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The ICT enhancing the creativity through collective intelligence

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Abstract

Nowadays, society and organizations face an accelerated innovation that requires of professionals with new skills and attitudes, especially those related to collective creativity. However, educational environments are slowly integrating emerging paradigms limiting the contribution to the development of key skills related to innovation. Multiple investigations claim that teachers have conservative attitudes toward collaborative schemes, while employers generally recognize the effectiveness of creativity at work. Management of ideas is the core of creativity in innovation processes in the industry and in production and service management. This depends largely on the collective work and individual social skills, as well as on the capabilities that information technology and communication (ICT) provide. This article presents a process of collective ideas refinement (CIR) and combines paradigms of swarm creativity and social skills as a means to capture the participants' emotions.

Keywords: emotional intelligence, collective intelligence, innovation, creativity, and ICT.

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1. Introduction

The information age confront companies to an accelerated rate of changes where innovation in its products and services is essential to their survival; however, educational environments are slowly integrating emerging paradigms that promote the development of collective creativity. Multiple investigations claim that teachers have conservative attitudes about the effectiveness of collective creativity, while employers generally recognize the effectiveness of creativity in their work. Google, Wikipedia, and Facebook are the best examples of innovation and collective intelligence (CI) in action [1].

Creativity currently combines a set of work paradigms, which is not only focused on the individual and on his or her individual creative abilities, but also on the ability to generate an environment of collective intelligence. In this environment, emerging skills such as swarm creativity and emotions arise spontaneously allowing the participant to propose solutions without fear of direct criticism from the group, which can be generated in classroom environments (face to face). The use of ICT has proven to be an effective means to mediate creativity in groups, and for this purpose, the group support systems (GSS) are an effective communication solution in teams of individuals, especially in tasks related to ideas generation [2].

In the process of managing and managing ideas, several authors agree that the application of convergent and divergent creativity techniques through multiple cycles leads to the selection of the best solution. Vandenbosch, Saatcioglu, & Fay, (2006) cited by [20] define the administration of ideas as the process of recognizing the need for the usefulness of ideas in solving problems, generating and evaluating them , further argues that ideas are the core of the creative process.

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[23] refer to Amabile, (1988), defines creativity as the ability to develop new solutions according to the needs of the context, in addition, [23] mentions to Amabile, Conti, Coon, Lazenby, & Herron, (1996) and Cummings, (1965), whose emphasize that literature states that creativity is typically a set of personal skills, and that organizations are the environment for the development of those skills. In this sense the creative process is influenced by its actors.

[25] argue that creativity based on problem solving is known as Creative problem-solving process (CPS). According to the literature, CPS is a creative problem solving process and consists of the stages of (a) looking at facts, (b) formulating the problem, (c) generating ideas, (d) Evaluation and selection of the solution and, finally, (e) the selection and application.

The creative process can affect several fields of knowledge, [19] identified four currents in relation to research in the field of creativity: (a) find the association of creativity with personal factors such as cognitive ability and /or personality traits, (b) examine the cognitive and social processes involved in creativity, (c) Ideational creativity through computer tools, and (d) to determine the environmental factors that nourish or inhibit creativity.

Many computer tools and research have been carried out in the field of ideas management and the promotion of creativity [22], [25],[24], [22], [27]. Another current of ideas management and management tools are what [26] calls Idea Management Systems, and defines it as a set of tools for collecting ideas in large crowds for innovation.

The development of the functionalities required in the ideas management and management tools need to consider several ideas filtering techniques as an applicable option. [21] proposed a classification of filtering techniques over several cases. [21] pointed out the work with the management of ideas and creativity is not directly linked to large volumes of information, therefore the attention in the present research has been focused on collaborative filtering, since the participants are mainly human who select the ideas and classify them contributing to the development of their creativity.

This article presents a process of collective ideas refinement CIR, which combines the paradigms of swarm creativity and GSS as a means to capture the ideas and emotions of the participants [3].

2. Literature Review

Intelligence is part of the innate higher cognitive processes, which has allowed determining the Intellectual Coefficient of individuals. According [4] considers three aspects of intelligence: the component element, which refers to the efficiency with which people analyze and process information. Element experience shows how people approach family tasks and the new ones. The contextual elements allow verifying the people and their relation with their environment. In a conventional system where beliefs, traditions, habits and paradigms are everyday part of our society; technology has been incorporated in small portions as a silent body. This gradual and at the same time accelerated process, that technology suggests, has allowed to know the complex world of emotions and its role in the context in which the individual is involved.

