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Micro Flip Teaching with Collective Intelligence

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Abstract. One of the main objectives within the educational context is that the students must be active during the learning process, and one of the indicators of this activity is the production of content by the students themselves. There are methods such as Micro Flip Teaching that promote active learning. However, achieving that the students generate content is not enough; these contents should also be used in the learning process itself and, for this, they should be managed appropriately. This article presents a method of management of the resources generated by the students and the professors as well, through the use of collective intelligence. A model of collective intelligence was developed, based on four pillars: the utility of the created contents, technology, methodology and the strategy of use. This work shows that the main factor needed so that the students generate knowledge was the strategy of use.

Keywords: Collective intelligence, Flip teaching, Knowledge management, Social networks.

1 Introduction

The organization, management and access to knowledge are vital for the development of society. For this, the appearance of technologies that allow for the creation, communication and access to knowledge has changed in the world. The Information and Communication Technologies (ICT) have contributed to the creation of present society, the society where we live: the society of knowledge.

One of the most characteristic products-services of this new society is the internet, which offers us the possibility of being connected to the rest of the people and the accessing of the content that is created at any time, place and immediately, synchronously or asynchronously.

But the manner of creating, organizing and utilizing internet content has two formats: Web 1.0 and Web 2.0. The Web 1.0 format is the heir to the classic communication media (newspaper, radio, cinema, television, etc.), where a set of people (frequently with a great reputation) create, select, organize and classify the content so that it is accessible for everyone. In this format, the person who accesses the content acts in a similar fashion as a radio listener; his or her degree of freedom consists on "changing the station". The Web 2.0 format, on the contrary, tries to liberate and democratize the creation and organization of knowledge. In this case, the former "listeners" rebel, gain prominence, and are creators at the same time that they are consumers of knowledge. A new figure is created, the spectator now becomes the "prosumer" (producer and consumer).

This atomization of the creation of knowledge leads to knowledge now having different sources of creation that are distributed in nodes with multiple flows between themselves. This is what is known as distributed and networked knowledge [1].

To optimally manage distributed knowledge, its own characteristics should be considered: knowledge created by different people, distributed in different nodes and with multiple fluxes and connections. The tools that allow for this management belong to the denominated Web 2.0, and the most common are the so-called social networks.

Likewise, the organizations of the industrial sector have applied this same approach as the method of management of the organization itself. This is what is known as knowledge management within the organizations, which is based on the generation, identification, classification, organization and use of the knowledge created not only by a single person, who is usually the one with the most expertise in the organization, but all the people that comprise it [2].

On the other hand, the educational context should not be set aside from the communication media utilized by the students, and should consider the multiple channels and varieties of these media [3]. Likewise, the "school", as an organization whose main objective is the creation of knowledge, should not remain detached from the new ways of managing it [4]. In other words, the social networks as a means of communication between people and their organizations, as well as knowledge management (KM), produced by these people, should be considered. The integration of social networks with KM is possible, as these networks allow for the sharing of information and promoting of the creation of scenarios that are suitable for the diffusion of knowledge [5].

Thus, at school as well as in organizations, the knowledge created by their members should be taken into consideration. If this condition is transferred to the context of the classroom, it is about the managing of the knowledge created by the professors and students to bring about learning, as the collective capacity always exceeds that of an individual member of this same collective [6]. This consideration is necessary, as it is usually the professors who provide the knowledge in the classroom, and the students only create knowledge to pass the evaluations, not for learning to take place.

History and evolution of humanity has been based on the cooperation of individuals, and has been the object of numerous studies, such as collective intelligence (CI), based on sociology and computer sciences. CI has been applied to diverse areas within the educational context, such as in medicine to improve diagnosis [7] or for the making of decisions [8]. Independently of its denomination, a common characteristic of all the applications is that their success depends on the capacity to activate the intelligence of all its members [9].

Thus, if CI is to be used between the students and the professors of a specific school subject, the following conditions must be met:

- That the students are willing to cooperate.

- That the students collaborate in the creation of knowledge.
- That knowledge is useful for the common objective of the students (to favor learning).
- That said knowledge is managed efficiently.
- That said knowledge is used.

