Sharing Course Contents - A Case Study

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Abstract: This paper presents a case study on how educational contents are effectively shared among professors and courses when the suitable system architecture is used. The system under consideration is an integrated Web-based learning, digital library and administrative system. The contents come from many areas of knowledge and are shared by professors in different departaments.

Keywords: Digital libraries, Web-based learning, Content sharing, Cooperative work.

1. Introduction

Information technologies in general and computers in particular have increased their role in libraries as well as in schools since the sixties. In both cases, computers started being used to fulfill administrative tasks and in libraries the additional mission of supporting the OPAC's (Online Public Access Catalogs). The use of OPAC's lead the library community to establish standards to exchange catalog information (MARC Format – Machine Readable Catalog Format – ISO2709 - 1973) and to connect systems (ANSI Z39.50 - 1988).

The use of computers in education, for non-administrative purposes, is newer and the education community is in the process of discussing the standards to connect WEB-based course servers (IMS Project, IEEE LTSC). Currently, there are proposals of metadata, functionality requirements and technology standards.

The creation of microcomputer networks and of the INTERNET made available information and services that were only used by people who had access to corporate networks of mainframes. This revolution started in the nineties and is going on at this moment. Information technology has become a part of everyday life for people all over the world. The INTERNET, among the many technologies, has increased its participation as a way of sharing information. Large companies and small business, schools, non governmental organizations and governement agencies communicate with citizens using the INTERNET.

This process has lead to the interesting and annoying situation where there is a whole world of useful information mixed up with poor quality data. This requires a discipline on generating, storing and describing data fed into the servers so that a selective use of information can be established.

The education community all over the world is faced with the problem of developing digital contents to support learning activities. Though many learning actvities are exclusive of specific cultures, as for example the history of a state of Brazil or the geography of a region of Asia, many of them are not particular of cultures, countries or regions. One example of the latter is the technical side of the curriculum of an Engineering course. Another suitable example is the mathematical background which is common to many branches of technology or even social sciences and humanities.

Researchers and educators all over the world are concerned with the problem of sharing knowledge and thus working in a collaborative manner. These efforts range from joint research projects to the electronic publishing of materials. At this moment there are universities engaged in projects of creating digital libraries to make available their theses. Two examples can be mentioned – Virginia Tech that has gone completely digital, i.e., there are no more paper issues of the theses, and Université de Montreal that is developing its eletronic theses project.

Information technology is changing the way knowledge is treated and this change is impacting education (*Oblinger* and *Rush*, 1997) and libraries (*Thorin* and *Sorkin*, 1997). The worldwide trend is toward sharing knowledge across countries and cultures.

This work presents examples of contents that are shared among courses that use the Maxwell System at PUC-Rio.

2. The Maxwell System - History and Numbers

Traditionally teaching has been a lone task, the teacher studied and prepared his course notes whose objective were to serve the author during the classes. When electronic copiers became available and making copies turned to be a popular activity around campus, class notes were lent to students to copy and add a new item to text books and references. All over the world class notes were embryos to books and many students are thanked in prefaces for their reviews and comments. At this stage a new professional joins the team – the publisher. And after the publisher the printers, the distributors and the sales personel.

A text book is thought to be used in a situation when the student has classes where the subjects are presented and discussed; questions are asked. All the interaction happens during classes or at office hours. The presentation of the contents also happen during class and are determined by the teacher.

When distance learning is considered the course contents must be prepared to be studied in a situation in which there are no classes, the teacher can not see the expression in the faces of the students and questions are not asked and aswered personally. Clerical info is not mentioned during class sessions either. For this reason, the contents must be developed and the system to deliver them must be such way that all these activites are present in the learning process. The contents must address the interaction and all this must be planned very carefully.

There is little or no room for improvisation in the creation of a distance learning course.

3. Education Eletronic Materials and System Architecture

Any person or team who has been involved with computer aided education knows that developing course materials is time consuming and also requires financial resources. Good eletronic materials must be customized not only to the public they will serve but also according to the area of knowledge they cover. The team to create these contents ranges from the author(s) to the computer programmer and in the middle there are the instructional designer, the visual programmer and the text reviewer, not to mention the animator, etc.

In order to make good use of the efforts devoted to create course materials, they are to be used to their full extent. The characteristic of many contents being common to different courses allows a sharing of the modules that deliver them as long as the architecture of the system yields this functionality.

