EDUCATIONAL ADVANCES AND TRENDS FOR SUSTAINABLE DEVELOPMENT: A RESEARCH PROJECT ON EDUCATIONAL INNOVATION

María Novo, María-Ángeles Murga-Menoyo & María-José Bautista-Cerro

Abstract. *Within the framework of the Bologna Process, the UNESCO Chair in Environmental Education and Sustainable Development, based at the National University of Distance Education of Spain, is developing research in the field of educational innovation with the aim of incorporating in its learning model the methodological procedures resulting from recent developments in information technology. The teaching innovation projects presented in this work have been designed for students of Environmental Education and Sustainable Development as part of their Environmental Sciences and Education Courses, who were used to test the learning potential of two teaching methodologies: a) the Cmap Tools editor for the construction of concept maps, which is particularly designed to enhance understanding of the relations that make up the conceptual structure of the topics of study; and b) online collaborative learning groups, intended to promote team work and encourage participation, dialogue and divergent thought, all of which are central to education for sustainability. Each pilot project generated material and resources specifically designed for this purpose and entailed a consistent assessment process.*

Key words: *Cmap Tools, educational information technology, environmental education, learning methodologies, online collaborative learning groups, sustainable development.*

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Introduction

A decade has now gone by since the *Bologna Declaration* (1999), which was the official point of departure for the construction of the European Higher Education Area (EHEA), and halfway through the *United Nations Decade of Education for Sustainable Development,* it seems that some trends can now be identified, based on the changes that both these factors are producing in the training programmes delivered by the University. There is a wealth of literature available (Heinze & Knill, 2008; Laurel, 2008; Rute Cardoso *et al.,* 2008; Fejes, 2006; Keeling, 2006; Papatsiba, 2006; Ravinet, 2008; Zgaga, 2006; Barkholt, 2005; Furlong, 2005; Nyborg, 2005; Saarinen, 2005; Huisman & Van der Wende, 2004; Reichert & Tauch, 2004; Tauch, 2004; Wächter, 2004; Witte, 2004; Froment, 2003; Kladis, 2003) and several international institutions and bodies have published their experiences of best practice (European Commission, 2005; Unesco, 2009).

This article hopes to contribute to identifying these trends, proposing some results from the line of work which, with the framework described above and in the field of educational innovation and the resulting evaluatory research, is being carried out by the Unesco Chair in Environmental Education and Sustainable Development of the National University of Distance Education (Spain). As indicated in a previous paper (Novo & Murga, 2009, p. 167) "our methodological position was based on the significant learning that the student ought to build, with our help, in order to rearrange his or her cognitive maps, values and attitudes, upon finding relationships between the new things learned and the old things already learned".

This research, supported by two projects funded by the EU European Regional Development Fund (ERDF), is known as *New strategies for excellence in learning processes within the framework of the EHEA: the case of Environmental Education for Sustainable*

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Development, and has a dual purpose. On one hand, it seeks to demonstrate the relevance of different methodological procedures for educating students in a model of sustainable development. On the other, it aims to contribute to the construction of knowledge by identifying a range of teaching-learning methodologies of proven effectiveness, available for possible use according to the requirements of the Chair's various educational programmes, the profiles of the students involved, and the model of higher education that Europe demands.

Since the Chair is involved with a distance learning educational system, from an instrumental perspective, information and communication technologies occupy a central part of the educational projects which are designed and implemented. As a result, information technology is the third element which, along with the two already mentioned, found in the educational innovation initiatives undertaken by the Chair.

The line of work considered here presents a dual perspective. It may be viewed as a longitudinal educational innovation project manifested in successive pilot projects of a complementary nature. At the same time, it may be presented as an heuristic project belonging to the category of evaluative research, which evaluates results and initiates processes of improvement, attached to the action-research paradigm. Thus, each pilot project has two main methodological stages. The first one involves designing the educational project, producing materials and means, and implementation. The second stage consists of evaluative research design, creation of instruments, and data gathering and processing.

