

# SUSTAINABILITY INDICATORS IN THE EDUCATIONAL AND RESEARCH CONTEXT

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## Summary

As UNESCO indicates "The Decade of the United Nations for the education with a view to the sustainable development tries to promote the education as foundation of a more viable society for the humanity and to integrate the sustainable development in the system of school education to all the levels". In essence it proposes to stimulate a solidarity education that contributes to a correct perception of the world state, generate attitudes and responsible behaviors and prepare for the decision making towards the achievement of a cultural plural and physically sustainable development.

This way the UPC has developed in its new study plan of studies, a system of generic competitions solved in seven levels: entrepreneur and innovation, sustainability and social understanding, third language, efficient oral and writing communication, team work, solvent use of the resources of information, autonomous learning.

With this, as a base of investigation, a group of indicators were developed under the EMAS Project umbrella; that would give the university a system to assess the educational processes that promote the competition in *SUSTAINABILITY AND SOCIAL COMMITMENT*.

Nevertheless, as sustainability is not based on a linear definition, but on the comprehension of the interconnections between the different aspects that it concerns, the indicators needed to give answer from different dimensions.

That is to say, it where developed a range of indicators that concerned the different degrees of conscience and knowledge that can be acquired during an educational process. These, took into account on one hand the conceptual knowledge acquired and on the other, the personal values, attitudes, behaviors developed during an educational process and finally the coherence the students had between them at the end of the course.

Having the previous in account there where developed 5 different indicators (Sustainability Credits Implication, Sustainability Students Internalizing, Professional Activity, Sustainability Investigation Implication, Sustainability Promotion and Diffusion Activities) which evaluate different scopes of the education for the sustainability from the school.

The development of this Project has been framed under the rules of the utility, practicality, extension possibilities and continuity at the university. Also it has taken into account the different methodologies for obtaining the data needed for the indicators.

Until now the results are being of satisfaction because of the easy-way of use in the different campus of the university and schools but also by the easy way of interpretation and understanding.

## INTRODUCTION

The World Summit for the Sustainable Development recommended to the General Assembly of the United Nations "to try to proclaim a Decade dedicated to the education for the sustainable development, from 2005 " (paragraph (d) of the paragraph 117 of the Plan of the putting in application). The resolution, 57/254 on the Decade of the United Nations of the education for the sustainable development in which 46 countries appear as co-authors presented by Japan in December 2002 was adopted as consensus and begun the 1° of January 2005. In this resolution, the General Assembly of the United Nations designated the UNESCO as responsible organ for the promotion of the Decade and requested it the elaboration of a project of program of international application.

The principal aim of the Decade of the Education for the Sustainable Development (ESD) is to integrate the values inherent in the sustainable development in all the aspects of the education to foment changes in the behavior that they facilitate the most sustainable attainment of a society and just for all.<sup>1</sup>

The objectives of the Decade are:

- ❖ Facilitate the creation of networks, links, exchanges and the interactions between the parts being interested in the ESD.
- ❖ Foment a major quality of education and the learning in the field of the ESD.
- ❖ Give assistance to the countries in order that they advance towards the aims of Development of the Millennium, and achieve them by means of initiatives related to the ESD.
- ❖ Provide the countries with new opportunities to incorporate the ESD in their educational reforms.

With these bases the knowledge organizations (universities, schools, colleges, etc.) have started different plans to achieve the goals raised by the EDS. Although the UPC have been already working in this line, in the last years it has done modifications for its improvement and has developed with more energy and empowerment the education for the sustainability.

One of these processes is to have the campuses with an Environmental Management System as it can be certified (EMAS - ISO 14001) or not. Based on this the EPSEM (Escola Politècnica d'Enginyeria de Manresa) during the last 2 years has been establishing the Project EMAS (Echo - management and Audit Scheme). Nevertheless, the EPSEM has wanted to come a beyond the standard system that only assess the negative environmental impacts assessing also the positive educational environmental impacts generated at the university.

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<sup>1</sup> Educación para el desarrollo sostenible. Decenio de las Naciones Unidas 2005 – 2014. Antecedentes y Objetivos.

