Information Technologies for Supporting in Classroom Learning and e-Learning

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Abstract: The paper's main objective is to present a Virtual School (VS), built to provide an infrastructure to develop new methodologies to assist classroom teaching and distance learning in Engineering. The environment of the Virtual School encourages exploration of teaching experiments in search of new pedagogical approaches and methodologies to improve and innovate web-based learning and teaching in the classroom. Based on the experience of graduate students in Information Technology (IT) resources of computer graphics in its broadest definition were used, involving CAD technologies for modeling, animation, text, multimedia and hypertext, photos, pictures and images, which make the visual appeal a powerful tool in improving the teaching-learning relationship. The exploitation of programming languages for the web to build sites, portals and web contents has also been accomplished. One of the most important technological aspects of the Virtual School and of the digital contents is the use of systems management database (DBMS) for the creation, modification, storage and data management. The use of video and sound technologies, videoconferencing and collaboration environments and the construction of a Web platform for e-learning are also part of the goals of this project. Finally, some case studies on web contents based on innovative technologies is presented for distance learning and to assist in classroom teaching of Structural Engineering.

1 INTRODUCTION

1.1 Development of a Virtual School

The creation of the infrastructure of the Virtual School involves knowledge of programming languages like ASP, ASP.NET, Java, Javascript, C#, ActionScript and mark-up languages such as HTML. Technology CAD for geometrical modeling and animation and graphics programs like Corel Draw, Photoshop and Flash are also important tools to improve the visual appeal of graphic design. Moreover, the management and manipulation of database skills are essential to the development of technologies for web courses.

In addition to these skills, each course taught within the School involves specific knowledge for each content developed such as: AUTOCAD, REVIT, Strength of Materials, Steel Structures, Finite Element Method, among others.

The Virtual School consists basically of an organized structure in the form of an Internet portal that provides computational resources for implementation of multiple activities for teaching and learning specific contents in engineering. These activities consist of seminars and online courses, focused on the areas of Engineering and Computer Graphics. Such activities are being designed to fully exploit the resources of the Internet, and especially those related to the visual appeal of computer graphics (multimedia, animations, videos, photos and images, models, etc. ..), with care to prevent the user is exposed to sensory overload, as recommended by (Torres and Mazzoni, 2004). As pointed out in (Integração, 2012), "*the goal of a customized e-Learning is to create a perfect environment for distance learning through resources like audio, animation and interactivity. In e-Learning, a virtual tutor guides the student through the steps of the course, making sure he interacts with the several access links on the screen. With each*

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click, the pedagogical content is presented to the student allowing a dynamic and enjoyable learning."

Access to the Virtual School-VS (called NucleoEAD) is done via links from the address "*http://www.cadtec.dees.ufmg.br*" of the CADTEC - Center for Advanced Technology Development and Teaching of Computer Graphics. The homepage of the VS is shown in Figure 1.

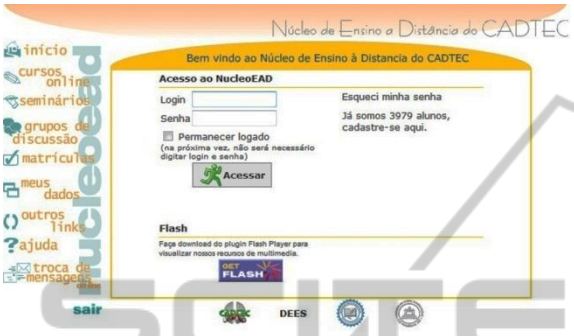


Figure 1: Virtual School Home Page.

To access some areas of the VS it is necessary to register at the school by providing some personal information and creating login and password. Once registered, access to various spaces and tools of interest is granted.

1.1.1 Technological Features of the Virtual School (VS)

The Virtual School is designed to provide, via the web, the following features shown on the portal of the EV, Figure 1:

- Online Registration (enrollment) to courses*;*
- Access to Courses Content
- Access to Seminars*;*
- Discussion forum and news*;*
- Update of personal information
- Chat Rooms*;*
- Useful links*;*
- Help Tool;
- Full control of data through Database*.*

Tools to establish and facilitate communication between students and lecturers in classroom courses of the Department of Structural Engineering are also available from the Discussion forum link *(grupos de discussao)*. These activities are administered by the lecturer responsible for the discipline. Lecturers and monitors have some limited administrative privileges to control the communication activities.