Frames of Reference

The theoretical framework of these projects responds to a dual requirement. On one hand, it follows the principles and values fostered by the *UN Decade of Education for Sustainable Development*. On the other hand, it adheres to the educational model promoted by the European Higher Education Area (EHEA). Both frameworks are described as follows.

The UN Decade of Education for Sustainable Development

A first frame of reference for the research presented is the educational model proposed by UNESCO for the *UN Decade of Education for Sustainable Development*. Its main features are interdisciplinarity and globality, based on values, critical thinking and a multi-methodological approach to problem-solving, student participation in the decision making process, importance of the local (UNESCO, 2006). All these features were already central to Environmental Education from the beginnings of the movement (Leal Filho et al., 1995 and 1996; Leal, 2002; Novo, 2006-a and 2009). All coincide in the idea that "education plays a special role in sustainable development. It connects past and future, conserves the old and shapes the new" (Schavan, 2007, p. 11).

Since the start of the *Decade,* emphasis has been placed on the choice of pedagogical methods which permit this type of education to be carried out in a rigorous and systematic manner. As a document published by the French National Commission for UNESCO states, "People who participate in training for interventions in projects for sustainable development are of various origins, and with extremely varied levels and backgrounds of knowledge and know-how. To enable them to acquire and develop the required competencies to become real professionals poses many problems, as much for the training content as for the choice of pedagogical methods" (Blandin, 2009, p. 19). Our proposal is consequently concerned with designing and experimenting with methods of educational innovation which contribute to an understanding of the principles and strategies of sustainability.

The priorities which underpin the model in the context of learning processes at university level are the following: to build knowledge on the basis of the learning subject's experiences; strengthen the bonds between the intellectual and the affective (learn through other people's reality); reveal the relationship between elements and factors of the phenomena; emphasize the procedural perspective; proceed to analyze the contexts and, as a matter of urgency, privilege creative behaviour and consideration of future scenarios.

Also, as has been indicated on previous occasions (Novo, 2002, p. 437), the importance of the

systemic focus on education for sustainable development is vital. It is not possible to understand the highly complex physical and social reality if not from a perspective which relates the whole to its parts, the global and the local, and shows the interrelation between environmental problems arising in various contexts, and the need to achieve interdisciplinary models of analysis. In respect of these, as Chernikova indicates (2006, p. 216), "inter faculty activities are particularly interesting as educators need interdisciplinary links in order to understand scientific discourse and sustainability issues". However, tension still persists in our universities "between social and academic objectives, between disciplinary traditions and the frequent calls for greater interdisciplinarity" (Scott, 2006, p. 542).

As a result an educational model focused on relations rather than isolated objects is required. A model which stimulates "the acquaintance with the interrelations between nature, social environment" as well as "the ability to comprehend interrelationships (…) synthesis or reintegration of parts into new wholes" (Reintam *et al*., 2006, p. 429). This approach represents a genuine change of paradigm for students, since they learn to focus on interaction where previously they only saw independent or barely connected concepts. It is with this aim in view that the authors have selected the innovation projects, as is explained in the following sections. The two experiences presented here attempt to provide students with the competences to make connections, both in the conceptual field (systemic-complex thought), and in the area of collaborative learning.

In respect of values, the UNESCO General Conference, held in October 2003, subscribes to the principles, goals and contents of the *Earth Charter* as an important ethical reference for sustainable development and recommends its text as an educational instrument within the framework of the aforementioned *Decade* (UNESCO, 2003, p. 36). One of the most significant of these is the principle of responsibility – universal, differentiated synchronic and diachronic; a principle which permits almost all actions taken by mankind to be seen as moral actions, thus they inter-relate with other living beings (not just those of their own kind); their role as a link in the species; the footprint they leave on the physical world; or their *glocal* and differentiated responsibility which requires them to respond according to their own status, ability and possibilities, prioritising a rigorous application of the precautionary principle (Murga, 2009). Therefore, "its value as a tool for teaching about sustainable development in the university classroom" (Clugston *et al*., 2002, p. 547) is significant.

