Models and instruments for assessing Technology Enhanced Learning Environments in higher education

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The Bologna Process calls for a substantive change in the pedagogical model of teaching and learning in higher education, focusing on the acquisition of skills by students and not the mere accumulation of knowledge. Technology Enhanced Learning Environments (TELE) are seen as a fundamental support in teaching reengineering, and may support a more effective approach to constructive educational philosophies.

The evaluation of TELE, as a means of certifying its quality, is giving rise to several initiatives and European experiences. However, the mechanisms for defining quality parameters vary according to different contexts. If assessment aims to function as a management tool, it should seek specific criteria and indicators that would allow it to respond to questions of well-defined contexts. In this study, which stems from a literature review, we present basic guidelines for TELE continuous assessment (as a management tool). Throughout this article the importance of ongoing, in-context evaluation is emphasized. Models, methods and tools to collect data that permit institutions to develop a properly contextualized assessment process are presented.

1. Technology Enhanced Learning Environments (TELE) delimitation of the concept

The concept *Technology Enhanced Learning Environments* (TELE) is comprehensive and, therefore, it is not easy to define nor does it have a single definition. In the *Report of the Technology Enhanced Learning Committee*, University of Texas (2004, p. 182) it is defined as follows:

> "*Technology enhanced learning leverages technology to maximize learning within an environment of sound course design that can offer students the options of time, place, and pace and emphasizes different learning styles.*
>
> *There is no one definition for the look or feel of a technology enhanced course; instead, this effort occurs along a very broad spectrum that at one end can include a course with only minimal technology enhancement such as a Web site with an electronic syllabus, while at the opposite end is found a robust, multimedia rich, interactive, collaborative, fully online course*" (Armstrong, et al., 2004).

In defining the concept of TELE rather than seek formulations or rigid definitions, we sought to establish common views that facilitate communication. Thus, following the approach in the University of Texas' Report, we understand that a TELE goes beyond technology related issues and focuses on building learning environments supported, in more or less detail, and more or less integrated by technology.

2. The growing importance of the Technology Enhanced Learning Environments (TELE) in higher education

The development of TELE efficient assumes a fundamental strategic importance in the competitiveness of Higher Education Institutions (HEIs). Figure 1 represents a gear, with the main social factors, which are pressing the HEIs for change, through technology. The capacity of the institutions understand the change and formulate strategies to adapt to the new environment is crucial to its success and survival. This situation is similar to the Darwinian Theory of Evolution by Natural Selection: "It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change" (quote attributed to Darwin that summarizes the theory of evolution by natural selection).
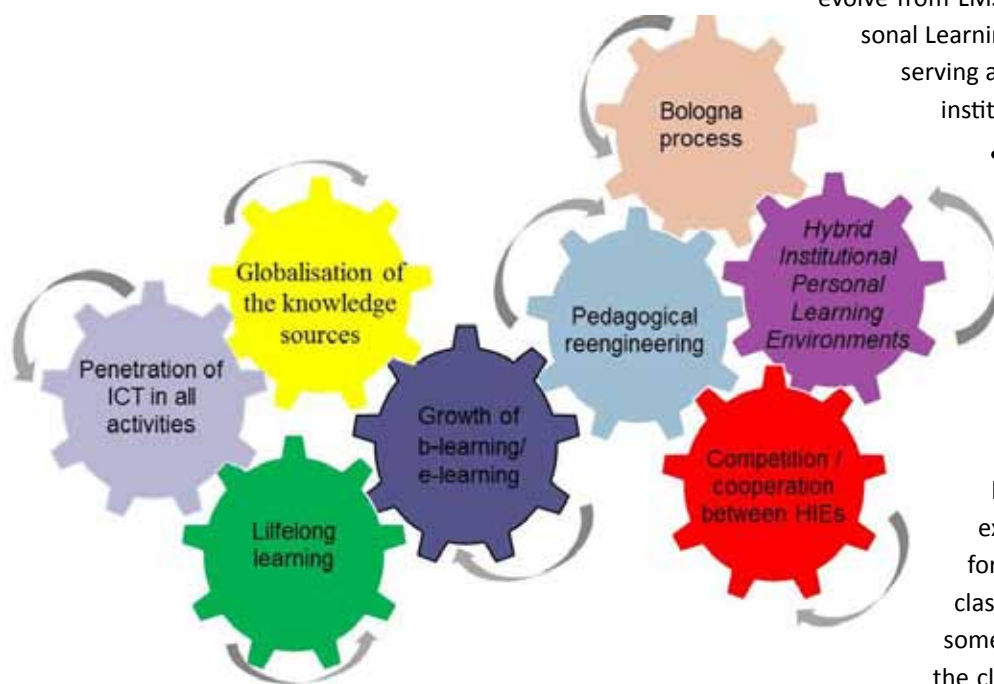

