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Rapid Development of Multimedia Instructional Modules for Information Technology Education

Nanda Ganesan
California State University, Los Angeles

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Nanda Ganesan
California State University Los Angeles
USA

ABSTRACT

A multifaceted learning model was developed for implementing e-learning in a largely commuter campus. The primary objective of the model was to build a flexible learning environment that combined the learning effectiveness of in-class learning with the flexibility and accessibility of online learning. One of the components of the model was the multimedia instructional modules produced to teach various Information Technology courses. Several different types of modules were produced representing chalk-and-talk type of lectures, PowerPoint presentations and software tutorials. The chalk-and-talk type of lecture modules and the software tutorials that emulated the in-class learning experience contributed positively towards enhancing the learning experience of the students. In producing the modules, emphasis was placed on the rapid development of the modules. An approach that sought to achieve a balance between rapid application development and learning effectiveness was found to be necessary to facilitate the adoptability and usability of the modules by the instructors. In this paper, the design, development and usage of the modules are discussed with an emphasis placed on the rapid development of appropriate modules for different learning scenarios.

INTRODUCTION

A multifaceted learning model was developed to introduce e-learning in selected Information Technology courses. A university-wide initiative that encouraged the use of technology in teaching provided the initial impetus for the development of the model (Clay, Harlan, & Swanson, 2000). The model consisted of three major components (Ganesan, 2002). The first component was the course websites designed to disseminate course related information. The second component was the multimedia instructional modules intended to broaden and enhance the learning experience of the students. The third component was the cyber lab implemented to facilitate the completion of hands-on laboratory assignments over the Internet.

The objective of the e-learning model was to build a learning environment that would combine the learning effectiveness of a traditional classroom with the learning flexibility of cyberspace. Recent advances in hardware and software technologies have made it possible for proven teaching techniques used in the traditional classrooms to be incorporated in multimedia instructional modules. The technologies have also matured to the extent that they are now able to support the rapid development of the modules as well. Moreover, the growth of the Internet has provided the opportunity to create a flexible learning environment that can transcend the temporal and spatial constraints of a traditional classroom.

In the ensuing effort, the development of the course websites and the multimedia modules proceeded without hindrance. The implementation of the cyber lab, however, was discontinued

due to security restrictions imposed on access given to the resources on the campus network. The course websites grew and matured to become an essential and integral part of instruction. The multimedia modules also followed suit. The modules now play an important and definitive role in enhancing the learning experience of the students. The factors that contributed to the successful development and deployment of the modules are the subject of this paper. In particular, the techniques used for incorporating the in-class learning experience in the modules and the technology that is now available for the repaid development of the modules are discussed in some detail in the following sections.

INITIAL DEVELOPMENT OF THE MODULES

During the initial stages of development, a twin-track approach was pursued to develop the modules. The first track focused on producing multimedia modules to teach the theoretical concepts taught in a course. The second track concentrated on producing the modules intended to teach the practical components of a course. The modules designed to teach the theoretical concepts were based on PowerPoint lectures while the modules that were designed to teach the practical components were based on software simulations. The latter functioned essentially as software tutorials. The tutorial modules were more effective than the modules developed for teaching the theoretical concepts.

Overall, however, both types of modules were well received by the students as noted in a brief initial survey conducted during the early stages of using the modules for instruction in the classrooms. The results of the survey are summarized in Figures 1, 2, 3 and 4. The favorable results depicted in these figures corroborate with the findings of others as well (Jereb & Smitek, 2006). In general, the positive responses received in the survey were attributed to the learning effectiveness and the flexibility of the multimedia modules.

Figure 1: Clarity of the Multimedia Modules.

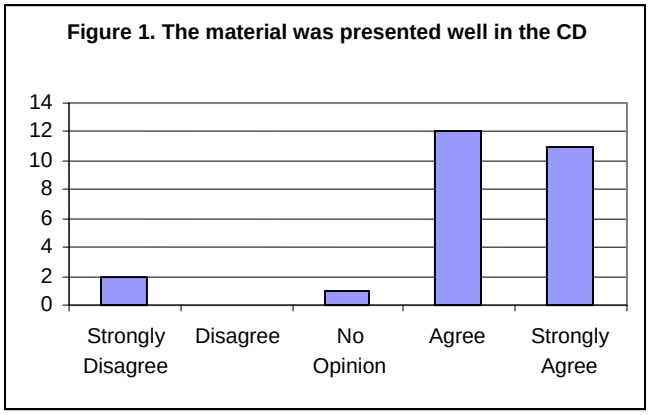


Figure 2: Learning Effectiveness of Multimedia Instructional Modules.

