PREVENTING DROPOUT USING INTRODUCTION TO ENGINEERING COUSES - TWO PARTICULAR CASES

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Abstract. *Studying engineering is known as hard, difficult, laborious work. Nonetheless, engineering courses do not have to be irremovable academic obstacles that drive students away from success, especially when there's a certain lack of basic skills and the degree of motivation is normally attainable only when sophomore's stage is reached. Some attempts have been made during the last three years to turn freshmen experiences into interesting approaches to engineering, particularly using Bologna's curricula freshly introduced "Introduction to Engineering" course. This paper reports some results on two particular areas: a first one that, due to recent global events, has (re-)gained a new life of its own- Ethics and Deontology, and a second one that embodies what engineering is all about gaining (and tasting) engineering feeling through the use of mathematical Models. Science, Technology and Society concepts were discussed. Students were asked to do a brief research on Science, Research and Technological Development relations (and their influence on society), followed by a discussion in class in order to clarify the meaning and interdependency of those concepts and how they affect people's everyday lives. After this first approach, the next subject dealt with were research methods and the steps involved. Two different cases were discussed; a scientific and an engineering case research; the purpose was identifying the main steps taken on each of them. Next, a model analysis was performed, specifically involving the different types that can be used in engineering, the validity of simplifying assumptions and their purposes. In order to attest their importance, students have tested three different mathematical models, all three representing the same real system (the process of emptying water from a cylindrical tank), but considering different simplifying assumptions. Using a common spreadsheet as a tool, each group represented, in a line chart, the behaviour of the real system and the three models. Conclusions were taken about the validity of the simplifying assumptions and about the importance of math to represent real system. Students get more involved and committed when they see the positive results of an effective participation on the construction of their own knowledge. This is, no doubt, a valid contribution: avoiding dropping out of many talented students, helping them through the learning process, how it works, why it goes wrong and how to avoid generational drawbacks.*

Keywords*: Engineering, Freshmen, Dropout*

1. INTRODUCTION

Introduction to Engineering is a recently widespread course in almost all engineering curricula. It should be noticed that, as in many other cases, when the author's tried to find material to support the concept and application of the curriculum proposed under Bologna's restructuration, back in 2005, they found that a pioneer particular attention had been given to the subject by the Brazilian scholars (Bazzo and Pereira, 1997), beyond traditionally focused Anglo-Saxon school (Wright, 1994; Oakes *et al.*, 2004; Landis, 2007). This course provides a general introduction to the principles and concepts of engineering covering a variety of topics in the history of engineering, in science, technology and society, in communication, design, modeling, simulation and creativity (Tab. 1). It is intended to serve as an introduction to the graduate programs in Mechanical and in Industrial Management Engineering at the Mechanical Department at the School of Technology of the Polytechnic of Viseu.

Quite often, this kind of initiatives, that not always embodied the formal nature of integrated courses, have a former history of optional/elective character, most of the times provided on a *pro bono* basis that very much enriched the actual structure. The main goal of this course was to diminish dropout rates. Its contents only recently have assertively incorporated the added value that is related to the fact that a better academic path, promotes, enables and/or facilitates these sort of experiences; it will translate, eventually, into a better engineer graduate. This is why we can find, in different periods of the last decade, that the learning objectives have been shifting smoothly from "I can be a successful engineering student" and "I have the right to be here", to a more comprehensive set of goals such that cover subjects from providing a general introduction to the field of engineering, to conveying social, professional, and ethical responsibilities of engineers; in the meantime, the teamwork approach to engineering and the skills needed to become a practicing engineer, especially as a result of the Engineering Criteria accreditation (ABET, 1997), that put the focus on what is learned rather than what is taught, have become widely accepted, not only by the Anglo-Saxon world but also by EU with its late Dublin descriptors (EUA, 2004).