The Portal of the Virtual School allows students navigate intuitively by the School in an attempt to simulate, as best as possible, the functionality of a conventional school. Thus, students can obtain all information necessary to participate in the activities available.

Figure 2 shows the homepage after someone has accessed the VS. The green band indicates that the person logged in has administrator privileges to access the virtual school.

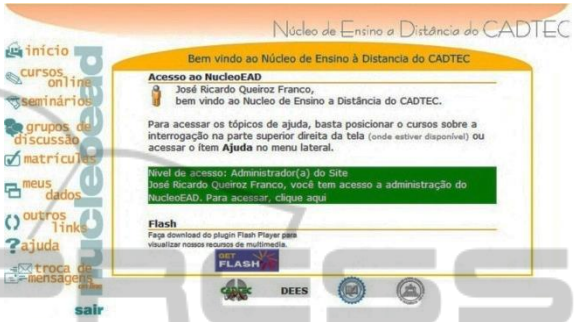


Figure 2: VS Home Page - Administrator Login.

1.2 Technological Basis Applied *(Software, Programming Languages and Technologies)*

One goal of the Virtual School is to explore technological resources in developing environments for distance learning, more specifically, to the development of tools to aid distance learning in structural engineering via web.

There are many motivations for this development, among which we can highlight the advancement of Information and Communication Technologies (ICTs), the advancement of internet programming languages (OOP) and the opportunities that this type of distance learning via the web offers in the area of engineering, (Neves, 2003).

Software. The main cast of software used are essential in the application of computer graphics environments for distance learning, for example: Microsoft Visio, Dreamweaver, Access, Microsoft Visual Studio framework, Flash, CorelDraw, AutoCAD and Revit.

Technologies and Programming Languages. The UML technology (*Unified Modeling Language*) consists of a language for modeling, specification, documentation, visualization and design of systems, including object-oriented. The UML was adopted in 1997 by the Object Management Group (OMG) as a standard language for software modelling, (Guedes, 2010).

The object oriented programming (OOP)

paradigm has been widely used associated with the following programming languages for the web: C#, ASP/ASP.NET, Java/Javascript and ActionScript. OOP is a paradigm of analysis, design and programming of software systems based on the composition and interaction of various software units called objects.

C# is a simple and complete object-oriented programming language, which is part of the framework .NET. The framewok.NET is a runtime environment and a class library that allows the abstraction of the operating system and of the hardware, (MSDN, 2012). The framewok.NET also encompasses an environment for developing applications for the web called ASP.NET. The main features of ASP.NET are: the choice of various programming languages, allows compilation, and is a component-based model (web controls, HTML controls and user controls), which allows complete separation of code and language HTML, (MSDN, 2012, W3Schools, 2010).

ASP (Active Server Pages) is not a language; it is a program that runs inside IIS (Internet Information Service). An ASP file can contain text and HTML scripting languages (VBScript or JavaScript); scripts in these files are executed on the server side (IIS) and return an HTML page to the browser.

JavaScript is a scripting language (interpreted). It appears as lines of code in the middle of the HTML page.

ActionScript is a scripting language used by Flash. This language uses concepts of object-oriented programming. You can make your pages more "intelligent", with additional features such as displaying the current time, make sure to fill out a form is correct, and more, (JavaScript Tutorial Brasil, 2005).

The technology CSS (*Cascading Style Sheets*) was applied to define styles for the appearance of HTML elements.

HTML (Hypertext Markup Language) is a markup language used to produce static pages for Web publishing. This language was developed for the presentation of data in browsers.

1.2.1 Database

The use of management systems Database (DBMS) for data manipulation of the EV is one of the key technological approaches in this project.

BD Relational Management Systems (DBMS) to facilitate change and data storage and ensure greater security and data integrity and better management control. A DBMS is composed of a control software and the database.

The DBMS used to manage the databases of the Virtual School and Digital Content are the following:

MSDE 2000 - Microsoft SQL Server 2000 Desktop Engine is a free version of SQL Server. It is a relational database server, which can used in smaller applications

Access - RDBMS from Microsoft, designed for small and medium applications, multi-user and multitasking. It is a data file and not a data server.

MySQL - The system is a MySQL relational database, multi-user and multitasking. It is free software and "open source", supports different platforms

2 DEVELOPMENT OF DIGITAL CONTENTS FOR COURSES

Once logged in you can access all areas of VS, including the area where the digital content of the courses are available online. However, to access the digital content of a course it is required to enroll in it. To enroll in a course simply click "Enrolment" (Matriculas) and choose one of the courses shown in Figure 3.