[5] determined that the individual handles two minds, a mind that thinks and a mind that feels. For this reason, the emotional and the rational mind are two relatively independent faculties that reflect the operation of distinct but interrelated brain circuits. This operation has allowed human beings to develop skills that allow them to unconsciously relate to and learn from interaction with other human beings.

The interaction of individuals the same kind in the activities everyday and in problem solving shapes a space emerging collective intelligence (CI). [6] defines collective intelligence as the ability of human groups to participate in intellectual cooperation in order to create, innovate and invent. [16] states that collective intelligence refers to the measure of the collective capacity of a group, and it should be, in the near future, a key determinant of efficiency with a particular challenge that can be understood and addressed effectively by an organization.

Collective intelligence in the field of education has been reported by several authors. According to [7], the vast majority of research in the last decade refers to collective intelligence with the use of technologies. [8] makes a critique about the educational system, and indicates that teaching is equal to 50 years, while it is not taking advantage of the collective intelligence, which allows the construction of global learning systems, content and networking. It is also maintained that the incorporation of collective intelligence implies not only a technological change or change in the attitude of the teachers, but also an education redefinition.

[9] indicates that collective intelligence can be used in the teaching-learning process, and that both teachers and students can apply it to content, assessments, and educational materials. [10] reports that there is a change in the approach to instructional design of learning content, allowing to create and share content, opening up new fields of collective intelligence research.

A research published by [11] indicates that there is evidence that students can be autonomous in their learning and also participate collaboratively. Research carried out by [12] reported a pilot study to evaluate the Wiki collaborative tool and investigate whether this could be used as a learning tool in schools. The results suggested that the use of this tool can enhance learning and encourage collaborative learning skills. Another study of [13] applied a methodology that allowed examining the benefits and challenges of contributing to a wiki; this study was conducted on Language and Literature classes. The results of this research indicate that the Wiki contribution has promoted collaborative processes among students by creating shared knowledge and strengthening the collective knowledge of the group, besides, [17] presented a framework about collective intelligence education.

(Basadur et al 1982;. Isaksen & Treffinger 1985; Mumford et al 1991;. Osborn 1957. Parnes et al 1977)

reported by [14], argue that creativity based on problem solving is known as a creative problem solving (CPS) process. According to the literature, CPS is a process of creative problem solving and is formed by the following stages (a) look at the facts, (b) problem formulation, (c) ideas generation, (d) evaluation and selection of the solution and, finally, (e) selection and application. Furthermore [14] refer to Basadur et al. (2000), argue that the Group Support Systems (GSS) could facilitate interaction and improve understanding among team members. According to [2] GSS are an effective solution to mediate communication in groups of individuals, especially in areas related to ideas generation.

3. Process of Ideas collective-refinement

With the general idea of promoting collective creativity in the educational environment, focused on problem solving , a prototype of GSS and refining process has been designed, developed and formally presented in this section (Fig . 1). The model allows teachers, students and groups, actively participate in the process of creative solution search, through ideas management and assessments according to the participant emotional factors. The archetype facilitates interaction and collaboration of students and groups through an organized refinement process, where in every phase ideas are obtained with greater refinement and acceptance of the participant group.

