The Quality of Physics Teaching in Engineering Courses in the Bologna Transition Period: University Teacher's Conceptions

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Abstract - **The importance of the quality of the teaching and learning process in Higher Education (HE) is a subject of increasing importance. We can support this statement by looking at different sources, namely the scientific literature concerning HE, several governments measures, specially in the scope of the Bologna Process, and also the public opinion expressed, for example, in the mass media.**
The Bologna Declaration, in particular, requires fundamental changes in HE. Just to quote two of them: the curricular structure and the design of degrees, and the way teaching and learning should be carried out. These changes must be done assuring the quality of the all process. However, besides the intentions stated it is important to look at how they are seen by HE teachers and how they are being implemented in practice.
This article focuses on a study in development which attempts to look at how HE teachers, in Portugal and in the Bologna transition period, see the quality issues concerning their teaching and learning and also what they say they are doing in their practices. The data has been collected through interviews with six University teachers of physics to future engineers, in two different Portuguese Universities. The results indicate that despite the changes which the teachers say they are introducing in their practices, there is a need to deep their understanding concerning what is quality in the teaching and learning process and also what this leads for practices, namely in accordance with the Bologna Process challenges.

Index Terms - Bologna Process, HE Teachers' conceptions, Quality in Teaching, Physics in Higher Education (HE).

INTRODUCTION

The word quality is an important concept in public debate. This debate is significant in the demands, wishes and expectations of the general public. The main idea is that quality should be evaluated by the final consumer or costumer of one product or service.

However the term quality is rather complex [1]: quality is "*the most complex, multi-dimensional concept that has ever been reduced to seven letters* (…) *quality is impossible to define, but we recognise it when we see it* " [2].

This complexity, in the context of Higher Education (HE) Institutions, can also be seen through the number of terms involving the word quality [3]:

- quality assurance;
- quality management;
- quality control;
- quality audit;
- quality assessment.

Quality in HE, according to Article nº 11st of the World Declaration on Higher Education published by the United Nations [4], is a multi-dimensional concept, which should embrace all its functions and activities: teaching and academic programmes, research and scholarship, staff, students, buildings, faculties, equipment, services, the community and the academic environment. It should, also, take the form of internal self-evaluation and external review, conducted openly by independent specialists, if possible with international expertise, which are vital for enhancing quality.

The speech about quality in HE has increasing considerable after the Bologna Declaration (1999). The Bologna Process has now 40 member states committed themselves to establish the European Higher Education Area by 2010 [5]. The Bologna Declaration encourages, among other dimensions, the European co-operation in quality assurance of HE with the objective of developing comparable criteria and methodologies. Other important goals agreed in the Bologna Process are easily comparable degrees, a system based on two main degree cycles (subsequently a third cycle has been included), a common European system of credits and mobility of students and teachers [6].

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Therefore the Bologna Process offers an interesting opportunity in reconsider the European dimension of quality in HE on the one hand and the national responses to quality policy on the other. The goals of this process are set international by discussions and political processes. Thus, the Bologna Process presents an interesting turning point in the internationalisation of European HE in general and in its 'quality policy' in particular [7].

In Portugal, the current system of evaluation of the HE courses was set-up 10 years ago, and the choice of the model adopted was mostly based on the Dutch system, after a period of scrutiny of various alternatives. Evaluation is compulsory and the system is now well established and has been extended in recent years to the polytechnical and private subsectors of higher education. The national agency (*Agência de Avaliação e Acreditação para a Garantia da Qualidade do Ensino Superior*, approved by the Portuguese government in February 2007) follows the international recommendation made by the report about HE in Portugal conducted by a group of experts from OCDE/ ENQA [8]. The goals of this agency are to promote the quality of HE and set the accreditation of the institutions and their courses [9].

In this paper we report a study in witch six university physics teachers were interviewed in order to understand the way they see and promote the implementation of Bologna Process. Furthermore we want to know the changes that occur due this implementation and finally the implications in teaching and learning process.