The principles of CI can be applied to any group of students enrolled in the same course, as the students have many common characteristics: their main objective is to pass the course, they have different degree of knowledge on the subject matter, they have access to the same channels of cooperation, and they can share tasks and processes.

The management of knowledge, as well as collective intelligence, require that the students be active, and also that the students create content during the learning process. These two characteristics (activity and creation of knowledge) are conducted through the active method of Micro Flip Teaching (MFT). This method combines the Flip Teaching method (the students have to conduct a pre-activity before the in-class session) with the believe that the students are able to create knowledge, the product of learning, and that this knowledge can be used as a resource for learning as well [10][11][12].

In the present work, a model of action is proposed, named "Active Cooperative Collective Intelligence (ACCI), which was devised so that students in a course create knowledge in a cooperative manner through an active methodology (such as MFT), which could be used under the principles of CI. For this, a model of action was proposed that included the use of:

1. Social networks as the communication channel between persons.
2. Active methodology (MFT) so that the students create knowledge.
3. Knowledge management systems (KMS) for its organization.
4. Strategic methodology that favors CI.

Items 2 and 3 have already been investigated by the authors of the present work, resulting in validated models of action within the university context [11][13]. The two main contributions of this present work are:

- The validation of a strategic methodology that favors CI (items 1 and 4)
- Integration of the result with other aspects validated in previous works to generate a model that integrates CI with MFT.

As for the strategy, the main approach of this work is the successful creation of knowledge (by the students) that neither depends only on the use of a social network (web 2.0), nor granting a perspective of usefulness to the students (planning of the KM as an organizational method), but the creation of an inertia among the students of the course for the creation and management of collective intelligence.

The proposed ACCI model integrates CI, learning communities (using social networks), the active method MFT, a KMS and the creation of knowledge by the students. For this, the following aspects will be measured:

- Capacity of the students to contribute contents during the learning process
- Type of knowledge provided by the students
- Use of knowledge
- Organization and search for knowledge
- Usefulness of knowledge

In the following sections, the ACCI model, the research context, the results and the conclusions will be presented.

2 Proposed ACCI model

The proposed ACCI model is based on the integration of three lines of educational innovation that are currently considered as tendencies: MFT, KMS and CI. Figure 1 shows the integration of 4 main sub-models: (a) MFT, (b) the student as the generator of didactic resources, (c) KMS and (d) CI.

In previous studies, the sub-models (a), (b) and (c) were validated in asynchronous situations; meaning that the students from a specific course contributed knowledge that was posteriorly used by students of other courses, or the same course, but in a different semester or academic year. In this case, the knowledge created was produced at the end of the learning process.

For example, creating a learned lesson that only the students from the subsequent courses could benefit from this knowledge; this method was named "collective intelligence in asynchrony". However, the students who were participative, active and cooperative did not benefit from this action (although they did benefit from the one conducted by the ex-students of said subject). The sub-model (d), related to CI is proposed so that the students benefit from their action and cooperation in real-time through the organized management of the resources as they are generated. This article presents the validation of sub-model (d).

