

Planning Effective Multimedia Programs for Technical Education

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Abstract

Successful multimedia (MM) programs achieve specific goals; they clarify abstract topics that are difficult to understand using traditional teaching media, they are available to both teacher and student, they provide an effective evaluation platform and they focus on teaching the concepts rather than entertaining the student with shallow special effects. MM provides a visualization tool that can transform abstract concepts into simple demonstrations. MM can also accommodate individual learning styles and evaluation needs. Students evince strong acceptance and improved learning when their instruction includes programs developed with the above principles.

Introduction

We live in a dynamic, colorful interactive world and yet, until quite recently, teachers had to rely on largely static, monochromatic teaching media and verbal lectures. Color and graphics could be provided with slides and sound and motion could be added with tape and movies - but only in a serial, non-interactive format. Live demonstrations such as working experiments or electronic instruments have always been helpful, but for large classes only those few in front could really see the details. Multimedia (MM) is the next generation teaching aid that integrates and enhances all these other media, making significant improvements to teaching. Slides become active, or interactive, and are integrated into the lecture. Animation sequences of varying degrees replace fixed movies. They can be run forward or backward, fast or slow, zoomed in or out, easily repeated in full or part. Live demonstrations of working models or experiments can be now included, projected on a large overhead screen along with other media.

This new generation of teaching tools is made possible through the wide availability of powerful personal computers. Thirty-two bit processors, multi-megabyte memories, gigabyte plus storage and new software suites to integrate and present materials are easily available. All this computer power has created and fueled MM development. Presentation systems, such as projectors are still the weak link in the chain. These are expensive and generally have poor contrast and

resolution. Progress in this area is urgently needed.

MM can be used to assist an instructor in the classroom or replace an instructor as in distance learning. The design of MM materials is quite different in these two cases. In the first the instructor and students interact together and the MM system is manipulated to illustrate the lesson. In the second the MM system must anticipate all questions and have answers ready. The MM system must also keep the attention of poor, average and exceptional students throughout the presentation without the benefit of an experienced instructor observing the class.

Multimedia assisted learning is being used in the EET program at BYU in three ways. First multimedia is used in the classroom, as an aid to lectures. Second the multimedia modules are available on laboratory computers for individual student review and study. And third the modules contain testing sections which the instructor and student can use for practice and evaluation.

Multimedia in the Class Room

What is MM in the class room environment? It could be an elaborate interactive computer program teaching a specified topic, or a simple computer simulation program, an animated sequence or a math calculation package. It could be a spreadsheet program, use of a presentation package, or just sound enhancements. Any of these, or a variety of other media integrated under control of the computer represents MM enhanced learning. We have used several combinations of the above to enhance the lecture and learning in technical classes. Such MM modules vary in size and complexity, as well as media used, each module being optimized for a particular application. There are several excellent authoring programs available to put these MM modules together, providing fairly easy development of the programs. While there is considerable time and expense involved in preparing these modules, much of it is one-time preparation, with only minimal modifications for further uses.

Multimedia in the class room provides distinct advantages for the instructor as well as for the student. Multimedia modules assist the student by making subjects more understandable, by enlivening lectures,

making them more interesting and holding the students' attention. If a picture is worth a thousand words, then how much more worth is the picture when animated and controlled. Concepts that are difficult, even impossible to see physically can be modeled with clarity using MM. An electron, an electromagnetic field, or a chemical reaction is easily demonstrated using animated multimedia models. MM can assist the instructor by giving better control and more advance preparation to the lectures. MM modules can be planned and prepared until they run smoothly, while allowing the instructor to remain involved and in control.

Development of MM Class Presentations

The first step in using MM in a given class is to select those topics which will most benefit from MM presentation. These should be topics that are difficult to communicate in traditional ways, those that will be easier to explain, and easier for students to understand when accompanied by media demonstrations. MM modules take time to prepare, and successful programs will be carefully designed to illustrate the most difficult concepts for a specific audience, but will not be used merely to entertain. Entertainment successfully attracts students' attention but if it is not focussed on the topics to be taught it eventually and inevitably devalues the effectiveness of MM in all applications.