As Lubbers (2008, p. 30) points out, the Earth Charter calls "for a fundamental change of mind and heart, and acknowledges the capital importance of harmonising diversity with unity, the exercise of freedom with the common good, short-term objectives with long-term goals". Numerous good educational practices attest to its relevance as an instrument in the service of sustainability (UNESCO/ECI, 2007; Murga-Menoyo & Novo, 2007; ECI/Earth Charter Initiative, 2008).

At the present time, with important changes occurring in the organisation of European university systems, there is a general consensus that "the sustainability principles have to be incorporated into the strategy of the university reflecting sustainability initiatives in education, research and maintenance" (Ciegis & Gineitiene, 2006, p. 511).

The European Higher Education Area (EHEA)

A second focus of our frame of reference is the Bologna Process, which addresses "several important issues, such as national and regional differences, diversity of languages, different educational traditions and systems, diversity of stakeholders, and the co-existence of universities and a strong non-university sector" (Wit, 2007, p. 461). The strategy to be followed, for various reasons, demands considerable efforts on the part of educational institutions and centres.

In Spain, in addition to structural changes in the organisation of teaching, a radical change is taking place in the dominant University teaching model. Curricula have shifted their focus from what is taught by the teacher to what the student should learn – the learning outcomes – results which are expressed in a term imported from the business world, namely "competencies". The underlying concept "represents a dynamic combination of cognitive and meta-cognitive skills, knowledge and understanding, interpersonal, intellectual and practical skills, and ethical values" (González & Wagenaar, 2008, p. 9). This change with respect to the teaching role, requires greater intensity, including

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a new emphasis on the role of teacher as specialist in the domain of methodologies which facilitate learning processes. The change must be taken into account in the educational innovation projects undertaken as part of this reform.

The new higher education model that is being established in Spain is mainly motivated by Declarations such as that of Bologna (1999), and Communiqués and documents subsequently issued at a supranational level by the EU (Prague, 2001; Berlin, 2003; Bergen, 2005; Glasgow, 2005; London, 2007; etc.). This indubitably reflects the priority of training students in the competencies needed for both the economic and social viability of a united Europe. This model is thus included in the Tuning Project created by a wide network of European universities led by the University of Deusto (Spain) with funding from the EU (González & Wagenaar, 2003).

Nevertheless, since it is profoundly imbued with the European concern for the employability of its citizens and competitiveness of its economy, the model places special emphasis on two of the four great pillars that the well known *Delors Report* attributes to education, i.e. *learning to know and learning to do,* with the danger that the other two, *learning to be and learning to live together* may, in practice, be sidelined (Murga-Menoyo, 2006). This threat, from the perspective of education for sustainable development, must be counteracted.

With this aim, it is appropriate to recall that in the field of acquiring ethical competencies, especially those linked to the last two pillars, the choice of methodology is not insignificant, as it is necessary to strengthen those learning methodologies that contribute to the construction of different aspects of the students' moral personality, including what has been termed conviviality – the capacity for dialogue, social skills and the ability to transform their environment.

Likewise, it should also be stressed that, together with ethical instrumental and interpersonal competencies, systemic skills are particularly relevant in the field of sustainable development, as they may help students to devise an integrated model of reality. As Makarevics (2008, p.71) points out, these are "skills and abilities related to systems as a whole. They presuppose the combination of understanding, receptivity and knowledge which allows an individual to see the parts of a whole and their connections in the unity".

In addition to the foregoing, a third focus defining the context of our activity consists of the virtuality of information technology and its extraordinary possibilities for promoting methodologies which provide a vehicle for learning processes. Recent advances have developed potentially innovative tools which, applied to the field of e-learning, improve aspects such as educational interaction, access to information or procedures, resources and ways of working.

In the case of the innovative educational projects which are presented next, a virtual tool, the *Cmap Tools* editor for creating concept maps, and a teaching technique whose impact is reinforced by the possibilities offered by Internet, namely *online collaborative learning groups*, occupy, respectively, a major position from the methodological perspective.

Characteristics of the Educational Innovation Projects

The two projects described in this work were implemented during the academic years 2006/07 and 2008/09, respectively. They were proposed as pilot schemes with voluntary participation by the students who enrolled for the subject Environmental Education and Sustainable Development, without any restriction and with the advantage of obtaining additional marks that would improve the students' final grade. The relevant characteristics of each project are described in Table 1.