Introduction to engineering subjects for freshmen at other U.S. engineering schools generally fall into two categories: one where subjects that present basic technical concepts are dealt with demonstration labs or design projects for a given engineering discipline; the other, a hands-on engineering approach of design subjects. This course develops both. Especially during the last three to four weeks, when a mechanical workshop is developed, interdisciplinarity of engineering work is highlighted as different engineering subjects are brought together to allow materializing a design of a lab device. These last three editions of this course saw freshmen presenting at the Polytechnic's Grand Hall, a device to demonstrate the existence and the conservation of the angular momentum, a structural, electric, electronic and pneumatic device that allowed flowing and demonstrating the projectile fall movement and, this last year, a robot arm with four degrees of liberty.

Recently, enlarging the range of application to especially targeted minorities, there is the 'minority introduction to engineering and science' (MIT, 2009).

Lectures and case studies are presented to help students to understand and analyze complex technical systems and grasping technical concepts underlying each system. Through presentation of a number of cases, students are introduced to many engineering subjects, such as political, economic and social and ethical aspects of the engineering activities. To further develop the sense of engineering systems and practice, students are taken on field trips to assist at on-site lectures delivered by companies' senior managers.

Table 1. Introduction to Engineering Course Timeline.

Week #	Description	Summary
1,2	Entering Higher Education	ICTs, Time management, study skills
3	History	Historical milestones
4	Engineering and Society	Profiles, Ethics
5	Science, Technology and Society	Engineering work, research methods science and technology
6,7	Engineering and Communication	Communication processes, written technical reports, visual communication
8	Design	The designing process
9	Modeling	Models and real systems
10	Simulation	Seminar
	Creativity	Seminar
11-13	Mechanical Workshop	Drawing and Manufacturing

This course was offered at the same time, during the same semester, as the Information and Communication Technologies (ICT) course, under the responsibility of the Computers and Systems department. ICTs courses are broadly perceived by fresh ex-K12 students as a sequel of similar subjects regularly taught in secondary schools and are renounced for being very easy ones, from student assessment point of view. Both courses, Introduction to Engineering and Technologies of Information and Communication Technologies, were offered as an elective to students.

2. ENGINEERING ETHICS (AND DEONTOLOGY)

The third module of the course, Engineering and Society, approached the different engineering profiles and the relations to engineering functions, the difference between an engineer and a technician and the importance of ethics and of corporate engineering societies in Portugal and abroad, namely in the United States and in Brazil. The goal was to provide cases and situations where students could know and understand the importance of engineering in society, to recognise the field of engineering and the applications that can be performed, as well as the social and ethical responsibility that an engineer must keep in mind when designing and taking decisions.

They would discover that engineering intersects nearly every other discipline in practice, including management and the sciences: engineering often deals with very large systems involving multidisciplinary skills, tradeoffs, schedules, costs, and social issues that affect how we live in our world.

The issue is to make the right choices, first, acknowledging the dilemmas and, next, to follow some guidelines to guide the decision making process towards what desirably will be considered, and recognized by the social and professional environment, as a right choice. In order to make the right decisions it is necessary to understand what are the principles, the moral imperatives that guide our conscience and what rules are fair or correct governing such obligations (Snoeyenbos, M. *et al.*, 1994). There are always complications to address issues from a moral point of view and this concern is fundamental for students: confusing this posture with moralism, or even worse, given the ages involved, with false moralism, is fundamentally counter-productive. The difficulty also stems from the fact that the moral validity can be accused of being cyclical, an evidence hard to accept by those that stand on the principle of non-relativistic. The truth is, however, that what was morally accepted a few centuries ago (or even decades- especially if looking at attitudes, customs, and manners of a society, including racial segregation) no longer is accepted today. And vice versa.

As will be exposed in section 3, Model Formulation and Analysis, one of the important features of the framework followed is that it enables students to grasp some fundamental concepts of system design. In so doing, a connection is made to the fact that, historically, failures and disasters were not only due to purely technical problems but also involved politics, deadlines, cost-cutting, environmental issues, management issues, the media, and regulatory procedures.

