argumentation, focus of attention) |
| Reflection phase | Four ítems | (Periodic self-evaluation, final self-evaluation, strategy evaluation, satisfaction/dissatisfaction reactions) |

The survey was taken by 27 students from class A and 25 students from class B, in order to apply the ant colony aggregation mode, the responses to the survey are tabulated with the following values 1 = Yes, 0 = No. So Table 2:

**Table 2.** Sample tabulation of responses to survey items

| Stu-id | Time | Search | Processes | Goals | Regulation | Learning | Attention | Reflection | Defend | … |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 2 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | |
| 3 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | |
| 4 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 6 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | |
| 7 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 9 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | |
| 10 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | |
| … | | | | | | | | | | |

For the present article, the results presented correspond to class A, in which the following options were obtained when using metaheuristics Tables 3, 4 and 5:

Option 1: Group

Report; open class.csv (Ecs1); 27 individuals

K1 = 0.0; K2 = 0.3; Threshold1 = 0.0; Threshold2 = 0.3

**Table 3.** Result of the first grouping

| Community | Individuals | Total individuals |
|---|---|---|
| Community 1 | 26; 23; 24; 5; 13 | 5 |
| Community 2 | 3; 16; 19; 14; 12; 1; 8 | 7 |
| Community 3 | 21; 4; 15; 9; 7; 25; 22 | 7 |
| Community 4 | 6; 2; 18; 11; 20; 17; 10; 27 | 8 |

Option 2: Group
Report; open class.csv (Ecs1); 27 individuals
K1 = 0.0; K2 = 0.5; Threshold1 = 0.0; Threshold2 = 0.2

**Table 4.** Result of the second grouping

| Community | Individuals | Total individuals |
|---|---|---|
| Community 1 | 24; 23; 22; 12; 17 | 5 |
| Community 2 | 1; 11; 5; 16 | 4 |
| Community 3 | 27; 18; 26; 9; 2; 10; 7; 6 | 8 |
| Community 4 | 15; 21; 4; 14 | 4 |
| Community 5 | 20; 3; 13; 19; 8; 25 | 6 |

Opción 3: Group
Report; open class.csv (Ecs1); 27 individuals
K1 = 0.0; K2 = 0.6; Threshold1 = 0.0; Threshold2 = 0.2

**Table 5.** Result of the third grouping

| Community | Individuals | Total individuals |
|---|---|---|
| Community 1 | 25; 24; 23; 22; 20; 17 | 6 |
| Community 2 | 15 | 1 |
| Community 3 | 19; 13; 3; 5; 8; 11 | 6 |
| Community 4 | 16; 1 | 2 |
| Community 5 | 4; 14; 6; 7; 21 | 5 |

The values of the grouping metric are called cohesion and separation [8, 27]. When applying grouping metric definitions, you can select the best form of team grouping, bearing in mind that the cohesion is the lowest and separation is the highest; therefore, of the three options, option 1 was chosen, since the cohesion level is 0 and the separation level is 3.

## 3 Results

The levels of cohesion and separation of each of the communities of option 1 are presented below (Fig. 1):