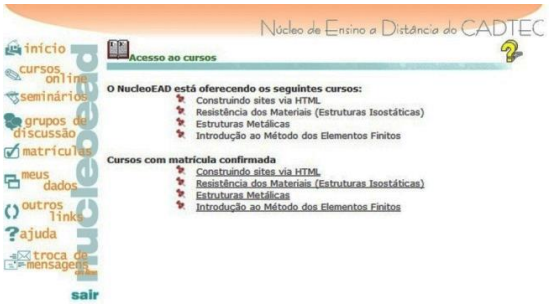


Figure 3: Access to Course Content.

The four courses have free access. The structure of the digital content of the courses is basically the same, nevertheless, the graphical designs of the portal and of the digital content of each course are unique, thanks to the creativity of those who developed them. See an example in Figure 4.

2.1 Typical Course Structure

The structure of all digital contents were designed to develop standard functional environments to make navigation easy and intuitive to users. Such a structure can be itemized as follows:

Figure 4: Structural analysis of statically determined structures.

2.1.1 Functional Structure of a Digital Content of Courses

The digital content for a course is primarily developed following a standard structure design that can be summarized in the following items:

- Presentation
- Agenda
- Book online (Digital Content)
- Discussion forum
- Online Chat
- Transfer (Upload / Download)
- Seminars
- News
- FAQ
- Searching
- Help
- Bibliography
- Log out

The functionality of each item will be presented using as an *example* the structure of the digital content from the course *Structural analysis of statically determined structures*. In comparison with the definition in (E-learning, 2011), "*E-learning includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, ... and computer-based learning, ... and web-based learning. E-learning can occur in or out of the classroom. It can be self-paced, asynchronous learning or may be instructor-led, synchronous learning. E-learning is suited to distance learning and flexible learning, but it can also be used in conjunction with face-to-face teaching, in which case the term blended learning is commonly used.",* the description that follows shows that the digital content of the example suits both modes of teaching/learning, "*asynchronous and synchronous learning"*

Figure 4 shows the entrance portal of the course designed in a cheerful and creative format of an amusement park.

The presentation page welcomes the students and briefly describes the technological resources available on the course. In addition, the student receives information about the course objectives, on teachers and on prerequisites. This page contains instructions on how to start the activities and important tips on how to undertake a distance learning course. The toolbar at the top of pages remains fixed on every page, allowing easy navigation through the course content. The link "Agenda" leads to a page where the instructor sets a schedule for completion of the course with targets and timeframes for each activity that the student must follow during the course. The importance of meeting this agenda for distance education courses should be emphasized (Chaves, 1991).

The hyperlink "Apostila" (Book online) allows access to the index of the digital content of the course as shown in Figure 5. A legend shows the technological resources (animation, film, photo, supplementary texts, and exercises) used to enhance the teaching-learning through the visual appeal of computer graphics. This legend also shows icons for downloads, frequently asked questions (FAQ) and for printing.

Figure 5: Apostila (Book online) (Hyperlinks to the Digital Content).

The Digital Content was divided into four (04) modules:

• Module 1: Basic Concepts

• Module 2: Introduction to Structural Systems
• Module 3: Calculating Support Reactions
• Module 4: Calculation of Normal and shear forces and bending moments and their diagrams

At the end of each module, the student undergoes an evaluation according to some defined criteria.

2.1.2 Module 1: Basic Concepts

The icon "Forcas" (*Forces*) in Figure 6, from the Module 1 lectures on force and its components and resultant force. The theoretical concepts and definitions are illustrated through animations and movies as shown in Figure 6. A list of solved exercises is also available.

To gain access to the next module students must pass an assessment test. Figure 7 shows question 5 of item 3 (Forces) of the assessment test in Module 1.