The apparent difficulties in introducing Ethics in engineering curricula were not new to the post-Bologna faculty. In fact, five years before, the so-called ABET 2000 "soft 6" Outcome included "an understanding of professional and ethical responsibility" that most of US engineering educators were not aware of how to include it in their curricula, and when they did, were not certain to know how to assess whether or not that outcome had been achieved (Schimmel, 1999). To overcome this perplexity, a pragmatic approach was then undertaken, bringing day-to-day cases and asking students to discuss them within the respective groups and to present them at the end of the classes. The same pattern was followed dealing with very well known cases of the recent and not so recent past, after being the object of online research. Several situations have occurred that left an important mark, mostly due, unfortunately, to the extreme impact on the loss of human lives. Some of these cases were the Chernobyl and Bopal disasters and, more recently (2001), the case of AZF's petrochemical factory in France; but also Three Mile Island, Exxon Valdez and Prestige, among others.

Two cases were discussed in detail (particularly in the scope of the Mechanical Engineering area) as episodes with a major impact on the automobile industry:

1. The Ford Pinto: a detailed explanation was provided on the alleged facts that resulted in a judicial decision by the California Court of Appeal that upheld compensatory damages of $2.5 million ($5.92 million today) and punitive damages of $3.5 million ($8.29 million today) against Ford Motor Co. (Time, 2009). It seems that the car's design allowed its fuel tank to be easily damaged in the event of a rear-end collision which sometimes resulted in deadly fires and explosion. Also, having no real rear bumper, in case of collision, the gas tank would be pushed against the differential that had a number of protruding bolts that could puncture the tank. Again allegedly, a memo from Ford had ruthlessly calculated the cost of reinforcing the rear end ($121 million) versus the potential payout to victims ($50 million). And, based on this analysis, Ford decided it would be cheaper to pay off possible lawsuits for resulting deaths, thus gaining a reputation for having manufactured "the barbecue that seats four" (Johnson, 1998).

2. The Oldsmobile Corvair: Ralph Nader wrote a book back in 1965 (Nader, 1965) that was considered 'groundbreaking' at the time. The book was eloquently entitled "Unsafe at Any Speed: The Designed-In Dangers of the American Automobile". He accused the American auto makers of manufacturing cars that endangered public safety, and doing that knowingly looking only for profit. Nader was pointing the finger to General Motors and especially to one of its sport models, the Chevrolet Corvair, considering it as an example of a finished car that had been the subject of a error of conception and, therefore, unsafe. He alleged that the rear suspension design was so bad that it was prone to let the rear end to slip and fishtail when dealing with a tight bend and, at the limit, to rollover. The phrase "Unsafe at any speed" was only the name of the first chapter of the book but it was enough to cause an irreparable damage to the sales of the Corvair. Ralph Nader was considered a number one enemy by GM that hired private detectives to look into Nader's private life; they tried to connect him to prostitutes and to convince the media that Nader was a homosexual. When these dirty expedients were exposed, GM was sentenced in $425,000 for invading Nader's privacy. By that time, Corvair sales had been irreparably affected.

Following these assignments and presentations, a brief lecture was made on the importance of Engineering in every day lives of the modern society and the need to draw some boundaries to the professional activity. The Portuguese legal chart of its engineering society was presented and the points where the ethics issues are addressed were discussed, art. 86 to 89 (Ordem dos Engenheiros, 2002), as well as its integration in the FEANI's Code of Conduct (European Federation of National Engineering Associations), the European Engineering Organization (FEANI, 2006), where the other Portuguese engineering society, that used to represent the Technical Engineers (ANET) has also a seat of his own. Subsequently, two more contemporary Ethic Codes for Engineers were analyzed and compared: I- the American Society of Mechanical Engineers (ASME) Code of Ethics of Engineers with its Fundamental Principles (i - using their knowledge and skill for the enhancement of human welfare; ii - being honest and impartial, and serving with fidelity the public, their employers and clients; iii - striving to increase the competence and prestige of the engineering profession) and Canons (1- Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties. 2- Engineers shall perform services only in the areas of their competence. 3- Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional development of those engineers under their supervision. 4- Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest. 5- Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others. 6- Engineers shall associate only with reputable persons or organizations. 7- Engineers shall issue public statements only in an objective and truthful manner); II- the Brazilian "New Code of Professional Ethics" (2002), adopted in 2002 by the national entities representing the professional areas of Engineering, Architecture, Agronomy, Geology, Geography and Meteorology, with its Ethical principles, concerning (1) the purpose, nature and honesty of the profession, the professional effectiveness of the professional relationship, the professional intervention on the environment and the freedom and professional safety; (2) the duties and the forbidden conducts regarding I- the human beings and their values, II- the profession, III- the relations with customers, employers and employees, IV- the relations with other professionals and V- the relations with the environment (Copece, 2002).

