

An Environmental Management Project: Situated Learning to Enhance Critical Thinking Skills in College Students

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Abstract:

The link between “what” to learn and “how” to learn it is built by the “learning and doing” connection provided by situated cognition. From this perspective, a classroom innovation is proposed an environmental management project, aimed at developing critical thinking skills in college students by structuring a real, problematic situation. 220 students from the Universidad Del Norte were involved in the experience and worked on reducing water and energy consumption at home. The impact on the learning process was assessed by a test, and progress in critical thinking skills was monitored via an assessment instrument (rubric). 76% of the student projects showed reduced water consumption and 87% reduced energy consumption. The comparison between the test and the application of the assessment instrument showed that 100% of the students experienced meaningful learning and improved their inference skills (evidence examination, alternative conjectures, drawing conclusions); interpretation (categorizing); analysis (exploring ideas); explanation (description of results); evaluation (weighing various statements); and self-regulation (self-correction, self-examination). Our study demonstrates that it is possible to construct significant communities for learning on the basis of environmental initiatives.

Key Words:

Situated cognition, community for learning, critical thinking, environmental management.

Introduction

The responsible care and management of natural resources has become a global concern. The present study was focused on water and energy issues. The documented United Nations' projections regarding water policy (2011), the 2013 report on water issues in FAO, the UNICEF & WHO report (2012) on sources and supply standards, and the commitments related to the millennium development goals have emphasized the need to inform students and communities about this problem. The need is for more doers rather than observers - people with solutions to propose. The objective of the present innovative project was to provide a scenario in which the teaching-learning process on environmental issues would improve "training for action" (Jensen & Schnack, 1994; Marcote, & Suárez, 2005). These actions of generating favorable attitudes towards sustainable use of natural resources, water and energy, were carried out in order to enhance students' critical thinking skills, essential for facing changing work environments and for learning (Halpern, 2014), higher education the being most adequate context to facilitate the honing of these skills (Rapanta et al., 2013).

Theoretical Framework

Situated cognition provides authentic, meaningful, and purposeful learning experiences (Huang et al., 2011; Onda, 2012; Stein, 1998; Ünal & İnan, 2010; Woolley & Jarvis, 2007; Wrostopk et al., 2014). This learning is in part a result of the context and the culture of the activity in which it develops and is used (Daniels, 2003; Herreid, 2007). It is based on cases of everyday problems and can help develop higher-order cognitive skills, including analyzing, evaluating, and creating, which are closely related to critical thinking skills (Bloom & Krathwohl, 1956).

Students achieve significant learning, reaching a basic level of reflection and criticism in the face of everyday problems, such as the responsible use of natural resources based on a teaching method that emphasizes the importance of the activity and the learning context (Diaz, 2003). They engage in the activity so that they reach a level of expertise in the subject of interest (Baquero, 2002; Hendricks, 2001). Parallel to the teaching-learning process, the aim is to enhance critical thinking skills, which are considered essential in cognitive settings (Halpern, 2003, American Association of Colleges and Universities, 2005) and important objectives of education at all levels (Brown et al., 1989; Daniels, 2003; Hendricks, 2001).

The Delphi Report defines critical thinking as the development of insight and self-regulation, which results in the interpretation, analysis, evaluation, inference, and explanation of the evidence, concepts, methodologies, criteria, or contextual considerations upon which judgment is based (Quitadamo & Kurtz, 2007). Critical thinking has an objective; it is focused and aware (Mong-Chue, 2000). It is acknowledged as a desirable condition for all members of society (Blair, 2009; Cline et al., 2007; Facione, 1990).

The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of

criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal. It combines developing critical thinking skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society (Facione, 1990).

Among the challenges surrounding the attempt to develop critical thinking skills in students is the lack of valid and reliable instruments of evaluation to measure their progress (American College Testing, 2010; Blair, 2009; Ennis, 2003; Moore et al., 2010; Saxton et al., 2012).

