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Abstract

Quality assurance in higher education is by no means only a European concern. All over the world there is an increasing interest in quality and standards, reflecting both the rapid growth of higher education and its cost to the public and the private purse. The EHEA with its 40 states is characterised by its diversity of political systems, higher education systems, socio-cultural and educational traditions, languages, aspirations and expectations. In the light of this diversity and variety, technical universities set their faces to develop their internal quality assurance systems according not only to the European standards and the guidelines, but also focusing more on what should be done rather than how it should be achieved as well as to different factors and sources.

Some of the schools of the Technical University of Madrid, along with other European universities, are in the initial stage of their Quality Assurance System implementation, awaiting the positive verification of the Spanish Quality Agency.

This paper presents the results of a study with the purpose of reuse the experience of implementing the quality processes models to the schools of this university without a Quality Assurance System. As processes models contribute to the enhancement of overall quality for higher education and enable successive progress towards the higher levels we have proposed a generic Maturity Model that is tuned to the most important key processes. Through several techniques, such as focus groups and surveys, success critical factors that are common to all the university are identified. Lessons learned allow the less mature schools to take an easier way to design new and more efficient processes.

1. Quality in the context of European Higher Education

The issue of quality assurance has risen very high on the Bologna agenda and is seen now as one of the key instruments to promote the attractiveness of European higher education. It was made clear that when defining common criteria and methodologies in European Higher Education it is necessary to take into account the diversity of the various systems and traditions that will go into the construction of a comparable framework.

As discussed at the Graz Convention (May 2003) [1], among the policy goals for an appropriate European QA dimension are:

- Achieve greater compatibility while managing diversity of QA procedures. There is a great diversity of national procedures in Europe that need to be accepted as this diversity reflects specific national circumstances that each national QA framework tries to address. Upholding a widely shared set of principles in the QA area would ensure compatibility while minimizing intrusiveness in national frameworks.

- Achieve trust: It is evident from discussions with various key actors, that some believe that trust across Europe can be achieved only if all QA agencies follow similar procedures and guidelines. In other words, trust is based on professionalism, grounded in a set of standards.

- Preserve and extend institutional autonomy while meeting the demands for accountability: It is essential that the development of a European QA dimension accompanies and extends institutional autonomy in order to ensure that QA is not merely window-dressing and a compliance exercise. The Berlin Communiqué acknowledges the central role that institutions must play in this respect.

Quality assurance systems need to be flexible and embrace this diversity in order to ensure that higher education serves society effectively.

In a further step forward, the establishment of networks of assessing entities was sponsored by the European Commission in exercise of its competence in respect to promoting the European dimension and incorporating added value to Member States' initiatives. The supreme such entity is the ENQA (ENQA's General Assembly confirmed on 4 November 2004 the change of the former European Network into the European Association) which was recognized by the conference of ministers at Berlin in September 2003 as the preferred interlocutor in matters of quality assurance in the European Convergence process.

The ENQA has played a crucial role in the implantation of institutional assessment as part of the activity of Higher Edcuation Institution (HEI), and as part of the national strategies of European States. ENQA through its members, to develop an agreed set of standards, procedures and guidelines on quality assurance and to explore ways of ensuring an adequate peer review system for quality assurance and/or accreditation agencies or bodies [2]. The standards and guidelines were designed to be applicable to all HEI and quality assurance agencies in Europe, irrespective of their structure, function and size, or the national system in which they are located.

In Spain, the Agency ANECA (Agencia Nacional de Evaluación de Calidad y Acreditación: Nacional Agency for Quality Evaluation and Accreditation), member of ENQA, has adapted the ENQA guidelines to the Spanish context and has published a document[3] with a set of guidelines for the systems of internal quality guarantee within HEI.

2. Maturity as an approach towards Excellence.

Many European universities face the designing of these kinds of systems from a perspective of continuous improvement towards excellence, i.e. to reach a high degree of maturity. This paper presents an approach based on "Maturity models" used to achieve the goal of reusing the experiences of the pioneer Engineering Schools of the same technical university to improve the processes they share and take that knowledge and apply it to other Schools. Maturity can be understood as the culmination point of a growth and development process that is obtained through the integration of distinct qualities. From the viewpoint of an organization, a maturity model offers a conceptual approach to improve the management process in an orderly, referenced, evaluated and controlled way.