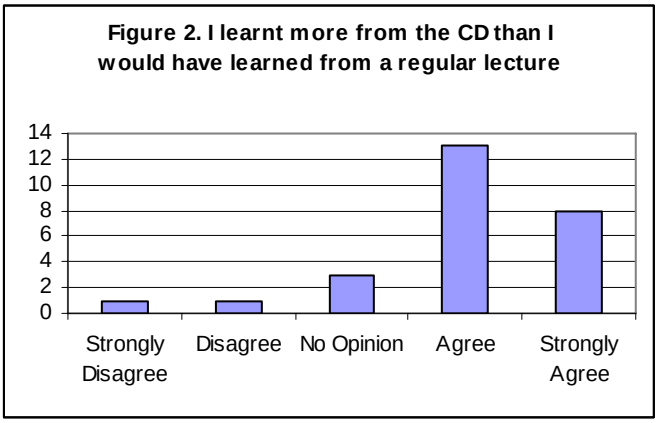


Figure 3: Comparison of CD Based and Non-CD Based Lecture Formats.

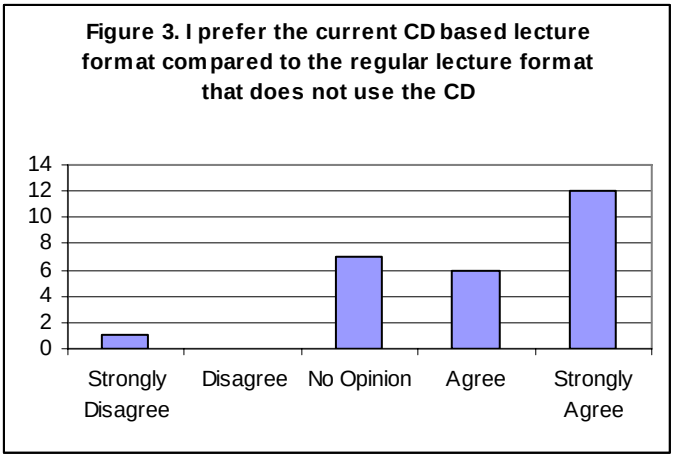
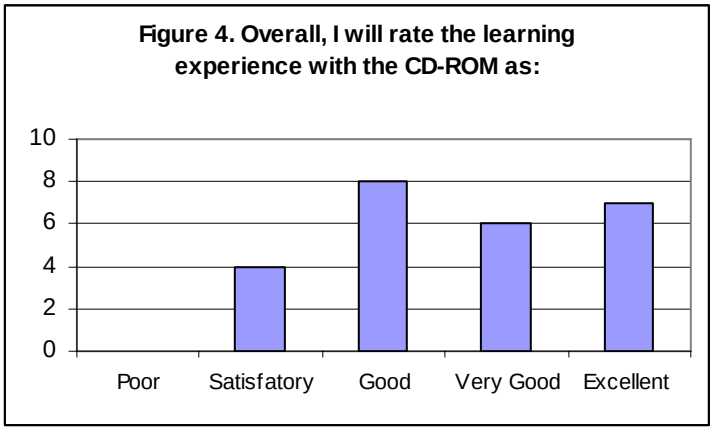


Figure 4: Overall Learning Experience with the Multimedia Modules.



There were a number of specific reasons as well that contributed to the favorable ratings given by the students. First and foremost, the students were able to control the pace and sequence of instruction and make personally meaningful choices for learning while using the modules (Editorial, British Journal of Educational Technology, 2003). Second, the multimedia modules were effective in addressing the diverse learning styles of the students (Montgomery, 1995; Choi, Lee & Jung, 2008). Third, the modules along with the course websites contributed to an improvement in the students' attitude towards the course and the instructor (Koeber, 2005). Encouraged by these initial positive results, the multimedia modules were earmarked for further development and improvement.