The Maxwell System [*Pavani*, 1999] was designed and implemented based on the concept that course contents have the following characteristics:

- They can be divided into parts that have an educational purpose, in the same way a book is divided into chapters, each one covering a specific topic.
- When implemented electronically, course contents can have different instances. For example, a text material can be delivered in the hypermedia format for online reading (with animations, interactive exercises and sound) and a standard text format for printing and linear offline reading.
- There is no need and it is not proper to duplicate an instance of a content. An instance of a content exists only once and is stored in the digital library.
- A content can be used in different courses.
- Contents are entities with charcteristics which are inherent to them and not to the course that uses them.
- Contents are not to be enclosed in a course but are to be stored in a way that many courses can use them (with no multiplication of the files that hold them).
- Contents must be stored in a way that allows them to be used outside a course environment, as the books, maps and magazines in a library.
- Contents must be identified so that they can be searched and retrieved, as the items of a library.
- Authors have the right to decide if the contents they create are to be made public or accessed under different types of control.
- Authors have the right to decide if the contents they create can be used in couses they are not teaching.

These characteristics lead to a model that deals with contents as the items of a library and aims at sharing course contents (*Pavani* and *Lukowiecki*, 1999).

The following sections discuss two cases that show that the model has fulfilled its function of content sharing. Both are related to math contents and this is not a surprise since math is basic to many other areas. They are different in their nature – one of the cases deals with sharing texts on Linear Algebra and the other with sharing visualization programs to teach Calculus.

4. Case Study – Content Sharing in the Maxwell System

The Maxwell System has been operating in a multidisciplinary environment for the last three semesters and sharing was shown to exist. Since this is a result over a short period of time, the authors are sure that the continued use of the system will show many more examples, specially when more courses are included.

The following examples of sharing contents prove that such architecture is a good economy of development time as well as of storage space. Integrity of data is also assured.

The saving of time can be split in different categories:

- Time of the author/teacher – when a teacher is preparing the materials of his/her course, if there is an option to use contents which already exist, the choice may be to develop the parts which are missing or to add more interactive exercises, etc.
- Time of the technical staff – the team who transform knowledge into electronic files will spend less time in developing identical contents if sharing occurs. The characteristic of not duplicating instances is time saving too, since maintenance is on the only occurrence of each instance. Therefore, the team will be able to develop new items or to add technological or educational improvements into the existing ones.

As far as the storage space is concerned, the fact that there is no duplication of contents yields economy of storage space. This also leads data integrity because there is no risk of having the same occurrence with different data.

The following sections present two types of sharing. The first shows the sharing of contents among different courses and the second one among many instructors teaching the same course (at the same time or not). It is important to emphasize that sharing is not limited to these two types. There can be sharing among institutions or even among institutions in different countries; this last option leads to an interesting topic – language compatibility. This is one of the topics of the authors' reasearch areas.

A. Sharing Among Courses

There are areas of knowledge that are common to many curricula of the university. Many courses are taught on them – they are distinct in some specific parts of theory and in the examples applications, but alike in the basics. One of these areas is Probability and Statistics. There are courses in the curricula of Electrical Engineering, Industrial Engineering, Social Sciences, Psychology, etc. that need the contents of probability and statisitics. The following example illustrates the sharing between two such courses.

a. Probability and Statistics (ELE1829 – Department of Electrical Engineering) and **Statistics for Industrial Engineering** (IND1113 – Department of Industrial Engineering)

Both courses have the same objective: to teach probability and statistics to undergraduate students. The difference between them is the department of the students. The first one is taught by the Electrical Engineering faculty but the students are all engineering students except Electrical and Industrial Engineerings. The second is devoted to Industrial Engineering students. The main chapters of both courses are the same but the appplications are different, yielding different exercises lists and tests.

The shared chapters are:

- Population and Sample (População e Amostra)
- Descriptive Statistics (Estatí stica Descritiva)
- Introduction to Probability (Introdução à Probabilidade)
- Continuous and Discrete Random Variables (Variáveis Aleatórias Contí nuas e Discretas)
- Discrete Distribuitions (Distribuições Discretas)
- Continuous Distributions (Distribuições Contí nuas)
- Normal (Gaussian) Distribution (Distribuição Normal (Gaussiana))
- Random Samples (Amostras Aleatórias)
- Sample Distributions and Parameters Estimation (Distribuições Amostrais e Estimação de Parâmetros)

All the chapters have the same author – Prof. Monica Barros of the Statistics group of the Electrical Engineering Department.