Each group of students was expected to initiate and react to discussions of that week's assigned readings concerning the two referred documents. Finally, to reinforce learning, student teams had to complete and deliver a written analysis that, after discussion with the associate professor in charge, were publicly presented the next class.

The model of the assignment consists of the following rationale:

"Practical assignment:

Make a comparative study of the codes of ethics of ASME, USA, FEANI (adopted by ANET), EU, and CONFEA, Brazil. The assignment must be prepared by the existing teams, with no more than 4 students each, and shall consist of a paper, limited to a maximum of 3 A4 pages, with the following entries:

i) Article/Item

ii) Principles/values (*e.g.*: reciprocity, tolerance, competence, public service, safety, welfare, health, honesty, loyalty, impartiality, respect for life, ...).

iii) Entity/Institution/Professional Society identification.

Table 2. Model of the assignment to be delivered.

Article/Item	Principles/values
A- FEANI 1.1 1.2 (…)	 *Competence, Competent professional* *Honesty, Equity* *(…)*
B- ASME 1.1 1.2 (…)	 *Human welfare* *Honesty, Impartiality, Fidelity* *(…)*
C- CONFEA 1.1 1.2 (…)	 *Reciprocity between rights and duties* *Unbiased application scope* *(…)*

iv) Finalize by writing down the conclusions that your team has inferred from the comparative analysis".

3. MODEL FORMULATION AND ANALYSIS

Previously to the second area in focus in this paper, witch is modeling, students were asked to reflect about the concepts of Science, Research and Technological Development (and their influence on society). To operationalize this, the teacher gave to the students' three questions to be answered in class, where they could use, if necessary, the internet to help them get the better answers to the questions purpose. The questions were:

- Distinguish between Science, Research and Technological Development. How do you think those three concepts interact with each other?
- "Research and Technological Development are distinct regarding the ends". Do you agree with this statement? Justify your answer.
- We can distinguish two types of research: fundamental and applied. Explain the differences between them.

The questions were answered in groups of two or three. After groups have finished, a discussion in class was followed in order to confront the different ideas from each group and, as ultimate goal, to clarify the meaning and interdependency of those concepts and how they affect people's everyday lives. After this first approach, the next subject dealt with, giving continuity to the previous one, was research methods and the steps involved, witch are: (1) bibliography research, (2) observation, (3) hypothesis, (4) experimentation, (5) analysis and synthesis, (6) induction and deduction and, finally, (7) theory.

Two different cases were discussed; an engineering case research and a scientific one; the purpose was to identify correctly the main steps taken on each of them. The engineering case research was a very simple one and it is described below (Bazzo, Pereira, 1997):

"A reinforced concrete wall of a warehouse broke down under the action of a few strong gusts of wind. Called to investigate the case in order to identify the cause of the collapse and to give a technical opinion, the engineer observed the structure that suffered the accident, examined the regions of rupture, the direction of the wind, the geometry and quality of materials of construction, among others. Having observed that the collapse of the support pillars occurred for a wind velocity below the one stated in the official standards, and having noted that calculation of the structure had been well done, the engineer admitted that the properties of steel used in the construction could be inferior to the ones stipulated in the project. To test this possibility, he removed parts of the steel used in the construction, to carry out experiments in the laboratory. One of these experiments, to verify the maximum breaking strength of the material, was to execute samples from the steel used in construction, and subjecting them to a traction test. In this test, the sample is pulled to rupture and traced, simultaneously, a deflection diagram of stress *vs* deformation. In these diagrams one can see the behavior of the material under stress. In possession of data from the test, the engineer was able to confirm the hypothesis that was considered. The final step was the preparation of a technical report outlining the collapse causes of the structure."