This study's evaluation strategy requires participants to prepare their own work, showing evidence of the skills and knowledge gained. This assessment is based on performance and is especially useful for evaluating the success of the teaching strategies and the fulfillment of program performance goals. It also demonstrates the evolution of the skills that the students have been able to strengthen through their experiences (Bernard et al., 2008; Jackson et al., 2002; Johnson et al., 2008; Lomask & Baron, 2003).

Description of the Pedagogical Innovation

A total of 220 students from various academic programs of the Universidad Del Norte (Barranquilla-Colombia) participated in the pedagogically innovative activity. Applying scientific methodology, each student conducted an environmental management project aimed at reducing the water and energy consumption in their homes, promoting sustainable management. The project took place during the first and second academic period of 2014 and the first academic period of 2015. The participants improved their critical thinking skills in parallel with the reduction of the consumption of these resources and built learning communities, involving their households in a context of situated cognition.

Process of implementation of the innovative pedagogical method.

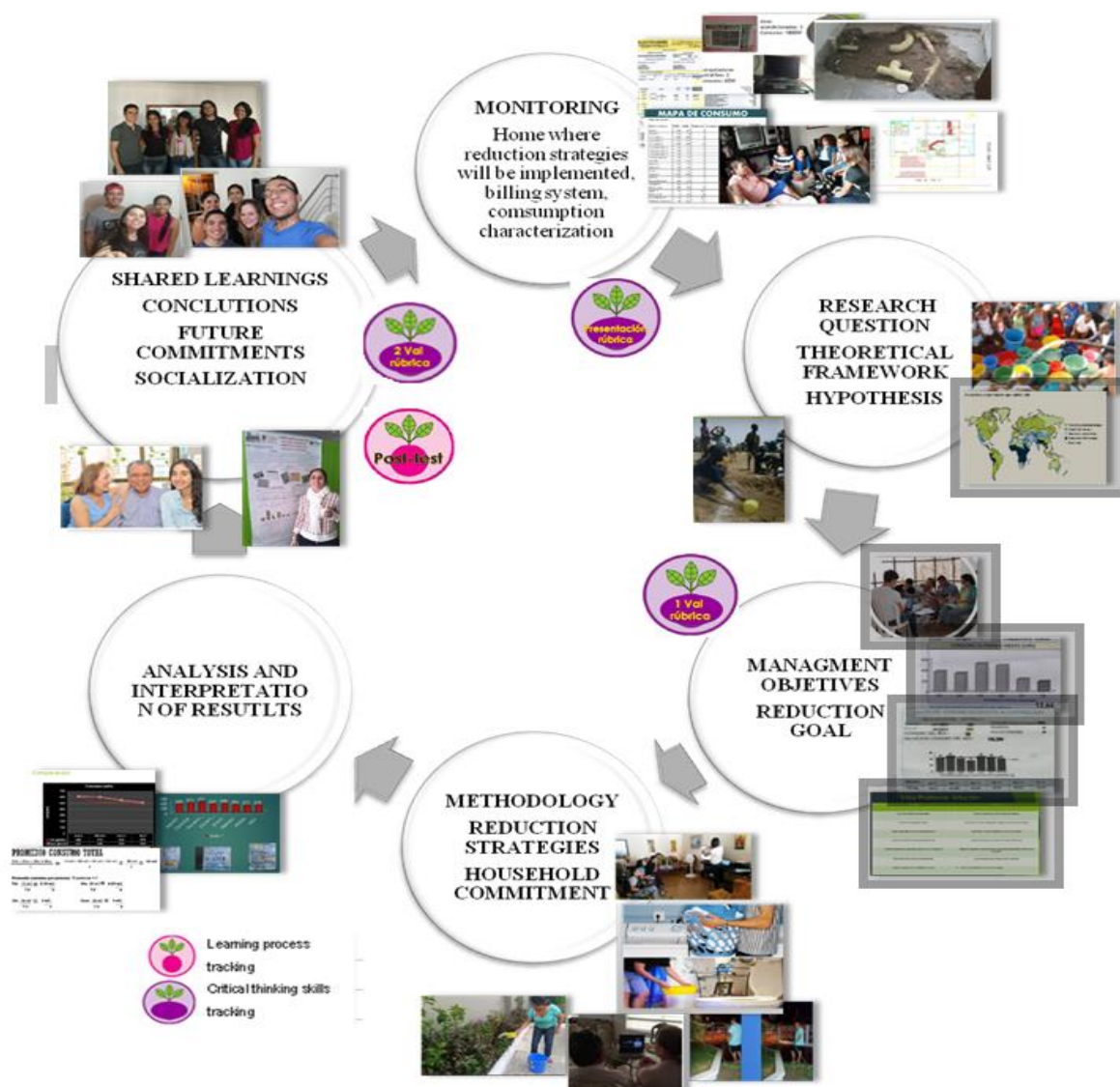
Participants were divided into 44 work teams identified with the label A, who worked on water-resource reduction, measured in cubic meters (m³) and label E for energy reduction teams; the result in this case was measured in kilowatt hours (kWh). Groups from A1 to A6 and E1 to E8 carried out their management projects and implemented reduction strategies between the months of January and May, 2014, groups from A7 to A14 and from E9 to E15 did so in the second half of 2014, between August and November, and groups from A15 to A21 and E16 to E23 were active between January and February, 2015. The previous six-month period was considered to be a control for all groups, since there was no reduction strategies carried out in their homes during this time period. Table 1 shows the distribution of such teams according to the resource and the work period.