FURTHER DEVELOPMENT AND IMPROVEMENT OF THE MODULES

Further improvements to the modules were sought in two fronts, namely in the learning effectiveness of the modules and in the adoptability of the modules. The effort to improve the learning effectiveness was centered on the PowerPoint based lecture modules because they were considered to be the least effective of the two types of modules produced. One of the reasons for the lack of effectiveness in these modules was attributed to the ineffective use of the dual-processing capability of the human memory by the modules.

The dual-processing model assumes memory capacities to be distributed over separate auditory and visual channels (Mayer & Moreno, 1998; Penney, 1989; Schneider & Detweiler, 1987). In the case of the modules based on PowerPoint presentations, the auditory channel was found to be overloaded while the information presented over the visual channel lagged behind. This was especially the case with modules of longer duration. The fact that the information displayed on the slides remained static without any accompanying animated explanations was also considered to be yet another contributing factor to the lack of effectiveness of the modules.

As a means of overcoming the said drawbacks with PowerPoint based lectures, it was decided to simulate the chalk-and-talk type of lectures in the modules. In the actual classroom environment, PowerPoint based lectures are often complemented by chalk-and-talk type of explanations to maximize the learning effectiveness. One of the reasons for the effectiveness of the chalk-and-talk type of lectures was that the pace of such lectures maintained a balance between the audio and video channels of learning. Furthermore, the lectures were invariably punctuated with animated explanations to elaborate the concepts presented in the lectures. Also, by simulating the chalk-and-talk type of lectures in the modules, it would be possible to capture the in-class learning experience in the modules. The inference made was that the simulation of the in-class lectures in the modules based on good and proven teaching techniques would improve the effectiveness of the multimedia modules significantly, especially in the case of modules that were intended to teach the theoretical concepts.

The above discussion on the drawbacks of adopting PowerPoint based lectures in the modules did not necessarily negate the use of PowerPoint slides altogether. PowerPoint presentations have received positive reviews as well (Frey & Birnbaum, 2002; Lowry, 1999; Susskind, 2005). They are particularly useful for presenting brief introductions and summaries without incurring the cognitive imbalance between the video and audio channels of learning. Also, the PowerPoint slides generally provide a good organizational structure to the lectures (Susskind, 2005). Given

these positive prospects of PowerPoint based lectures, they were slated for use in the production of modules of shorter duration such as those intended to present overviews and summaries.

The second area mentioned earlier for further improvement was adoptability. Adoptability implied the ability to easily and rapidly develop the modules by the instructors. In order to facilitate the rapid development of the modules, it was important to identify and use hardware and software tools that could support the development of the modules with minimum effort and time. In this respect, a survey of hardware and software was conducted that successfully identified the necessary tools for the rapid development of the modules. The results of the survey have been published elsewhere (Ganesan, 2007). This article serves the added purpose of presenting the actual development and deployment of the modules using the hardware and software identified by the earlier survey.