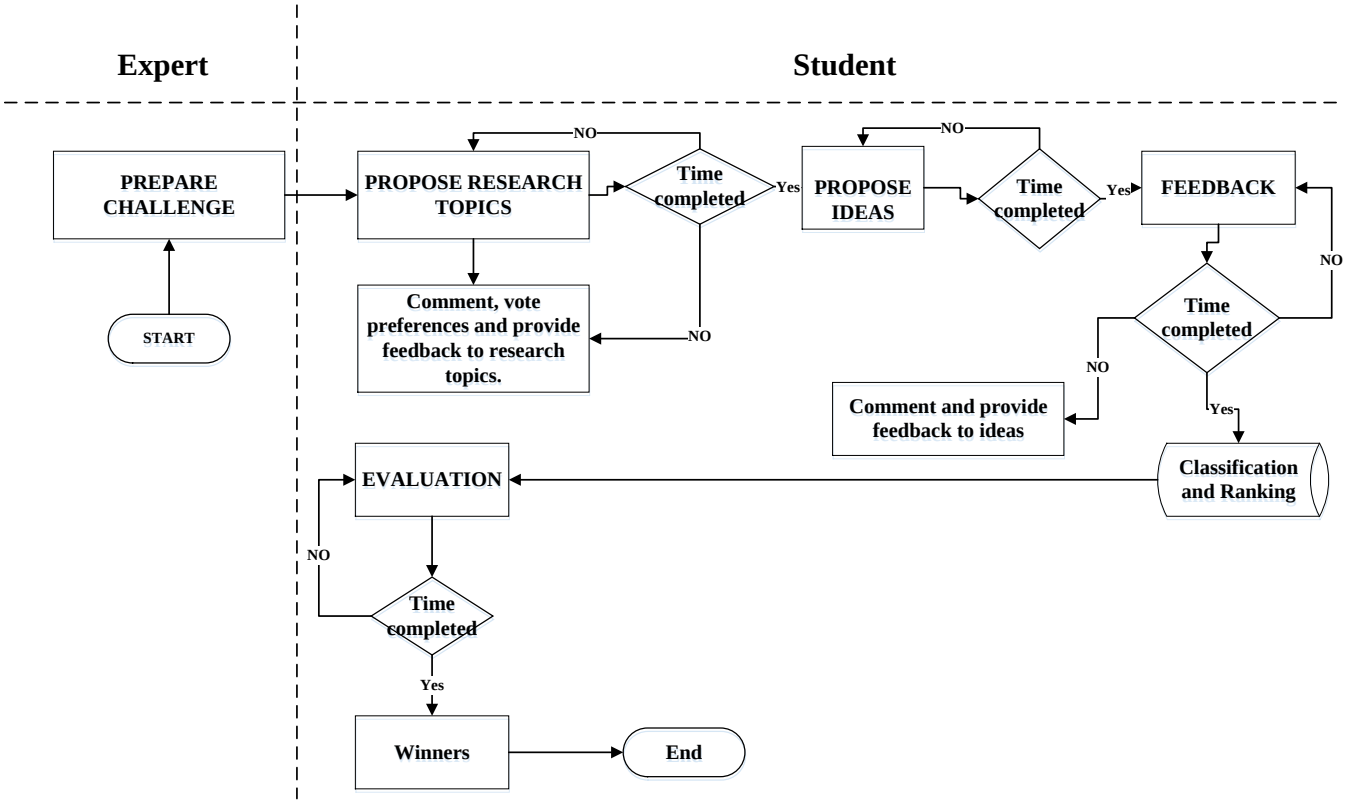

Figure 1. CIR Process

The objective of the proposed model considers the implementation of the GSS as an effective means of ideas refinement to solve a problem through collective creativity.

Figure 1 presents the participation of two actors, experts and students working asynchronously on a set of key activities of CIR. The details of CIR activities are presented in the follow section:

3.1. CIR activities

Prepare Challenge

The expert (s) define an area of general interest (Example : Educational Projects) where it is required to seek for possible problem research areas as well as determine the allocated time for the fulfilment of each of the challenge stages.

Topics of Interest

Each one of the participants are enlisted in the suggested challenge and during the assigned time to the challenge, they propose possible topics that present potential problems within the context of the challenge. Each participant in this process can propose as well as to make comments and vote for their preferences on the proposals submitted by other participants, encouraging a constant feedback.

Ideas

In one or more topics of interest, even in those proposed by the same participant, solution ideas are posed to the selected topics. The design of the proposal includes: a title of the solution, a short explanation on how to do it, besides, if required, a short essay of ideas, as well as videos and annexes that support the proposal could be included.

Feedback

When the phase of ideas is finished, participants come with the first iteration of quantitative refinement. Each participant makes a vote (I like it / I do not like it) on each one of the ideas proposed as a solution, except on the own ones. They can also comment and provide feedback on the proposals of solutions to improve them. Comments include a brief description and, if necessary, a report that includes videos, images, etc. As a result of this process, a ranking of preferences of ideas is generated. The ideas that go to the next stage are classified according to the indicator of preferences ranking RP (Table 1).

Evaluation

The ideas that exceeded the preference ranking come to be valued by the / the expert (s) as well as the participants as well as the proponent of the idea. The rating scale is done according to a set of rubrics Table 2. Each item is evaluated by the emotion caused on the evaluator (participant / expert) in accordance to the criteria in Table 3.