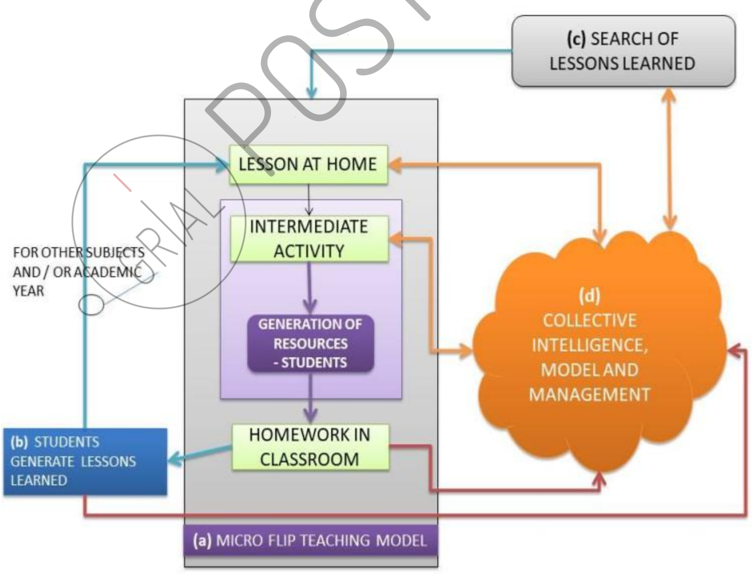

Fig. 1. Design of the ACCI model

2.1 Micro Flip Teaching

The Flip Teaching (FT) model is based on changing the place where the two main generic activities of the learning process take place: the lesson and homework. In the traditional model, the lesson is conducted in the classroom, and later, the homework is done at home. However, the FT model proposes that the lesson be done at home, and the homework in the classroom. This favors that the student study the theoretical lesson, and later, their presence in the classroom is exploited for conducting more practical activities [14][15][16].

The main problem of the FT model is that the inactivity of the students is transferred from the classroom to the home, and there seems to be a disconnection between the activities "at home" and the ones in "the classroom" [17]. The Micro Flip Teaching (MFT) model resolves this disconnection, as it adds an intermediate activity in which the students conduct a micro activity related to the video from the "lesson at home".

This activity creates evidences that are used posteriorly by the teacher in the in-class session [18]. In previous research, it has been shown that this method succeeds in making the students active, making them create useful knowledge for the learning process [10][11]. Thus, the proposed model integrates the MFT sub-model with active methodology, which allows the students to be participants in their learning process, thereby making individual knowledge flow, a condition that is necessary for constructing CI.

2.2 The student as the generator of learning resources

This sub-model is based on the peer learning approach, which proposes that the students are able to create useful knowledge for the students themselves [18] and, that this knowledge is varied (depending on the academic level of each student), and thus, the production of knowledge and the variety can lead to learning [19]. The creation of knowledge by the students is the result of active methodologies where the students participate in their own process of learning.

On the other hand, during the process of learning the student acquires experience in contents, abilities and competencies on a specific school subject, arriving at its culmination when the student has finished the learning of a specific bit of knowledge.

Thus, the student can produce useful knowledge [20] that can be used by students in another course or academic year [12]. The students explain (through a video) what they have done, and how they have conducted a specific learning activity. To prove the validity of the lesson learned, a previous research study was conducted where an experimental group only used the lessons learned by the students, and a control group used the knowledge created by the teachers. The results did not show significant differences in the learning results, showing the validity of the knowledge created by the students as didactic resources [11].

2.3 KMS

In the proposed ACCI model proposed, a KMS is needed, as the combination of the previous two sub-modules succeeds at having the student create a great quantity of knowledge, as the result of different learning activities. If the resources that are created by the students during the different courses (with common materials) are added to the different academic courses where they are produced, then the amount of knowledge that is able to be used as a didactic resource increases. But this process and accumulation presents two problems: the degree of validity of the knowledge created by the students and its organization so that it is easy to find.

The KMS is a repository named the BRACO repository (Collaborative Academic Resource Finder, or Buscador de Recursos Académicos Colaborativos in Spanish) [19] [20] designed so that the students can find knowledge from another student based on the activity that will be conducted with this knowledge, meaning, based on the final aim of the use of said knowledge [12][21].

2.4 CI sub-model

The objective of this sub-model is to achieve, in an environment that is participative and active, that the student from a specific course share the knowledge created continuously during the learning process and allow for the creation of CI. It is based on 4 pillars: technology, the content to be shared, the methodology and the strategy for its use.

- *Technology:* a social network was chosen as it is a communication channel that is very utilized by the students, who have the habit of use and the necessary technical skills. Google+ was chosen as the social network due to its characteristics of content organization. In other popular networks, the contents are organized as a list where the last contents introduced appear at the top of the page, and the older ones at the bottom of the page. However, Google+ allows the establishing of categories that work as an index where the content can be organized, and within each section of the index, the organization works as in other social networks.
- *Content to be shared.* Any information is considered as content as long as it contributes didactic value to the learning process, such as, for example, a doubt, an answer to this doubt, an example, a thought, resolution of a problem, notes, etc.
- *Methodology.* The methodology, which is shown in figure 2, should provide the necessary support so that the knowledge can be shared as it is created. For example, a question or doubt can appear previous to an in-class session, in class or after class. Thus, the concept is that the social network can be used everywhere and under every circumstance where learning is produced such as, for example, allowing the students to use their mobile devices during the in-class sessions.
- *The strategy.* It is about establishing a procedure for the use of the aforementioned elements. The strategy, described in the next section, should have in mind the student's habits of use of social networks in the academic context. One of the objectives of this work was to determine the influence of this habit for creating collective intelligence.

