Quality and innovation. Web-based code of good teaching practice.

R. Igual, I. Plaza  
EduQTech group – University of Zaragoza  
EUPT – C/Ciudad Escolar s/n, 44003 Teruel (Spain)  
(+34) 978 61 81 02  
{rigual, inmap}@unizar.es

F. Ibañez  
EduQTech group – University of Zaragoza  
EINA - Calle María de Luna, 50018 Zaragoza (Spain)  
(+34) 976 76 18 68  
fcoiba@unizar.es

C. Medrano, F. Arcega  
EduQTech group – University of Zaragoza  
EUPT and EINA (Spain)  
(+34) 978 61 81 02/976 76 18 68  
{ctmedra,arcegafi}@unizar.es

ABSTRACT
Applying the concepts of “quality” and “innovation” in daily teaching is not an easy task. In this paper a Web tool to support the use of a code of good teaching practice based on quality and innovation is presented. The code has been applied during several years in Electrical, Electronic and Computer Engineering, but the platform could be used in other areas of Engineering. It could also been adapted for using in any Higher Education degree.

Categories and Subject Descriptors
J. Computer Applications: J.1 Administrative Data Processing - Application.

General Terms
Documentation, Standardization, Management, Measurement.

Keywords
Quality; Innovation; Higher Education; Good practice; Web-application.

1. INTRODUCTION
Higher education has long been committed to excellence, which can be thought of as high achievement in meeting core objectives. Broadly speaking, these core objectives are to educate a large number of people to a high standard and simultaneously to advance and disseminate knowledge. The pursuit of excellence pertains to both undergraduate and graduate teaching and to research, and it has both scale and quality dimensions [1].

Additionally, the concept of excellence is strongly related to quality or innovation concepts. In this sense, through the application of the quality and innovation culture in the teaching activities, it is possible to achieve the excellence in Higher Education.

On the one hand, the most widely accepted definition of quality is the one provided by the International Standardization Association (ISO) which defines quality as the degree to which a set of inherent characteristics fulfills requirements. In this context, the term “degree” refers to a level to which a product or service satisfies. So, depending upon the level of satisfaction, a product may be termed as excellent, good or poor quality product. In turn, “inherent characteristics” refer to those features that are a part of the product and are responsible to achieve satisfaction, while the term “requirements” is associated with the needs of customer, needs of organization and those of other interested parties [2]. This definition not only refers to meeting the customer needs but also takes care of the needs of other stakeholders involved in different stages of realizing the product. In the education field, the satisfaction of students, teachers, university staff, families, companies and society as a whole should be considered.

On the other hand, unlike the quality concept, the term “innovation” is still without a consistent, agreed-to definition in the business world. According to Anttila [3], most commonly innovation is a conceptually new and commercially viable solution in products, processes, business systems, and technologies, or a new solution that is available to markets, governments, and society. In simple words, innovation means improved quality.

Although the innovation concept is usually associated with the entrepreneurial field, it can and should be applied to other disciplines such as education. In this sense, innovation activities should serve as a tool to improve the quality of education.

At this point, a question emerges: How can a teacher apply the quality and innovation culture in the classrooms or laboratories? The answer to this question is neither easy nor obvious, but a first response can be obtained from several standards that have shown good results in the management of organizations (SQuaRE [4], ISO/IEC 19796 [5], UNE-ISO 10002:2004 [6], UNE 66167:2005 [7], UNE 66173 IN:2003 [8], UNE 66175:2003 [9] and UNE 66178:2004 [10]). The major challenge is to apply these standards to the teaching activities.

One possible way to do it is through a code of good teaching practice designed according to quality and innovation concepts.

However, it should be noted that the application of the code in a real-world context involves considerable difficulty: it consists of different levels and stages, its application requires the active involvement of teachers throughout the school year, the number of records to manage can hinder the application of the code, etc. Therefore, there is a clear need for a tool to support the application of this code. In this sense, this paper presents a Web-based platform implementing the proposed code of good teaching practice.