The strategies were implemented in the chosen household by the work team and their effectiveness was monitored by the monthly consumption reported in the invoices generated by the utilities companies. Consumption results were statistically analyzed via the IBM SPSS Statistics 20 software.

Table 1. Distribution of teams according to the resource to be managed.

Water Team	Energy Team	Management period
A1 – A6	E1 – E8	January to May /2014
A7 – A14	E9 – E15	August to November /2014

Students responded to an open-ended-question survey after the completion of the project in order to assess the learning gained by students and their defense of their responses. Results would demonstrate if the pedagogical innovation provided meaningful learning, validated by a change in or strengthening of attitude regarding responsible use of natural resources. The methodology is schematically shown in Figure 1.

**Figure 1. Methodology developed in the environmental management project, and educational intervention.**

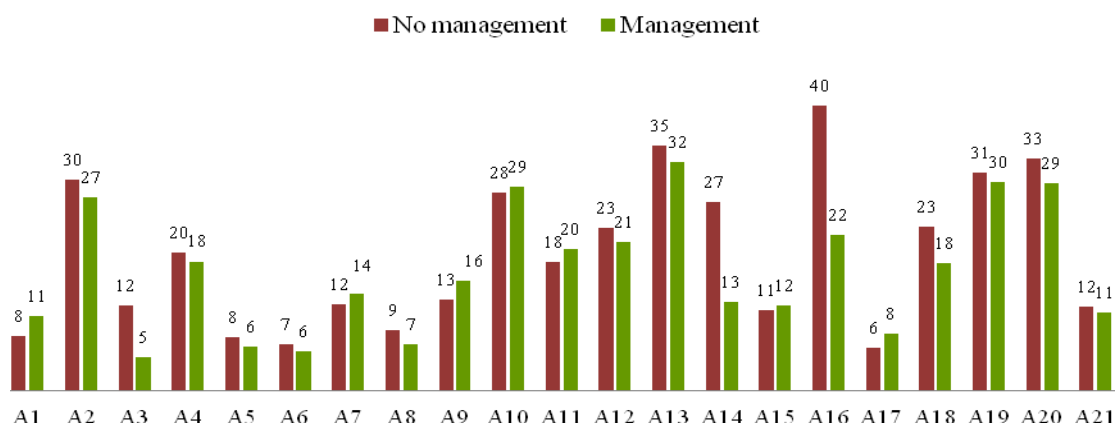
In parallel, a pilot study was conducted with 15 work teams, who were administered an assessment instrument (rubric) designed and validated by peers. The rubric applied sought to evaluate the progress in critical thinking skills associated with activities such as the resolution of environmental problems, the decision-making, the reflection on the results obtained in the water and energy consumption reduction, the verification of the effectiveness of the proposed actions, establishing inferences from the challenges generated during the experience and analyze about the lessons learned, which could increase their level of cognitive skills raised in the instrument. The abilities monitored through rubric were: inference (evidence examination, evaluating alternatives, drawing conclusions); interpretation (categorization); analysis (exploring ideas); explanation (description of results); evaluation (weighing various statements), and self-regulation (self-correction, self-examination; Carter et al., 2015, Facione, 1990; Muoni, 2012).