Defining process maturity refers to expounding the development level they are in. A maturity model allows one to determine a series of rules to evaluate the maturity level for each process and establish improvement points. Maturity models provide organizations with useful tools for auto evaluation and pondering upon the past, present and future goals.[4] Organizations increasingly recognize the importance of quality management processes for business success.

2.a Maturity Models for Organizations.

Philip Crosby is considered a pioneer in the concept of maturity in the quality field. In his book "*Quality is Free*"[5] Crosby describes a Maturity Grid that consists of five stages and six management measurements or attributes that are the experience relationships that should be analyzed in order to complete the matrix. Table 1 provides a summary description for the five Stages for Crosby's Maturity Grid.

Table 1: Crosby's Quality Management Maturity Stages

Stage	**Description**
Stage 1: Uncertainty	This stage is confused, uncommitted, and with no knowledge of quality as a positive tool.
Stage 2: Awakening	Management recognizes quality as a useful management tool but is not willing to invest in time and money.
Stage 3: Enlightenment	This stage begins with commitment taking place. The organization has decided to carryout a quality improvement program. A quality department is established as a functioning unit and is capable of handling conflicts. At this stage the cost of quality is evaluated.
Stage 4: Wisdom	This stage is characterized by the organization's capability of making a permanent change.
Stage 5: Certainty	The last stage where quality is considered to be a vital part of management. A prevention system exists and the quality team is evolving.

Based on this model, the Capability Maturity Model (CMM) is developed in 1984[6]. CMM is the first maturity model developed to evaluate the processes of an organization. It was created as a requirement of the Department of Defence of the United States to define the processes necessary for software development. CMM evaluates the maturity level of the processes of an organization on a one to five scale. It's based on knowledge obtained from the evaluation of software processes and feedback from industrial organizations.

In 2000, COBIT emerges as a framework for managing IT processes with a strong focus on control[7]. During this time, the model was designed based on CMM, but with the addition of an extra level (level zero) where the focus on processes is not applied.

Compared to CMMI, COBIT is an approach to strategic level, focused on IT management processes. Later on, a range of generic maturity attributes was developed, a total of six based on experience and feedback.

Both cases the maturity models are developed starting with the qualitative generic model to which, are increasingly added, principles as attributes.

2.b. Maturity Models for Education.

These processes have started to be implemented in the software industry in order to improve development processes. Due to the success of these maturity models, other organizations decided to adapt them to their field of work. In this way we found maturity models applied to education.

The challenges faced by educational institutions are the same challenges that other organizations around the world deal with. The need to provide quality service prevails, as professionals are becoming more demanding, and the proposal of a maturity model helps us describe the characteristics of the development of educational processes. It highlights the need to establish a model for obtaining a correct diagnosis of the situation of the centre and defining a set of best practices that serve as a guide for improvement.

Maturity models in education are usually adaptations of large frameworks and existing methodologies for the management process. The different proposals for maturity models in education focus on different aspects such as courses, e-learning, and workshops. Examples of experience in the mentioned areas are:

- Face-to-face Education: The Educational Capability Maturity Model (E-CMM) is proposed by the National University of Computer and Emerging Sciences focused on higher education[8]. Their work is based on the study of the CMM Capability Model and the People Capability Model (P-CMM) who identified the key activities necessary to improve overall institutional performance. Like CMM, the model consists of five levels recognizing the importance of learning about past mistakes, the organization and its effective use of resources, and the development of quality processes as the reasoning behind a Maturity Model. Another approach, the ERP Maturity Model for Education, compares the ERP Maturity Model[9] with the educational system by identifying five levels, where the progress from one level to another is given according to the evolution of the educational system's curriculum. In this maturity model there are three points that define each category: The number of different disciplines or functions represented in a ERP (Enterprise Resource Education) curriculum; for example, accounting, sales and production management; the integration of processes between different disciplines or within one and the same level of the current curriculum development in the educational organization. Based on the Business Process Maturity Model[10] (Fisher, 2004), suggests a checklist to assign a maturity level or approach.

