A Framework for Designing Multimedia-based Engineering Courses

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Abstract

The phenomenal growth of the Internet coupled with the advances in multimedia development tools presented new and exciting opportunities for educators as studies have shown that courses delivered via these mediums may improve retention, learning rate, and course completion. In designing a multimedia courseware, several related issues needs to be addressed such as course specification, instructional design, multimedia design, integration, implementation and evaluation. In this paper, we present a framework that addresses the course specification, instructional and multimedia design aspects. Although, an undergraduate electrical engineering course was used as an example, the framework presented is general enough that it can be used in others courses. The aim of the ware is to achieve the following broad objectives:
To strike a balance between lecturer-centered and student-centered approaches, and to cater for the different learning abilities of students

Keywords: Multimedia, Course Design, Instructional Design, Multimedia-Based Courses

1. Introduction

One of the main issues faced by educators is how to effectively deliver their lectures. By effective we mean to satisfy the diverse learning styles of students. Susan M. Montgomery has used Soloman's inventory of learning styles to classify the learning styles of students in a large class [2]. The results, shown in Table 1, show that student learning styles run the gambit of all the available styles. Although, it can be argued that the traditional method of delivering course materials may satisfy these diverse learning styles if the course materials were adequately designed and the delivery method was geared toward these goals. Indeed, the earlier implementations of computer-aided instruction were basically just conversion of the course materials from paper to computer format. The adoption of computer-aided instructions (CAI) was because studies have shown it may improve retention, learning rate and an increase in course completion compared with traditional methods of delivery [3]. In addition, the phenomenal growth of the Internet during the last few years coupled with the advances in multimedia development tools presented new and exciting opportunities for educators such as bringing "real-world decision making issues to the classroom as has never been done before" [4]. Moreover, the use of information technology in education "has facilitated" feedback to the students as well as "provided the teachers timely data that accurately identified difficulties which students encountered" [7]. Another important feature of computer-based instruction is that students can learn at their own speed and time.

Table 1: Learning Styles (Adopted From 2)

Processing		**Perception**	
Active	67%	Sensing	57%
Reflective	32%	Intuitive	42%
None	1%	None	1%
Input		**Understanding**	
Visual	69%	Sequential	71%
Verbal	30%	Global	28%
None	1%	None	1%

The above argument does not mean that multimedia based courses are suitable for all situations or they should replace the traditional method of delivery. What it does mean however is that faculty should evaluate the suitability of multimedia for their courses. Harmon and Jones [5] listed 11 factors that influence the desirability of web-based instructions and some of these factors

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apply to multimedia-based courses regardless of the way they are delivered.

Having decided to use multimedia-based courses either as the primary means of presenting their courses or as a supplement to the traditional delivery method, the question faced by faculty is how to go about designing multimedia-based courses. In this paper, we present a general framework for designing multimedia-based courses. The framework aims to achieve the following broad objectives: To strike a balance between lecturer-centered and student-centered approaches, and to cater for the different learning abilities of students.

2. The Framework

Benyon et al [1] identified several related activities that must be undertaken. These are course specification, instructional design, multimedia design, integration, implementation, and evaluation. In this paper, only the first three stages will be described. However, a brief description of student-centered and teacher-centered approaches will be given first. In the teacher-centered approach the teacher lectured and promoted discussion. Cste and Gentry [6] used the term "learner-controlled instruction" to describe the student-centered approach. In their definition, a learner-controlled environment exists when the learner have some control over the learning environment. This control can be in the form of "procedure", "time restraints", or "evaluation".

2.1 Course Organization

To enable the realization of the first objective, the course materials are organized as shown in Figure 1. The course materials are divided into Chapters. Each chapter contains a set of learning objectives that inform the student what he should be able to do after completing the chapter. This followed by several units. Each unit has an objective, a fundamental part, and a unit test. Preferably, each unit should only cover one small topic that the student is able to study in one session. The chapter ends with a summary that enforces the materials which has been studied followed by a chapter test to test the level of achievement of the student. The unit test and the chapter test should have a large enough number of questions so that different students taking the same test will get different questions so that copying of answers between students is minimized. It also minimizes the ability of the same student guessing the questions when taking the same exam more than once.

2.2 Instructional Design

Instructional design is concerned with the pedagogic approach taken in the organization of the course

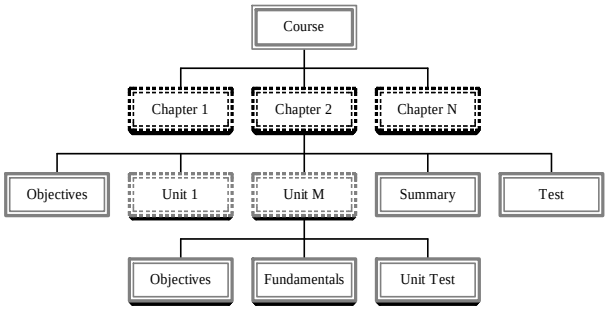

Figure 1. Course Organisation

materials. The instructional design is guided by the following principles:

- Learning by objectives whereby for each chapter and a unit of a chapter, a list of learning objectives is given at the beginning. These objectives inform the students of what they are expected to know or should be able to do after the completion of the chapter or unit. In addition, they are used as a guide in formulation the test questions given at the end of the chapter or unit.
- Re-enforced learning whereby the test given at the end of each unit or chapter should have some