The rest of this paper is organized as follows: Section 2 describes some related work, section 3 briefly introduces the code of good teaching practice based on quality and innovation concepts, section 4 describes the methodology used to develop the Web application, section 5 presents its structural architecture, section 6 introduces the Web-based platform to support the application of the code and section 7 draws some initial conclusions and outlines areas for further research.
2. RELATED WORK
A search for studies applying both quality and innovation concepts in Higher Education has been conducted. As a result, two different trends were identified: studies focused only on applying quality concepts and studies dealing with the use of innovation concepts. However, when a search was made considering both quality and innovation simultaneously, the number of references reduced dramatically.

On the one hand, the application of quality concepts in Higher Education has traditionally been a hot topic. However, an inflection point was observed when the European Higher Education Area (EHEA) was launched. The Bologna Process [11] [12] stated that the quality culture should be part of the education activities and its application could not be subjected to the discretion of each teacher. In this regard, several studies identifying the factors that determine the quality of the Higher Education appeared [13] or examining the role played by quality assurance in university education [14]. Other studies go further and propose a model to manage or evaluate quality in Higher Education. For example, Chen et al. [15] use the Plan-Do-Check-Act cycle of total quality management to establish a higher education quality management system. Other authors stressed the complexity of incorporating the quality culture in Higher Education. For example, Newton [16] states that quality enhancement is a messy business and that achieving success with improvement initiatives presents challenges. Similarly, Pratasavitskaya et al. [17] conclude that although researches in the field of quality management share a number of similarities, the contributions can be characterized as conceptually heterogeneous and multidisciplinary.

On the other hand, although to a lesser extent, the innovation concept has been a recurring topic in Higher Education. Several authors pressed the need for fresh innovations in higher education in order to revitalize colleges and universities [18]. Other papers state that knowing how best to improve intellectual capital is considered the most significant factor of success in enhancing innovation [19] and that the education reforms should take the cultivation of innovation talent as center [20], [21]. Some related works highlight the importance of this concept in Higher Education in order to strengthen the relationship between industry and education as well as stimulate business creation [22], [23]. However, only a few studies have addressed the incorporation of an innovation culture in all facets of Higher Education [Clayton 24], [25]. They include some suggestions and present some measures to promote innovation of higher education. However, incorporating an innovation culture in Higher Education is a challenging task that has still not been addressed in its entirety. Therefore, further research is still needed.

Although there are strong relations between quality and innovation concepts only a few recent studies consider the option of applying them simultaneously to the Higher Education field [26]. In this sense, the study of Militaru et al. [27] focuses on quality and innovation as factors of sustainable development in higher education. They conclude that promoting creativity and innovation might improve quality of higher education. As a result, they propose a conceptual model of the sustainable development of higher education based on the link between ethics, quality, creativity and innovation. Additionally, Van Kemenade et al. [28] state that the emerging paradigm at this very moment is a higher education that is less dependent on government support but more responsible for the quality and feasibility of its products and services by developing a new organizational culture, by promoting the innovation spirit. Apart from these few studies, we could not identify any other relevant research focused on the application of quality and innovation concepts in Higher Education. Additionally, common to all these studies is the lack of digital tools to manage the application of the concepts, since they are mostly focused on the theoretical design rather than on a real-world implementation. In this sense, considering that this is a challenging process, there is a clear need for a computer-based technological system that facilitates the application of the quality and innovation culture in the Higher Education.

3. CODE OF GOOD TEACHING PRACTICE
The goal of a code of good teaching practice is to set the aspects that university teachers have to take into consideration during their daily activities in order to meet the needs of all agents involved in the education process. Therefore, it should cover all aspects of the education process: planning, teaching, evaluation, etc. Additionally, as we aim to incorporate quality and innovation concepts in higher education, the code should include recommendations and guidelines to help teachers to apply the quality and innovation culture in their daily activities.

In this context, the standard UNE 66931 recommends an approach based on processes. According to this standard, it is essential to identify the processes, their relations and the way of managing them. For this code of good teaching practice, the traditional classification proposed by [29] was selected. It categorizes the processes into three groups:

- Operative processes
- Strategic processes
- Support processes
Then, we have identified several sub-processes in each of these three categories. The 4 sub-processes within the operative group are the following:
- Specific planning
- Teaching
- Final assessment
- End of the scholar year

Strategic processes:
- Management
- Advance planning
- Continuous improvement

Support processes:
- Resources
- Documentation
- Problem solving
- Quality

All these processes should not be seen as isolated entities but as elements with strong relations among them. In fact, the processes and their relations are represented in a process map, which is a graphical representation of the processes comprising the code.