Winners

Upon completion of the period of time assigned for the assessment, the final ranking of solution proposals is generated for subsequent application; addition, as a result of the refinement process a set of collective work indexes are generated Table 1.

According to [15], there are some evidence that the effects of cooperative learning achievement depend on social cohesion and the quality of the group. In this sense, the list of indicators (Table 1) is a tool for monitoring levels of cohesion in the group. Therefore, it is maintained that low refinement rates denote groups with scattered criteria. It is also noted that the CIR assessment approach uses emotions as a criterion for assessing the rubrics (Table 2). In this sense, the classification of emotions in positive and negative groups has been considered (Table 3).

Table 1. Rate formula

Rate	Description
Preferences Ranking (RP).	It establishes as valid ideas the ones where the score is among the most voted minus one standard deviation.
Final Ranking (RF)	It establishes a winners range which is given in terms of the rubric valuations of the expert (s) X 60% and students' ratings X 40%. Only those ideas which punctuation is among the most voted and the most voted minus one standard deviation will be eligible.
Preferences Rate	It considers the ratio of the number of received votes by the number of total votes.
Preferences Filtering Rate	It considers the ratio of the number of ideas that reach the RP by the total number of proposed ideas, minus the unit. That is 1 - (RP / # Total Ideas).
Emotional homogeneity Rate	It is the standard deviation of evaluations, this is Average of evaluations $\pm$ 1 one standard deviation of evaluations.
Similarity Rate	It establishes the similarity ratio of rubrics assessment criteria between the expert (s) and students [18].
Refinement Rate	It considers the ratio of the number of ideas that reach the RF among the total number of proposed ideas, minus the unit. That is 1 - (RF / # Total Ideas).

Table 2. Rubrics for Evaluation

Rubric	Description
Novelty	The thing is new, it exists, it is known or used for a short time.
Added Value	The proposal generates added value or contributes to the solution of the problem like never before.
Innovation	The presented novelty can become a reality.
Inspirer	The proposed content inspires new ideas and it can extend the discussion topic.
Appropriate	It is suitable for the solution of the analyzed problem.
Complete	The content is complete and it can be easily understood.

Table 3. Emotional criteria

Emotion	Description	Group	Value
Dissapointment	I feel a little bad. The proposal is disappointing.	Negative	3
Rage	It's terrible. It is the worst proposal I have ever listened about.	Negative	1
Anger	There is no effort. It is bad. I do not think it helps to anything.	Negative	2
Sadness	It might be better with a little more effort.	Negative	4
Joy	I really like it. It makes me happy and I think it could be put into practice.	Positive	5

Admiration	It's the best proposal I have ever read. It is excellent.	Positive	6

4. Applying CIR through a web tool

In this section, the empirical evidence of CIR application through a web tool is described. CIR was used by three group of student from the University of the Armed Forces of Ecuador ESPE (Table 4) in the academic year 2016.

Table 4. Groups of students & empirical experience settings

Degree	Career	Subject of challenge	N	Time
Undergraduate	Early Childhood education	Problems and solution for Early Childhood education	23	15 d
Undergraduate	Science of Physical Activity and Recreation Sports	Physical Activity projects and its influence in the student performance	15	15 d
Postgraduate	Master in University Teaching	Higher education of Ecuador on the future	15	8 d

For each group a challenge was proposed, at the end of the time (Table 4), the students applied a web tool (Figure 3) for each one of the stages of CIR, at the end of time assigned for resolve the challenge some outcomes about of collective creativity were obtained measured thought the indicator proposed in Table 1. Some indicators gotten after the experiences are presented to follow:

Table 5. Indicators of Early Childhood education (STEI), & Science of Physical Activity and Recreation Sports (STEF).