Results

Reduction of Water Consumption

Seventy six % of the groups that worked with water reduction managed to achieve their reduction goals, showing average consumption during the four months of implementation of the strategies lower than the six months with no management. Each work team includes strategies such as home visits and interviews of resident family members, to characterize their attitudes towards use, their interest in participating in the project, and determine the infrastructure of the living space, including points of greatest demand, the condition of the faucets and pipes, and activities in which water is used. Once the work team had determined and analyzed their current consumption in the home chose with the participation of their family, they listed the problems related to water use, and through bibliographic enquiries, expert visits, etc., established their reduction goal and undertook the implementation of strategies to achieve it. Figure 2 shows the averages with no management versus the averages with management in the groups that worked with water resource. Figure 2 shows the averages with no management versus the averages with management in the groups that worked with water resource. The results of the t-test showed significance for the A3, A5, A7, A9, A14, A15, A16 and A18 groups, with a 95% level of confidence.

Figure 2. Comparison of Total Water Consumption Without Management vs. With Management (m³)

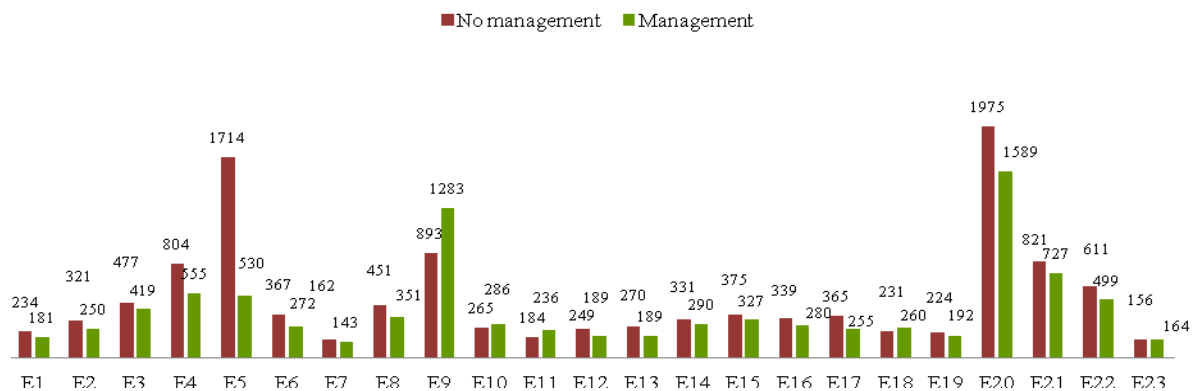


Reduction of Energy Consumption

Eighty seven % of the teams tasked with working on energy achieved the proposed goals of reduced consumption. Figure 3 shows the averages with no management versus the averages with management for these groups. The results of the t-test for E2, E4, E5, E6, E8, E9, E11, E13, E16, E18, E19, and E21 were significant to a 95% level of confidence.

Note that the teams that implemented their project in the first half of 2014 and 2015 exhibited major differences in both the case of water and that of energy with respect to the groups that operated during the second half of 2014. One of the external conditions that may have caused this trend was temperature. The results suggest that a decisive situational factor for achieving reduction goals set by the groups was closely related to this condition. Barranquilla is among the hottest cities in Colombia. It is noteworthy that in the second half of the study, the temperature and relative humidity increased, resulting in an increase in the sensation of heat. This situation leads to a greater demand for electrical equipment such as air conditioners, fans, etc., and in some cases to an increase in the frequency of washing laundry and taking showers on the part of the residents, thus impacting the demand for water and energy.