Likewise, the professors include, in the social network, all the didactic resources, scripts, examples, etc. that can be used in each in-class session before it is conducted, so that the students can use it during the in-class session. The objective of this research is to validate this CI sub-model and to integrate it into the ACCI model, so that it will be possible to work synchronously; thus, during the learning process itself, and so that the beneficiary is the CI's own creator.

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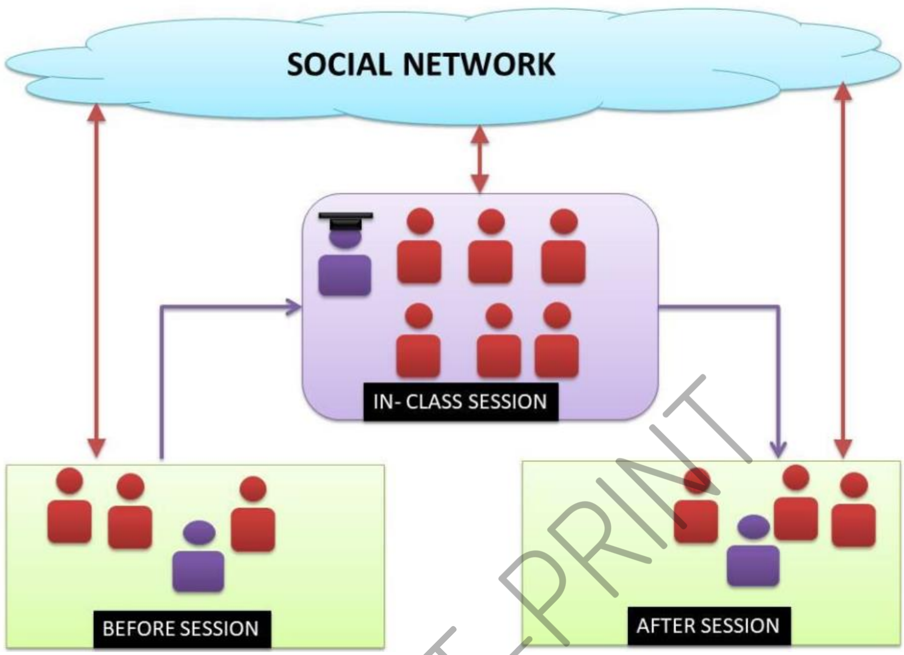

Fig. 2. Methodology of creation and utilization of CI

3 Research context

The research was conducted in the "Informatics and Programming" course, which corresponded to the first academic year of the Energy Engineering and Mine Engineering degrees. The model was applied in 2017, in the first semester, to a laboratory group from the Energy Engineering degree, and to two laboratory groups during the second semester of the Mine Engineering degree.

The course included 6 laboratory classes on Matlab programming. Each laboratory was organized into 9 sessions lasting 2 hours each, so that the sections created in the Google+ social network coincided with each in-class session. The professor created the sections through the option "filters", and each filter was equivalent to the name of each session (see figure 3-a). For example, the link with the name "session 3" only showed the resources that had been created in that session.

Likewise, the type of resource that each member contributed to the network was classified into three categories: "Action, Subject and Source", and each category, at the same time, was decomposed into a set of tags: Syllabus, Petition, Doubt, Answer and Contribution (for Action), Matlab and Algorithm (for Subject), Professor and student (for Source). The list is shown in Figure 3-b.