[http://portal.unesco.org/education/es/ev.php-URL\\_ID=23279&URL\\_DO=DO\\_TOPIC&URL\\_SECTION=201.html](http://portal.unesco.org/education/es/ev.php-URL_ID=23279&URL_DO=DO_TOPIC&URL_SECTION=201.html)

The work team of the EMAS - EPSEM knows that to be able to evaluate the positive impacts that the school generates across the education the different aspects of the sustainability - ecological, social, and economic – have to be undertaken and also the different degrees in which these develop across the education.

For the previous, the “sustainability” concept has been addressed from a human context; defined from the way of living.<sup>2 3</sup> To be precise, in order to be able to say that people live in a sustainable way; the natural resources of the Earth must be used in a rate in which these can be regenerated or restored. Additional, the understanding of sustainability is based on the relation between its different aspects and the existence of interconnections among them.

Therefore, the impact evaluation of educational processes which aim is the promotion of sustainability is an issue that has been discussed for several years. The impact evaluation has to take into account several aspects of knowledge; as Bloom’s Taxonomy shows in Figure 1.

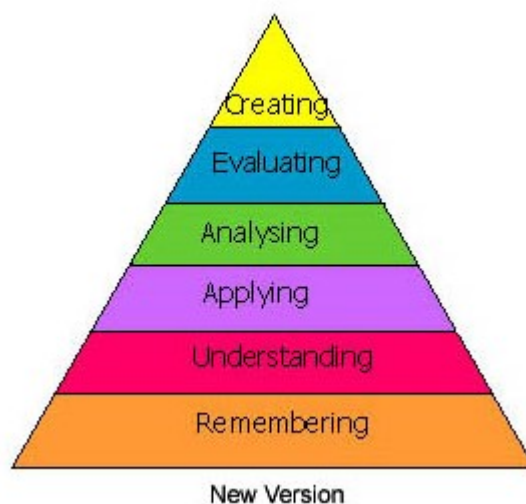


Fig 1. Bloom’s Taxonomy;

[http://www.odu.edu/educ/roverbau/Bloom/blooms\\_taxonomy.htm](http://www.odu.edu/educ/roverbau/Bloom/blooms_taxonomy.htm)

- Remembering: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
- Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
- Applying: Carrying out or using a procedure through executing, or implementing.
- Analyzing: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.

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<sup>2</sup> Gismondi, M. (2000). Interview of Dr. William Rees. Aurora Online. Retrieved on 2009-03-10

<sup>3</sup> Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. Summary for Decision-makers. pp.1-16. Washington, DC.: World Resources Institute. The full range of reports is available on the Millennium Ecosystem Assessment web site. Retrieved on: 2009-03-10

- Evaluating: Making judgments based on criteria and standards through checking and critiquing.
- Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.<sup>4</sup>

For this, it's to say that the sustainability concept and its aspects cannot be evaluated in a linear way and unique methodology.

This way the work team of the Project EMAS at the EPSEM not only had in mind the development of indicators of Environmental Management, also decided to develop a group of special indicators with which the system could evaluate the formation and research in sustainability of the School from the most objective point of view having the characteristics that concern Sustainability.

### **FORMATION AND RESEARCH INDICATORS DEVELOPMENT**

As UNESCO indicates "The Decade of the United Nations for the education with a view to the sustainable development tries to promote the education as foundation of a more viable society for the humanity and to integrate the sustainable development in the system of school education to all the levels " (Vilches, Gil Perez, Toscano, Macías, 2008). In essence it proposes to stimulate a solidarity education that contributes to a correct perception of the world state, generate attitudes and responsible behaviors and prepare for the decision making (Aikenhead 1985) towards the achievement of a cultural plural and physically sustainable development ((Delors, (1996), Cortina, A. (1998), Vilches, Gil Pérez, Toscano, Macías, (2008)).

This way the UPC has developed in its new study plan of studies, a system of generic competitions solved by levels:

1. Entrepreneur and Innovation
2. Sustainability and Social Understanding
3. Third Language
4. Efficient oral and writing communication
5. Team work
6. Solvent use of the resources of information
7. Autonomous learning

For the development of the indicators of Formation and Research in Sustainability the EMAS - EPSEM team used as support the competition in SUSTAINABILITY AND SOCIAL COMMITMENT.