Figure 3. Comparison Average Energy Consumption Without Management vs. With the Resource Management in (Kw/h)



Learning outcomes

Through the open-ended-question survey, after the completion of the environmental management project students expressed their views on the impact and the benefits of the environmental management projects, where they acted as leaders for the solution of their community's environmental problems. They emphasized the utility and functionality of learning in this real context (Díaz, 2003) and had an authentic, meaningful, and purposeful learning experience (Hendricks, 2001; Huang et al., 2011; Onda, 2012; Ünal & İnan, 2010; Wyrostok et al, 2014).

The students changed their view of the use of resources at home and they transitioned to a greater awareness of the environmental challenge; some of them acknowledged an awareness of the need for preservation of natural resources and of the cost benefits of lower resource consumption and reasonable use of electronic devices. This learning is shown in Figure 4.

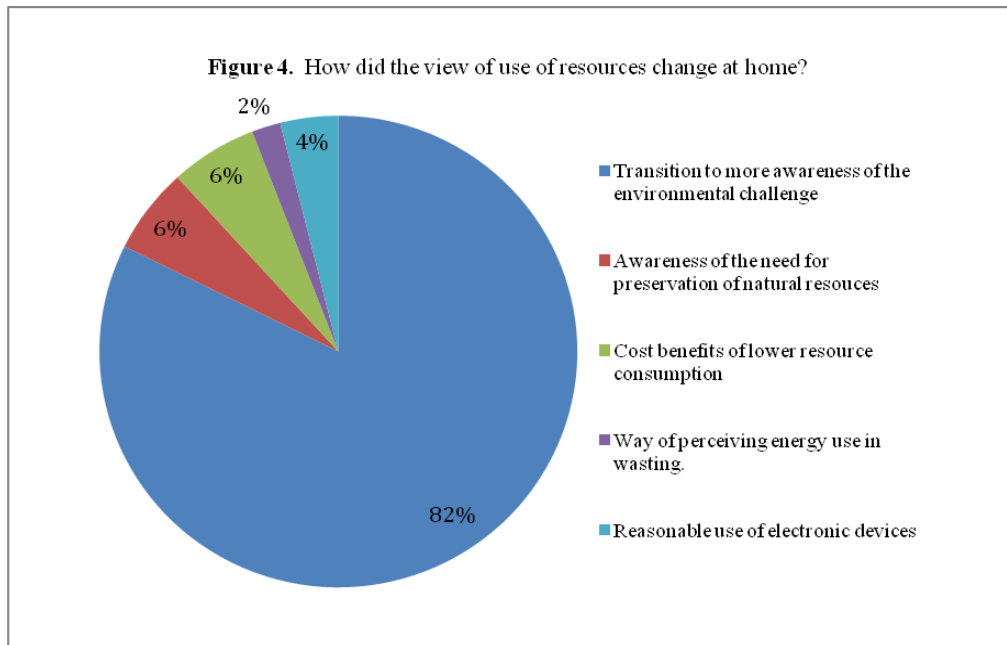


Figure 5 shows how they managed to include their relatives in implementing the reduction strategies posed by the group, and Figure 6 shows the knowledge obtained by the students after participating in the experience. They stated that the project helped them economize their daily use of water and energy at home. It is noteworthy that 82% of the participants achieved a transition to sustainable habits by implementing the practices in their homes, recognizing in these actions a direct link with the issues of conservation of natural resources, protection of local biodiversity, mitigation of global warming, enhancement of the social welfare, and reduction of costs. Also the students came to be identified as leaders and managers, who through spreading awareness of the strategies attempted to involve their family in the reduction in the use of water and energy resources. Work teams involves their relatives with awareness lectures where they showed videos about global warming and climate change, agreements were established for the use of appliances, and frequencies of showers and laundry activities too, thus energy and water points of loss were identified, water reuse was developed; the routine of video games was changed, frequency of use of air conditioning. They started to do more outdoor activities where they shared with all members of the family. Their action plane involved employees of General Services, who carried out many household chores; and even they established rules of use responsible to people who came to his home as visitors.

