Teaching Experiments and Student Feedback

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1   INTRODUCTION

Universities are organizations aimed at pursuing two institutional and social macro-objectives: the research, intended as systematic creation of new knowledge, and the higher education of the new worker generations. In Italy such objectives are mandated by laws, and represent two needs of the society.

In this article we will focus our attention on the education. Higher education is a pre-condition for the cultural and economic growth in every country. Accordingly, every country has a crucial role in fixing rules concerning both the contents of education and the modalities for its supply.

That is certainly true for the mandatory school, but also in different measures and modalities for the higher education. In universities the objective of education is mostly pursued through the design and realization of degree programs, any of which is made of a coherent set of courses necessary to form a professional profile corresponding to prefixed parameters. Every university responds to a reference community, represented by:
- the State, guarantee of the cultural development and research, as shared principles (art. 9 Italian Constitution);
- the labour market, demanding professional figures;
- students, direct users of the offered educational service;
- parents, who invest in favour of their sons.

This work considers a generic course included in a degree program. In accordance with Fram & Camp (1995), a university course constitutes in fact a basic

service offered by an academic institution. In the supply/fruition of such service, two subjects have a fundamental role: the course holder and the population of students who have that course in their study plan.

A university course can be intended as a system of lessons, practices and exams developing through the contextual realization of the complementary processes of teaching and learning. Thus, in this work the concept of "university course" is analysed from two perspectives: the teacher and the student perspective.

From the teacher perspective a course can be naturally associated to the idea of a process. In fact, a teacher, in managing his/her own course, always considers the three phases of design, supply, and assessment. He/she, more or less implicitly, has more roles respect to the course (Kanji & Tambi, 1999). From the student perspective, every course is a service supplied by the university where he/she is enrolled (Harvey, 2003); in this sense, the student is a user of the service-course, and he/she is a direct customer of the university (Owlia & Aspinwall, 1996a. Canic & McCarthy, 2000. Wallace, 1999. Polese & Moletta, 2006).

The course is a service, not a product, because it presents all the typical characteristics of a service: intangibility, heterogeneity, and inseparability (Clewes, 2003).

For the course holder, design, realization, assessment, and improvement of the course represent the main phases of the process that he/she should manage, following the logic of the well-known PDSA (Plan Do Study Act) cycle. The activation and the maintenance of such cycle favour the achievement of ever more ambitious goals in favour of direct and indirect customers of the course (Kanji, 1996). Within the PDSA cycle, the phase of assessment by the teacher, consists of judging the degree of achievement of prefixed objectives, by identifying strengths and improvement areas. In this activity the teacher must involve the direct service beneficiaries, listening to their "voice" (Sirvanci, 1996).

Once admitted that the university course has several stakeholders, in this work we recommend to a teacher the adoption of a methodology for designing some aspects of the course. Such methodology is aimed at maximizing the satisfaction of students, as direct beneficiaries, and their results at examination time. The last assertion is based on the assumption that students, can perceive an added value (positive or negative) of lessons and practices respect to studying only by books and/or handouts. So, when satisfied of the course, they constantly and with commitment attend the lessons, and dedicate with growing interest to the study of the course contents.

 It is necessary to remark that all characteristics of the course (for example: the topics to include in the degree syllabus and their relative deepness, the amount of hours dedicated to lessons and practices, and their ratio), responding to interests of other subjects before than students (teachers of other courses of the same degree program; society; public administration; companies; etc.), cannot be object of the proposed methodology.

Such methodology, useful to the design and the continuous improvement of a course (Zaciewski, 1994) is characterized by the integration of the design of experiments (Box *et al.*, , 1978. Wu & Hamada, 2000) with a tool for the student feedback, based on the SERVQUAL model (Parasuraman *et al.*, 1988).

The article is so structured: in Section 2 the concepts related to the quality of teaching are presented; in Section 3 the basic concepts of two methods – design of experiments and SERVQUAL – useful in a design phase, are given; Section 4 is dedicated to the description of our proposed methodology; Section 5 provides the conclusions, and outlines possible future developments.

2 QUALITY OF TEACHING

The introduction of TQM principles in University is a relatively recent phenomenon. As from the early 90's we find the first evidences of the success derived by the adoption of the TQM philosophy to this sector (Kanji & Tambi, 1999) in USA and England. In the rest of the world TQM was not applied, except for rare cases (Kanji *et al.*, 1999).