Figure 1: Social factors that require the change of HEIs through technology

- The Bologna Process calls for a substantive change in the pedagogical model of teaching and learning in higher education, focusing on skills acquisition by students and not the mere accumulation of knowledge. In other words, it is not just about learning concepts, which will then be assessed; the students will have to acquire skills themselves, and therefore they will be co-responsible for their own education. This philosophy leads us to pedagogical models with

a more constructive approach. The TELE based on LMS are advocated as being able to support more effectively the knowledge construction in higher education;

- The TELE as support in pedagogical reengineering. The ICT, as educational technologies, are advocated as being able to support more effectively the construction of knowledge and the promotion of meaningful learning, particularly if used as cognitive tools to expand mental capacities and not, as traditionally happens, just as a means of transmission of information, as communicators of knowledge or guardians of students;

- The growing importance of social networks and collaborative work performed by collective intelligence has heightened the value of Social Learning Networks (Tapscott & Williams, 2008). As such it has become necessary for IES's to evolve from LMS architecture to Hybrid Institutional Personal Learning Environment (HIPLE) architecture, thus serving as a bridge between the vision held by the institution and by the student.

- With the implementation in Higher Education of the Bologna reform, there will predictably be, a significant part of the student population that will tend to be less available to have a face to face full-time education after completion of primary school. The HEIs will be able to reap dividends if they offer combined ways of learning (b-learning) and the distance which enables extending the range of potential candidates for middle and secondary school. Even in classroom learning, the online availability of some of the syllabus or the virtual extension of the classroom, may allow a greater monitoring of the teaching activity by students, who for professional or other compelling reasons, see their presence in the class compromised;

- The deepening of inter-institutional cooperation of HEIs for different countries, the projection of movement of people (teachers, researchers, students and administrative staff) and integrated programs of study, training and research, foreseen by the Bologna declaration may be favored if there is a basis for work online to facilitate them;

- The decline in birth rate, which is reflected in the decreasing number of students, coupled with the growing mobility

of the student population throughout the course of their training, fosters competition between IES's. The development of efficient TELE's may be a determining factor in the attractiveness of the institutions;

- Considering that the globalization of the sources of knowledge takes the world to school, it can additionally be considered that notebooks, netbooks, tablets, smartphones and other alike can take school anywhere in the world. In this fashion a new frontier of Personal Learning Environments (PLE) has been opened, enabling students to control and manage their own learning experience;

- The increasing need for lifelong training requires models of distance learning or a combination of classroom/distance learning;

- The penetration of technology into all human activities is a reality, and IES's that fail to make the change via technology will be less competitive.

If it is true that an investment in technology does not necessarily lead to the construction of efficient TELE, then it is also true that an investment in technology does not necessarily signify the construction of an intelligent TELE (Lippert & Davis, 2006). Rosenberg (2006) considers that the lack of assessment of various aspects of TELEs is one of the factors responsible for the failure of these initiatives.

Khan and Granato (2007) argue that, in order to understand a TELE, it is necessary to consider multiple dimensions: people, processes and products. In his own words: "To understand online learning environment, we need to have a comprehensive picture of people, process and product involved in it, and also study critical issues encompassing its various dimensions" (Khan & Granato, 2007).