Some of the specific objectives included in the first project were: *promoting attitudes and values of cooperation and solidarity and constructive dialogue in the students,* for which purpose working groups were organised for online collaborative work. The aim was to successfully carry out a group activity with pre-established content and characteristics which would result in both individual and group achievements.

Table 1.   Characteristics of the two educational innovation projects.

	Project 1 Online collaborative learning groups	Project 2 Concept Maps using Cmap Tools
Time period	Academic year 2006/07	Academic year 2008/09
Expected work load	1 ECTS (25 hours)	1 ECTS (25 hours)
Main objectives	Promote attitudes and values of co-operation, solidarity and constructive dialogue in the students	Encourage the acquisition of cognitive skills with an emphasis on systemic thought
Additional objectives	Acquire instrumental skills and make use of ICT	Acquire instrumental skills and make use of ICT
Tasks	Design an educational project associated with an environmental topic	Construction of concept maps about an environmental topic
Learning material	Teaching Guide Documental archive	Teaching Guide Video class
Teaching methodology	Promote the self-organization of online working groups for collaborative learning	Practical lesson on the use of the Cmap Tools editor in the framework of the course

As has been argued in several works (Murga, 2007, p. 171), the technique of *collaborative learning* "allows educational achievements concerning a very wide range of fields, among many others: those of systemic and cognitive character, of technical, relational and social type. And it offers the best opportunity to train in ethical scopes because it not only requires the students to assume the disciplinary contents, but also to, simultaneously, internalize values and co-responsibility, solidarity, and cooperation attitudes, or negotiated resolutions of conflicts, which are all basic from the sustainability point of view". Extensive literature has been published on this topic (Tokoro & Steels, 2004; Du et al., 2007; Alexandrov, Ramirez & Alexandrov, 2005; inter alii).

The second project focused on *encouraging the acquisition of cognitive skills with an emphasis on systemic thought*, so that students could: a) accurately learn the basic concepts of the subject; b) understand the reciprocal relations between those concepts, and perceive the corresponding sphere of knowledge as an integrated whole; and c) progress in articulating their own pedagogical philosophy based on solid arguments. For this purpose students had to make a concept map of one of one of the topics of the subject using the Cmap Tools editor, which is free educational software.

The educational value of concept maps is very high when working in a systemic thought context, as they permit visualisation of the labyrinths of relations developed by each student in order to articulate concepts and principles of a topic (Novak & Cañas, 2006). Furthermore, the integration of metacognitive strategies such as this one "provides the teacher (and the learner) with a clear picture of how the learner responds to and acts upon incoming information" (Bruer, 1993). Consequently, "learners become the agents of their own learning since they are actively participating in their own learning process" (Vanhear & Pace, 2008, p. 52).

Both projects additionally sought to encourage students to acquire instrumental competencies and use ICTs (Information and Communications Technologies) at the service of autonomous learning.

By means of the virtual platform supporting the academic subjects, students were able to access various types of information in respect of the projects: a) a letter of presentation explaining the goals, conditions of participation and the effects of the results on final marks; b) a Teaching Guide with precise directions for carrying out the specific activity proposed; c) a theoretical-practical video class on the use of software; and d) a file containing Appendices, with significant documents relating to the thematic content of the activity.

After implementing the projects, the results were evaluated in order to establish strong points, weaknesses and possible areas for improvement.

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Methodology of Research

General Background of Research

Our research is within the general framework of the search for synergies among the objectives of the education for sustainable development and some instruments and techniques that allow to make progress in the field of teaching innovation. In this work, we have focused on two techniques, which are widely acknowledged in the educational field (Novak & Cañas, 2006; Cañas *et al*., 2004; Tokoro & Steels, 2004; Du *et al*., 2007; Alexandrov, Ramirez & Alexandrov, 2005), and we have applied them to the context of virtual learning: the Cmap Tools editor for the creation of concept maps and the use of online collaborative learning groups.

