Methodology to use Multimedia Applications and Mobile Devices When Teaching Structural Analysis

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Abstract **- This work has as proposal the introduction of new technologies when teaching engineering, namely to use interactive multimedia resources and mobile devices as assistance to fight the failure in school performance and to motive students to learn Structural Analysis I of the 3rd year of the Civil Engineering course in the Faculty of Engineering of the University of Porto (FEUP). We introduce the problem, the results of approvals/failures and discontinuance of the subject. We also present the advantages of using information and communication technologies in higher education.**

Index Terms - Multimedia Applications, Structural Analysis, M-Learning

1. INTRODUCTION

After globalization and introduction of new technologies, it is impossible to think of education as a static process, in which the teacher is seen as an informer and students as listeners. In this new educational context, the teacher becomes an information manager and a guider to those students who seek for knowledge. The students are surrounded by information of several sources and teachers need to use all technological resources, in order to appeal to and facilitate the teaching process. For Oliveira Netto (2005, p.36) "new technologies in education can be used to energize the classes, making them more interesting and connected to reality and mainly to learning."

Within this context, we analyzed the last 10 (ten) years of teaching of Structural Analysis I in Faculty of Engineering of the University of Porto (FEUP) and we detected a high level of failures and discontinuances along these years. Having these problematic results in mind, we proposed the use of multimedia applications and mobile technologies to fight the negative performance of students.

This paper has as main goal to introduce new teaching methodologies in engineering by using interactive multimedia resources as a support material when teaching Engineering. We have started to identify the low approvals of FEUP students, we introduced the advantages of using multimedia applications in education, we presented some examples of the usage of multimedia in others universities that adopt ICT (Information and Communication Technologies) as a pedagogical resource. Besides the mobile devices that can motivate students and consequently improve the students' approval in the subject, we also presented the software FTOOL (*Two dimensional Frame Analysis Tool*) as a didactic proposal.

2. PROBLEM

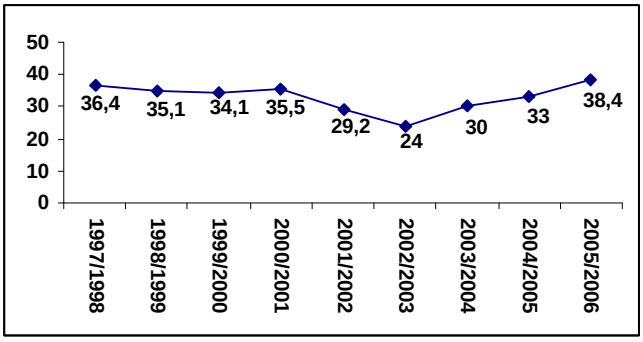
The subject that we have used as a parameter to this study was Structural Analysis, taught in the 5th year of the Civil Engineering course in FEUP. Data collection to this research was done through the information system of the University of Porto (SIFEUP), where we obtained data to evaluate the amount of Discontinuances, Approvals and Failures of the students between 1997 and 2006 (see table 1).

According to graphics 1 and 2, based on collected data, we see a high number of discontinuances with a maximum point of 38,5% and when we add the discontinuances to the failures this number is even higher, with a maximum point of 55,4%. These results reveal a low approval of students in this subject, which make us believe that innovative methodologies could change this image.

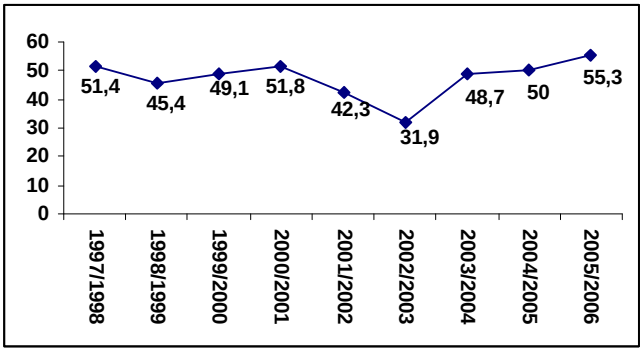
Structural Analysis				
Year	**D**	**F**	**A**	**F +D**
1997/1998	36,4	15	48,6	51,4
1998/1999	35,1	10,3	54,6	45,4
1999/2000	34,1	15	50,9	49,1
2000/2001	35,5	16,3	48,2	51,8
2001/2002	29,2	13,1	57,7	42,3
2002/2003	24	7,9	68,1	31,9
2003/2004	30	18,7	51,3	48,7
2004/2005	33	17	50	50
2005/2006	38,4	16,9	44,7	55,3