Figure 5. ¿How did you include your family in your group's implementation of reduction strategies?

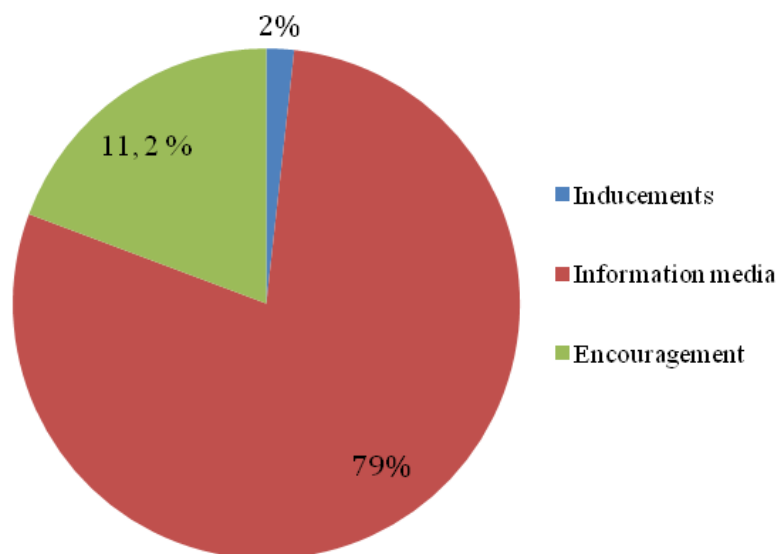
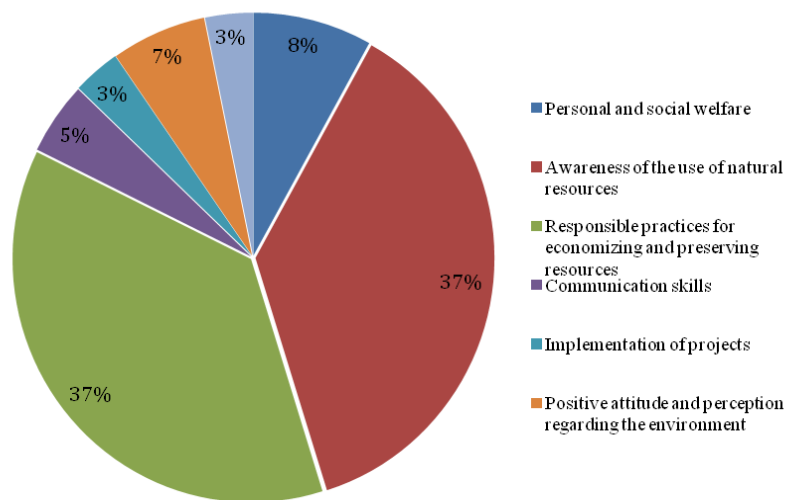


Figure 6. After this experience, what are you better at?