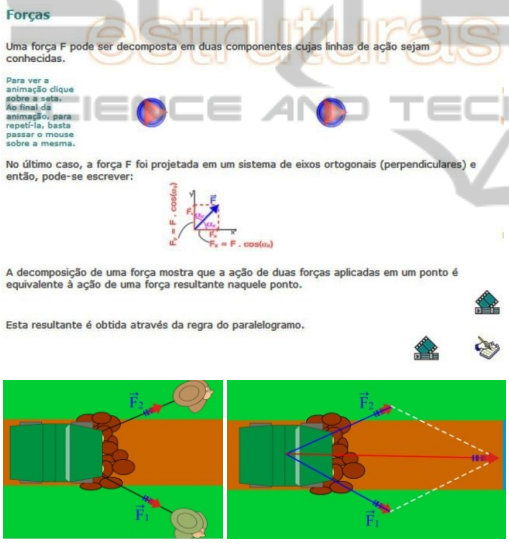


Figure 6: Forces, components and resultant force.

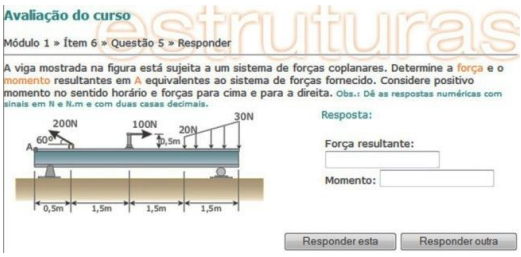


Figure 7: Module 1 - Item 6 (Balance of Systems of Forces) - Question 5.

2.1.3 Module 2: Introduction to Structural Systems

Important concepts about structural systems, support systems, load types, degrees of freedom, types of structures, critical forms and types of forces are introduced in Module 2. Photos, (Figure 8), illustrating two types of support, a fixed pin support and a mobile roller support, help the student in understanding these concepts. Again, in the end the student has to undergo an evaluation to access the third module.

Figure 8: Fixed pin support and Mobile roller support.

2.1.4 Module 3: Calculating Support Reactions

Once approved in the evaluation of Module 2 students gain access to the next module, which teaches how to calculate support reactions, (Figure 9). Calculation procedure starts with the design of the Free Body Diagram (FBD), defined by replacing the supports by their reactions, which become the unknowns of a problem of equilibrium of force systems. In the case of statically determined plane structures simply use the equilibrium equations of force systems on the plane to determine such reactions at the supports. Access to module 4 will be granted only after the student passes the assessment test on the content of Module 3.

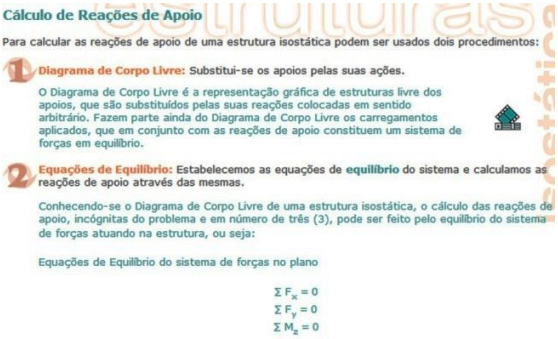


Figure 9: Calculating Support Reactions.

2.1.5 Module 4: Calculating Normal and Shear Forces and Bending Moments and Their Diagrams

On the first page of Module 4 fundamental concepts of internal forces are presented. Then, fundamental exercises on the calculation of internal forces are resolved through animated videos. The sign conventions adopted for the calculation of the internal forces is described and illustrated by images and drawings.

Then the concept of balance of nodes and bars is introduced with the aid of graphic video animations.

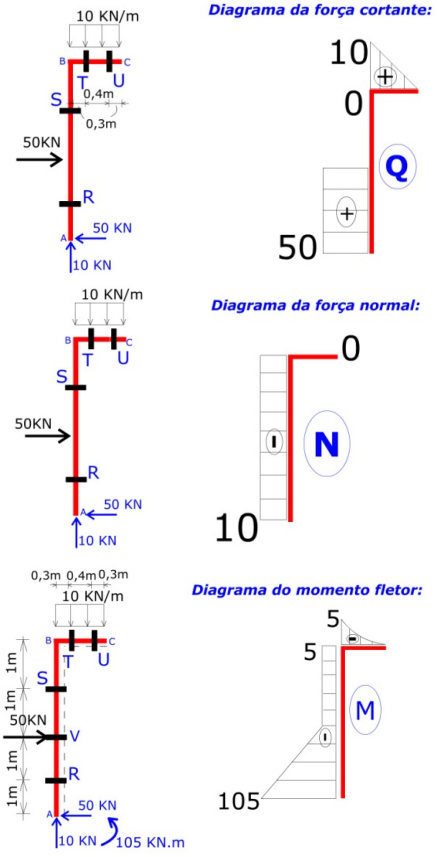
Further, a simple way to derive the equations of internal forces in individual bars is demonstrated also through video animations.