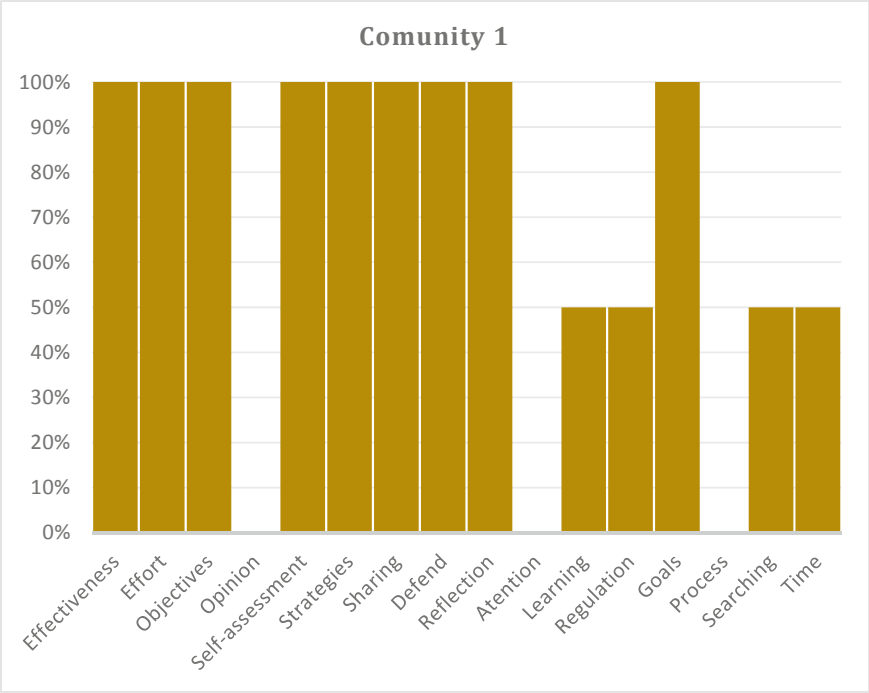


**Fig. 1.** Answers to the items of the community questionnaire 1.

As shown in community one, we have 100% cohesion in the response of 9 items, 50% cohesion in four items; likewise, there is a separation in three items, one oriented to the previous phase (management of mental processes towards the achievement of goals), and two in the phase of realization (argumentation of opinions and attention to relevant things).

In the community 2, there are 9 items answered with 100%, there two items with the answers with 80%, three items with answers with 65% and two items with answers of 50%, both oriented to the reflection phase (attention to relevant things and reflection on dense or difficult topics) (Fig. 2).

From what can be observed in community 3, there are six items that have 100% cohesion, four items with a cohesion over 70%, two items with 50% one oriented to the reflection phase (periodic verification of the scope of the proposed objectives) and the other oriented to the reflection phase (analysis and reflection of dense or difficult texts), three items with 25%, two of them correspond to the previous phase (time organization and management of mental processes to achieve goals), while the other item corresponds

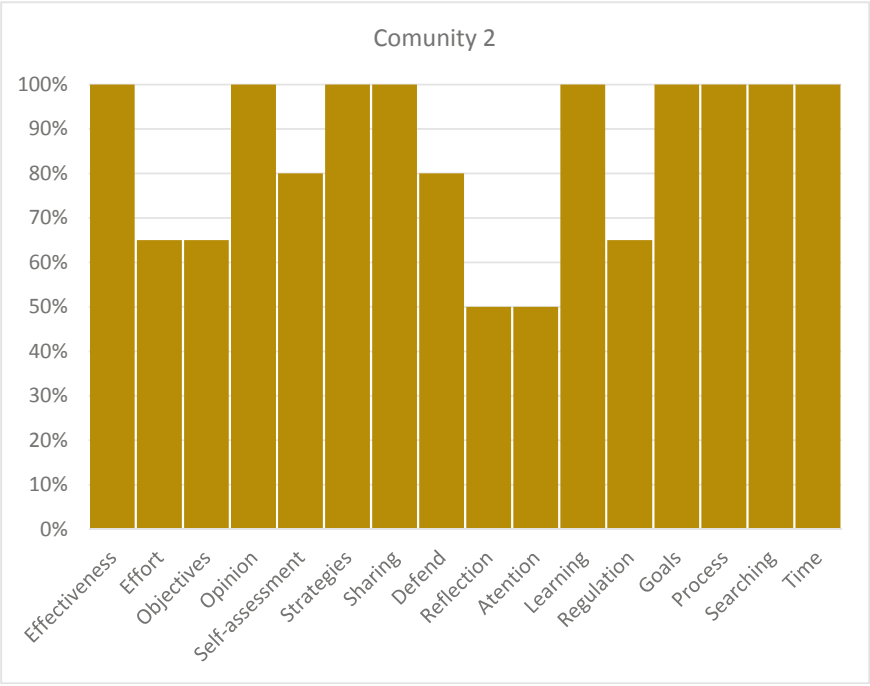


**Fig. 2.** Answers to the items of the community questionnaire 2.

to the realization phase (information search); likewise, there is an item that marks the level of separation within the community and is located in the realization phase (effort to defend what you know or ask for an explanation of what you do not understand) (Fig. 3).