- E-learning: E-Learning Maturity Model (EMM)[11]is a maturity model for e-Learning processes also based on CMM ideas and the ISO framework for SPICE (Software Process Improvement and Capability Determination) process evaluation. Making a connection with this model, the developed model identifies five areas or main categories that encompass a set of processes. Practices needed for each category were identified based on research in literature, grouped and adapted according to each category. For evaluation, the model was implemented at the University of New Zealand, assessing their e-learning programs.

- Courses: The Computing Education Maturity Model (CEMM)[12] evaluates the maturity of educational organizations in the same way CMM evaluates software oriented organizations. This model also has a five level hierarchy and translates the concepts and ideas to the domain of education, focused on academic courses. Similar to the Sneed quadrant, it proposes a quadrant for education where the positive poles include coverage of the course's main topics and an in-depth understanding of the students on the imparted course. The negative pole includes the time required to develop the teaching material and the course fees for both teachers and students. To increase coverage or better understanding of the teaching material, more time and cost is required. In this way, to improve a department's maturity, experience should be used

to maintain a good balance. It has also been applied to the design and implementation of online courses. The Online Course Design Maturity Model (OCDMM)[13] is online courses maturity model consisting of five maturity levels which reflect how technology is used, and five key process areas identified by the study of best practices in designing an online course.

These models are although in some way related, however, their orientation is towards their particular objectives which have been defined and contain a different interpretation of the distinct maturity levels. Table 2 presents a summary of the different orientations the maturity model has for the experiences presented.

Table 2: A comparison between some Maturity Models for Education

Stages	**Description Per Maturity Model**
Level 0	**EMM:** Not performed**:** Not done at all.
Level 1	**E-CMM:** *Initial:* Ad-hoc Processes **EMM:** *Initial:* Ad-hoc Processes **ERP Maturity Model on Education:** *Initial:* Enterprise systems curriculum not well defined **CEMM:** *Initial:* Educational processes are informal and poorly controlled
Level 2	**E-CMM:** *Independent:* Basic education level processes are established. **EMM:** *Planned:* Clear and measurable objectives for e-learning projects **ERP Maturity Model on Education:** *Repeatable:* One or more courses are defined with ERP concepts **CEMM:** *Repeatable***:** Planning and implementation of courses are bases on previous experience
Level 3	**E-CMM:** *Coordinated***:** Processes at institution level are established, documented and coordinated. **EMM:** *Defined***:** Defined process for development and support of e-Learning **ERP Maturity Model on Education:** *Defined:* Several courses, concepts defined. Curriculum maintained **CEMM:** *Defined:* Course concepts and materials have been improved in several iterations, so they have reached certain stability
Level 4	**E-CMM:** *Measured:* Detailed measures of educational programs are established and used organization wide. **EMM:** *Managed***:** Ensuring the quality of both the e-learning resources and student learning outcomes **ERP Maturity Model on Education:** *Managed:* Curriculum integrates concepts, modules. Implemented in more than 1 business discipline **CEMM:** *Managed:* Educational organization has established a measurement program
Level 5	**E-CMM:** *Learning***:** Organization becomes a learning organization and continuous process improvement is adopted **EMM:** *Optimizing:* Continual improvement in all aspects of the e-Learning

	process **ERP Maturity Model on Education:** *Optimising***:** Curriculum is well managed and optimized **CEMM:** *Optimising:* Changes to the process are carefully managed and reflect best practices

In conclusion, there are valid experiences in the education field; however, the application of a maturity model to a specific educational environment requires the need to define appropriate levels adapted to the scope, context and particular institution.

3. Critical Success Factors Identification within Management of an Engineering School.

"Maturity models" has been used to reuse the experiences of various centers of Engineering Schools to improve the processes they share.

In this context a method for the reuse of the experiences of various Engineering School centers to improve processes, applicable to a technical university model which has a series of centralized basic services as well as an independent management at each center. In other words, all centers share processes that ensure the quality of programs offered but the optimization path is autonomous and does not coincide in time. Therefore, the lessons learned by each center that have dealt with the implementation of quality processes can be transmitted to the rest of the centers.