In class, students have analyzed the case in groups of two and, once more, after the job done, a discussion toke place comparing the conclusions reached by each group.

The scientific cases used for the same analysis were chosen from a Brazilian scientific journal called "Revista Produção Online" published exclusively online by ABEPRO (Associação Brasileira de Engenharia de Produção – *Brazilian Association of Production Engineering*). The main reason for the choice of this journal was because all papers were written in Portuguese, and so, students had less difficulty in analyzing them. At this stage of the course, most of the students still have tremendous difficulties in reading and understanding English. Three scientific papers concerning different subjects and having different structures were distributed to each group. This assessment was supposed to be done out of class and delivered in one week.

The seventh module and simultaneously the second area focused in this paper concerned Modeling and Model Classification, the relationship between the model and the real physical system, the validity of simplifying assumptions and the purpose of the model. The aim was to demonstrate the fundamental importance of models in Scientific Research or Technological Development (Branco *et al.*, 2007). Different types of models were presented and some examples are shown in Fig. 1.

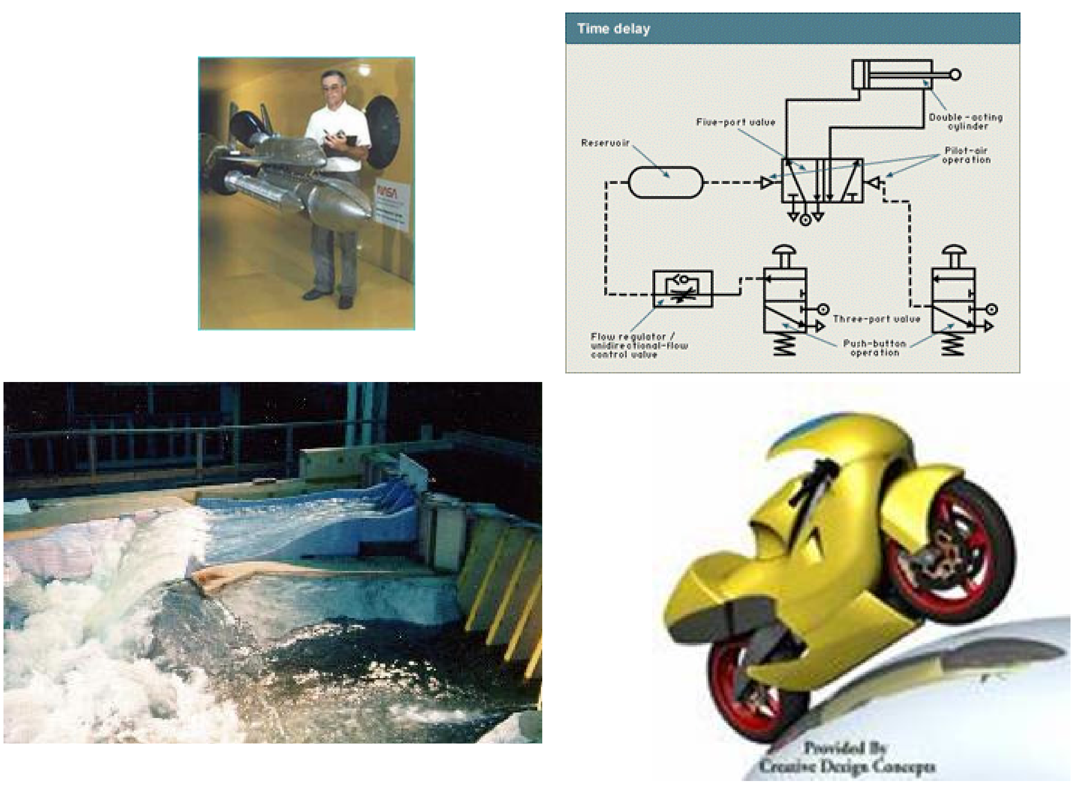


Figure 1. Some examples of models presented in class

For a better understanding of the importance of models in engineering and in technological development it was explored, in class, an example of application of mathematical models. The example used was adopted from an experience made with Civil Engineering students from School of Engineering of S. Paulo, and described at Giorgetti (1997).