Sample of Research

As shown in Table 2, a total of 98 out of 815 students registered in the courses showed initial interest in taking part in the projects. In the first project (Online collaborative learning groups), 37 subjects (8.8% of the total students registered in the course) showed interest in participating, and 30 of them satisfactorily completed the project. The remaining 7 left the project during the first week. This means that the abandonment rate was 18.9%. In the second project (Concept Maps using Cmap Tools), 61 subjects volunteered to participate (15.4% participation rate). However, only 46 successfully completed the project. This means that the abandonment rate was 24.6%.

Table 2.   People involved in the projects.

	Project 1: Online collaborative learning groups	Project 2: Concept Maps using Cmap Tools
Students registered in the course	420	395
Students that showed initial intention to participate in the project	37	61
Students that successfully completed the project	30	46
Participation rate	8.8 %	15.4 %
Abandonment rate	18.9 %	24.6 %

A significant increase is noted in the number of students who voluntarily decided to participate in the pilot projects. While in the 2006/07 course 8.8% of those registered took part, in 2008/09 the percentage rose to 15.4%, which may be due, among other factors, to the students' awareness of the advantages to their learning processes deriving from educational innovation projects. The unwanted counterpoint to this would be the greater abandonment occurring in this second project, which would have to be explained through a more in-depth analysis taking into account complex variables that were not considered in the research.

Performance Indicators for Evaluating Research

The following principles were established as indicators of results: a) the participation rate in relation to the total number of students enrolled on the course; b) achievements in respect of the specific objectives of each of the projects, assessed through indicators such as the quality of the tasks carried out, frequency and relevance of participation in forums, or group atmosphere; c) satisfaction of the students taking part in the experiment; and, finally, d) satisfaction of the teaching team with the results of the experiment. Table 3 describes the performance indicators used to evaluate the projects.

Table 3. **Performance indicators for evaluating research.**

Performance indicators		Project 1: Online collaborative learning groups	Project 2: Concept Maps using Cmap Tools
		Participation rate	Participation rate
	Associated with the objectives of the project	Quality of the group work	Complexity of the concept map
		Collaborative attitude of the students	Number of basic concepts selected
		Attitude of each collaborative group	Importance of the concepts identified
		Participation in the virtual forum	Number of correct relations between the concepts
		Student satisfaction	Student satisfaction
		Teacher satisfaction	Teacher satisfaction

Instrument and Procedures

The tools used to evaluate the projects are described in Table 4. Data was compiled using: a) the actual work submitted by the students when they had finished the activity, b) a multiple-choice test which was completed online within a ten minute time limit, c) a report of the students' participation in the virtual forum of their collaborative learning group, and d) a satisfaction questionnaire, completed by each student, with a scale of 1 (minimum) to 10 (maximum), carried out on an *ad hoc* basis.

Table 4. **Instruments for evaluation research.**

Evaluation instruments	Project 1: *Online collaborative learning groups*	Project 2: *Concept Maps using Cmap Tools*
	Report on the education project designed by each group	Concept maps made by the students
	Participation report on the virtual forum	Written test about basic concepts
	Questionnaire on student satisfaction	Questionnaire on student satisfaction
	Project evaluation session by teachers	Project evaluation session by teachers

The evaluation of the experience by the teaching team took the form of a self regulated group debate. On this occasion no specific data collection instrument was prepared.

Data Analysis

The data were subjected to an analysis process using descriptive parameters such as: a) percentages of students that achieve the different grades; b) average of the grades corresponding to the students taking part in the experience versus the ones not participating; c) group means corresponding to each of the indicators of student satisfaction with the project.

Results of Research

The results of the evaluation research will be presented under four subheadings. The first will indicate how many subjects voluntarily took part in the two teaching innovation projects which have

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been carried out, referring to the participation rate in respect of the relevant population. Next come the results in respect of the objectives of the projects, reflecting the learning outcomes, both individual and collective. Then the data on the degree of satisfaction that students feel about the experiences they have undergone is provided. Finally, the global evaluation of the projects from the teachers' point of view will be described.