D-Discontinuances, F-Failures, A- Approvals

Table 1: Students' performance in Structural Analysis I between 1997 and 2006.



Graphic 1: Discontinuances between 1997 and 2006.



Graphic 2: Addition of discontinuances and failures between 1997 and 2006.

Structural Analysis I aims to study the principles and behaviour of reticulate structures and the development of the force and displacement method to calculate it. It also deepens the knowledge of hyperstatical structures behaviour in linear regime.

The teaching method is based on the presentation and discussion of all aspects of the subject, by showing simple and appropriate examples. On practical-theoretical classes are proposed and discussed applications related to the theoretical part. Some exercises are also proposed to be done individually and as a way of evaluation.

3. MULTIMEDIA APPLICATIONS IN EDUCATION

Koma (1991), Preece (1993) and Tolhurst (1995) said that the word multimedia appeared in the end of the 50's and it represented the introduction, session or courses that used several methods or formats such as text, image, video and sound to present information. For Ribeiro (2004, p.3) a multimedia application "is the program that controls the presentation of information to the user using multimedia services." Some examples of multimedia applications are the games, the graphics, images and sounds that allow an interaction between the user and the contents. Interactivity is one of the main characteristics of multimedia applications, because students can control the rhythm of the presentation of information. The student has the ability to skip between contents and multimedia and this ability defines hypermedia.

For Carvalho (2002) multimedia has four components that characterize it:

- *Formats* – multimedia documents can have several formats in the same file (sound, image, video, animation and graphics).
- *Organization of information* – structure or topology that defines and limits the navigation of the user can be classified as: sequential or linear, hierarchical or network structure.
- *Information storage* – Represents the way information is codified and stored in multimedia applications.
- *User role* – an interactive multimedia document is dynamic due to its own interactivity and the user has an active role by selecting what he wants to see and by being responsible for search information in his own learning process.

The advantages of using multimedia applications in education are well known and some of them are:

- Linear or non-linear access to information
- Possibility of working in cooperative environments
- The advantage of presenting information through several formats
- Redirection of information through hyperlinks

The multimedia application in an educational context has to be comment because the laboratory that is being developed has some multimedia characteristics as they allow learners to access (linear or non-linear) and interact with the system.

For Wald (1998), Assis, Bittencourt and Noronha (2002) the advantages of using multimedia applications when teaching engineering are several and some of them are:

- Applications are good to explain the concepts
- They allow the simulation of abstract objects and concepts
- They allow interactivity
- They allow a fast and efficient cooperation and communication between the users
- They allow a fast update of the courses contents and they make them available for a bigger number of students
- They can be used in distance learning and as an incentive to self-learning
- They raise the productivity once the time to travel is reduced as well as the time for students at different places to participate in the experiences
- They allow the development of new knowledge
- Their cost and maintenance is low

4. RECENT STUDIES IN THIS AREA

Assis, Bittencourt and Noronha (2002) have developed a project in order to offer courses based on "interactive classes" to subjects such as Resistências dos Materiais (Strength of Materials) and Estruturas de Concreto Armado (Reinforced Concrete Structures). The developed resources would be helpful in theoretical classes, allowing students to see complex graphics and the simulation of engineering analyses.