Following the same line of thought, Ehlers and Goertz (2005) wrote that: "It is necessary to regard all factors of influence – the learner, the subject, the intended results, the technological and social surrounding (work place, learning culture in the company, private learning situation etc.). An effective quality assurance has to cover the whole process from the first plan up to the development and implementation until the assurance of transfer" (Ehlers & Goertz, 2005, p. 169)

Many European and international institutions emerged to try and meet this challenge of change which has been imposed upon Institutions. It is essential that the process of change is accompanied by quality assurance initiatives. There are several examples in literature that seek to contribute to the quality assurance of TELEs. Over the next two chapters, we will briefly review some relevant points.

3. Quality evaluation and improvement of practices: a growing concern

The issue of TELE, supported by ICT, education is one of the most relevant topics in discussion. Many hopes have been deposited in its potential to serve education, but many have also been the failures in terms of results. In the words of (2006, p. 434): "Trillions of dollars are annually spent on the development and implementation of information technology within the United States and around the world. On average, roughly 50% of such systems are considered failures or fall short of meeting the expectations set forth by management."

In view of the American Society for Quality[1], quality is what defines and guides the individual success of organizations and communities without interrupting their process of evolution. This is an ongoing process of development and pursuit of the best practices. Quality can only be improved if there is an evaluation of practices

According to the *European Quality Observatory*[2]:

> "*Quality in e-learning has a twofold significance in Europe: first, e-learning is associated in many discussion papers and plans with an increase in the quality of educational opportunities, ensuring that the shift to the information society is more successful. We call this context 'quality through e-learning'. Second, there is a separate but associated debate about ways of improving the quality of e learning itself. We term this context 'quality for e-learnin.*"(Ehlers, Goertz, Hildebrandt, & Pawlowski, 2005, p. 1).

The evaluation of the quality and the improvement of practices are the goals of the *European Foundation for Quality in E-Learning* (EFQUEL)[3], a European organization whose main objective is to promote the quality of e-learning in Europe through support services to institutions and agents involved in e-learning in general. This foundation has created a European observatory of quality in e-learning, projects, workgroups and publications of interest, as well as the creation of a European prize for the

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1 http://www.asq.org/

2 http://www.virtualcampuses.eu/index.php/European_Quality_Observatory

3 www.efquel.org

eQuality. Among the EFQUEL projects, we would like to high-light eUnique[4], which involves several research centers and European universities, and aims to create a tool that will help European universities to maximize the educational use they make of technology.

There are some other European associations promoting projects, seminars and specific publications about the quality of e-learning, making some proposals about how to evaluate the TELE, such as: The *European Distance and online-learning* Network (EDEN)[5] and the *European Association for Distance Teaching Universities* (EADTU)[6].

Although in literature there is a consensus that evaluation is an aspect of capital importance in the development of TELE, in particular in e-learning courses, the way how we assess them and what aspects should be examined are issues of great controversy: "How to evaluate e-learning appropriately is thus the crucial question for researchers trying to understand the impact and effectiveness of e-learning in a business or academic environment" (C. Voigt & Swatman, 2004).

Level	Evaluation Parameters
Level 1 Satisfaction	• Are the course objectives relevant? • Does the course have the ability to maintain interest? • Is the Syllabus appropriate and do they have the interactivity needed? • Is it easy to navigate? • Are the value and the possibility of transferring knowledge to the workplace perceived?
Level 2 Learning	• Did the students achieve the objectives (knowledge, skills and attitudes) required in the program?
Level 3 Skills	• To what extent is the new knowledge and skills applied in the workplace?
Level4 Results	• Does the knowledge acquired in training have an impact on the company's business?

Table 1: Evaluation in e-learning: Introduction to the Kirkpatrick model (Kruse, K. 2002)

4 http://www.qualityfoundation.org/

5 http://www.eden-online.org/

6 http://www.eadtu.eu/

4. Evaluation Models

In literature there have been many proposals for the global evaluation of the use of technology in education. Under e-learning, the classic model of Kirkpatrick is widely applied. Kruse (2002) recovers the classical model of the four levels of evaluation of Kirkpatrick (1975) and adapts it to the evaluation in e-learning (table 1).