In conclusion, each time that a student contributed a resource to the social network, the following information was created: user (generated by the network by default), filter (the network obliges the choosing of a filter before making the resource public) and the tags (optional). Thus, when a resource was included (Figure 3-c), the session (Figure 3-a) and its tags (Figure 3-b) that only the professor had included according to the content that the student included, could be observed.

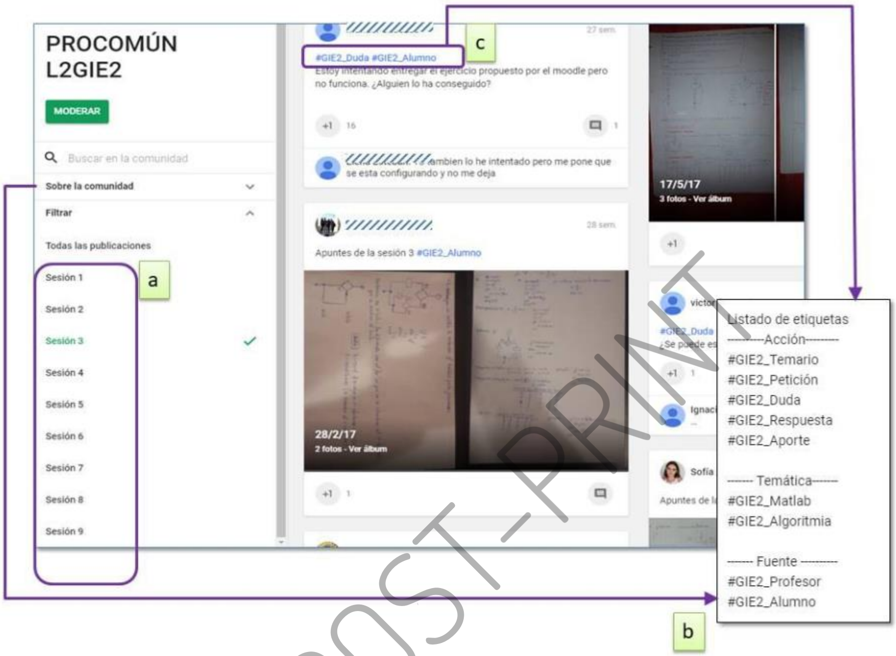

Fig. 3. Social network for managing CI

The strategy of the ACCI model (section 2.4) is described through the following procedure:

1. On the first day of the course, the mission and objectives of the creation and the use of the CI is explained, the functioning of the network is explained and the student's membership is verified.
2. Previous to the session, the professors include the planning of the session and the resources that will be used in the social network. The tag "syllabus" is assigned.
3. During the in-class session:
   a. Laboratory 1, first semester. The professor establishes the procedure for including, within the network, every doubt, class notes taken, example resolved, comments, etc. In the case of the class notes, a specific student will include his or her notes in the social network (this process is conducted in the first four sessions).
   b. Laboratories 2 and 3 of the second semester. During the in-class session, the professor does not establish any procedures, the students decide what to include in the network and when to do it.
4. The students share, in the network and in real time, doubts, clarifications, examples, problem solutions and any other information that they consider to be the results of

learning. For example, the explanation of a doubt that was resolved for them, or a difficulty that they resolved themselves.

5. After the in-class session, the social network is maintained, so that the students continue posting their doubts, sharing their notes or any other information that results from the learning conducted outside of the class.
6. The professor supervises the resources contributed by the students and those that are considered to be useful for the rest of the students are linked through the syllabus that was initially included in the social network.

Step 3 was done differently in each semester, as the habit of use of the social networks for the creation of collective intelligence during the process of learning, was measured. In this way, step 3.a was applied to the laboratory of the first semester (laboratory 1), and step 3.b was applied to the second semester laboratories.

4 Results

The gathering of data was conducted from two sources: the evidences contributed to the network (shared knowledge) and from a perception questionnaire.

4.1 Evidences contributed to the social network

The quantification of knowledge, shared by the students, was obtained from the sum of the resources included in the social networks: shared class notes, doubts mentioned, responses to these doubts, examples solved, etc.