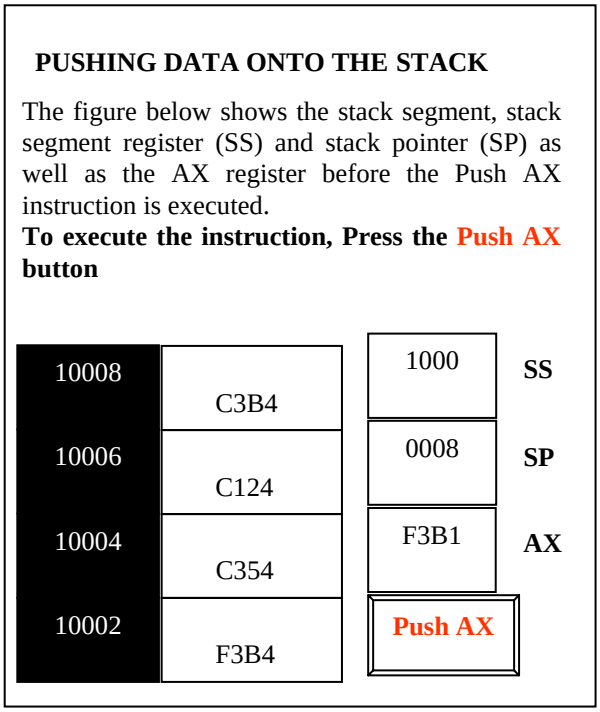

Figure 2. Discovery Learning

questions about materials covered in the previous chapters.

- Discovery learning whereby simulations and visual explanations should be used wherever possible, as most learners prefer active and visual learning. Figure 2 shows an example of a simple simulation that explains how data is pushed onto the stack.
- Personalised learning whereby the style of presenting the course material to the student is tailored to the student's learning ability. The student's learning ability is determined in real-time by the multimedia component according to the cumulative percentage mark obtained by the student for the tests as well as the average time taken to complete the previous units or chapters. Students will be classified, according to their learning abilities, into weak, average, and good. For weak students, more detailed explanations will be given compared with average and good students. Figure 3 shows the explanation given to a weak student while Figure 4 for an average or a good student after they have carried out the simulation of Figure 2.

Did you notice?

- The data stored in the AX register is placed in the stack segment at the address given by SS:SP register pair.
- The data in the AX register did not change
- The value of the SP register is decremented by 2 because the size of AX register is 2 bytes.

Thus, the PUSH instruction places 2 or 4 bytes of data on the stack depending on the size of the register being pushed. The general syntax is:

PUSH source.
Where source can be a register or an immediate Value

Figure 3. Presentation Style for Weak Students

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PUSH source.
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Figure 4. Presentation Style for Average and Good Students

2.3 Multimedia Design

The multimedia design stage involves the selection of multimedia authoring tool, the design and production of the multimedia components of the course. The selection of the multimedia-authoring tool should be done after the design of the multimedia components is completed. To strike a balance between student-centered approach where the student is free to study the course materials in any manner he/she likes and the lecturer-centered approach whereby the lecturer decides what to study, the system should have two modes: Study mode and Review mode. In the study mode, which is basically a lecturer-centered approach, the student is guided through the course materials. The course materials that have been studied by the student will be available, in a student-centered approach, in the Review mode.

For each student, a percentage cumulative mark achieved by the students as well as the average time to complete a unit will be maintained. The percentage cumulative mark will be used to classify the students into three categories of Low, Average, and High. While the Average time will also be used to classify students into another three categories of Slow, Average, and Fast as shown in Figure 5. These two categories will be used to

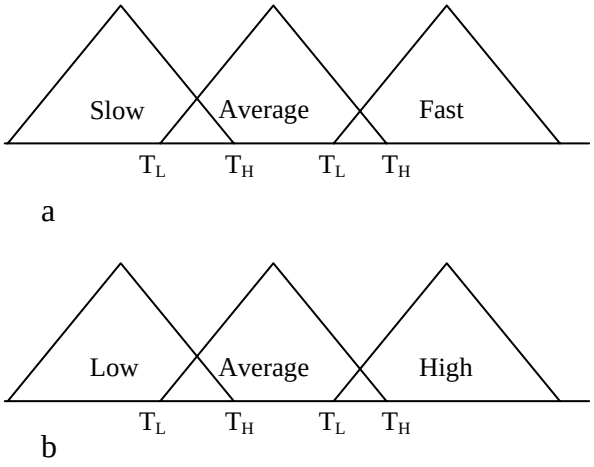

Figure 5. Classification of Students according to Learning Speed (a) and Percentage Cumulative Mark (b)

classify the learning ability of the student into Weak, Average, or Good as shown in Table 2.

When a student uses the system for the first time, he will be classified, as average learner and he will be in Study mode in chapter one. The student can either study the chapter from beginning to end or he can go straight to the unit 1 test. However, the student can only progress to the next unit only if he obtains a passing mark on the test of the current unit.

When a unit is completed, the student's learning speed and his percentage cumulative mark will be calculated. These will be to re-classify the student as follows. If the learning speed or mark is higher than the upper threshold of his current category then he will be moved up category. However, if it is below the lower threshold then he will be moved down one category, otherwise, no change to his category. Thus, the learning ability of the student and thus, his learning experience is adjusted, in real-time, by the mark he obtains and the time he spends learning the materials.

Table 2. Learning Ability Classification and the Associated Control based on the Mark and Speed Categories.

Mark	Speed	Learning Ability	Control
Low	Any	Weak	None
Average	Slow	Weak	None
Average	Average or Fast	Normal	Detail
High	Slow	Normal	Detail
High	Average or Fast	Good	Detail & Explore

3. Conclusions

In this paper, we have argued that multimedia-based courseware gives educators new and exciting opportunities for effectively delivering their courses in a way that can meet the varying learning styles and abilities of their students. In addition, a framework for designing multi-media-based engineering courses was presented. The framework highlighted the design methodology we have used in the course organization, as well as the instructional and multimedia design stages to achieve the framework objectives of striking a balance between lecturer-centered and student-centered approaches as well as to cater for the different learning abilities of students

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