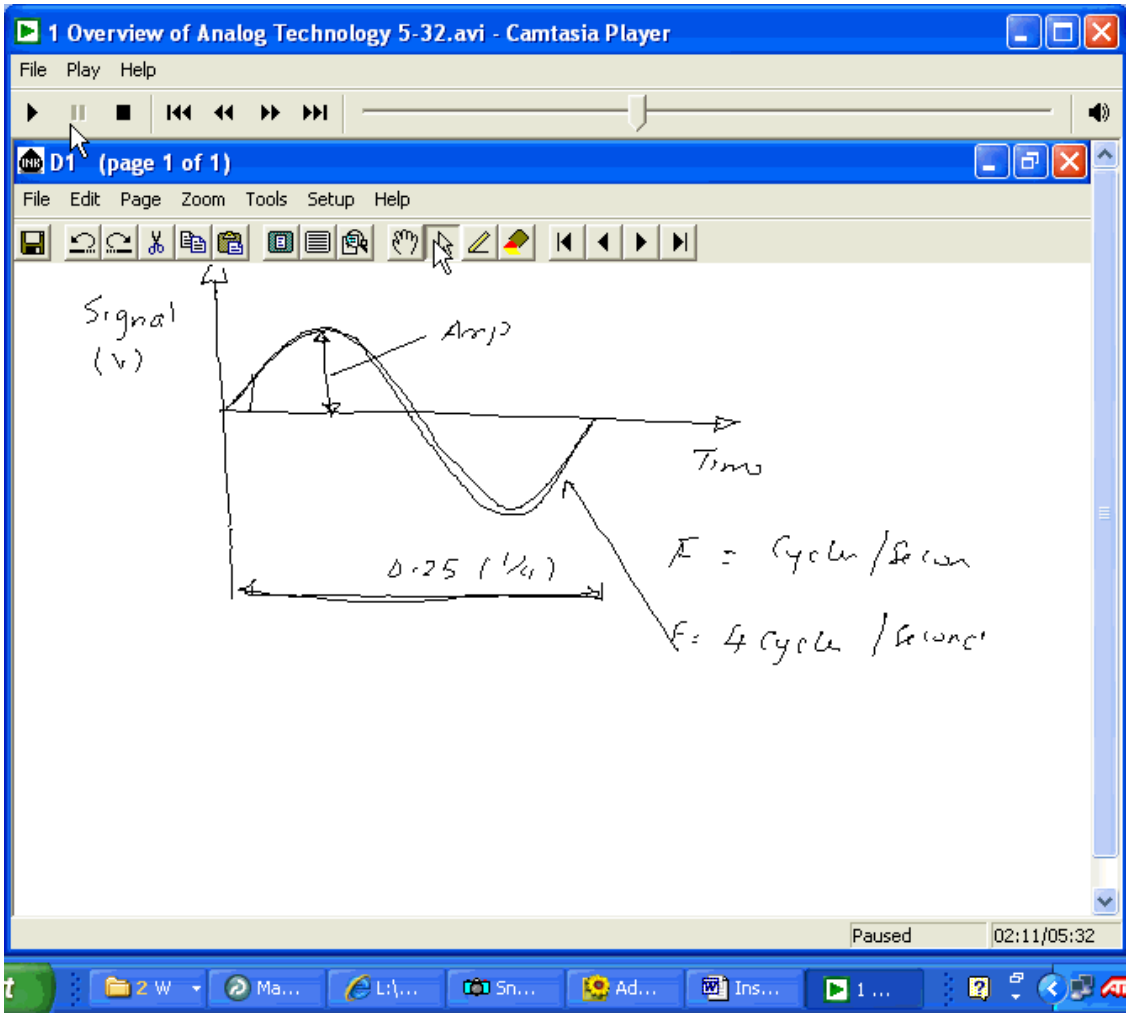
DEVELOPMENT OF THE MODULES

Five different types of multimedia modules were produced based on the design strategies and methodologies discussed in the previous section. The modules are listed in Table 1 along with a brief description and the purpose of each of the modules. The first type of modules produced, namely the chalk-and-talk type of lecture modules, was created using Camtasia (Smith & Smith, 2007; TechSmith, 2007). To simulate the electronic whiteboard used in the lectures, the Seiko InkLink handwriting system was used (Frey, 2002). The written explanations on the whiteboard and an accompanying audio narration were recorded using Camtasia to simulate the lectures given in the classrooms. A screen image of a video frame from a module produced in this manner is shown in Figure 5.

Table 1: Types of Multimedia Modules Produced.

Module	**Module Type**	**Purpose**
1	Chalk-and-talk lectures	Teach concepts and theory
2	Short lectures based on PowerPoint slides	Present introduction and summaries
3	Software tutorial modules with narration	Teach software applications in detail
4	Software tutorials with annotated explanations	Teach software applications
5	Interactive software tutorial requiring input from students	Test software application skills

Figure 5: Screen Image from a Chalk-and-Talk Type of Multimedia Module.