Criteria	Indicators of quality
Criteria I Teaching Program	• *Quality indicator 1:* How are the objectives of a training program prepared? • *Quality Indicator 2:* How can we facilitate the curricular flexibility while answering to the objectives of the training program?
Criteria II Teaching and learning organization	• *Quality Indicator 3:* How to plan actions for continuous improvement? • *Quality Indicator 4:* How to establish effective communication?
Criteria III Human resources	• *Quality Indicator 5:* How to engage teachers in research, development and innovation? • *Quality Indicator 6:* How to value teaching?
Criteria IV Material resources	• *Quality Indicator 7:* How to articulate the library and document databases with the educational process? • Quality Indicator 8: Are the means and resources adapted to the training program?
Criteria V Training process	• *Quality Indicator 9:* How to develop students' skills in the teaching and learning process? • *Quality Indicator 10:* What is the methodology of the teaching and learning process? • *Quality Indicator 11:* How does the tutor guide and motivates the student during the training?
Criteria VI Results	• *Quality Indicator 12:* How do you measure student satisfaction in the training process?

Table 2: Criteria and indicators of MEPFL quality (Model of Excellence Programs for Online Training) (Rosa & Angulo 2007)

The academic environments still in transition of processes, from one centered on classroom learning and teaching, to a mixed

Axes	Levels
Access Dynamics What is the necessary frequency of access to succeed in the course?	• One access per semester • One access per month • One access per week • Two or three accesses a week • Daily
Evaluation What is the volume of online assessment?	• None • Reduced • About half • Majority • All assessment
Communication What is the volume seen in online communication?	• Reduced • Less than half • More than half • Most • All communication
Syllabus (elements) What is the content of the Curriculum Unit (CU) available online?	• Information about CU (program, evaluation, objectives, teaching staff, etc.) • Book, or supporting text • Lectures material from lectures (theoretical and practical) • Exercises (cases, solutions, exams, etc.) • Additional information (one point for each)
Syllabus (Digital wealth) Does the content take advantage of the digital environment?	• Simulators (games and animations) • Video (specific, youtube) • Audio (podcast) • Slides (class slides) • Additional Sites (one point for each)
Independence What is the degree of independence of the CU model in comparison with the traditional model?	• Essentially dependent on presence • Significant lessons, but online materials, exercises and evaluation • Limited regular face-to-face contact • Sporadic face-to-face contact • No face-to-face contact

Table 3: Adaptation of the Kaczynski, Wood and Harding's (2008) Model

education and with increasing use of technology, combined with a survey of pedagogical changes, require a quick and easy to apply model for monitoring. Table 3 identifies in detail a possible approach to this simple system of monitoring the migration from a traditional system to a system that incorporates technology in teaching and learning.

For everything that was said, the assessment is quite a relevant topic and essential in creating a participatory dynamic of construction, adaptation and continuous appreciation of TELE. The process of assessment will therefore have to consider the participation and negotiations between the various actors involved in that same process (designers, trainees, trainers...) and should result in a continuous reflection on the objectives, if they were met or not, about what is necessary to redefine, what is important to keep and what may be important to change, in a contin-

uum between diagnostic assessment (Where are we? The status) and prognostic (where do we want to go? objectives to be achieved). This is a process of continuous assessment-training in which the different actors involved participate. (Gomes, Silva, & Silva, 2004, pp. 1,2)

The Matrix Integration Technology (MIT) developed by the Florida Center for Instructional Technology (2009), illustrates the five stages of organizational change to achieve the highest level of change in a TELE. Ideally, a TELE will evolve from an introductory phase (entry) to a stage of transformation (transformation), which is reached when the technology is used effectively by everyone in the organization and the culture of knowledge sharing is the rule. In the transformation phase, the whole TELE is immersed in technology and does not work without it. A production of participatory evaluation is essential in the construction,