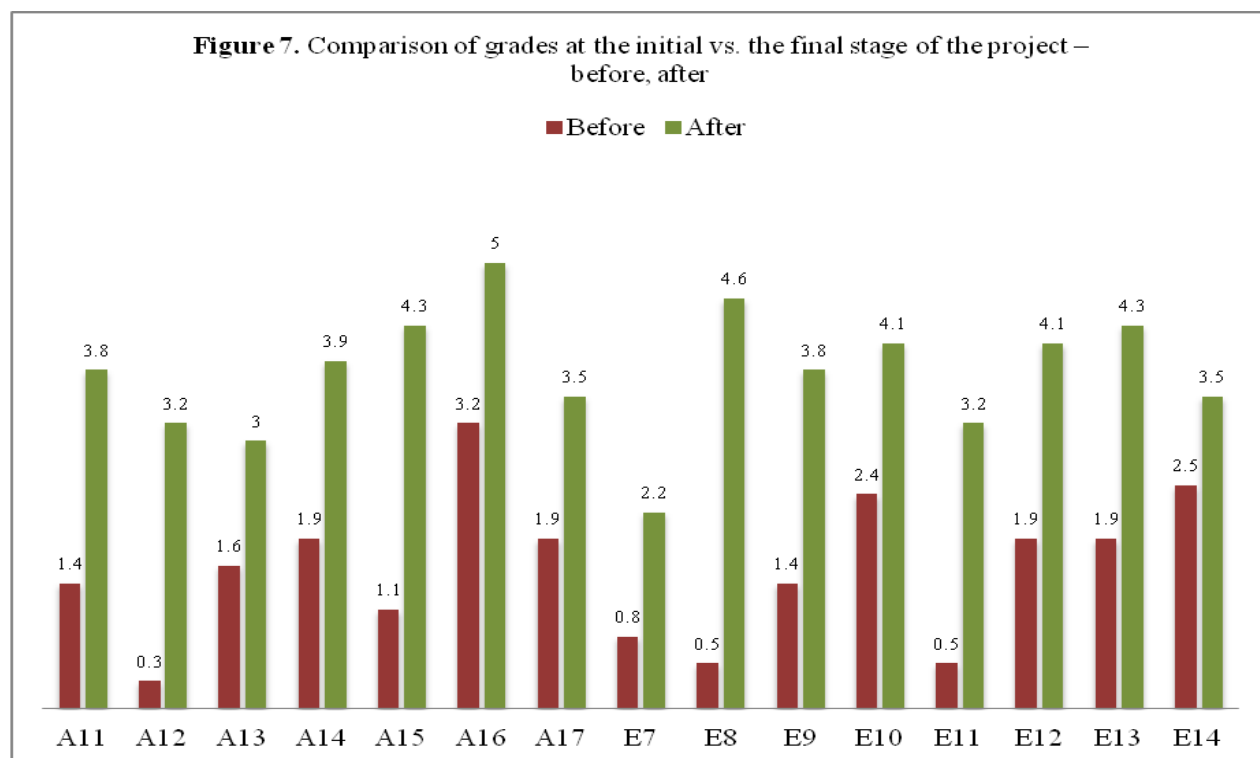


With respect to the question of what the experience made them better at, the students emphasized that these innovations allowed them to improve how they use natural resources and to implement responsible practices for economizing and preserving resources. They also mentioned that they enhanced their communication skills and that the implementation of projects, identifying performance indicators and

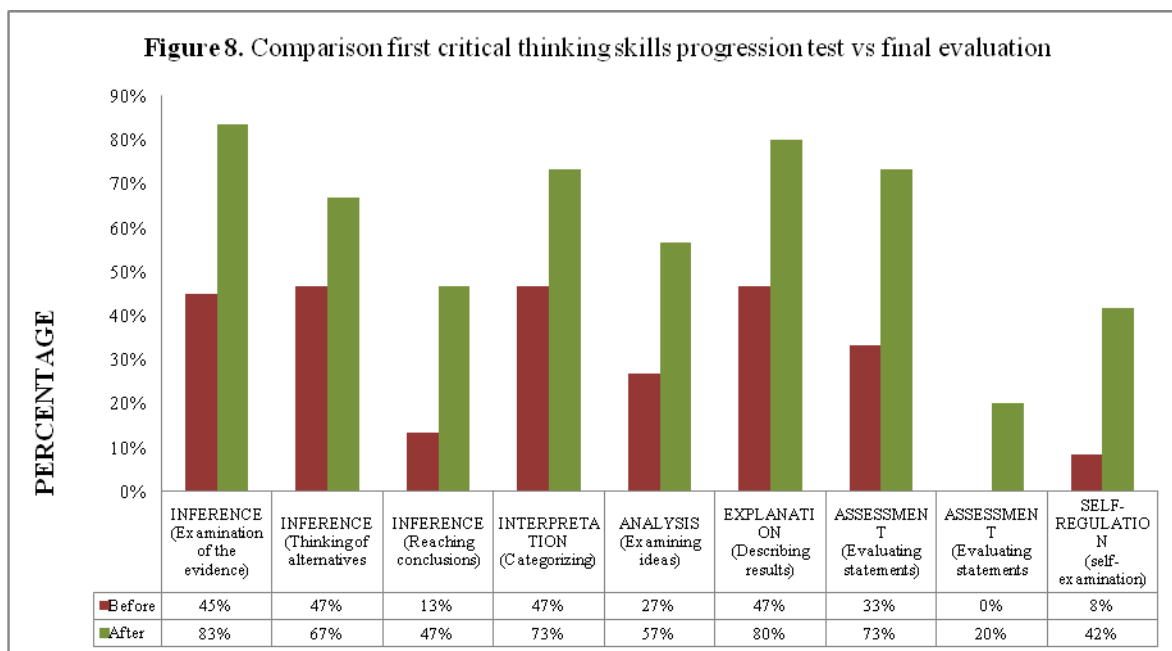
tracking their own commitments, helped to build a positive attitude and perception regarding the environment and to improve teamwork skills.