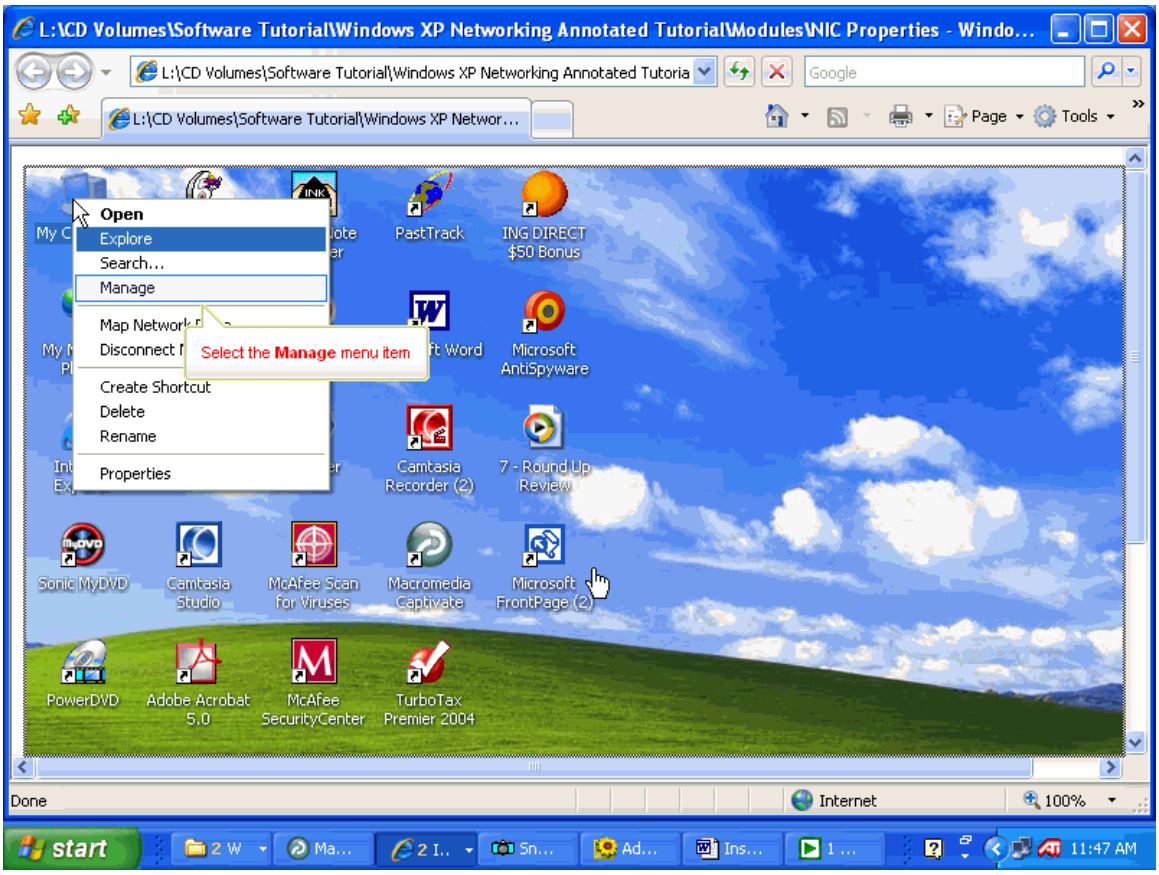
While the modules that were longer in duration were modeled based on chalk-and-talk type of lectures, the modules that were shorter in duration were created based on PowerPoint presentations. These modules are listed as the second type of modules produced in Table 1. As in the previous case, Camtasia was used to record the slides displayed on the screen along with an accompanying narration. Both the chalk-and-talk type of lecture modules and the PowerPoint based lecture modules were produced rapidly and with relative ease.

The third type of instructional modules listed in Table 1 was known as the passive software tutorial. These modules were termed as passive tutorials because they did not require the students to provide any input during a tutorial session. The passive tutorial modules were produced using Camtasia. To create the tutorials, the software related activities that were being displayed on the computer screen were recorded in real-time along with an accompanying narration. These modules required minimum time and effort to produce.

To develop similar tutorials but with annotated text in place of the accompanying audio narration, the Captivate tutorial authoring software was used. Captivate automatically created

and inserted the annotated explanations without user intervention (Adobe, 2008; Digital Inspiration 2008). As such, it was possible to produce the modules rapidly and with minimum effort. Figure 6 shows a screen image containing an annotated text. In this particular example, the user is guided by the text shown on the screen into selecting the "Manage" option from a list of options displayed on a dropdown menu.

Figure 6: Screen Image from a Software Tutorial with Annotated Text.