adaptation and evolution of TELE to growing levels of integration. In Figure 2, we have constructed the plan of the evolution of technology integration in the curriculum, based on the MIT, proposed by the Florida Center for Instructional Technology.
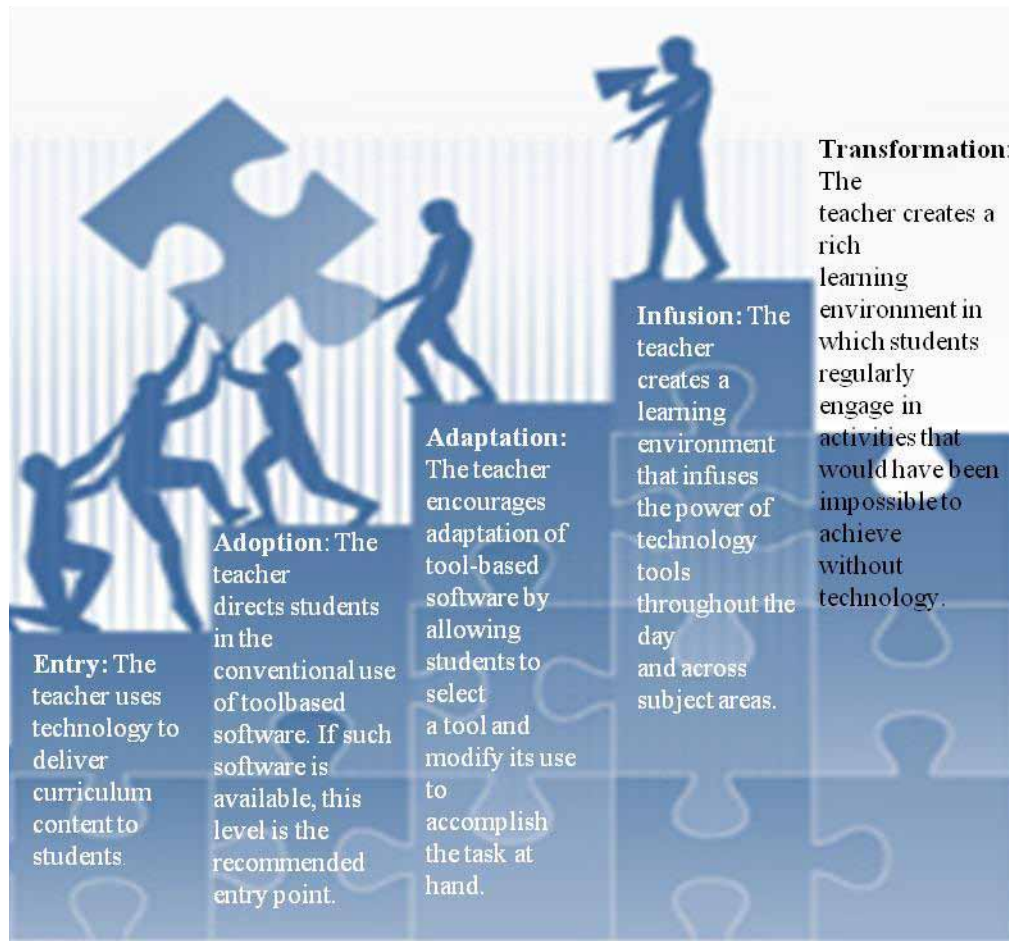
indicators of a given institution with difficulty, so its effectiveness as an instrument of management and of improvement of practices in the institution, will be limited.

In evaluating TELE it is possible to distinguish models of partial and global focus.

In models of global focus, we can discriminate trends:

- The evaluation of systems focusing on models and / or quality standards;
- Systems based on the practice of benchmarking.