Indicator	Description	STEI	STEF
Preferences Ranking	It establishes as valid ideas the ones where the score is among the most voted minus one standard deviation.	5	4
Preferences Rate	It considers the ratio of the number of received votes by the number of total votes.	76%	69%
Emotional homogeneity Rate	It is the standard deviation of evaluations, this is Average of evaluations ± 1 one standard deviation of evaluations.	4 - 6	3 - 5
Similarity Rate	It establishes the similarity ratio of rubrics assessment criteria between the expert (s) and students.	88%	96%
Refinement Rate	It considers the ratio of the number of ideas that reach the RF among the total number of proposed ideas, minus the unit. That is 1 - (RF / # Total Ideas).	86%	92%

Some patterns was picked up from the refinement process applying CIR especially in the undergraduate groups because the nature, age range we consider they are into the same population. The picked up patterns were related with emotion vote pattern (Table 6). Table 6 presents the vote frequency in four columns: Early Childhood education experts (EXEI), Early Childhood education students (STEI), Science of Physical Activity and Recreation Sports Experts (EXEF), Science of Physical Activity and Recreation Sports students (STEF).

Table 6. Vote frequency by participants about emotions

Emotion	EXEI	STEI	EXEF	STEF
Rage	0,36%	3,11%	0,00%	5,15%
Anger	8,57%	1,16%	7,69%	3,67%
Disappointment	23,21%	5,40%	16,92%	7,81%
Sadness	36,43%	21,43%	42,56%	33,54%
Joy	27,14%	51,76%	28,72%	44,37%
Admiration	4,29%	17,14%	4,10%	5,47

The frequencies presented in Table 6, has been represented in the Fig. 2, how a voting patterns between the participants. The voting patterns generated have shown a really strong correlation between the participants groups (Table 7).