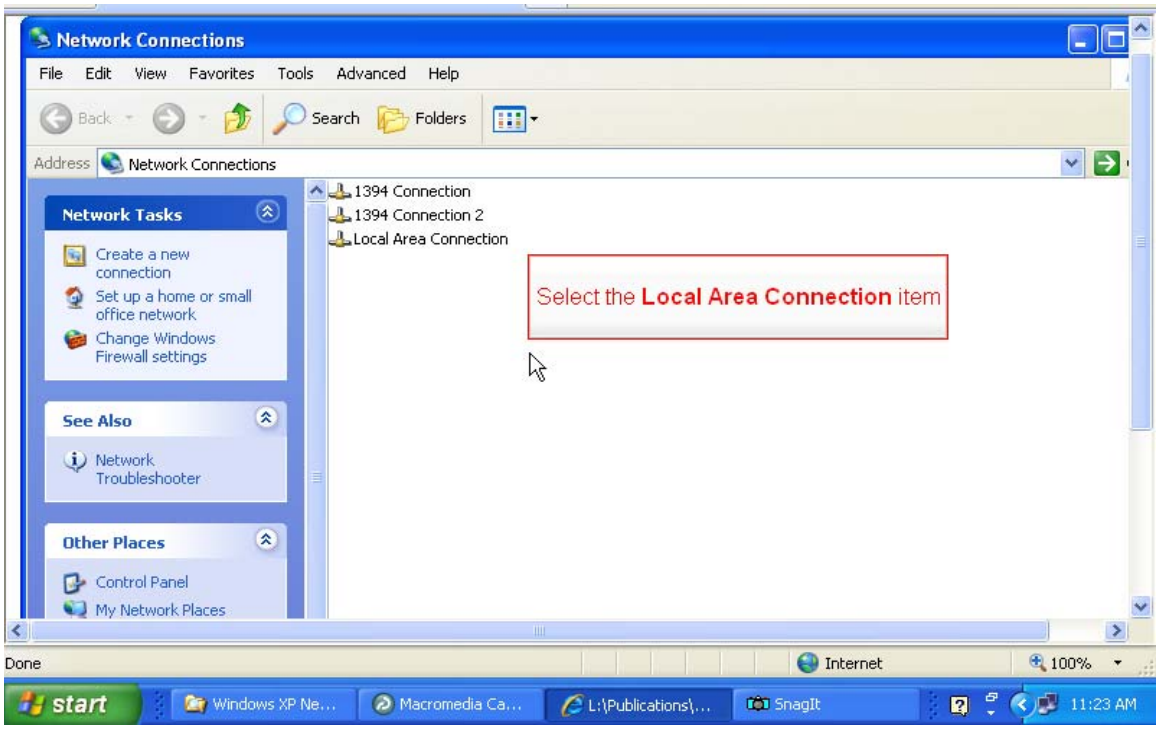


Audio explanations could also have been added to the annotated text, but the additional information provided in this manner would have been redundant and counterproductive to the learning process (Jamet & Le Bohec, 2007). The modules with annotated text also functioned as passive tutorials because they did not require the students to provide any input during a tutorial session. The passive software tutorials produced in this manner are listed as the fourth type of modules produced in Table 1.

The fifth type of modules produced was the interactive software tutorials. These modules were produced easily and rapidly using the software simulation option available within Captivate (Good & Luigi, 2008). The software tutorials enabled the students to engage in interactive learning by requiring them to provide inputs at regular intervals during a tutorial session. The students were allowed to proceed from one stage to another only if they provided the correct input at each stage. If not, an error message was displayed offering the students guidance on the

correct procedure to follow. Figure 7 shows a screen image from an interactive tutorial session. In this screen, the text displayed is designed to offer guidance on the corrective action to pursue in response to an incorrect input given earlier by the student.

Figure 7: Screen Image from an Interactive Tutorial Module Offering Guidance.



LEARNING EFFECTIVENESS, ADOPTABILITY AND USABILITY

Following the development and use of the modules for a period of four academic quarters, they were evaluated with respect to their effectiveness and adoptability. Several methods and procedures have been suggested for systematically and objectively evaluating the effectiveness of multimedia instructional modules (Kennedy, Petrovic, & Keppell 1998; Sing & Der-Thanq, 2004). At this time, however, it was decided to conduct a subjective evaluation of the modules. The intention was to obtain an early feedback on the effectiveness and adoptability of the modules. A detailed evaluation was to follow after exploring the opportunities now available to stream the modules for efficient delivery over the Internet.