The models of partial focus are centered on issues such as:

- Training activity;
- Training syllabus;
- Technologic platforms;
- Cost/benefit analysis

Figure 2: Levels of technology integration in the curriculum (Florida Center for Instructional, 2009)

Although we can integrate continuous evaluation as a management tool into the category of partial focus evaluation, its goal is to examine in depth all the components of TELE from the perspective that all actors somehow participate in the environment. To meet this goal, the evaluation should have the following characteristics:

5. Evaluation methodology

The evaluation of the TELE, as a means of certification of its quality, is giving rise to several initiatives and European experiences, some already mentioned. However, the mechanisms for parameterization of quality vary according to each context (Tait, 1997), so if the evaluation has the aim to perform functions of a management tool, it will have to seek specific criteria and indicators, which respond to questions of delimited contexts (Rubio, 2003). In other words, the import and direct application of an evaluation model will contemplate variables, criteria and

- *Circular evaluation (360º)* - All players and components of the environment are evaluated by all participants. Each actor evaluates the responsibility aspects of the other actors, and simultaneously is evaluated by peers. This methodology involves the development of a multidirectional evaluation that overcomes the limitations of a one-way evaluation, as it allows you to compare various aspects of the environment, from different perspectives. (Acuña & Aymes, 2010; Fernández, 1997)

- *Evaluation of procedure* - During the process, as we continue to develop the different modules of the courses, there is a collection of data and from the evaluation that is made de-

cisions must be taken to improve the TELE. Training Evaluation.

- *Final Evaluation* – The training evaluation prepared during the process aims not only to contribute to the improvement of the TELE, but also to enable the final results at the course and organization levels (summative assessment) as an aid to decision making.

- *Mixed focus evaluation* - Resorting to qualitative instruments (interviews, focus group) we expect to deepen and get contextual information that enables us to identify the dimensions and factors of the integration of the TELE. The information extracted from the qualitative analysis will serve as input for the construction of quantitative instruments (questionnaires). The data is collected, analyzed and processed in the quantitative phase (dynamic of access, communication volume, nature and wealth of digital content, ...).

6. Data collection tool

In a continuous evaluation, which is intended to be a management tool, data collection should be made according to a pre-established plan. We have already mentioned the potential of a participatory and multidirectional assessment. If the aim is to provide decision makers with accurate and detailed information, it will be important to take a holistic view of reality. Data collection should be done in a real context, and given the complexity of the phenomenon, it requires the collection of varied data, hence this type of approach is similar to a case study when seen as research methodology (Yin, 2009).

Harvey, Cathy Higgison and Gunn (2000) list a number of tools to collect data for the evaluation of TELE:

- *Questionnaires* – They are recording instruments planned to search for data about subjects, through questions about knowledge, attitudes, beliefs and feelings (Wood. & Haber, 2001).They can be useful tools to obtain feedback from all the participants in the TELE.

- *Online discussions* - online discussion forums on various aspects related to the operation of the course.

- *Interviews and focus groups* - Interviews and meetings in small or medium groups (between five and ten people), in which participants talk in a relaxed and informal environment (Sampiere, Collado, & Lucio, 2006).

- *Peer review* - Sharing of views between tutors on content, activities and communication structures.

- *Comparative Studies* - Comparison between different subjects, courses and schools to identify potentials and bottle-necks of the TELE.

- *Students' evaluation results* – They can offer a big variety of information on learning outcomes.

- *User tracking* – Tracking the students' activities enables us to capture differences in participation rates and in use of resources.

- *Charts of direct observation* - Comparison between the characteristics of the course criticism strands (tutoring, materials, activities) and the ones desired.

- *Online Learning Environment Survey (OLES)* - In the perspective of research the OLES evaluation system (http://www.monochrome.com.au/oles/survey.htm) is anchored to the environment assessment of the classroom, in dynamics of distance education and the contributions of technology in teaching and learning. This method comprises nine dimensions (1 - Computer Usage, 2 - Teacher Support, 3 - Student Interaction and Collaboration; 4 - Personal Relevance, 5 - Authentic Learning, 6 - Student Autonomy; 7 - Equity EQ; 8 - Enjoyment and 9 - Asynchronicity), perfectly framed in constructivist philosophy, and fifty-four factors on a scale of five levels that explains not only the current perception of students in relation to the system under study, but also seeks to project its expected ideal (Pearson & Trinidad, 2005). This way, it is possible to foresee the differences between the current state and the desired one. This system can be used online, by creating an account for the effect, which consists of the generation of an address for the access of teachers and students, addressing both perspectives (teacher and student.) The OLES latest version can be entirely administered online by the teacher, with charts to be automatically produced for discussion and comparison. This view of assessment is perfectly aligned with the multi-directional methodologies of evaluation participated by all actors, allowing, at each moment, to the gathering of relevant information on the operation of the course, becoming, therefore, great management tools.