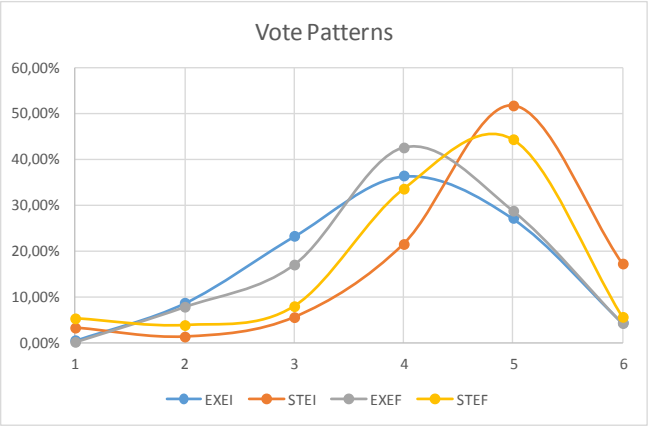

Figure 2. Voting patterns between the participants

Table 7. Participant correlation's patterns

	EXEI	STEI	EXEF
EXEI			
STEI	0,53		

EXEF	0,97	0,58	
STEF	0,79	0,90	0,85

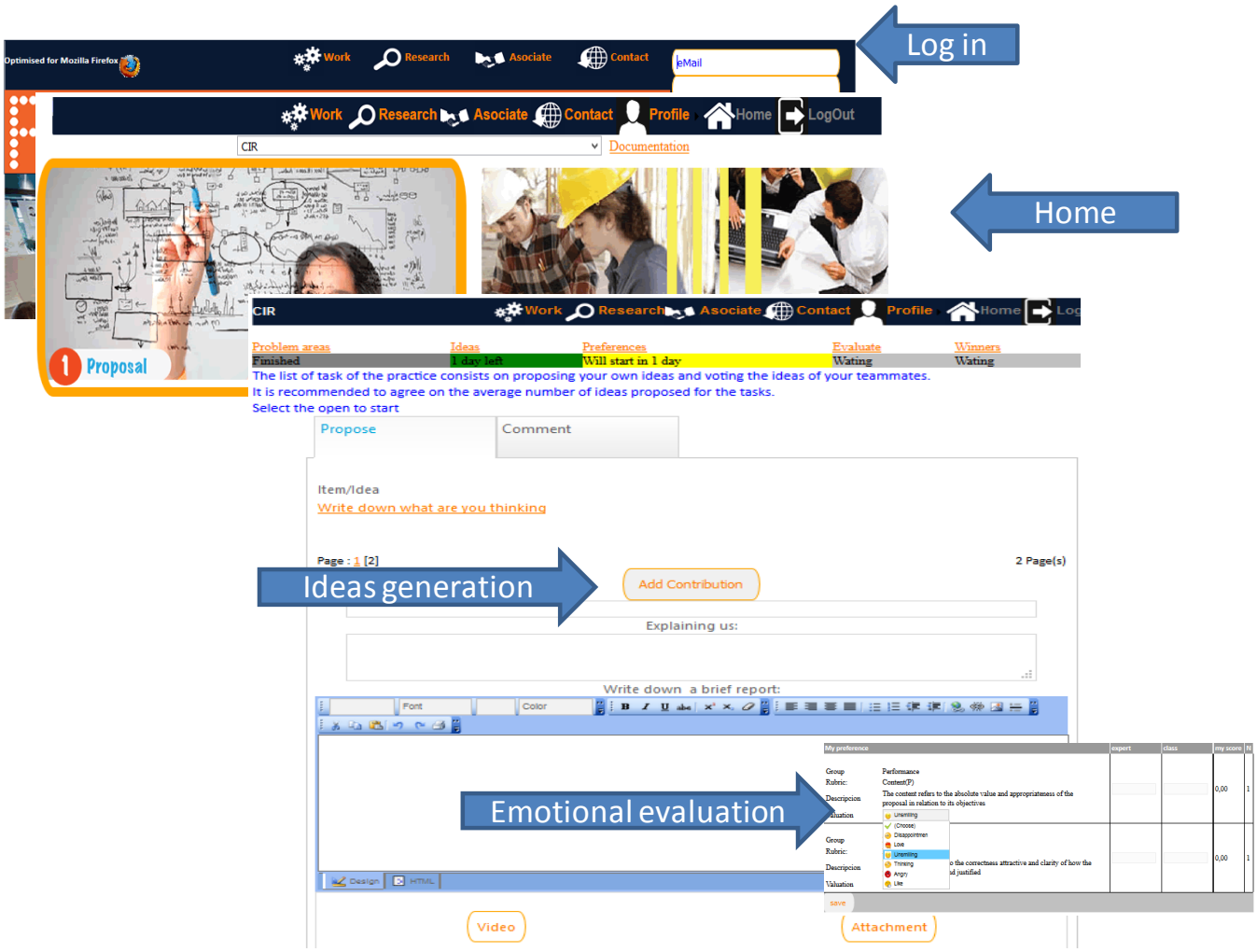

Figure 3. Main interfaces of the web tool

5. Discussion & conclusions

The outcomes presented, have evidence about the importance of ideas filtering process in creative environments. CIR implemented several indicators that allowed supervising the behavior teachers & students into the creative process. Some highest indicators were Similarity Rate & Refinement Rate, this results are agree on[15], and show evidence about the effects of cooperative learning, social cohesion and group quality, as CIR maintained that high refinement rates & similarity.

In the other hand, the outcomes plotted in the Fig 2, confirmed the tendency the human's collective the vote in the center of the scale. We have to point out, the teachers & students did not know the value by emotion. Their interaction was guided by the emoticon (Fig. 3. arrow emotional evaluation). Both teachers & students shown a really strong correlation, it correlation support also the idea of social cohesion behaviors. This correlation allows considered that CIR as a useful tool to foster consensus of groups.

Using emoticons is related on the field of sentiment analysis. In this context CIR, presented a great potential in develop the critical thinking of student according their emotions. In this sense, we point out that the inseparable link between body, mind and spirit would help in the formation of a whole human being, using emotional intelligence strategies, collaborative work and ICT, essential components for his or her formation.

The feedback analysis over the information picked up from the students, shown increasing of motivation and engagement. This is supported because the students continually participating in the platform, although in some cases their ideas was not classified. Therefore the application of CIR has shown evidence on the usefulness of the model in the development of creative solutions to problems in the educational environment. Moreover, the outcomes validating that CIR could be considered as GSS.

Based on the discussion and outcomes presented in this paper we have the following conclusions:

- CIR has a very broad and open conceptual framework and more theoretical and empirical research is necessary to generalize the application of model.
- The proposed model and the corresponding web tool are the result of a creative combination of theoretical and practical perspectives. From this point, with a consistent model, it will be possible to continue with the development of new features oriented to make recommendations on the continuous improvement to the state of art in the field of collective creativity assisted by a GSS.
- Sentiment analysis has a great potential in the creativity in the higher education.
- The collective intelligence and creativity are stronger related, because the base of creativity is the ideas management, and the ideas management is develop by at least two persons where the collaboration and competition is present, therefore the Collective intelligence emerge.

Futures essays could be applied for solve problems into the Business environments. For instance, solving problems about IT budgets.

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