The subjective evaluation conducted was based partly on the time and effort required to develop the modules by the instructor, and partly on the feedback received from the students on the effectiveness of the modules. The former was used for assessing the adoptability of the modules while the latter was used for gauging the learning effectiveness of the modules. In the case of the latter, both formal and informal feedbacks were obtained to assess the effectiveness of the modules. Formal feedback was obtained from anonymous comments written by the students on student evaluation forms. Informal feedback was received from students while they were in the process of using the modules. The results of the evaluation of the modules with respect to the two measurement criteria are summarized in Table 2. Also, the potential for rapid application

development in the case of each of the modules is listed in the Table as an indicator of the module's adoptability.

Table 2: Evaluation of the Modules.

Module	Teaching Purpose	Learning Effectiveness	Rapid Application Development Potential
1. Chalk-and-talk type of lectures	Concepts and theory	Excellent	Excellent
2. Short lectures providing summary or introductions	Introductions and summaries	Good	Excellent
3. Software tutorials with audio narration	Software applications	Excellent	Excellent
4. Software tutorials with annotated explanations	Software applications	Unsatisfactory as a teaching tool as the tutorial requires prior knowledge of software	Good
5. Interactive software tutorial requiring input from students	Software applications and skill testing	Unsatisfactory as a teaching tool, but satisfactory as a testing tool	Good

The first type of modules produced, namely the chalk-and-talk type of modules, was found to be far more effective in teaching the theoretical or the descriptive components of a subject compared to the PowerPoint based lecture modules that were used earlier for the same purpose. This is an important observation in light of the findings of others (Marold & Haga, 2004) who have noted that the students may not perform well in the theoretical components of web delivered courses. The inference made is that the simulation of chalk-and-talk type of lectures in the modules can be particularly useful in overcoming the stated drawback and provide answers to similar concerns.

The second type of modules produced, termed as the short PowerPoint based lecture modules, was found to be effective in presenting introductions and summaries. Although there are contradictory results reported on the use of audio and video in learning modules of this nature (Koroghlanian & Klein, 2004; Veronikas & Maushak, 2005), the combined effect of audio and video on learning effectiveness has been beneficial to the students.

The third type of modules produced, termed as the software tutorial modules with audio narration, was found to be very effective in teaching software applications. The audio narration offered the advantage of being able to elaborate the screen activities demonstrated on the screen. These modules were effective notwithstanding the lack of interactivity in the modules.

Interactivity was introduced as an afterthought by requiring the students to pause the modules at regular intervals during a learning a session and perform the procedures being demonstrated on the screen.

The fourth type of modules produced, namely the software tutorials with annotated explanations, had limited success in teaching software applications. These modules contained only brief annotated explanations of the screen activities. As such, the students who were unfamiliar with the software were unable to fully benefit from the tutorials. In contrast, the audio explanations included in the previous set of modules did not require the students to have any prior knowledge of the software package being demonstrated.

The fifth type of modules produced, namely the interactive software tutorials, required the students to provide input at various stages of a tutorial session. In spite of the presence of interactivity in the modules, the modules were not very effective in teaching the software concepts and applications. As in the previous cases, the students were required to have a reasonable understanding of the software beforehand in order to be able to provide the required input at each stage of a tutorial session. Without such an understanding, the students often found themselves lost and unable to navigate effectively through the tutorial.

The interactive software tutorials were found to be better suited for testing the knowledge of the students on software applications. In this case, the number of correct responses given by the students during a software simulation session was scored and provided as feedback to the students to assess their performances. The feedback also offered the opportunity to implement learning assessment in the modules. The readily available and built-in scoring option provided in Captivate was found to be particularly useful in scoring the number of correct responses given by the students.

SELECTION AND USE OF THE MODULES

The salient points of the above discussion on the usability and effectiveness of the modules are summarized and presented in Table 3. Based on this assessment of the modules, the chalk-and-talk type of lecture modules, the PowerPoint based lecture modules and the software tutorial modules incorporating audio narrations were selected for use both in the classrooms and in the computer labs. All three modules were easily and rapidly produced. Each type of module was effective in serving a particular purpose of learning as outlined in Table 3. These modules provided the optimum balance between learning effectiveness and the potential for rapid application development. The software tutorials with the annotated text and the interactive tutorials mentioned earlier were both found to be unsuitable for instructional purposes. They were not pursued further due to stated limitations.