In this community, the level of cohesion is given by 9 items to which all members respond in affirmative and a separation provided by 7 items, one oriented to the planning phase (time organization), five to the realization phase (periodic verification of the scope of the proposed objectives, argumentation of opinions, availability to share knowledge, analysis and reflection of dense or difficult texts and one to the reflection phase (periodic verification of the scope of the proposed objectives) (Fig. 4).

Once the groups were formed, students were informed about the group to which they belonged; as well as the role they must play within the group. For the execution of the collaborative task that had a period of six months, a star-type organization was made since everyone had to complete the entire activity individually to elaborate subsequently the final product jointly from the individual elaborations.

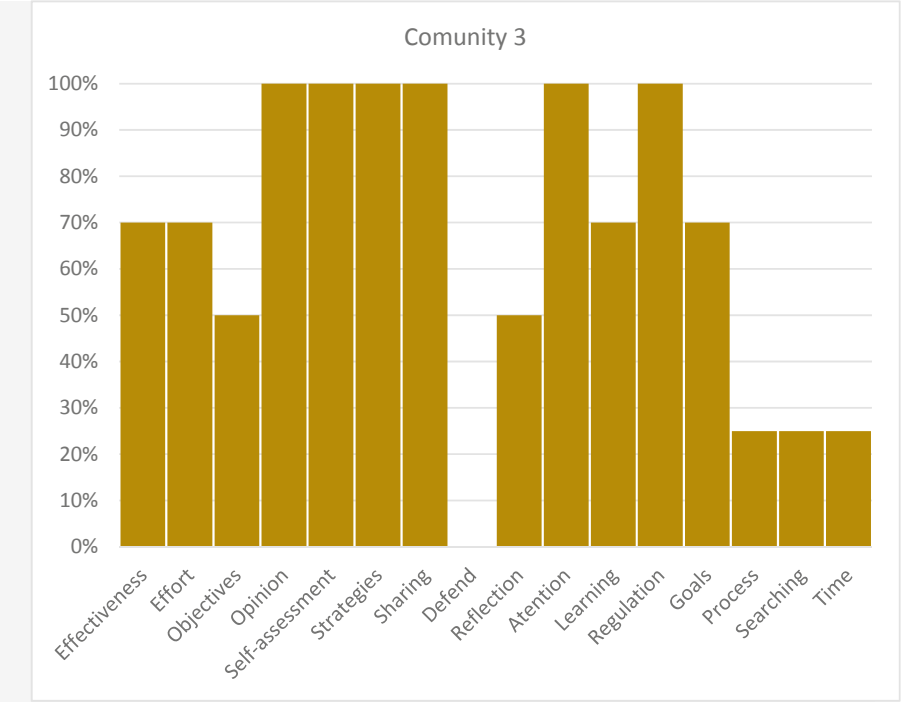


**Fig. 3.** Answers to the items of the community questionnaire 3.

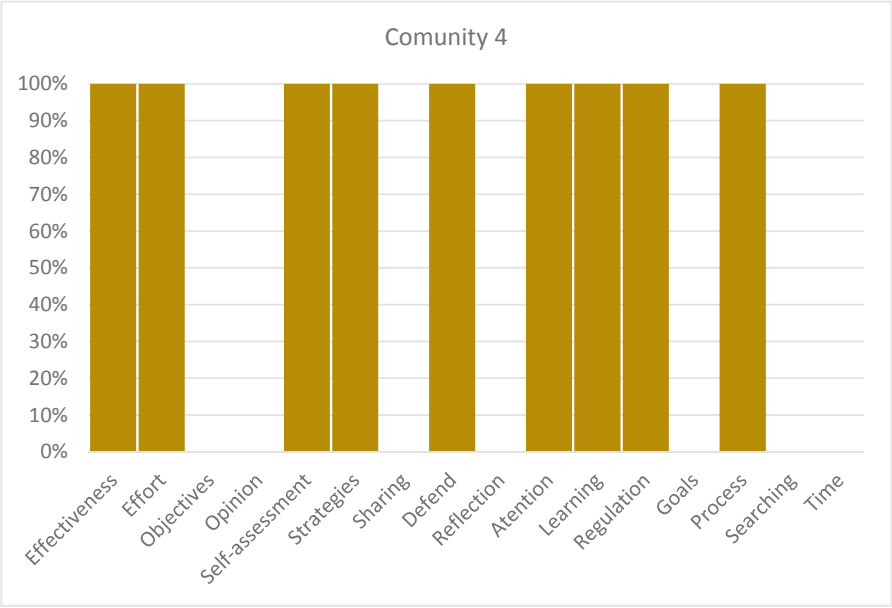


**Fig. 4.** Answers to the items of the community questionnaire 4.

## 4 Discussion

Once the academic period of class finished in which they had to carry out the collaborative task, we observed how the synergy of individual regulation known as socially shared regulation influenced the execution of the collaborative task, confirming the study hypothesis: The use of emerging algorithms for group assignment, where the differentiating element is self-regulation allows for better learning.

The community 1 composed of five people, concluded the task with an average of 38.94/40 which means that cohesion in the realization phase was a fundamental element to complete the collaborative task successfully, considering that it began with a global cohesion of the 56.25%, this forced the group to regulate its activity collectively as indicated in [16] mainly in the process of arguing opinions; as well as, in paying attention to the relevant things, since the metacognitive processes must be measured continuously having the opportunity to change thoughts, actions fulfilling what it mentions [18].

Community 2 composed of seven people, completed the task with an average of 33.74/40, a community that began with a global cohesion of 84.68%. Likewise, Community 3 composed of seven people, concluded the task with an average of 35.72/40, a community that began with a global cohesion of 65.94%. In these communities it is observed that in a group of low familiarity the dialogue, the agreements, disagreements, negotiation is slower, therefore, they need more time for the social construction of knowledge, according to [24].