Additionally, to apply the code in a real-world scenario, it is necessary to follow a certain methodology and work continuously. These tasks are accomplished in a systematic way by the use of records. In this sense, each process has several associated records. The use of records is essential in order to document and standardize the application of the code. The records have been defined in the form of digital templates to be filled in by teachers using the specific data of the case to which the code is being applied.

Therefore, these four elements (process map, sheets of process, flowcharts and records) comprise the code of good teaching practice. Figure 1 represents a general scheme of the different elements of the code. Each process is related to other processes and is associated with a flowchart, a sheet of process and several records. These concepts have been applied for several years in Electronic, Electric and Computer engineering. As a conclusion: it requires a considerable amount of work from teachers. In this sense, next section presents a Web platform that facilitates the use of the code in Higher Education courses.

4. METHODOLOGY
In order to facilitate the use of the code of good teaching practice, a Web application based on this code has been developed. This application includes all the levels of the code: from the representation of the process map to the level comprising the records. This platform will allow teachers to continuously improve the quality of their work. It has three main goals:
- To facilitate that any teacher in the world has access to the code.
- To ease the understanding of the code structure.
- To provide a tool to support the application of the code of good teaching practice in a real-world environment. It includes a private area in which teachers can upload the records that they complete when applying the code. The
idea is that those records can be listed, chronologically ordered, downloaded or even modified. In other words, the web application facilitates the management of the documentation, supporting the real application of the code.

Six basic principles have been applied in the design of the platform. They are related to both the system’s structural architecture and its operation:

- **Universality**: This platform is aimed at teachers of all areas. Although it has been initially designed for Electrical Engineering courses, it targets any kind of discipline such as social sciences, humanities, health studies or any other branch of the Higher Education. This is consistent with the philosophy behind the quality and innovation concepts, which are applicable to all type of products, processes or services.

  - **Ease of use**: Due to the different profiles of its potential users, the platform has been designed considering usability recommendations [30]: all pages follow the same pattern, each process includes a graphical representation (flowchart) and a text description (sheet of process), the color distribution facilitates the operation, etc.

- **Normalization**: The platform has been designed according to standardized quality and innovation models [31].

- **Accessibility**: As a Web-based system, the platform can be accessed from any place with Internet connection.

- **Privacy**: The Web-based tool is composed of a public area, which can be accessed by any interested person, and a private area, in which teachers can upload their personal records. Each teacher only has access to his or her own records.

- **Personalization**: The platform allows uploading records in different formats. Although some reference templates are available in order to facilitate the application of the code of good teaching practice, teachers can upload personalized documents. In this way, the system adapts to the specific needs of each teacher.

5. PLATFORM STRUCTURAL ARCHITECTURE

The Web platform has been implemented using the Model-View-Controller approach. The basis for the MVC architecture is to have a clean separation of responsibilities and reducing coupling between application layers [32]. Model-View-Controller (MVC) programming is the application of this three-way factoring, whereby objects of different classes take over the operations related to the application domain (the model), the display of the application's state (the view), and the user interaction with the model and the view (the controller) [33]. The MVC architecture has been implemented through the Struts framework. The Struts web framework is a free open-source solution for creating Java web applications [34]. This framework covers the three layers of the system, requiring each one of them of other resources for its programming. They are described in the next subsections.

5.1 The model layer

The Model layer controls access to data and persistence [35], provides the business functionality for an application as well as an interface to interact with the controller. The following resources have been used to implement this layer:

- **Java**: It is a high-level object-oriented programming language that has achieved a high level of penetration [36].

- **MySQL**: It is a popular open-source database management system for relational databases [37].

- **Hibernate framework**: Hibernate is a framework to manage persistent data. It mediates the application’s interaction with a relational database, integrating smoothly with most new and existing applications and thus, avoiding disruptive changes to the rest of the application [38].

5.2 The view layer

Views deal with everything graphical; they request data from their model, and display the data [33]. The view pages can be static (they always look similar) or dynamic (the content varies depending on the specific context). To generate them, the following resources have been considered:

- **Java Server Pages (JSP)**: This technology allows creating dynamic and interactive Web sites. JSP pages combine Java code with HTML code. This Java code is compiled and run in the server side, generating an equivalent HTML code that is sent to the client that made the request. In this way, high levels of personalization and interaction can be achieved.