Internal Forces Diagrams (Normal and Shear Forces and Bending Moments)

A brief introduction to internal forces diagrams is made in the introductory page of the issue. On this page access to a video animation is available through the legend to Figure 10.

Figure 10: Legend to access video.

The video shows the construction of internal forces diagrams on a cantilever bar subjected to a concentrated load and an uniformly distributed load. The results are shown in Figures 11. The construction of the diagrams using the visual appeal of a video enhance learning and allow the student to rewind the animation in case some concept needs to be reinforced.



Figures 11: Internal Forces Diagrams.

An important auxiliary tool in tracing the diagrams of internal forces are the Auxiliary Differential Equations. These are deducted from the balance on the free body diagram of an infinitesimal element of a bar subjected to a generic distributed load. Differential equations provide various useful information about the format of diagrams, even before they are plotted. The derivation of these equations is presented through animation and the results are shown in Figure 12.

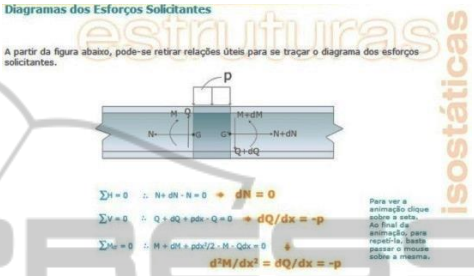


Figure 12: Auxiliary Differential Equations for Tracing Internal Forces Diagrams.

In the following pages, examples of the determination of internal forces diagrams in beams are presented through video animations. The diagrams and the solution for a bi-supported beam subjected to a uniformly distributed load are shown statically in Figure 13.

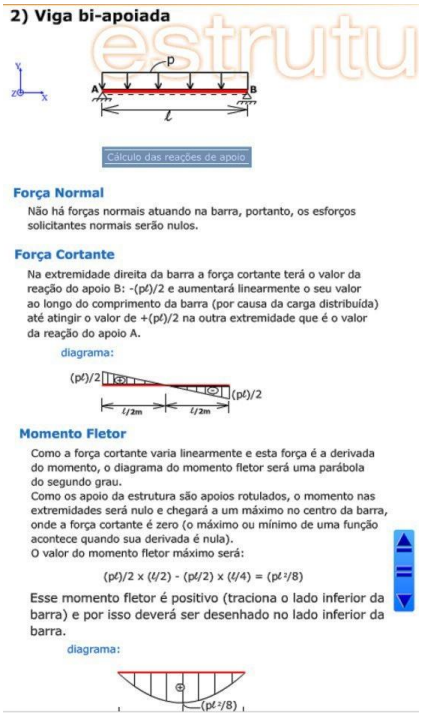


Figure 13: Internal Forces Diagrams - Bi-supported beam subjected to a uniformly distributed load.

3 CONCLUDING REMARKS

E-Learning has become an essential mode of education for massive dissemination of knowledge. The increasing expectations of society for new methodologies and pedagogical approaches impose great challenges for e-Learning (Shimizu, 2006). Therefore, every project in distance education should be initiated through a careful planning including maintenance and prediction of continuous improvement through technological and methodological projects. The content of a course for e-Learning should be well prepared, taking care not to overload the page with text or multimedia features. This certainly transforms the study into something enjoyable rather than stressful. Texts, audios and interactive tools should be balanced, so that the visual appeal of multimedia serves to reinforce the learning of concepts, making the learning environment natural and intuitive, where the student is challenged to be more active in the learning process. In this process the student learns through digital contents available for free on the web.

The Project of Virtual School presented here required an intense program for qualification and training of the team of developers, which was constituted mostly of graduate and undergraduate students. The qualification program included learning programming languages for the web and practice with modelling in computer graphics. Furthermore, the digital contents developed within the project require specific knowledge for each course. Projects of this type show the importance of a multidisciplinary team, with professionals in education, information technology, communication, arts, and experts in specific content, among others. Further, analysis and definitions of teaching methodologies and developing the educational contents of courses are activities that require professionals in education.

Two aspects of the Virtual School and of the courses digital contents developed in this project must be highlighted. First, the access is free and it is available anywhere, anytime to anyone seeking for education and knowledge. Second, the differential of the proposal is the graphical visual appeal of the School environment and especially of the digital contents of the courses.

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