The evaluation was based on evidence, data and facts, which have allowed an analysis and rigorous assessment and the maximum objectivity possible within the limitations of the work and the nature of the information to be obtained.

Individual and Group Achievements

All the groups and students on the *online collaborative learning* project fulfilled the undertaking to hand in both individual and group set tasks within the established time frames. In addition, there was a high rate of participation in virtual forums, with an average quarterly group exchange of 115 messages. In terms of atmosphere, the teaching team considered the group to be pleasant and extremely co-operative. As a result, except for two members of one of the groups, the other students obtained an extra point in their final subject mark which shows that the methodology was able to positively contribute to the students' academic performance.

The learning outcomes achieved in the second project, *concept maps using Cmap Tools,* are shown in Figure 1. When the final marks for the subject obtained by students participating in the project are compared with those of students who did not take part, there is a striking difference in the percentage of students who were graded "very good" amounting to 52.27% of the project members, compared to 29.12% in students who did not take part. Furthermore, the percentage of students who failed was 4.54% compared to 19.78% of those who did not take part.
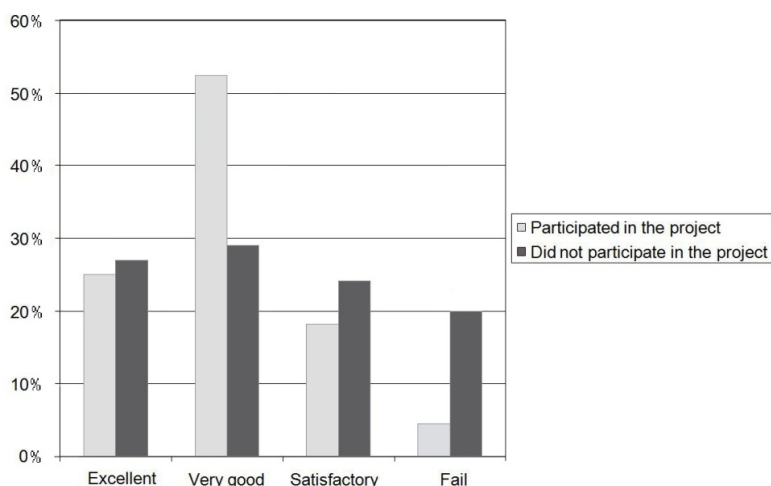
Figure 1:   Percentage of students that achieved the different grades.

Given that the percentage of "excellent" marks is similar in both groups, it could be thought that those who are situated on pass/fail border are those who perhaps due the influence of the project have improved their performance, moving up to a higher grade. And also it was noted that poor performance meriting a fail mark was avoided.

In both projects, *online collaborative learning groups* and *concept maps using Cmap Tools,* the data shows positive results in respect of the proposed objectives.

Student Satisfaction

Student satisfaction with the experience is indicated in Table 5 which shows the average marks of the two groups of students participating, respectively, in the educational innovation experiences. In the case of the *online collaborative learning groups*, project acceptance can be qualified as high overall as the marks in eight of the cases are higher than 8 out of a possible ten; and the other four students are all above 5.8.

Students largely agree that the collaborative groups have helped them to increase their knowledge (8.30), to understand and relate significant aspects of the subject (8.30), to improve their skills with the technologies (8.70) and motivate them to use the tools (8.70). They consider that the online collaborative groups offer a useful methodological model for facilitating study. The lowest grading, a simple average position (6.70), was obtained by the question on the capacity of groups to accompany students and support them in their learning process. In this respect the motivation afforded by the methodology does not appear to be significant, although this may have been influenced by the short time span that the groups were in operation, only two months.

With respect to the project constructing *concept maps with Cmap Tools*, students acknowledge that its strength lies in facilitating the acquisition of knowledge (8.9% is the average grading awarded by the group for this aspect) however, the potential for stimulation and study motivation is also given a high grade (8.9 points). The lowest grades, still on the threshold of six points, correspond to the assessment of the editor's capacity for consolidating computer skills, and if this result is interpreted by comparing it with the level of 8.70 points which this same item achieves for collaborative groups, it points to the greater suitability of this technique in relation to the initial profile of students in this aspect, and the possibility of self exclusion of participants on grounds of expertise, as the technical complexity of using the editor is objectively greater than that required for the work of the online collaborative groups.