The proposed methodology consists of the following steps:

- Definition of a generic maturity model which includes the interpretation of each maturity level to be taken into account, the generic attributes of each level and the indicators associated with each level or attribute.
- Adaptation of the generic model to a specific process.
- Identification of Critical Success Factors.

Step 1: Establish a Generic maturity model for the institution.

The Maturity Model was developed based on an analysis of the various maturity models and there main contributions. The starting point was Philip Crosby and the Quality Grid, following with COBIT's Generic Maturity Model and attributes table and finally the Capability Maturity Model CMMI.

With the quality guidelines affecting the institution of higher education on which the method has been applied, and the experience of those responsible in the design and implementation of quality assurance processes, a generic maturity model has been developed (Table 3). This model allows us to determine what maturity degree for the processes contained in the Quality Assurance Systems.

Table 3: Generic Maturity Model

Level	Description
Level 1: Uncertainty	Complete lack of any recognizable process. The centre does not understand quality as a positive tool for management. At this point, there is not systematic process of quality management; instead there

	are ad hoc approaches that tend to be applied individually, occasionally, by chance. There is not a general approach for the management of quality processes. Success depends on the competence of individuals in the organization and not on the use of pre-designed processes.
Level 2: Awakening	There is some evidence that the center has recognized the importance of implement a system to ensure the quality of internal processes, with criteria and guidelines. At this level has become aware of its importance and started a formalized commitment to the design of a internal quality assurance system. At this maturity level, processes are developed following an institutional quality policy. The design process is a reflection of the management model of the center. Needs are identified, a plan for system design is planned and the center is equipped with the necessary resources in accordance with the guidelines of the Technical University of Madrid. Typically the design will not cover all the specific needs of the center but a minimum set of processes that ensure compliance with corporate guidelines.
Level 3: Start up	At this level of maturity, the processes are implemented according to the predetermined design. A quality and a deployment plan is obtained according to the prioritization and taking into account the working groups involved in each. The implementation takes into account the establishment of a control and monitoring system for each process, and for the entire system, through an external audit to the centre, which can lead to certification of the Quality Assurnace System.
Level 4: Processes management	Groups to improve quality are established, and implemented processes are refine in order to be identify as a good practice, thus providing a mechanism for continuous improvement based on quality objectives in a realistic, measurable and time-bound way. The organizational structure is adequate to processes map and design.
Level 5: Optimizing	Problems are anticipated. Actions to improve quality are aimed to the prevention and continuous improvement of efficiency. Environment and the demands of customers are observed to anticipate their future needs. The organization has a lean and efficient operation.

As the description for each level is obtained, the construction of the generic model is completed by selecting a series of attributes, or measurement categories, in which it is possible to describe the principles for each level. These attributes are described in terms of quality indicators that provide the measures to determine the level of each process.

Step 2. Identifying Critical Success Factors of all the processes considered.

The goal is to recycle a set of critical success factors that characterize the transition from one maturity level to the next and allows visualization of the path a School should follow to reach the maximum maturity level.

We assume that the experience of how to successfully implement the process is found in those willing to collaborate. With this in mind, the objective is to collect the critical success factors extracted from the experiences learned. The most appropriate techniques in order to accomplish this are the questionnaire or focus group, a small group selected from a wider population and sampled, as by open discussion, for its members' opinions about a particular subject or area. The critical success knowledge can then be identified using these tools.

4. Method application for a process at the Technical University of Madrid.

The application of the method requires firstly the description of the context of the institution under review, and the selection of the process to be applied.

4.1 Matching requirements of the method: organizative model and process selection.

The implementation of the generic maturity model in one of the main processes of the institution is the next step to validate the developed model. All the Schools of this University share a common minimum process collected in the processes map of the university.
The actual situation of the Technical University of Madrid is the following: four of their centers have been part of the first call for the design of their Quality Assurance Systems, and many other schools are in the process of developing the memories of their new study programs that include a section for the Quality Assurance Systems for their respective titles.