7. Presentation of results

The results of the evaluation process should have an impact on the educational environment, in relation to content, attitudes of students and teachers, in the way of content delivery and in a more efficient integration of technology (Moussiades & Ili-

opolou, 2006). Thus, regardless of how it is conducted, it is important to present the evaluation results.

In 1996, Leading Change Kotter writes, the best-selling book in the last decade about change in organizations. *Leading Change* was based on extensive research, which identified and defined a standard eight steps associated with change initiatives with a high success rate. In eight steps, a methodology capable of dealing with big changes is defined: to create new and improved relations, to encourage greater growth, to eliminate weaknesses, to improve the quality of products and services or to restructure the human resources and processes. Kotter (1996) considers that disclosure of evaluation results is a key point in developing the strategy for change, as it allows to:

- Create some visible, unambiguous successes quickly, which will serve as incentive for the implementation of the strategy;

- Remove barriers, so that those who want to make the vision a reality can do so;

- Carry on on a more intense and faster way after the first successes. Successive changes enable the new production to become a reality;

- The promotion of new forms of conduct and the certainty that the successful cases are published and become strong enough to replace the traditional ones.

The publication of results is, according Moussiades and Iliopolou (2006, p. 182), a crucial factor in the success of the evaluation. In his words: "A possible reason for an evaluation method to be unsuccessful is that the results of the evaluation research are presented in a way that is not comprehensible. Thus the interested parties don't bother to look at them and to take any action to repair the malfunctioning components of a learning environment":

Moussiades and Iliopolou (2006) summarize some of the most common ways for presentation of results:

- Data sets;

- Executive summary of the activity to be taken;

- Narrative accounts of the evaluation;

- Presentations, embedding oral descriptions;

- Poster of findings;

- Research reports;

- Spreadsheets.

We have already mentioned the potential of tools such as OLES, which facilitate the collection of relevant information and the producing of charts just in time. Thus, the results are immediately available for discussion and action.

We have also highlighted the potential of the radar chart in the presentation of results. The American Society for Quality defines radar chart as follows: "A graph with multiple scales to report self-assessed knowledge or competence, often several points in time. A Radar Chart is used to identify current level of self-assessed knowledge or competence, and then monitor change or growth across several factors" (American Society for Quality, 2006, p. 375). Radar charts due to their versatility in representing knowledge, are often used in the analysis of organizational development and quality measurement (Kaczynski, et al., 2008).

Thus, in an academic environment still in transition of processes in which there is an increasing use of technology, combined
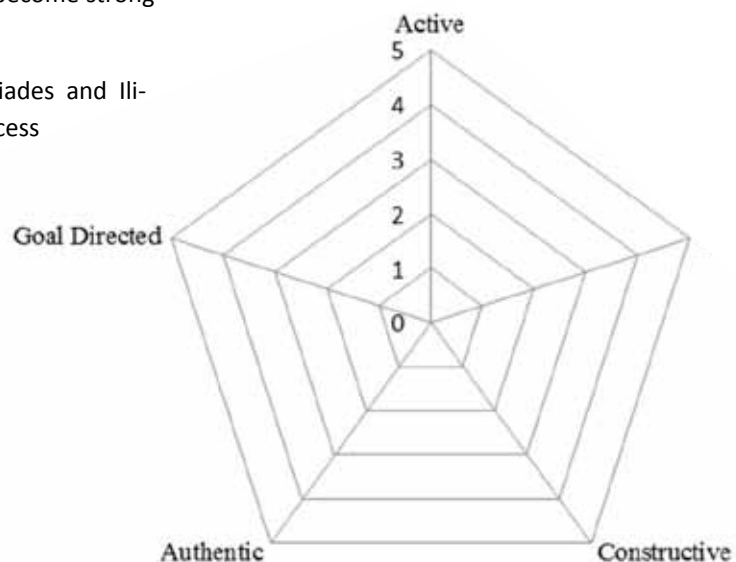
Figure 3: Radar Charts - Relationship between the characteristics of the learning environment and the Levels of Technology Integration