Table 5.   Group means of student satisfaction.

Indicators	Concept maps Cmap Tools	Online collaborative learning groups
	Average group grading (scale 1-10)	Average group grading (scale 1-10)
The procedure helped me to consolidate knowledge	8.9	8.30
I found the experience stimulating and motivating	8.9	6.70
The methodological procedure is attractive and useful	8.5	8.70
My interest in Environmental Education has increased.	8.2	8.30
I now find it easier to analyse, understand and relate content.	8.0	8.30
It has facilitated my acquisition of significant knowledge.	7.9	8.30
Thanks to this activity I also use the subject's virtual platform more assiduously	5.8	8.70
I am more skilled than before in using the Internet as an autonomous learning tool	5.8	8.70

One curious fact is that the students participating in the collaborative learning groups show a less varied satisfaction profile than those corresponding to the project using the *Cmap Tools* editor, which could mean that there is a general feeling of satisfaction which is more diffuse and homogenous among these students. The second group appears able to more accurately discern the strengths of the methodology for the objectives described in the various items of the questionnaire.

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Teacher Assessment

In the session interpreting the results the teaching team identified some coincidences in the strengths and weaknesses of both projects. The following four points were listed as strengths: a) the intense social and affective and cognitive involvement of the participants; b) the matching of the activities to the interests and needs of the students; c) the adjustment between the times established and used for carrying out activities; and d) the efficacy of guidance and the appropriateness of the educational materials.

The main weaknesses were seen to be the following: a) minority participation; b) the slowness in the self organisation process of the collaborative learning groups; c) the need to dedicate additional time to teaching the students the technological skills needed to take part in the project; d) the collaborative group's tendency to divide the work, thus detracting from the essential purpose of the methodology; and f) the requirement for greater commitment from teachers to the subject demanded by both methodologies.

Conclusions

The evaluative research carried out confirms that the *methodology of online collaborative learning groups* is of interest to the purposes of the subject. The satisfaction which students acknowledge that they feel largely supports the motivational capacity of this methodology to facilitate learning processes and encourage team work, the values of participation and dialogue for reaching consensus. As a result it may be stated that online collaborative learning groups are an appropriate instrument for encouraging the acquisition of ethical competencies. They seek assimilation of disciplinary contents, but, inevitably, by the very nature of the procedure, they require the daily application of attitudes of co-responsibility, solidarity, cooperation and negotiated settlement of conflicts. All these are directly linked to the objectives for environmental education for sustainable development to be achieved in higher education.

With respect to the Cmap Tools editor, the software tool that facilitates the creation of concept maps, the results of the assessment of the achievements of the corresponding educational innovation project have not only shown the motivating power of ICTs through the satisfaction shown by students, but also the potential of this computer tool for reinforcing both the learning subjects' analytical thinking and their comprehension of the relationships between basic concepts, thus contributing to development of a systemic and complex system of thought.

Both projects have shown their appropriateness for the objectives of environmental education for sustainable development, both in terms of their suitability for the new learning model demanded by the European Higher Education Area (EHEA) of the University. Its greatest weakness lies in the permanent attention required from the teacher in monitoring the learning process, a requirement that is incompatible with high staff-student ratios.

The results of our research are particularly relevant within the context of the UNED, a distance learning university of international scope, where information and communication technologies are now essential for its teaching-learning processes. These technologies make it possible to develop learning processes from the perspective of significant learning and collaborative learning, as it has become clear in both of the projects described. Likewise, UNED´s experience could be of interest to other higher education centers working in virtual learning contexts.

Finally, it should be noted that researching in order to innovate always means beginning processes involving a great deal of self learning and that it is the achievements and the mistakes that show us the path to success. In this respect the experiences of innovative education the authors have presented provide different steps forward in a stable research project which will continue in future, always seeking the motivation and integral development of the students and their progress towards the collaborative dynamics which are so essential for a cooperative world.

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