- **HTML**: This language is needed to explain the structure of any web page [39].

- **CSS**: This language is a standard for defining the presentation of documents written in HTML. It provides with global control over the user interface of the Web sites. In fact, this technology has become the de facto means by which a site’s design is built [40].

- **JavaScript**: Javascript is primarily a client-side scripting language for use in Web browsers [41].

- **jQuery**: jQuery is a framework that is built on top of JavaScript, not a language in its own right [42]. It has several strong points: it diminishes many cross browser concerns, it is good at handling fairly complex JavaScript code with relatively little code and new official and third-party plugins come out every day, extending its core functionality [43].

5.3 The controller layer

All the requests performed by the client are directed to the controller. Its operation consists of determining the actions that should be undertaken for each request and selecting the components of the application (Model or View) involved [44]. Over-simplifying a bit, the controller handles the input whilst the view handles the output [45]. The Struts framework allows programming the operation of the controller using XML tags.
6. OPERATION OF WEB-BASED CODE OF GOOD TEACHING PRACTICE

This section introduces the Web-based code of good teaching practice. Firstly, when a particular teacher accesses this platform, a page showing the basic process map is displayed. This interactive screen is shown in figure 2.

It represents all the different processes comprising the code of good teaching practice. The processes are distributed into the three basic categories identified in section 3. At this point, teachers can click on each one of these processes and, as a result, a new page describing the corresponding process is displayed. Its heading comprises a small paragraph with a brief description of the process as well as an option to download the sheet of the process (just in case teachers want a more detailed description of it). The main part of the page is filled with the process’s flowchart, in order to easily visualize its content and structure. As an example, figure 3 shows the page corresponding to the continuous improvement process.

Until now the informative part of the Web code has been described, from now on the focus will be on the functional part of the platform.

The idea is that teachers can use this tool to support the application of the code of good teaching practice during their daily activities. For that, the private part of the application allows managing the documentation that should be generated as a result of applying the code. The flowchart of each process includes a Record column where all the document templates associated with the process can be downloaded. They can be accessed by clicking over the corresponding record on that column (green squares). At this point, a log on screen is displayed.

Once authenticated, each teacher accesses his or her personal session (figure 4). In this private part of the application, teachers can perform two basic actions:

- To download the corresponding record template by clicking on the “download record” option. Once downloaded, the template can be filled with the specific data of the course.
- To upload a filled record to his or her personal session by clicking on the “upload new record” option.
In case a new record is uploaded, it automatically appears in the list of “registered records” of figure 4. Two fields providing information about the document are displayed: the name of the record and the date and time at which it was uploaded.

Additionally, teachers can modify any registered document by clicking on the “modify” button or removing it from the site by selecting the “delete” option. It is also possible to list all uploaded records. For that, there is an option in the home page. Teachers can categorize the records according to different criteria: The process to which they belong, the type of document, the date when the records were introduced, etc.

Figure 3. Process description in the web application.

Figure 4. Private site where teacher can download record templates and upload their personal documents.
Teachers can also log out of the application at any moment. Once done, the private part is no longer accessible, although the description of the code of good teaching practice is still available.

7. CONCLUSIONS AND FUTURE WORK
Applying quality and innovation in daily teaching is not an easy task. In this sense, we have presented a Web tool to support the application of a code of good teaching practice based on quality and innovation concepts. The idea is that this platform can be used during the real-world teaching activities of university professors. This tool aims at systematizing and easing the application of quality and innovation concepts in university teaching.

The most relevant part of the Web application is the private site to upload or download the different records generated. In this sense, the records do not follow a standardized structure. However, in the near future, we have planned to give the option of converting them in reusable learning objects (RLOs). A RLO can be defined as a digital resource that can be reused to support learning. The generation of RLOs follows a double objective: to promote the access to digital learning resources and to optimize the existing resources by reusing them. The idea is that teachers all over the world share their learning resources by converting them to a standardized format that allows exchangeability [46].

8. ACKNOWLEDGMENTS
The authors wish to thank the “Chair in Innovation and Technological Quality” for their help. Thanks to the “Gobierno de Aragón” and to the “Fondo Social Europeo” for their support to the EduQTech group.

9. REFERENCES