During the 90's most of the initiatives aimed at applying TQM to University concerned administrative departments and financial services (Felder & Brent, 1999. Aly & Akpovi, 2001). However it was early understood that the preservation and the improvement of all university services must require the active participation of both administration and faculty (Goh, 1996).

In particular, according to Zacieswsky (1994) and Tribus (1993), in order to improve student performances, it is necessary to act on the teaching process. Babbar (1995) shows that the adoption by the teacher of a creative approach inspired to TQM can positively influence the student outcome. Techniques as "active learning" and "cooperative learning", together with the repeated evaluation of the results of a course can improve its quality (Felder & Brent, 1999). In Sandvik Wiklund & Wiklund (1999), and Bier & Cornesky (2001), the QFD methodology was applied for the design of a university course syllabus. Sandvik Wiklund & Wiklund (1999) apply the Conjoint Analysis, too.

Despite the support of textbooks, handouts, and the aid of devices that teacher can adopt (board, computer, etc.), the university teaching, considered as a professional service has mostly a character of intangibility. This makes difficult the definition and respect of production specifications, the experimentation of prototypes before the supply, the awareness of customer desiderata and the measurement of customer perceptions (Harvey & Busher, 1996). Teaching heterogeneity is the direct consequence of its unrepeatability; it is mostly due to the relevance of the human factor (supplier and receptor of teaching), and to the difficulty of performance standardization (Owlia & Aspinwall, 1996b). Finally, the inseparability is referred to the phases of production and consumption, which are mostly concomitant, and reciprocally influencing each other. In fact, the inseparability implies the customer participation to the supply process. In the case of teaching, in order the process to be effective, "*...students can not be passive consumers of services, but must be actively engaged in the learning process...*" (Helms & Key, 1994).

For the above reasons, the design of a university course is a complex activity. Also, the presence of hidden variables and uncontrollable variables increases the risk of results not in line with the prefixed objectives. Nevertheless, designing is a necessary activity for guaranteeing the repeatability of the service and the continuous improvement of its quality, as much as possible.

For "quality" of a university course we intend the degree at which it satisfies the expectations of all stakeholders. The system of university education is characterised by the presence of several categories of stakeholders having different interests (Owlia & Aspinwall, 1997).

A university course should respond to requirements fixed by the government (ministerial programs), and requirements of the pertaining degree program (fixed in agreement among faculty members and concerning the relationships between the contents of different courses within the same degree program). Furthermore, a course should respond to the labour market needs (employers) thanks to interesting and non-

obsolete contents. However, the main category of stakeholders is represented by students, since they are the direct beneficiaries of the course.

Consequently, an exhaustive evaluation of the quality of a course, intended as a single process of the system "University institution", should consider a multiplicity of output categories and several customer categories, direct and indirect, actual and potential (Kanji & Tambi, 1999). Nevertheless, in this work we focus attention only on direct customers, i.e. the students. What we suggest is the adoption by a teacher of a methodology for designing certain aspects of the course, aimed at favouring the maximisation of student satisfaction, then their results at the examination time. In fact, students expect useful lessons and practices, providing an added value. Such added value primarily consist of a support to an adequate preparation to the final exam, to allow them getting the hoped mark (Zaciewski, 1994).

More in general, we assume that a student, as an individual who voluntarily enrols to a degree program, with the direct objective to obtain a degree, is moved by a need to increase his knowledge and that such need is kept throughout the whole university career. Therefore, a student who is satisfied of an attended course, is pleased by the lessons and practices and is interested to study the relative contents. The satisfaction constitutes one of the output of the teaching process, at direct benefit of the students. Another important output is the mark at the final exam.

It is necessary to remark that all those characteristics of a course responding to interests of other subjects before than students (faculty members of the same degree program, public administration, etc.), as for example: the course syllabus contents and their relative deepness, the amount of hours dedicated to lessons and practices and their ratio, are not considered in the proposed methodology.

Now, in order to analyse the quality of a course, it is necessary to deepen the meaning of "course" from two perspectives: the teacher and the student perspective. This implies the identification of the main activities that both figures are called to do.

In our opinion, a university course is immediately related to the concept of process and to the concept of result of such process (Grönroos, 2001) depending on which perspective it is analysed from.