This competition is defined "To know and to understand the complexity of the economic and social typical phenomena of the well-being society; aptitude to relate the

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<sup>4</sup> Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives: Complete edition, New York : Longman.

well-being to globalization and sustainability; skill to use in a balanced and compatible way the technology, the economy and the sustainability.”<sup>5</sup>

Objectives by levels:

- Level 1: To analyze systemically and critically the global situation, attending in a interdisciplinary way sustainability as well as the human sustainable development, and to recognize the social and environmental implications of the professional activity of the same area.
- Level 2: To apply criteria of sustainability and the deontological codes of the profession in the design and the evaluation of the technological solutions.
- Level 3: Bear in mind the social, economic and environmental dimensions on applied solutions and having carried out coherent projects with the human development and the sustainability.

On the other hand, the team EMAS took in consideration the dimensions of sustainability and of the scope of the education. That is to say, it kept in mind the different degrees of conscience and knowledge that can be acquired during an educational process

- Conceptual knowledge
- Personal values
- Attitudes
- Behaviors
- Coherence

The same way; there were considered the different activities or educational processes developed in the school.

- Subjects
- Research Processes
- Cooperation for development or transfer of technology processes.

Having the previous in account there were developed 5 different indicators which evaluates different scopes of the education for the sustainability from the school.

Types of Indicators

1. Sustainability Credits Implication
2. Sustainability Students Internalizing
3. Professional Activity
4. Sustainability Investigation Implication
5. Sustainability Promotion and Diffusion Activities

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<sup>5</sup> Resumen sobre las competencias genéricas a implantar en los planes de estudios de grado de la UPC. Institut de Ciències de l'Educació – UPC – febrer 2009.

## SUSTAINABILITY CREDITS IMPLICATION

The indicator "Credits implication in Sustainability" has as main aim to evaluate the level of sustainability that the teachers promote in each of the subjects developed in the school. This indicator is composed by three different levels of evaluation

- The first level evaluates the materials and resources used in the communication of the subject, that is to say; it evaluates the use of the type of paper, the computer systems, etc.
- The second level evaluates the contents and references presented by the teachers in each one of the subjects, and the use of educational methodologies that promote the sustainability.
- The third level, it evaluates the incorporation of sustainability in the methodologies of evaluation of the subject, it verifies if the subject develops in its evaluations the "evaluation of sustainability related to the subject."

To obtain the information, the tool used for this indicator is a closed survey; nevertheless the presented answers are descriptive.

The results of this indicator can be read of different way, every level as new paragraph has a result that is given in percentage. However, when analyzing the three different results; integrating them and finally by normalization it gives the general indicator of the subject which describes in a general way the implication of the subject with sustainability; it is read as a percentage.

Credit implication in the Sustainability	Percentage
Sostenibilisation of Materials and Communication Resources	60%
Sostenibilisation of the Contents and presented References	33,33%
Evaluation of the subject; incorporation of the Sustainability in the evaluations of the subject	8,33%
Sostenibilisation of the Subject	25,28%

This indicator is useful to evaluate the teachers since they are the ones who with their reasoning answer, but simultaneously the tool allow also the students to answer and give their opinion and permit us to compare both answers.

## SUSTAINABILITY STUDENTS INTERNALIZING

"Sustainability Students Internalizing" is an indicator that is based on two different tools, whereas one of them answers to the conceptual knowledge acquired by the students, other one answers to the values, attitudes and behaviors of them. This indicator is based on the conceptual theory of "Social Representations", since these, they are social forms of knowledge, free of constraints scientific and formalized in a

figurative scheme. The social representations; provides a base to perceive and to interpret the reality, as well as to canalize the behavior of the subjects.

Parallel, they are related to the social characteristics of the subjects (in this case students of degree, with different nationalities, sex and university careers). According to Moscovici's approaches, the social representations are produced from the objectification and the anchorage. Taking into account the previous, it was decided to choose to analyze different tools for the compilation of information in sociology to manage to do the assessment of knowledge, attitudes, values and behaviors of students as complete as possible.

In a general way there were analyzed two types of associative technologies; "Conceptual Maps and free Association of Words" and different methods of surveys and interviews.