Figure 4 shows the distribution of the contributions created in each group/laboratory. Figure 4(a) corresponds to the students from laboratory 1 (31 students) during the in-class sessions, and the figures 4(b) and 4(c) correspond to the two groups (35 students in each group) from laboratories 2 and 3. The difference between laboratory 1 and laboratories 2 and 3 is that laboratory 1 conducted step 3.a from the ACCI strategy (presented in the research context section), while the other two laboratories conducted step 3.b.

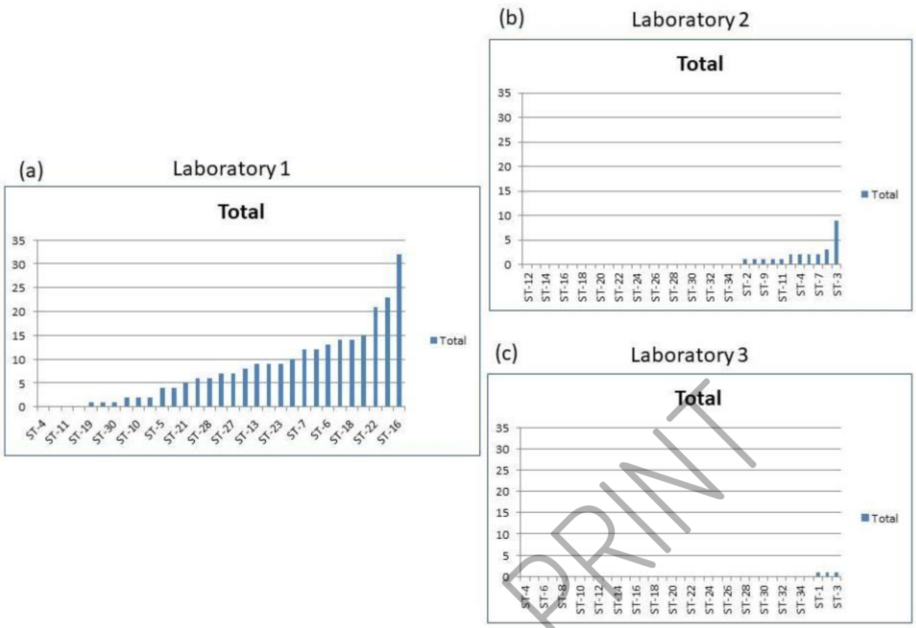

Fig. 4. Number of contributions per group / laboratory

Table 1 shows the percentage of participation, i.e., the number of students who contributed at least one type of content with respect to the total number of students, and table 2 shows the type of knowledge and the number of contributions from each group. The “Likes” are not considered contents, but show that this contribution was useful for the students.

Table 1. Percentage of participation per group/laboratory

Group	**Laboratory 1**	**Laboratory 2**	**Laboratory 3**
Percentage of participation	87.09	31.42	8.57

Table 2. Type and quantity of contributions per group/laboratory

Group	**Laboratory 1**	**Laboratory 2**	**Laboratory 3**
Notes	16	6	0
Doubts	28	4	0
Responses	41	9	0
Examples	16	6	3
Total contributions	**101**	**15**	**3**
Contributions per person	3.25	0.71	0.08
“Likes”	170	0	0

4.2 Qualitative data

The qualitative data were obtained from a questionnaire that was by comprised by 9 questions, and was structured in three dimensions: the resources included in the social network, the management of the network itself and the academic management of the laboratory itself. Each dimension had three associated questions. The first two dimensions (resources Q1-Q3 and network Q4-Q6) would be applicable to any other course. The third dimension (management of the laboratory) aimed to improve the laboratory, and thus it would only be applicable to courses that included Matlab programming laboratories. For this reason, this third dimension is not included in this article.

The first three questions (Q1-Q3) measured the use of the resources contributed in the social network through a 4 point Likert scale (1 not in agreement, 2 somewhat agree, 3 in agreement and 4 completely agree). Their objective was to verify the use, utility and quality of the contributed content. Q1: I have read some content corresponding to the different sessions in class. Q2: Indicate the degree of usefulness of the following contents. Q3: I would prefer that the contents of the social network uploaded individually by a classmate would be reviewed previously by a group of people.