The example consisted in testing three distinct mathematical models that intend to represent the same physical system, but considering different simplifying assumptions. The real system in analysis was the process of emptying water from a cylindrical tank. The cylindrical container, initially filled with water, is emptied through a small hole in its flat base. The position of the water level h is recorded against time; the clock is started when the water level is at h_o. The water flow rate is Q and the final level is h_f. A, a constant in this case, is the area of the water surface.

Data from the experimental sequence are given in Table 3.

Table 3 – Original Experimental results

t (s)	h-h_f (cm)	t (s)	h-h_f (cm)
0	15	246	5
21	14	282	4
42	13	301	3,5
64	12	321	3
85	11	343	2,5
108	10	369	2
134	9	395	1,5
159	8	427	1
186	7	469	0,5
215	6	510	0,2

The model that was developed to represent this system results from the application of the law of conservation of mass and intends to perform the balance of the mass of water in the container. The initial differential equation obtained with this first step in mathematical formulation is:

$$\frac{d(h-h_f)}{dt} = -\frac{Q}{A} \tag{1}$$

Having Eq. (1) as the starting point, it became necessary to find a solution that represented the emptying of the cylinder. With that purpose, three different assumptions were considered; the resulting models and the assumptions are the ones exposed bellow:

a) The flow rate Q is considered constant, which is $Q = Q_0$.

$$h = h_0 - \frac{Q_0}{A}t \quad \text{where} \quad \frac{Q_0}{A} = 0{,}047619\, cm/s \tag{2}$$

b) It is assumed that the flow rate Q is linearly proportional to the potential $(h - h_f)$.

$$h = h_f + (h_0 - h_f)\exp\left(-\frac{Q_0}{A(h_0 - h_f)}t\right) \tag{3}$$

c) It is assumed that the flow rate Q has a non linear relation to the potential $(h - h_f)$.

$$h = h_f + \left[(h_0 - h_f)^{1-n} - \frac{1-n}{(h_0 - h_f)^n}\frac{Q_0}{A}t\right]^{\frac{1}{(1-n)}} \quad \text{Where the best value found for n was } n = 0{,}41 \tag{4}$$

In the possession of the equations and using a common spreadsheet as a tool, each group represented, in a line chart, the behavior of the real system and the three models. An example of the result achieved is shown on Fig. 2, where it can be clearly seen the importance and accuracy (or not) of mathematical models. After the chart was constructed, students wrote their (critical) opinion about the chart representation obtained from each mathematical model.

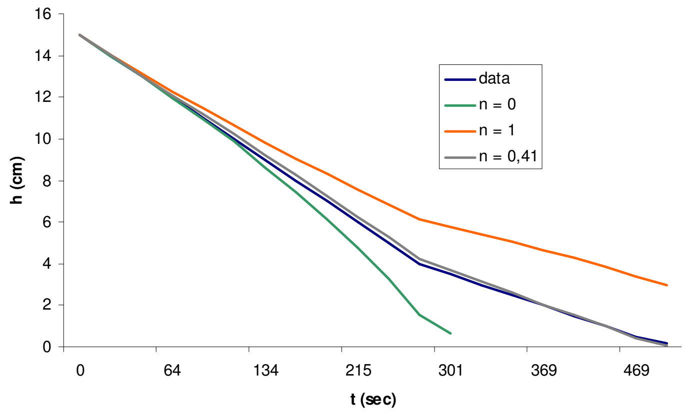


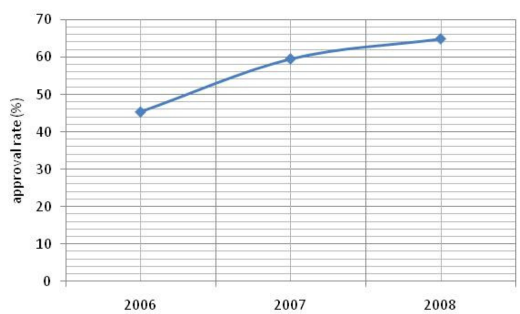
Figure 2. Representation of experimental results and the three models considered.