The "conceptual maps" was one of the first tools considered for the development of this indicator. J. Novak (Novak, 1991), used the conceptual maps in order to facilitate students in learning and organizing what they have learned. On the other hand, according to J. Segalas (2006), the conceptual maps are a useful tool for the evaluation of the concepts of Sustainability acquired in the university subjects. In general, the conceptual maps contain three fundamental elements: concept, proposition and linking words. The concepts are words or signs with those who express regularities to themselves; the propositions are two or more conceptual terms joined by a linking word to create a semantic unit; and the linking words therefore, work to relate the concepts (Díaz, Fernandez, 1997). As example Figure 2 illustrates the interpretation of the sustainable tourism of a university pupil by means of conceptual maps.



Fig. 2 Mapas Conceptuales sobre el Turismo Sostenible. Walshe; Nicola. Universidad de Cambridge, UK.

On the other hand, it was studied the methodology of free association of words: "Social representations". The analysis was realized using the model of Vergès (1989, 1992) who identifies the semantic content of the representation, the hierarchy and the organization

of its elements. This tool is used usually to identify the "social representation" of a concept or inducting term in a group of persons. This type of tool is generally used for evaluating the level of perception of the risk; risk of a sport, the labor exercised in a work, or to the risk caused by environmental degradation, between others. This tool consists of a simple list of words that written in a certain order they show the priority that every person gives and relates to the analyzed concept.

From this data it can be measured three measurements: the frequency of the words, its average range of appearance and the importance of the words for the persons (average of the order in which there was mentioned the word, order that changes from one to five). With this tool we can obtain a graphical analysis like it there shows the following figure Figure 3.

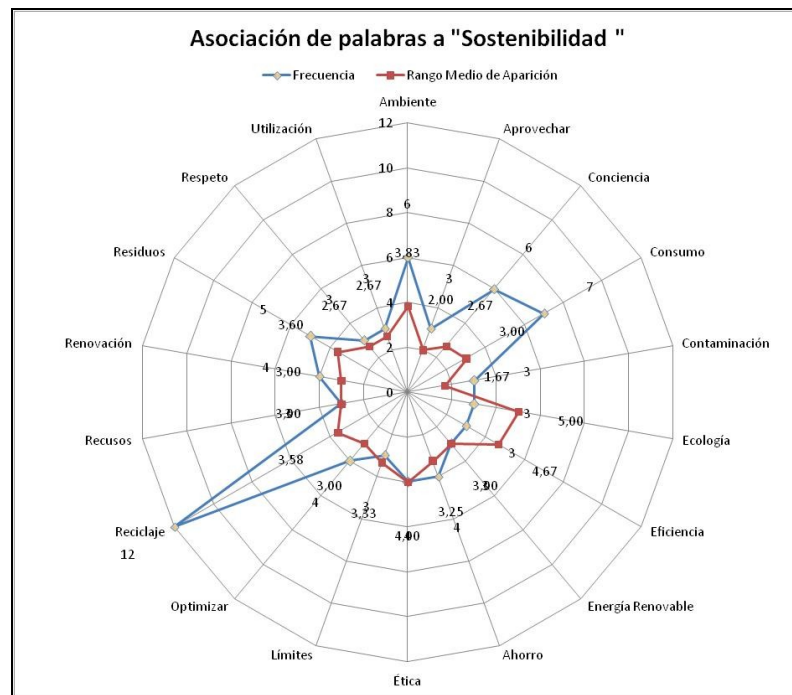


Fig. 3 Representación Social de Estudiantes de Grado UPC (Workshop – "Pensactua glocalment 2009) sobre la Sostenibilidad. 2009. Walsh, Nicola. Universidad de Cambridge. UK

Additionally, it was evaluated the possibility of doing interviews, but because of the timing and quantity it was removed this alternative.

Finally it was analyzed the surveys with a Likert scale. This tool was considered because the methodologies previously studied where able to analyze the cognitive knowledge, but values (though the methodology of conceptual maps bears it in mind in a symbolic way) they are not evaluated by any of the two tools.

Equally, the attitudes and the behaviors are not evaluated either. For the previous thing, it was designed a survey which seeks to fulfill the blankness the other tools leave.

The survey tries to analyze:

- Equitable Values of balance
- Problematics and responsibility
- Reality of the Limits of Growth
- Problem solution in time
- Relation with the society

In addition the behavioral aspect is analyzed concerning the behaviors people have with respect to: solid waste, water, energy and to the social subject.