RESULTS AND DISCUSSION

The study was conducted, during the academic year 2006-2007, involving six university teachers from two different universities. Three of them are from Oporto University and the others three are from Aveiro University. All of them are physics teachers and teach introductory physics to engineer courses.

The results we present were obtained from six interviews (numbered from E1 to E6) conducted with each teacher. The transcriptions were done and after were validated by the teachers. The results emerged by contents analyses made with N6 software [10]. The specific aims were to find out teachers' opinions about the teaching methods, quality of teaching, the effects the Bologna Process have had in way they teach and finally, their perception about the leaning/teaching process and its quality.

To understand the analyses, it is important to know how the courses are organized and the purpose of each kind of class.
In Aveiro University exists two different types of lessons:

- Theoretical-practical (TP) – where teachers give the physics principles and solve exercises;
- Laboratory (Lab) – where students are expected to do laboratory work following a given protocol.

In Oporto University there are two different types of lessons:

- Theoretical-practical (TP) – where teachers give the physics principles and give practical examples;
- Practical (P) – where students, with the help of teachers, solve exercises and in some of the lessons they go to do laboratory work with a given protocol.

The results are now presented in four dimensions: i) teaching methods, ii) effects from Bologna Process, iii) quality in HE and finally iv) learning/teaching process.

Teaching methods

All TP's lessons are expositive to introduce the physics concepts. After this expositive period an exercises solving period occurs. Some of the teachers have the opinion that with this kind of methodology students are more active and the lessons are not so boring.

The resources used by the teachers in TP's are the blackboard, transparency and datashow.

In order to illustrate what was said some teacher's opinions will be transcribed: The E2 interview the teacher said "*In my TP's lessons I expose the physics concepts and then I do some exercises…the purpose of the exercises is turning the lessons more attractive and not so boring*." Looking to E4: "*In TP's we introduce only the fundamental theoretic concepts needed to students solve the exercises. The objective is starting solving problems…*"

The general idea drawn by the teacher's opinions is that students learn, stay more focus and motivated when solving exercises. So teachers transmit the physics concepts and try to illustrate them with examples or exercises.

In lessons were students are asked to solve exercises teachers use different methods. One of the teachers organizes students in groups where they discuss and solve the exercises. Others discuss, with students, the strategies to solve the exercises and then the teacher solves them on blackboard. In the E4 interview we can read "*After the discussion with the students the resolutions is made on blackboard. When we start a new exercise I give some time to students to think and make suggestions. It's very important to avoid the passive attitude among students*."

Effects from Bologna Process

Looking at teacher's opinion we can divide the effects produced due to the implementation of the Bologna Process in positives and negatives.

The positives ones are:

- each lesson has fewer students;

- students are more active in lessons;
- the same teacher teaches TP and Lab with the same students so the interaction between teacher and students is improved. This change occurs only in one of the two institutions.

The negatives are:

- the course had reduced the number of hours and so fewer hours to lecture;
- less physics contents and fewer knowledge acquired from students;
- students are asked to work by themselves and they are not prepare to do it.

When they were asked what had change in their practice here we notice a difference between the several teachers. To illustrate this difference we quote three positions.

The teacher in the E1 interview said *"…I give my lesson the same way I did before the Bologna Process… From what I understood Bologna Process implies a more participation of students in classes. How can they participate if they don't have the knowledge? The physics concepts must be taught, so I didn't change my way of giving lesson…I believe that what they want from us is to teach physics like the books of scientific divulgation, they want us to give information and not educate the students…"*

The teacher E4 said *"…One change due the Bologna Process was to assure that the same teacher that teaches TP teaches the Lab with the same students. This idea is for teacher and students interact more closely. In this way teachers can detect the difficulties and try to dissipate them. They also know students better and so they know students interest and can motivated them more easily… Another change was the numbers of students per lesson, in previous years in theoretical classes were almost 100, now we have 50…"*

Finally the teacher E3 said: *"Because of the reduction of lectures hours we introduce homework... These were very important to kept students working during all semester…"*

From these statements we can say that Bologna Process did not bring many differences in their way of lecturing. Notice that one of changes that occur was an institutional one, namely putting the same teacher lecturing different lesson to the same students and reducing the number of students per class. Another changed introduced by teachers was the homework with teachers' feedback. They said that it was a tool that kept the students active.