4. RESULTS

A traditionally less interesting subject, Ethics and Deontology gained a new breath due to the present financial and economical crisis. Students were very keen on recognizing the need to apply boundaries to economical and financial activities, both from a greed point of view concerning stock markets and delocalization and globalization, related to bankruptcy, insolvency, lay-off and, eventually, failure that led to unemployment. There was a new interest in how these issues relate to the central role played by engineers on creating conditions to maintain, both technologically and operationally managing, the workplaces of vast number ok workpeople.

Table 4. Ethics and deontology results.
(a. inscription nr; b. attending nr; c. approved, nr and percentage; figure representing approval rate percentages)

Engineering and Society: Ethics and Deontology module											
2006				2007				2008			
a.	b.	c.		a.	b.	c.	d.	a.	b.	c.	
51	42	19	45.3	95	52	31	59.6	138	91	60	65



The results of the module concerning Science, Technology and Society and their relation with Research and Development were quite interesting. In fact, the discussion generated from student's answers to the questions purposed was very dynamic, especially with older students. The typical freshmen with 18/19 years old are clearly less participative (obviously with some exceptions). With those students, teacher had to make a bigger effort to promote discussion and to engage them into class.

Regarding research methods, the first one to be analyzed, the engineering case was, generally speaking, well interpreted and the steps involved correctly identified. Perhaps because it was a simple and very objective case, the great majority of groups found no difficulties in identifying the research steps involved. The discussion that happened in class to compare the several solutions also helped eliminate any doubts. However, the same conclusions can't be taken concerning the scientific cases; in fact, the assessments delivered have showed, in a large majority, an enormous confusion and uncertainty concerning the correct identification of the steps involved in each case. A possible reason for this could be the non familiarity of students with this kind of scientific papers. Due to lack of time, there was no opportunity to confirm this theory.

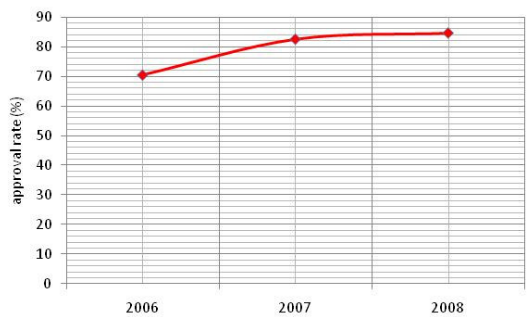
About the second area focused in this paper, modeling, the example of application of mathematical models explored in class was very well accepted and students have put some enthusiasm in solving the case. By seeing the groups working, one could reach the conclusion that there were two main reasons for this interest: the first reason, and the most obvious, was that students actually verified that math can effectively be use to represent real systems and to realize that the assumptions considered have a crucial importance in the fidelity of mathematical models; the second reason, and perhaps the most surprising, was to verify that students have enjoyed working with Excel because most of the tools used in this assessment were new to them and so, at the end, they were very pleased with what they've learned by using Microsoft Excel calculus spreadsheet.

Summing up the results obtained and by watching how students react with the work purposed in class, in these two modules, one can say that students in fact get more involved and committed when they see the results of their effective participation on the construction of knowledge. However, there is still much to be done, especially with some of the freshmen newly arrived from high school; also, some older students that arrived from the special admission mode (candidates older than 23 years old) showed some substantial lack of basic knowledge. For those students, in particular, and for all the others, in general, this kind of interactive and participative method seems to be quite helpful in developing some of their skills such as analytical skills, critical thinking skills, communication skills and interpersonal skills. On the other hand, by working in class and doing the assessments 'online', students become more easily conscious of their real difficulties and have the chance to clarify their doubts and discuss the subjects with colleagues and the teacher. This way, higher productivity is achieved in the learning process.