Next, the 31 answers from laboratory 1 are presented. These results have been published in a previous research study [4] to analyze the perception of the students of this laboratory. Tables 3 and 5 show this data as a percentage of answers.

Table 3. Percentages of responses to question Q1 (resources)

Q1. I have read some content corresponding to the different sessions in class.				
	1	**2**	**3**	**4**
Notes contributed by other classmates	13	28	41	19
Doubts and Responses	6	31	31	31
Professor's syllabus	0	3	47	50
Programs solved by classmates	9	13	41	38

Table 4. Percentages of responses to question Q2 (resources)

Q2. Indicate the degree of usefulness of the following contents.				
	1	**2**	**3**	**4**
Notes contributed by other classmates	16	50	28	6
Doubts and Responses	0	19	56	25
Professor's syllabus	0	13	41	47
Programs solved by classmates	0	19	38	44

Table 5. Percentages of responses to question Q3 (resources)

Q3. I would prefer that the contents of the social network uploaded individually by a classmate would be reviewed previously by a group of people.				
	1	**2**	**3**	**4**
Notes	6	31	34	28
Doubts and responses	16	25	38	22
Programs solved (its proper functioning verified by the professor)	9	13	31	47

Questions Q4-Q6 are open-ended questions used to verify the efficiency of the CI sub-model (through the social network), as well as its improvement: Q4-indicate what you liked the most of the social network, Q5- indicate what you liked the least of the social network and Q6- indicate what you would improve about the social network. An analysis of the open-ended questions was conducted, and these were later grouped into diverse categories: What I liked the most (collaboration, content, accessibility, organization, teacher relationship and novelty), What I liked the least (types of content, difficulty finding content, quality control, nothing and technical problems) and Improvements (organizations and search, specific content, nothing, other applications – help with recovering missed classes, involvement of the professor and quality control). Figure 5 shows the evaluations of the students from laboratory 1 for the five most valued answers.

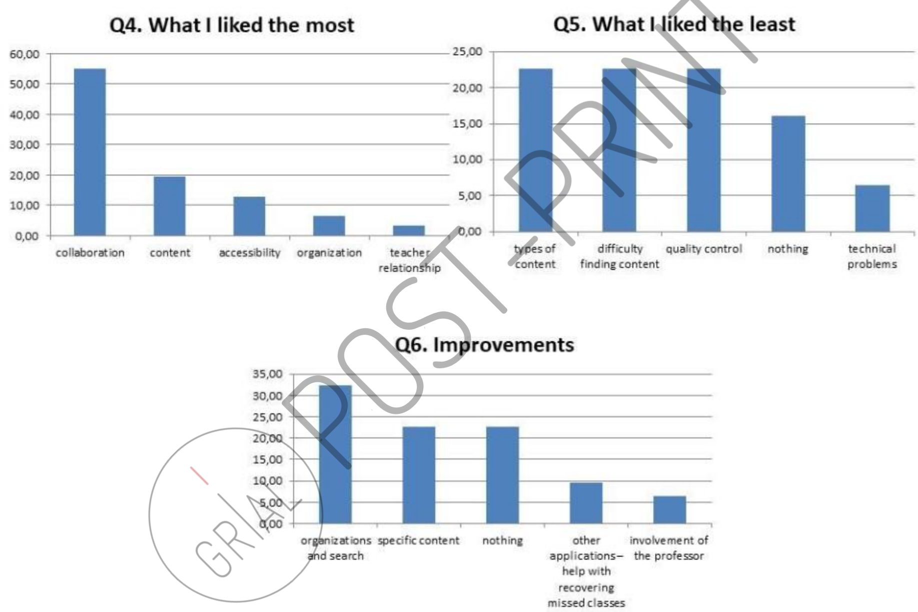

Fig. 5. Evaluation questions Q4, Q5 and Q6 of the CI sub-model

5 Conclusions

From the results gathered, the following conclusions are drawn, grouped into the following sections that contribute with the validation of the ACCI model:

- Capacity of the students to contribute content during the process of learning
- Type of knowledge contributed by the students
- Use of the knowledge
- Usefulness of the knowledge

● Organization and search of knowledge

Capacity of the students to contribute content during the process of learning. This refers to the capacity of the students to generate the elements of knowledge necessary to construct the process of collective intelligence. That is, the elements of knowledge that they contribute during the process of learning. The laboratory 1 group had a high capacity for creating contributions in the contents of the social network (101 in table 2) as well as in the verification of the usefulness of said content (170 "likes" in table 2). Likewise, in this same lab, 87.1% of the students contributed at least one type of content (table 1).