From the teacher perspective, the idea of "course" is associated to the concept of process. In fact the teacher "*tends to act out three roles – customer, processor and further supplier*" (Kanji & Tambi, 1999). He is: internal customer of the university, as recipient of directives and constraints fixed at higher levels (relatively to contents, timetables, rooms, etc.); course designer, since he is called to design the specific contents and the modalities for delivering lessons, practices and exams; responsible of the educational process, since he is called to respond of the results of his work (Mergen *et al.*, 2000); course supplier, through the delivering of lessons, practices and exams; assessor of the main output of the course, i.e. the degree of knowledge and maturity acquired by the students (Ensby & Mahmoodi, 1997).

Furthermore, the teacher should manage the relations with the upstream and downstream processes, take care of the re-examination of the course/process, trying to continuously translate the vision and policy of the degree program in an operative plan and such plan in results, in respect to given constraints.

Vice versa, from the student perspective, a course is firstly an output of the university institution, of which he/she is a customer (Harvey, 2003. Owlia & Aspinwall, 1996a. Canic & McCarthy, 2000. Chinn & Hilgers, 2000) in the sense of *user*.

Teachers and students are the main responsible in reaching the goals of the teaching/learning process (Wallace, 1999. Ensby & Mahmoodi, 1997). In fact,

students should actively participate to the learning process, personally contributing to build their own knowledge (Helms & Key, 1994. Mehra & Rhree, 1999. Durlabhji & Fusilier, 1999), in order the course to be effective.

3   TWO METHODS FOR QUALITY DESIGN AND ASSESSMENT

In this section we provide a brief description of the pillars on which our proposed methodology is founded.

3.1   Design of Experiments (DOE)

DOE is a branch of Statistics constituted by methodologies and tools for an effective and efficient experimentation (Box *et al*., 1978. Wu & Hamada, 2000). The term "experimenter" can be intended in the widest possible sense, as whoever uses all existing knowledge to discover, in a systematic and repeatable way, something new and possibly better than the existing.

Designing experiments implies defining a plan, i.e. a program of experiments, moments in which the experimenter can observe and measure one or more responses from one or more experimental units of the system under study. In performing an experiment, the experimenter usually set the values of so called control factors, for which he wishes to evaluate the single or combined effect on the response(s). If it is of interest taking several control factors into consideration, then we refer to factorial experimentation. In this case the experimental plan involves a sequence of experimental treatments, i.e. specific combinations of control factor levels. An experimental plan, effectively and efficiently allows estimating not only the main effects of control factors, i.e. the effects that each factor singularly produces on the response(s), but also the interaction effects between two or more factors, i.e. a measure of the control factors synergies and anti-synergies.

3.2   SERVQUAL

It is well known that Parasuraman *et al.* presented for the first time the SERVQUAL model in 1985 (Parasuraman *et al*., 1985). Since then, the SERVQUAL has been widely discussed and adopted for measuring service quality in several sectors. In the model proposed by those authors, the quality of a service is the result of a comparison, made by the service user, between the expectations and the perceptions derived from the fruition of the service. Furthermore they turn the perceived quality into a series of dimensions, through which it is possible to obtain an overall measure. The model has been revised along the years. In the latest version (Parasuraman *et al*., 1988), five quality dimensions are identified: responsiveness, tangibles, assurance, empathy, and reliability.

The SERVQUAL has also been used in university settings, mostly for measuring quality of administrative and other support services (Hughey & Sudhir, 2003). Conversely, very little attention has been paid to the evaluation of teaching and to student satisfaction (Lawrence & Mc Collough, 2004); sometimes it has been considered in a wider framework considering all services offered by a university (Polese & Moletta, 2006. Srikatanyoo & Gnoth, 2005).