From this survey the questions and the obtained answers are grouped as is shown in Table 1.

Table 1. Reality of the Limits of Growth. (Workshop – “Pensactua glocalment 2009)

Reality of the Limits of Growth					Analysis
	Students		Organizers		
	Average	Distance from 1	Average	Distance from 1	The development of the human being is conceived from the growth (population, industrial, economic), causing a low perception in the limit need.
P12	0,76	<b>0,24</b>	0,56	0,44	
P13	0,81	0,19	1,00	<b>0,00</b>	
P15	0,73	<b>0,27</b>	0,28	<b>0,72</b>	
P16	0,76	<b>0,24</b>	0,60	<b>0,40</b>	
Distance Average		<b>0,24</b>		<b>0,39</b>	

## PROFESSIONAL ACTIVITY

The indicator "*Professional Activity*" has as main purpose to present the contexts (jobs) where the UPC graduate students are developing the skills and competences acquired at the university. On the other hand, with this survey the university can have a small blaze of the state of the sustainable business market.

This indicator was develop exclusively with the intention of verifying the continuity that sustainability has in employment world.

1	La meva empresa es desenvolupa en el ambit de _____.	Tecnología	Comercializació i Ventes	Turism	Construcció	Administració	Calidad Producció I+D	Diseny	Educació i Formació	Marketing i Comunicació	Altre
		NO	SI	NO	NO	NO	NO	NO	NO	NO	

		Medi Ambient	Desenvolupament Social	Econòmic
2	La meva empresa, per la seva activitat, esta indirectament implicada en _____.	SI	SI	SI
3	La meva empresa fa accions de Resposabilitat Corporativa en el ambit de _____.	SI	NO	SI
4	La meva empresa utilitza indicadors _____.	NO	SI	NO
5	La meva empresa, per la seva activitat, esta directament implicada en _____.	NO	NO	SI
6	La meva empresa desenvolupa programes, projectes o plans _____.	NO	NO	SI
7	La meva activitat professional es desenvolupa al ambit del _____ directament.	SI	SI	SI
8	La meva activitat professional desenvolupa projectes, programas o plans _____.	SI	SI	SI
9	Personalment intento implicar-me en programas de cooperació: _____.	SI	SI	SI
10	Pertanyo a alguna associació que treballa a favor del _____.	SI	SI	SI
<b>Total Marcas</b>		15	15	17

## SUSTAINABILITY INVESTIGATION IMPLICATION

The “Sustainability Investigation Implication” indicator refers to the thesis developed from the graduate students for the different careers of the EPSEM. This indicator used the data made from evaluations made for the thesis where it says if the work presented had considered the environmental concepts and analysis during its development. The indicator keeps in mind that the evaluation is done with the teacher’s criterion, for what there is not a systemic and rigorous evaluation. Nevertheless, it helps to have a global vision of the thesis completed at the university.

It offers brings a graph as a result which the presents the percentages that all of the careers have every year of “environmental analysis” as it can be seen in figure 4.