Quality in HE

From the analysis of the transcribed interviews the idea which emerges is that quality in HE is a concept with different meanings. The opinions from the teachers interviewed are not unanimous. To illustrate this ambiguity in defining quality of teaching we will quote some opinions taken from interviews E4, E3, E1 and E6:

- *"In a system with quality teaching it's important that **students**, more than academic knowledge, must develop competences that permit them to construct their own path. To fulfil this objective the academic instruction must be the first step to lifelong education."*

- *"… the evaluation of the quality of teaching is also made at the end. We must evaluate the employment of **students**, **student's** career after they leave universities. We can't see the quality of teaching by looking to the grades of students in that course… "*

- *"…to have teaching quality we first have to define the objectives of the course, the teaching methods, defining the bibliography… and finally evaluate the **students** according with what was defined earlier."*

- *"Our system of teaching has quality. I was abroad doing my PhD and I assure you that our **students** have the same or more knowledge than other foreign **students**. The problem is convincing our **students** to learn…. Universities should be schools of elite, but with the massification of Higher Education Institutions they shed to be. I always give this example: Not all football players can play in Porto or Benfica. Many of them have to play in other teams and in other leagues..."*

Analyzing teachers´ opinions we find one idea that is common to all of them relative to quality in HE, expressed by the word **student** (bold added in the transcriptions above). All interviewed teachers see quality from a single dimensional perspective, that is, depending solely on the students and not on teachers or institutions. This teachers' view is only part of the multidimensional concept of quality in HE proposed by UNESCO [4].

Learning/teaching process

The general opinion taken from the interviews is that beyond the basic physic concepts teachers want to develop competences in their students that allow them to look into the world with some scientific knowledge and give them some tools that help students to solve problems in their professional life. E2 teacher said: *"What we teach should permit students to develop transversal competences and with them connect physics to other sciences and engineer… we need to show the real application of physics, put her in a real word context to show the importance of this course in the academic instructional of an engineer…"*

When a teacher speaks about learning they say that learning is obtained when students achieved the objectives stated for the course, From E4: *"… learning is obtained when the proposed objectives are satisfied. Each unit has very specific objectives. These objectives are important to the development of the students in several dimensions. For that it's necessary to use different methods of teaching."*

CONCLUSION

From the results found we can conclude that some changes had and some more must occur due to the implementation of Bologna Process.

The main changes that were referred were:

a) The number of hours of the courses were reduced to allow more time to individual work by students;

b) The number of students in each class had diminished (from 100 students went to 50). This also permits more interaction between teachers and students.

c) The theoretical classes were abolished and now only exists TP and Laboratories. In the TP's teachers give the theoretical concepts and then solve exercises.

d) The same teacher teaches TP and the Lab with the same students. This idea is for teacher and students interact more closely.

e) The students are asked to be more active in class.

All this results imply a paradigm change of HE in Portugal since the learning process had changed and so the teaching methods will have to change to adapt to it.

The teachers identify in these changes positives and negatives aspects. All of them say that the diminished of lectures hours is a negative point because the course subjects can be reduced and so the amount of knowledge will be minor. This is a real concern between teachers. Another negative aspect is that students are not prepared to work alone. The positive points are the active role of students in their learning process; having the same teacher in different types of lesson (TP and Lab) with the same students will permit that teachers interact more closely with students and detect their difficulties and helped them to overcome it.

Another conclusion that we can infer is that, for the teachers, the meaning of quality teaching has different dimension (academic, carer, competences…) but all of them centred in students. So, the majority thinks that quality issues are related only with students and not with a multi-dimensional concept as has been defined by UNESCO [4]. In this multi-dimensional concept teaching methods and curriculum design have an important role.

These demands open a window to new types of research like the one that is being conducted by the first author of this article in hers PhD project. The aim of this PhD project is to develop and validate a handbook that will help in the curriculum design and give guidelines according to the Bologna challenges.

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