By analyzing the evolution of the results accomplished with those two modules during the last three years, shown on Table 5, it can be observed that the rate of approved students has increased, confirming teachers' expectations about the learning method.

Table 5. Science, Technology and Society, and Modeling results.
(a. inscription nr; b. attending nr; c. approved, nr and percentage; figure representing approval rate percentages)

Science, Technology and Society, and Modeling modules											
2006				2007				2008			
a.	b.	c.	d.	a.	b.	c.	d.	a.	b.	c.	d.
51	44	31	70.5	95	81	67	82.7	138	99	84	84.8



Generally speaking, and taking into account that Introduction to Engineering is an optional course in Mechanical Engineering Graduation, it can be verified that the number of students has increased during the last three years (see Table 4 and 5, column a. and Fig. 3). This fact shows the growing interest in the course of Introducing Engineering over Information and Communication Technologies, the other elective course. In fact, of one single shift in the 2006/2007 scholar year, a sensible evolution took place until the three shifts of the present one. This also could be recognized as a very positive sign: students seem to acknowledge that all the work developed and the way it is developed helps them to achieve (better) results and, as a consequence, gives them the will and motivation to continue. It's supposed to work as an encouragement for achieving good results in the other courses of the 1st year as well and, as a greater major goal, preventing students from dropping out.

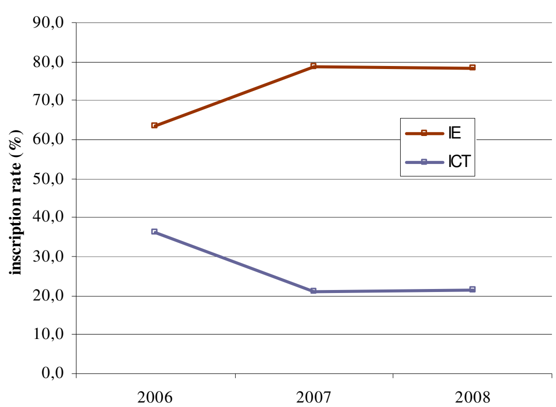


Figure 3. Inscription rate in IE and ICT

5. CONCLUSIONS

Subjects were developed in a format that provides students with interactive, discussion-based sessions on the issues involving ethics in engineering design and decision-making processes.

The subjects were structured to simultaneous achieve several outcomes: (a) to motivate students to study engineering, (b) to enable them to understand the wide variety of engineering and non-engineering activities that professional engineers can be involved in as part of the design of a complex engineering system and (c) to grasp the complex interplay of economic, political, social, ethical and technical factors that influence the development of complex engineering systems.

The bottom line is that, in addition to the goals above, it has been possible to contribute to reduce drop out by means of enabling a better awareness of the future engineering condition that freshmen are looking forward to become. And the results obtained so far permit to look at this kind of courses in a positive way.

There is an educational significance in assisting students in being aware of the major trends in engineering and in developing essential skills that will help in building intellectual bridges between their technical studies the social issues concerning the engineering profession. As rational beings, students can exercise their mode of thinking and find their own judgments to decide that certain conducts are to be right, as compared to others, considered to be wrong, feeling that it is their individual duty to recognize the first from the second, to do the first and not to do the second.

We tend to agree with Kant (1788) in asserting that the idea or consciousness of right and wrong and duty is a fact; so, we would like to finish with this quotation from him that:

> "*Two things fill the mind with ever new and increasing admiration and awe, the more often and steadily we reflect upon them: The starry heavens above me and the moral law within me*".

6. ACKNOWLEDGEMENTS

The authors wish to acknowledge Prof. Doutor Luís Sá for his contribution to the discussion of the Ethics and Deontological issues modestly approached by this paper.

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