Table 3: Effectiveness, Usability and Adoptability of the Modules.

Module Type	Effectiveness and Usability
1. Chalk-and-talk type of lectures	- Very effective for teaching the theoretical concepts and the descriptive details of a subject - Simulated the in-class learning experience remarkably well - Produced better results when complemented by course related information such as PowerPoint slides hosted on a course website
2. Short lectures and presentations	- Useful for short lectures such as those intended to deliver introductions and summaries
3. Software tutorials with audio narration	- Very effective as tutorials in spite of the lack of interactivity - If desired, interactivity could be introduced by pausing the modules at appropriate intervals and performing the activities demonstrated on the screen during a tutorial session - Audio narrations provided comprehensive explanations of the screen activities
4. Software tutorials with annotated explanations	- Not found to be effective as software tutorials - Students were required to have a basic knowledge of the software package prior to using the tutorial - Although considered redundant, audio narration could be included, if desired
5. Interactive software tutorials requiring input from students	- Not found to be effective as standalone software tutorials - Students were required to know the basic operations of the software beforehand - Could possibly be used for testing the knowledge of the students

CONCLUSION

The development and use of the instructional multimedia modules discussed in the previous sections led to a number of important conclusions. First and foremost, it confirmed the value of the age old concept of using the chalkboard for explanations as one of the most effective methods of teaching. Second, it asserted the need for the multimedia modules to be simple. Simplicity in learning has always reined as the formula for success in traditional learning and multimedia learning is no exception to this notion. Third, the study drew attention to the fact that instructors should be able to readily and rapidly develop the modules. The adoption and use of the modules by instructors is contingent upon them being able to easily and readily develop the

modules. Fourth, the study highlighted the emergence of powerful software and hardware tools that could now facilitate the rapid development of effective multimedia instructional modules.

Given the availability of the right tools and techniques for rapid application development, the effectiveness of the modules for the most part will now depend on the developer's creativity and teaching ability. As such, the best possible learning experience delivered in the modules will be consequential to the teaching effectiveness of a good instructor whose method and style of teaching are captured and embodied in the modules. In general, multimedia modules based on good teaching practices are likely to yield better results than in-class lectures that employ poor teaching techniques and approaches. Also, when the teaching materials provided by the instructors on a CD-ROM are authentic and contextually relevant, they are likely to yield better results (Khine & Lourdusamy 2003).

The instructors also stand to benefit from the use of the multimedia modules in classrooms. In using the learning modules in ways that increase the participation of students, the instructors can become less teacher-centered and more student-oriented in the classroom (Koebar, 2005). They can now devote more time for creative interaction with the students while spending less time providing repetitive explanations of the material covered in the lecture. Overall, the combined effect of text, multimedia and face-to-face instruction can enhance the learning experience of the students (Passerini, 2007). A hybrid teaching approach that uses e-learning tools to complement face-to-face instruction is thought to be well suited for college-level education (Debevec, Shih, & Kashyap, 2006; Peat, Franklin, Lewis, & Sims, 2002). It can provide the students with a range of benefits such as empowering them to take more control over their learning experiences (Gibson, Buche, & Waite, 2008).

The above mentioned advantages are likely to motivate instructors to develop and use multimedia instructional modules in their teaching provided they are able to rapidly develop such modules. As the instructors gain more experience in producing effective learning modules, the use of such modules for instructional purpose in colleges is likely to grow. Factors such as the anticipated and eventual increase in the deployment of ultra-wideband communications (Templeton & Schmidt, 2005) would also contribute to the availability of multimedia learning modules on the Internet. Furthermore, with declining prices of home PCs and the increasing importance of Internet, the affordability of the technology has improved (Maskara, Aggarwal, & Maskara, 2006) enabling students to personally benefit from e-learning tools such as the multimedia learning modules.

The availability of instructional videos on YouTube has added yet another dimension to the possibility of these modules being used for instruction. Other than YouTube, there are new avenues for the instructor's to publish their work on refereed portals such as Merlot (Cafolla, 2006) that offer the added advantage of their work being peer reviewed and recognized. Given the many advantages of using multimedia learning modules and the anticipated growth in the use of such modules, this paper has hopefully given an insight into the possibilities, opportunities and challenges that await those contemplating the development and deployment of multimedia instructional modules for IT education.

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