b. National Accounts (ECO1212 – Department of Economics), **Linear Algebra for Economists** (MAT1215 – Department of Mathematics) and **Linear Algebra for Computer Science** (MAT1210 – Department od Mathematics);

The National Accounts course is taught to Economics students and requires knowledge of Linear Algebra. There is a course on Linear Algebra that is taught to Economics students but which is not a pre-requisite. When the National Accounts professor decided to use Maxwell to support his course, he noticed that on its digital library there was a large amount of Linear Algebra contents, that could save him a lot of in class time, reviewing those subjects.
The shared chapters are:

- Matrices (Matrizes)
- Determinant and Inverse Matrix (Determinante e Matriz Inversa)

The two chapters have the same author – Prof. Carlos Eduardo Pedreira of the Systems group of the Electrical Engineering Department. Some exercise lists were also used from Prof. Regina Posternak, who taught the Linear Algebra course with Prof. Pedreira.

c. Probability Theory (IND1114 – Department of Industrial Engineering) **and Probability and Statistics** (ELE1829 – Department of Electrical Engineering)

This example has the same characteristics of the one in item a, but involves different teachers and authors.
The shared chapters are:

- Probability (Probabilidade)
- Probability Examples (Exemplos de Probabilidade)
- Random Variable and Probability Distribuition (Variáveis Aleatórias e Distribuição de Probabilidades)
- Some Discrete Distribution (Algumas Distribuições Discretas)
- Some Continuous Distribution (Algumas Distribuições Contí nuas)
- Joint Probability Distribution (Distribuição de Proabilidade Conjunta)
- Point Estimation (Estimação Pontual)

All the chapters have the same author – Prof. Ana Cristina de Oliveira of the Statistics group of the Electrical Engineering Department, except the chapter Probability Examples, from Prof. Álvaro de Lima Veiga of the same group.

d. Controls and Servomechanisms I (ELE1741 – Department of Electrical Engineering) **and Mathematics Applied to Engineering** (MAX0006 – Department of Electrical Engineering)

The Mathematics Aplied to Engineering course was created for graduate students on Eletrical Engineering as a review on the most important topics in Math. Two chapters were shared:

- Diference Equation (Equações a Diferenças Finitas)
- Z Transform (Transformada Z)

The two chapters have the same author – Prof. Ana M. B. Pavani of the Systems group of the Electrical Engineering Department.
There are many other courses that share contents like **Econometry** (Department of Economics) **and Special Topics on Electrical Engineering** (Department of Electrical Engineering) or **Transport and Logistics** (Department of Industrial Engineering) **and Analisys of Transport Systems** (Department of Industrial Engineering). We believe that many other courses will share contents as our digital library grows and professors discovers the advantages on doing this.

B. Sharing Among Instructors

There are some situations in which courses are taught with many classes. In this case, each class has its instructor but they cover the same contents. Two examples of cooperative work lead to sharing of contents.

Linear Algebra for Economists (MAT1215 – Department of Mathematics)

In this course the two professors divided the work. Prof. Pedreira developed all text materials and Prof. Posternak all the exercises and problems. Both of them use the two sets. The students benefit from a homogeneous set of contents and the workload was split between the professors.

Calculus (Department of Mathematics)

The various courses on Calculus have many classes since they are taught to all Engineering and Economics students. The educational contents are of various natures – there are simulators for the student to interact with the contents and visualize the results, there are analytic exercises and problems to develop theoretical skills, etc. Since many instructors teach the classes, they all use the same the simulators and the lists of exercises are developed by the group and presented to all the students.

The simulators number more than 20 and were developed by the visualization laboratory of the Department of Mathematics – MatMí dia (http://www.matmidia.mat.puc-rio.br).

7. Conclusions

This paper presented a case study to illustrate the benefits of a digital library architecture that allows the reuse of the educational contents. As previously mentioned, the reuse is expected to grow when more contents are added to the digital library and more courses start using the system.

One of such cases is the undergraduate course on Business Administration. If it uses the systems, it is probable that items of the Economics, the Mathematics and the Industrial Engineering courses can be shared. The same may happen with courses on Theology and Philosophy or Education and Psychology.

Another observation on sharing contents which must be mentioned is that on reference materials which are common to many courses. One such examples is a booklet on how to use MatLab. Though it was written by a professor in the area of Electronics, it is used by all the EE students for their courses on Circuits, Controls, Electronics and Fuzzy Systems. It is an opinion of the authors that the digital library architecture of the system not only allows the sharing of contents but is a stimulating factor to it.

8. References

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