Table I. Course Quality Dimensions

| |
|---|
| *Responsiveness* |
| Willingness and readiness of the teacher and his staff to respond to student expectations on the course, during its progress. Moreover, capacity to face unforeseen events of organisational nature without disappointing students, willingness to support students in their learning process during the course, willingness to transfer all necessary information on the course. |
| *Tangibles* |
| They include the physical aspects of the course, such as the textbooks suggested by the teacher for the study of the subject, the material tools aiding the teacher in the explanation of the lesson (traditional blackboard, computer, slides, etc.), the room conditions where lessons take place. |
| *Assurance* |
| It means teacher's competence (i.e. possess of the abilities and necessary knowledge to teach the course contents) and credibility (i.e. ability to inspire loyalty and honesty). It also means courtesy (intended as kindness and respect towards students) and safety (intended as freedom from doubts and uncertainty). |
| *Empathy* |
| It means teacher's ability to transfer his/her own knowledge to students through a clear expression way, and ability in keeping alive the interest during the lesson. The teacher is committed to understand student needs and pays them attention at individual level. It also means possibility to easy access to lessons and easy contact with the teacher (timetable and place where lessons and student reception are delivered). |

4   THE PROPOSED METHODOLOGY

The methodology here proposed is aimed at the improvement of a course quality, and is based on the use of DOE and SERVQUAL. A sketch of the methodology is presented in Figure 1.

The SERVQUAL model was adapted to the particular service "university course", leading to the Course Quality Dimensions (QD) described in Table I.

To make experiments, a teacher has preliminarily to:

- identify the variables which can have an effect on the QD;
- select some of them as control factors;
- select the levels for each control factor;
- define the experimental plan.

The execution of the formulated experimental plan implies the segmentation of the course syllabus in sections. To each section an experimental treatment is associated. The number of these sections should be the least possible.
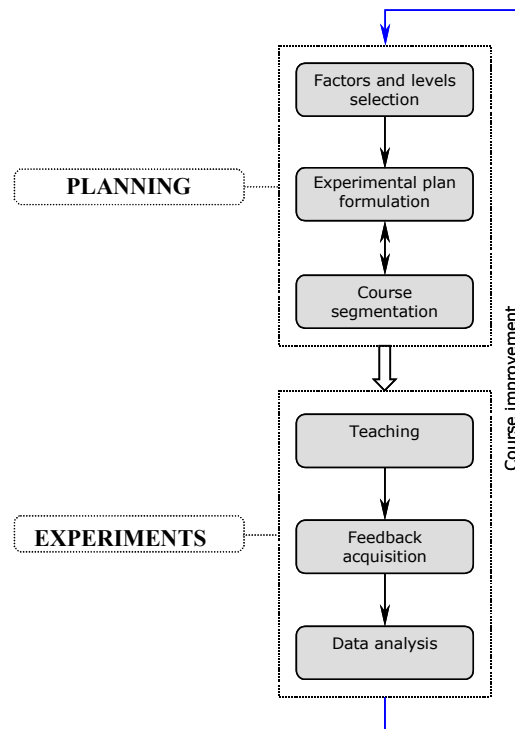
Figure 1. Sketch of the proposed methodology.

4.1   The feedback tool

A feedback tool is elaborated, based on the QD, and aimed at measuring the degree of satisfaction perceived by the students.

The target population is an undefined population formed by the students who currently attend the course, and the students who will potentially attend the course in the future. The involvement of all students who currently attend the course could determine organisational difficulties especially for crowded courses. Therefore, in order to apply the methodology, it can be convenient to involve only a sample of the attending students. Such group is denoted as Students-Evaluators Sample (SES).

The feedback tool is made up of three documents: the Course Quality Dimensions; the Periodic Form, and the Evaluation Matrix. These last two documents are fully described in Barone & Lo Franco (2007).

The Quality Dimensions represent an important training tool in order the activity required to the SES can be done in a correct way.

The Periodic Form is the framework that allows the SES expressing their evaluation about the four quality dimensions: responsiveness, tangibles, assurance, and empathy. The Form is conceived as a monitoring tool and it is submitted at the end of each course section.

The QD "reliability" is not included in the Periodic Form. The evaluation of this dimension gives account of the overall perception about the correspondence between

promises and facts. Therefore, it is not convenient to measure it for a course that suffers intentional variations during its carrying out.

Conversely, the evaluation of the first four QD expresses a judgement on the modalities through which the course is developed.

An Evaluation Matrix helps the SES in filling the Periodic Form. It provides a brief explanation of the scores that can be attributed to each item in the Form.

4.2 Design of teaching experiments

The identification of the variables potentially effective on the QD can be obtained by focusing attention on what can be perceived by a student through the feedback tool.