with a survey of pedagogical changes, the radar charts are appropriate and adaptable. In Figure 3, is shown the versatility of the radar charts: here are represented the characteristics of the learning environment (Active, Collaborative, Constructive, and Goal Directed Authentic) as well as the levels of technology integration in the curriculum for each of the characteristics (Entry, Adoption, Constructive, Infusion and Transformation), available under the Technology Integration Matrix (TIM) developed by the Florida Center for Instructional Technology (2009).

Conclusions

The TELE has a major strategic importance in the competitiveness of Institutions of Higher Education and is a central support to pedagogic reengineering. However, the implementation of TELE does not necessarily mean a gain or a break with the educational models of the past, and therefore it is important to develop evaluation models that are the guarantor of quality systems and promote the improvement of practices.

Several institutions and researchers have proposed assessment models that focus on the problem of TELE assessment. These contributions are important assets in quality control. However, the quality parameterization mechanisms vary according to context. It is therefore important that HEIs are able to implement these contributions, choose the best tools to collect data and present the data effectively. Starting with a revision of the existing literature, in this study we seek to address these issues.
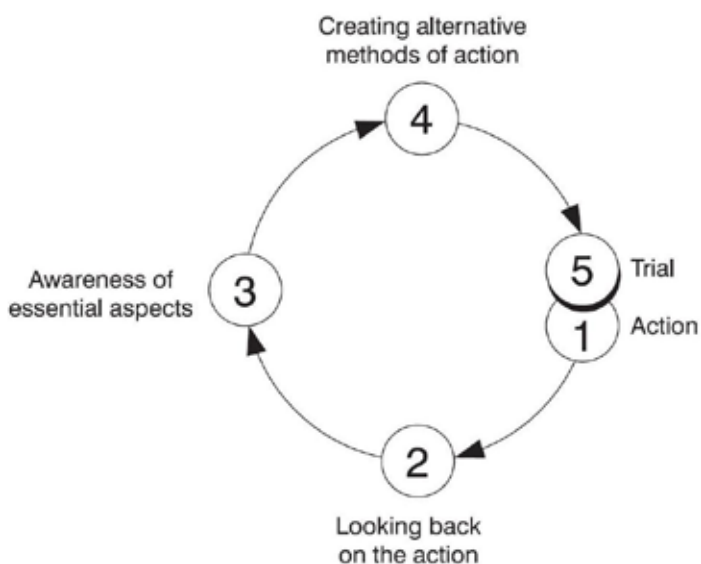
We believe that continuous assessment, as a management tool, should examine in depth all the components of the TELE, from a multidirectional perspective to 3600, in which each player gives an opinion about the various components of the TELE, evaluates and is evaluated by other actors. We recognize it as virtues of a model of cross-sectional evaluation and participated by all: the availability of current information, contextualized and meaningful for all participants.

The model ALACT (Korthagen & Vasalos, 2005) is a concept of the reflection process, in which a restructuring dialectic of experience and knowledge is visible. The restructuring of the experiences and knowledge is a cyclical process that results from a process and multifaceted evaluation of the reality and, in this sense, it synthesizes the main conclusions of this study (Fig. 4)

After the action (1), steps 2, 3 and 4 illustrate how the continuous assessment can work as a tool for management and improvement of practices:

- Step 2: Looking back of the action (What is happening?)

- Step 3: Awareness of essential aspects (What are the positive and negative aspects of the TELE?)

- Step 4: What will I determine for the next time? (What are the alternatives for improvement? What advantages / disadvantages have they got?)

The evaluation will be a management tool, an effective promoter in improving practices, if it is based on notions of progress, change, adaptation and rationalization.

Figure 4: The ALACT model (Korthagen & Vasalos, 2005)

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