Community 4 composed of eight people completed the task with an average of 37.14/40, started with a global cohesion of 56.25%. in this community it is observed that there were strategies of self-regulation, coregulation and collective regulation according to [18]. Likewise, the three principles of socially shared regulation become visible, which mentions [16] (1) increased student awareness of their own learning process and that of others, (2) support in the learning process performing their own tasks and/or the tasks of others, thus helping to share and interact, and (3) causing the acquisition and activation of regulatory processes.

## 5 Conclusions

It is important to continue testing the emerging algorithms in the assignment groups for the execution of collaborative works, with many larger samples and these experiments need to be made in virtual, semi presential, and presential systems of study, so we can generalize the following conclusions:

When applying the metaheuristic model of aggregation of the ant colony, in the assignment of groups for the execution of a collaborative work one of the dynamics indicated in [8] “the group of animals regulates their activities, through social interattractions”, this should be changed animals for people.

Performance and small groups will not necessarily go hand in hand, it is observed that the group independent of the number of members can reach an effective performance. With regard to cohesion, it can be mentioned that the lower the cohesion of the group, the greater the regulation of socially shared learning, and that the cohesion of a group is not a determining variable to achieve meaningful learning.

Regarding Zimmerman's self-regulated learning cycle, it can be mentioned that the indicators of the previous phase and the reflection phase are of personal responsibility and they can be modified in the execution or completion of the collaborative task; meanwhile, the indicators of the realization phase can be changed in the execution of the collaborative task through socially shared regulation.

From the observation, the assignment of groups must not necessarily be composed of three to five people to work in a committed way in a shared virtual environment to achieve a common objective as mentioned [19]. The assignment of groups must not necessarily be composed of three to five people to work in a compromised way in a shared virtual environment to achieve a common goal. The number of people in a group is irrelevant, since the performance of a group does not necessarily depend on the number of members as indicated by several authors.

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