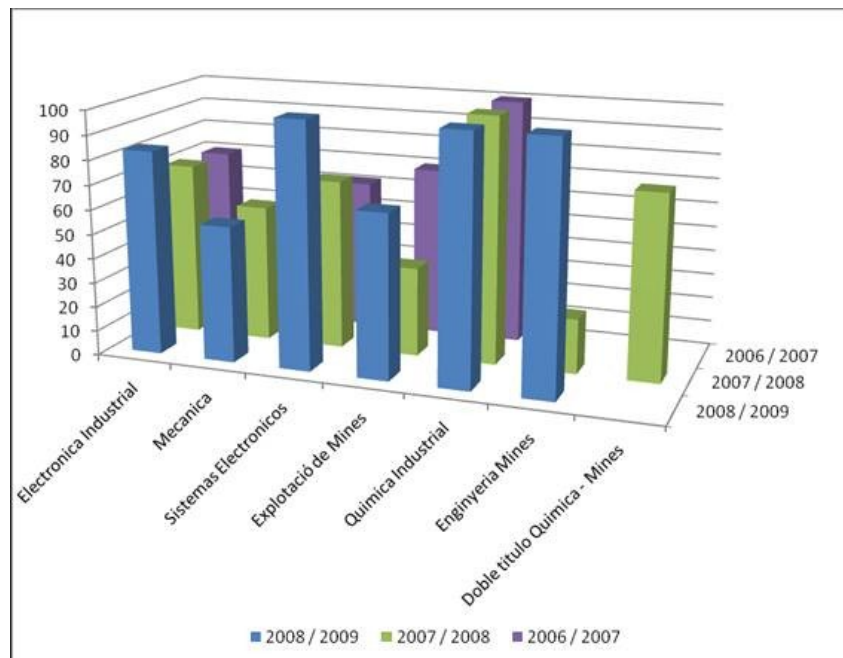


Fig 4. Sustainability Investigation Implication Results EMAS – EPSEM 2009 Project

However, at the UPC is developing a new project called "Sustainability Qualitative Evaluation and Characterization in at the UPC Research".

The study tries to evaluate the Sustainability Research done at the UPC, as well as the way of achieving it and focusing the different scientific activities that are done.<sup>6</sup>

## **SUSTAINABILITY PROMOTION AND DIFFUSION ACTIVITIES**

The "Sustainability Promotion and Diffusion Activities" indicator has as aim to check the activities that the university develops during the academic year concerning Sustainability as main objective. This indicator is divided in 5 different sub-aims:

1. Actions directed to the increase the conscience and sensibility of the teachers, the students and the administrative personnel.
2. Give information of the environmental state of the campus and of the careers implicated in sustainability.
3. Actions directed to the information of the regulation for the student's project presentation.
4. Actions directed to increase the offer of the non-formal and formal Sustainability and Environmental formation.
5. Actions intended to make promotion and diffusion of the activities developed at the university related with Sustainability in Manresa.

This indicator is based on a series of questions that give a result in percentage. That is to say, the percentage of the indicator increases if the actions proposed are fulfilled.

As the indicator Sustainability Credit Implication, this one also gives a percentage of accomplishment for each of five sub-objectives depending on the achievement of each one on them.

## **EVALUATION AND CONCLUSIONS**

From the group of indicators that have been developed during the EMAS project for the UPC it has been found that evaluating sustainability needs a pluri perspective and vision for a complete analysis. That is to say, in a university to manage to do a complete analysis of Sustainability it's necessary to keep in mind on one hand the management system (consumptions of energy, water, chemical products between others, and the emissions, solid wastes, etc); but also the generation of knowledge and conscience in the students based on the different aspects that sustainability concerns.

The "Sustainability Credit Implication" and "Sustainability Students Internalizing" indicators are of complementary use since these are the evaluation of an educational process therefore both parts must be kept in mind, students and teachers as axes of the educational process for the sustainability.

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<sup>6</sup> Estudi Qualitatiu d'avaluació i Caracterització de la Recerca en Sostenibilitat a la UPC  
[http://www.upc.edu/sostenible2015/avaluacio\\_recerca\\_sostenibilitat/inici](http://www.upc.edu/sostenible2015/avaluacio_recerca_sostenibilitat/inici)

That is to say, the analysis is done comparing the objectives raised by the teachers for the educational process (subject, workshop, workshop, career's final project, course's final project, etc) and the achievements reached by the students with regard to the sustainability concepts and its implication in the educational processes. Therefore to be able to evaluate the educational processes with regard to sustainability, the different tools (surveys and 8 word listing) used for this evaluation must be made for both groups; students and teachers.

On the other hand the tools used for this indicator are complementary and need to work together to have good results. This is because one of them only values the cognitive knowledge and the other one values the behaviors and values of the group.

In contrast the Sustainability Activities of Promotion / Diffusion indicator shows the university interest to develop the sustainability topic from different perspectives and the participation value of the different existing groups at the university.

Finally, the Sustainability Investigation Implication indicator has not been developed by major progress having into account the existence of other investigation groups at the UPC. And the Professional Activity indicator is the summary of information about the companies' interest state in the sustainability area

In conclusion, it is possible to say that the Education for Sustainability must involve both the cognitive (technical) knowledge and the formation in values (ethics, respect, transparency, etc.) towards the sustainability paradigm, allowing this way the systemic understanding of the reality. Thought that will develop real questions and real solutions focus toward sustainability.

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