Pilot results of assessment of critical thinking skills.

In contemporary life, where individuals cope with large amounts of information and complex problems, critical thinking is important (Angeli & Valanides, 2009). In that way, the results of the pilot test show that the implementation of the assessment instrument (rubric) to guide and orient the student toward the methodological practice of science and achieve the resolution of their environmental management work succeeds in stimulating thinking ability of a higher order. This is evidenced by the increase in the final grade with respect to the first evaluation of their ability to empower themselves. The rubric used was the same in the first and final application. The data is presented in Figure 7.



Critical thinking provides the necessary equipment to discern the type of knowledge to be used in a certain situation (Beltrán & Castillo, 2009). Students increased their score associated with the tested skills in the expected sub skills and the complexity level posed by the project. This data is shown in Figure 8.



It should be emphasized that innovation allowed using the skills described by Halpern (2006): problem solving, inference making, probability calculation, and decision-making for implementing the reduction plans designed by each group.

The levels of critical thinking which are developed through the project, involve the ability of analysis, where from an environmental problem: "the responsible use of water and energy resources," work teams manages to build arguments robust, involve your family looking to get their support and participation. Works in a comprehensive search of information on mechanisms for efficient use of these resources. Work teams must increase their observation skills to find opportunities to improvement offered by your home to achieve the goals it is proposed, should have clarity on the criteria which postulated to house choose in which its working group will develop the management, and should enhance his leadership skills to achieve its savings plan to be implemented by relatives.

The rubric involves evidence that work team has showed during the semester. Finally each work team socializes their experience. These evidences respond at level of progress that work teams are making in critical thinking skills evaluated.

Analysis is the first skill that is assessed. In this part is intended to the work teams be able to examine ideas, identify and analyze arguments. Here the groups analyzed data from previous consumption, interprets the interviews that apply to their relatives, assess their chances of success, draws arguments to involve the inhabitants of their home, identifies the savings points, sets its baseline, and list the problems observed.

At the same time is evaluated the interpretation and inference. Since the information and data collected the work teams can infer the expected results. From the characterization performed where identified those positive practices and activities that increase consumption. The team can generate hypotheses about the potential results if they change or modify the conditions of not saving towards a responsible use of water and energy.

In the evaluation stage the team presents evidence on methods and strategies implemented to achieve the objectives and resolve the proposed hypothesis. And what results achieved obtained. The work team also includes their reflections on learning achieved, fortresses which developed, the weaknesses that limited their results; and the positive and negative aspects that their family constructed in their home to participate in the project and the increase in critical thinking skills have been achieved.

Conclusions

This pedagogical proposal encouraged the approach, contextualization, and participation of the students in the sustainable management of resources under study, providing empowering settings aimed at enhancement of leadership related to environmental issues.

Scenarios of significant and proactive learning upon facing collective needs were generated based on the proposed methodology.

Students worked out viable solutions, which they implemented and monitored, in most cases successfully, thanks to the construction of learning communities where their family was included, achieving the social dissemination of knowledge to solve local problems in favor of collective needs.

This pilot study showed that situated cognition is an ideal learning framework for fostering scenarios designed to enhance development of students' critical thinking skills, a desirable result in the context of college education.

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