This project was developed at the Departamento de Engenharia de Estruturas e Fundações of Escola Politécnica da Universidade de São Paulo, Brazil, and the experiences are available on http://www.lmc.ep.usp.br/pesquisas/TecEdu/. The main proposals of this project were:

- Development and introduction of new teaching methodologies using multimedia resources as helpful material;
- Digitising of existing print material for the students of the course (books, notes and list of exercises);
- Development of new educational material using educative programs, graphical animations and simulations of engineering analyses;
- Disclosure of the results in seminars, master and doctoral theses and publishing of articles in congresses and magazines;
- Bibliographical research on the subject;
- Use of the developed materials in theoretical classes;
- Availability of the material in a specific homepage on the Internet;
- Creation of a support group to develop the material;
- Collection of preparation material to create distance courses;

Another example of the use of the multimedia applications in teaching enginnering is Liang's case (2002).

In the author's experience, engineering dynamics is a difficult course for students to study and for instructors to teach. The course is rather analytical and has little or no laboratory work. Typically engineering technology students would like to relate the concepts in a course to their work and life in order to learn well. However, probably because dynamics textbooks are written by scholars in theoretical mechanics, some descriptions in these books may not have clear engineering sense to students.

Some dynamics textbooks today include computer disks or CD's to use computer graphics simulation to illustrate the motion of some mechanical devices such as Geneva mechanism. While those multimedia materials are very helpful, they have the following limitations:

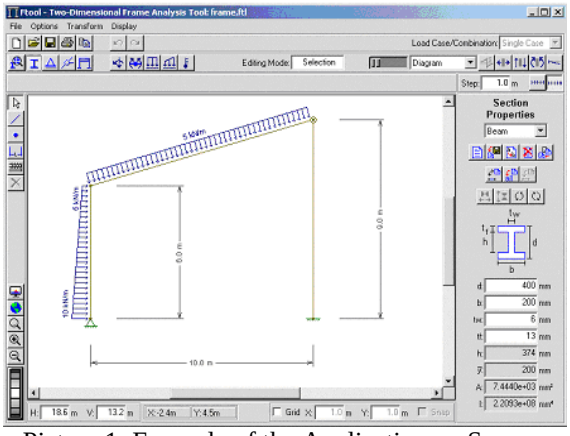
- Only selected example problems are illustrated. Homework problems are basically not included.
- Only a multimedia viewer, which limits how the animation can be manipulated, is included on the CD.
- Students are not involved in development of the models. Hence they do not learn the techniques to develop models of their own.

According to the author's experience, developing multimedia models for the dynamics course has the following benefits:

- Through the process of creating and using dynamics models of mechanisms in the book, students will hopefully be able to use multimedia dynamic modeling technique in their work.
- During the process of creating a dynamic solid model, students will need to add some design details to the original dynamic sketch and therefore gain more engineering design knowledge and experience.
- Constructing dynamic solid models of given problems often presents challenges to students beyond what they have learned in the CAD course. They will gain more knowledge and experience of computer-aided solid design.

5. PROPOSAL TO USE MULTIMEADIA APPLICATIONS AND MOBILE DEVICES

We have suggested the software FTOOL (Two-dimensional Frame Analysis Tool) as a way to fight the failure in Structural Analysis I at the Faculty of Engineering. This software is a program to teach the structural behaviour of plane porticoes and it has as main goal to teach the numerical techniques of analyses. Its educational proposal is to encourage the student to learn about structural behaviour. Martha (2002) says that teaching of this subject has proving that the learning process of structural analyses methods is not good without some previous knowledge of the structural behaviour. It is very difficult to encourage the student to learn about analyses methods theory without some understanding of the models' behaviour in practice. When the student has the opportunity to learn about the structural behaviour at the same time he learns about analyses methods, this learning improves a lot. (see picture 1)



Picture 1: Example of the Application on Screen.

In this application, the student has full control over the structural model that is being analyzed. The control is done through mouse or keyboard. The program has all the phases of the structural analyses process, which are:

- Creation and control over the model with application of attributes (pre-processing);
- Direct stiffness method or nonlinear external solution (ADINA);
- Presentation of the results (pos-processing).

For Martha (2002) the basic goal of FTOOL is based on the need of being a simple tool, joining in a single interface resources to achieve an effective creation and control over the model (pre-processing) with a quick and clear structural analyses and fast and effective presentation of the results (pos-processing). The system has a graphical interface based