In the other hand, among all these processes, the Educational Innovation (EI) Process has been chosen as pilot. One of the reasons for the selection of this process is its high centralization within the main services of the university. Independent of the implementation of the process, all the schools are addressing how to introduce new active methods necessary to carry out the integration in the EHEA (European Higher Education Area).
The EI process consists of a set of actions that aim to promote innovation, channeling the efforts and resources to reverse in a continuous improvement of teaching and training programs, and to involved teacher's actions been recognized to encourage motivation.

4.2 Method application

Step 1. Adaptation of the generic model for the process
Using the description of the EI process and the generic maturity model a maturity model for this particular process has been developed.

Table 4: EI Process Maturity Model Stages

Level	Description
Level 1: Uncertainty	A recognizable process of EI does not exist nor awareness of its importance in the quality of the curriculum and meeting new demands. Activities are implemented informally and inconsistently.
Level 2: Awakening	Awareness of the importance of EI although practices are mostly informal. A plan of EI is developed and provided with resources. A proposal defining the main priorities in EI, objectives, scope and integration of active methodologies is created. A committee is formed with a definition of functions and essential staff requirements.

Level 3: Start up	The activities for the EI process are developed and implemented. Corrective measures are taken in the required areas. Those responsible for each activity are identified and results are monitored. Third parties relationships are developed, including management and internal auditing committees. Management has recognized the importance of EI and initiates awareness programs. Formal training is available but is not applied rigorously. Although there is a framework for policy development, monitoring is inconsistent.
Level 4: Processes Management	Quality improvement groups are established and innovation activities are refined and identified as good practices. Results are monitored and a control environment of positive and proactive information is established. The process undergoes an internal audit process.
Level 5: Optimizing	The EI atmosphere sides with the strategic administrative framework and the vision of the institution, and is often revised, updated and improved. Both internal and external experts are assigned to ensure best practices are adopted with respect to educational innovation. Satisfaction surveys are a constant procedure and lead to improvement measures.

From this description of the model and from the attributes, a table of indicators definition was developed. It was made by level and for each attribute that best describes the process of EI (table 4).

Table 4: Indicators for Management understanding and attitude for the "Innovative Education Process"

Attribute: Management understanding and attitude				
Level 1: Uncertainty	**Level 2:** Awakening	**Level 3:** Start up	**Level 4:** Processes management	**Level 5:** Optimizado
Indicator 1: Does the management understand the EI as a management tool?	**Indicator 1**: The management recognizes the importance of managing EI? **Indicator 2:** The center has the resources to manage EI?	**Indicator 1**: The management recognizes that quality management is supportive? **Indicator 2:** The management recognizes that quality management is helpful?	**Indicator 1**: The organizational structure is adequate for the process map?	**Indicator 1**: The management understands the management of quality processes? **Indicator 2:** The attitude of management is projected into the future?

Step 2. Identification of CSF for the IE process

To capture the success factors, a discussion group was convened with members from different centers of the Technical University of Madrid who are related with the Educational Innovation process and with representatives of the group that conducts the research. The process was divided into two parts: first the centers, based on the description of the maturity model for EI, determined what level of maturity they were. Then, fill out a pilot questionnaire developed based on experience to identify possible factors of success and failure within the process. Finally, there was a moderated discussion to explore the past and identify what factors had influenced to mature from one level to another, and the obstacles which currently prevent them climb to the next stage.

The ideas raised in the discussion group along with the results of the questionnaire were the basis for getting the success factors for the process of educational innovation. Although an attempt was made to maintain the attributes generic model, in the end changes were necessary in order to present the factors found in the research. The attributes table was analyzed refining some definitions, changing the perspective of the attribute when needed.

Due to the method used to obtain data, it was not possible to determine success factors for scaling the level 4 to level 5, because we do not have centers with this level of experience.

Conclusions

Many technical universities find many problems when they try to implement their Quality Assurance Systems. However, these difficulties are not the last ones. The first designs of these systems are not permanent; therefore they are under a continuous improvement cycle. For this reason efforts should be addressed on how to improve the excellence. This problem can be supported with the use of the "maturity models" to see the big picture in the improvement pathway.

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