However, the laboratories 2 and 3 had a low contribution of resources (15 in lab 2 and 3 in lab 3, table 2), with 0 "likes", which could be a sign of the low interest of both groups. The percentages of participation of the persons that contributed content were very low, with 31.42 for lab 2 and 8.57 for lab 3.

Taking into account that the 4 pillars (technology, content to be shared, model and strategy of use) for the ACCI model, the first three are identical for all three laboratories. The strategy of use, the only variation between lab 1 and labs 2-3 was step 3, is the step that could be associated to the different degree of participation.

Thus, a first conclusion can be stated: so that the students involve themselves with the social network and thus contribute basic content to create collective intelligence, it is necessary to create a habit during the in-class sessions (at least during the first sessions).

Type of knowledge contributed by the students. The knowledge consists on the contents that are contributed by the students as a result of the process of learning. Also, this knowledge should be useful for favoring the learning by another student. The information on the content is mirrored in the social network. On the one hand, the section where the content belongs to is defined, which indicated the in-class session related to it (figure 3-a). The type of content is defined as a tag.

The process of creation of tags is conducted continuously and dynamically, so that at the start of laboratory 1, there are no tags, but as content is added by the students, the tags are identified and added (by the professors, in this case).

Due to this process, once the laboratory is finished, the type of content can be identified through the mere analysis of the different tags contributed. After the analysis is conducted, it was determined that the content contributed by the students was the following:

● *Class notes*. Photographs of the notes taken by the students in the in-class sessions (they have the professor's permission, according to the intellectual property norms).
● *Doubts*. The doubts that arise during the in-class session or outside of the classroom.
● *Responses to the doubts.* These are solutions contributed to the doubts asked by the students. Some students answer their own doubts; meaning that the students who posted a doubt have already solved it through their own means.
● *Examples resolved*. As these are programming laboratories, these are examples that are done in a different manner as those conducted in class, and that the students have conducted to understand specific concepts or proposed problems.

Use of knowledge. The most significant contribution comes from laboratory 1, as it is the most reliable group as there are quantitative data (the use of the social network, tables 1 and 2) that back the utilization of knowledge. Question Q1 provided information on the utilization of the knowledge contributed to the social network, in relation to values 3 and 4 of the scale (in agreement and complete agreement): 97% used the contents contributed by the professors, 79% the examples resolved, 62% the contents of type doubts and responses, and 60% the notes taken by other classmates. Thus, there is a greater use of the contents contributed in the social network.

Utility of the knowledge. This data was obtained from question Q2. The perception of the utility of the content, as related to the students that had answered "in complete agreement" or "in agreement", was almost 90% of the cases for the content contributed by the professors (88%), doubts and responses (81%) and examples (81%). However, it was very scarce for the notes contributed by other classmates (34%). Thus, it was shown that the contents contributed by other people in the network were useful for learning, however, the contents contributed that coincided with the contents that was already possessed by the students (as in the case of class notes), were not considered useful.

Organization and search for information. It was evident that if there are little resources in a social network, it would be difficult to find them (due to their scarcity), but when there is a great number of resources, the organization is closely linked to the ease of searching, identification and utilization. In the open-ended questions, it was observed that one of the aspects that was least liked by the students (open-ended question Q5) was the difficulty in finding contents in the network, and on the other hand, this was complemented by the open-ended answers provided for Q6 (improvements), where the students considered that the most important was the organization and search for content. This justifies the utilization of component (c) within the ACCI model (figure 1-c): the knowledge management system, where in other research studies, the ease of its system of searching was evaluated.

In this work, the strategy of use of the CI sub-model was validated and defined. The next step of the research study will be to apply the complete ACCI model; meaning, including all the sub-models.

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