The selection of variables to adopt as control factors is done on the basis of the assumed particular influence on the QD and on the basis of the capacity of the teacher to act on them. Examples of control factors are:

- Modality of practices/laboratory work. It can affect the QD "Responsiveness".
- Board type. It can affect the QD "Tangibles".
- Case studies. It can affect the QD "Assurance".
- Teacher-students interaction. It can affect the QD "Empathy".

Each factor must be carefully defined, as well as its levels. The number of control factors and levels must be chosen on the basis of the experimental plan to be adopted. To this aim, it is necessary to think at the implications in terms of burden and practical realization of the experimental plan.

For example, if four factors (A,B,C,D) are selected and two levels are chosen for each of them, the most natural and simple plan to adopt could be a full factorial 2^4, allowing the estimation of all main effects and interactions (Table II). However, it would require 16 experimental treatments that could be unaffordable. In fact, each experimental treatment should correspond to a specific section of the same course. Therefore, according to that plan, the teacher should divide the whole course in 16 sections and provide the course in 16 different ways.

Table II. An example of teaching experiments plan: a full factorial 2^4.

Course section	Control factors				Course section	Control factors			
	A	B	C	D		A	B	C	D
1	− 1	− 1	− 1	− 1	9	− 1	− 1	− 1	+ 1
2	+ 1	− 1	− 1	− 1	10	+ 1	− 1	− 1	+ 1
3	− 1	+ 1	− 1	− 1	11	− 1	+ 1	− 1	+ 1
4	+ 1	+ 1	− 1	− 1	12	+ 1	+ 1	− 1	+ 1
5	− 1	− 1	+ 1	− 1	13	− 1	− 1	+ 1	+ 1
6	+ 1	− 1	+ 1	− 1	14	+ 1	− 1	+ 1	+ 1
7	− 1	+ 1	+ 1	− 1	15	− 1	+ 1	+ 1	+ 1
8	+ 1	+ 1	+ 1	− 1	16	+ 1	+ 1	+ 1	+ 1

4.3 The experimental phases

For the submission of the feedback tool we can distinguish three phases: 1. "selection of the SES"; 2. "SES training"; 3. "Evaluation by the SES".

Phase 1. At the conclusion of the first course lesson, the teacher invites students interested in taking part of an evaluation process of the course quality and willing to constantly attend the course, to remain in classroom for some minutes. He then explains that the commitment of the future components of the SES will consist of the careful understanding of modalities for a correct filling of a Periodic Form at the end of each section in which the course is divided. Lastly, he introduces a project collaborator (CP) to the SES. The CP is a person who will train the SES, and will deliver and collect the Periodic Forms and the Evaluation Matrix. In general he is the direct interface with the SES in order students will not feel embarrassed by the presence of the teacher. It is to remark that none is informed about the teaching experiments, except for the teacher and (not necessarily) the CP.

Phase 2. This phase is spanned throughout the whole course. It is conducted by the CP. At the beginning of the course the CP delivers the QD to the SES. He illustrates their meaning. Then he explains the evaluation process. The submission of the first Periodic Form will be done at the end of the first course section. Any time the CP will deliver a Periodic Form he will also deliver an Evaluation Matrix and will be at students disposal for any clarification on the evaluation process.

Phase 3. The evaluation phase is also spanned throughout the whole course. The SES will be called to evaluate at the end of each course section. During the first evaluation step, the CP informs the SES that each of them should choose a nickname and must use it throughout the evaluation process. At each evaluation step the teacher leaves the SES with the CP.

5 Conclusions

The adoption of the proposed methodology is auspicated for the design and the improvement of courses and degree programs. Its flexibility makes it possible to apply it to any course, not necessarily included in a degree program, e.g. a master program.

In fact, the modality of teaching is object of experimentation. Students, who must be unaware of the experimentation, do not absolutely suffer any negative effect of it. The experimentation does not modify the contents of teaching. Furthermore, aspects as the teacher kindness or his/her availability towards student needs (when explicitly expressed) should not be intentionally varied.

The methodology focuses attention on the satisfaction expressed by the students through a solicited feedback tool. This is not the only indicator of the process result.

Other indicators can be: new knowledge and competences acquired by the students, the obtained mark, the time gap between the course end and the exam date. Also these indicators can be interpreted as parameters of stakeholder satisfaction. Particularly, the results at the final exams can indirectly express the degree of

satisfaction of the teacher. In such direction the authors will continue their research, hoping in new interesting findings.

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