Prepared presentations can be in a variety of styles or methods. Traditionally technical classes use overhead transparencies to augment classroom discussion. For example, to explain the conditions required to launch a light wave in a fiber optic cable, it helps to use overhead transparencies showing the angles of refraction and reflection. This is complicated to explain because propagation in the cable depends on the application of Snell's law at the fiber internal cladding, and this must be translated through the related angles to Snell's law at the fiber input. By animating the light vectors however, it is immediately apparent that light exceeding a given critical angle at the input is refracted and lost to the cladding, while light below the critical angle at the input is reflected at the cladding and propagates. In addition to demonstrating the critical launch angle, the vectors are animated. Animation attracts and holds audience attention and should thus be used to emphasize the topic under discussion and not to detract from it. We have found that, with experience, presentations such as this can be prepared in little more than normal lecture preparation time, and require a minimal software development program. More difficult topics require detailed graphics and an animated series of presentations. Radiation of electromagnetic fields from an antenna is much easier to understand when viewing

the animated vectors and resulting radiated power vector. These take more time and thought, and usually require more sophisticated development software.

It is a basic tenet of engineering technology that theory must be reduced to practice. This can be achieved in the classroom with live presentations. Concepts such as the Fourier transform and its related coefficients are much easier to understand while showing a spectrum analyzer display with a nonlinear signal such as a square or triangle wave applied. Live demonstrations allow for classroom discussion and the demonstration can be adjusted in response to the discussion. Live presentations also make very good teaching aids, presentations such as instruments or working experiments. These can be displayed for easy viewing by a large class with a camera connected to the overhead projector.

We have also found that preparing MM modules is one of the best methods of improving a class lecture. Topics that are difficult to present in a lecture run smoother after taking the time to develop a multimedia presentation. Some topics are difficult to understand and explain. You feel uncomfortable and you may end a lecture wondering if anyone really understood. These are the topics that benefit most from MM development. A good way to begin is by writing the modules just as though you are in front of the class giving the lecture. Using the class text and any instructor notes and references used for the subject, the lecture can be developed in detail, a step at a time, until it is just the way you want it. Once the program is complete and stored it remains prepared until presented. Each time the lecture is given new ideas will occur for improvement. Students are usually eager to give feedback on what was effective, and what wasn't, from understanding the subject matter to distractions such as bad colors, or poor lighting conditions.

Developing the presentations takes time, but it is time spent preparing for the lecture, and results in better lectures. What it amounts to is giving the lecture in advance, with time to think about and develop each idea well. Each part of the lecture can be analyzed ahead of time, with time to think about all the details that you want to include. How many times have you remembered ideas that were important to the lecture, after the class was over? Now these ideas are solidly in place, and in place for this as well as all future lectures. As each idea is written it can be developed a step at a time, animated, scrolled, segments added or removed, accompanied with music, or enhanced by a variety of ways. Supplemental material not contained in the assigned text book can be added and referenced, explained in whatever detail necessary. Pictures and graphs can be scanned in as part of the presentation. Video segments can be added, or live

instruments displayed. Circuits can be shown with current flowing through various paths. Systems can be modified on the screen to display different aspects or advantages and disadvantages. These displays can be interactive, so the students can explore the effects of changes themselves and see immediate results.

Preparation Time

MM systems are notorious for requiring preparation to delivery time ratios of 100:1 or worse. We certainly experienced this in early stages of development. It probably will continue to be true for developing distance learning systems which are akin to movie production. We have found that for class presentation where an instructor will be with the class that many presentations can be prepared in just a few hours. The presence of the instructor in the class controlling the computer makes it much less necessary to design the presentation to anticipate and answer every question. Indeed, very profitable classroom discussions can be held using a calculation package and allowing the students to provide the input parameters.

Out of Class Use of Multimedia

After Class Review

The multimedia modules used for lectures can be made available to students after lectures by placing runtime versions on the network. Some modifications may need to be made, depending on the computers that are available to students. With the necessary modifications in place, students can run the same modules as used in class room lectures, to review and study. These modules can also contain homework assignments, with examples to follow where advantageous. When a well-prepared MM module is presented in the lecture, students will usually leave understanding the basic ideas given. Then this introduction must be followed by further concentrated study to learn the information well. Using the lecture modules individually, students can study the assigned material using the same ideas that were presented in the lecture. This provides continuity between the lecture and the other related study and assignments the student does in the course. If the modules have been developed in parallel with the class text, with references to the text at appropriate places, the MM modules can provide a meaningful guide for students in their study.

Multimedia in the Laboratory

Accessibility is an important issue for MM in the labs. Labs frequently are much less well equipped than classrooms. For MM purposes it is desirable to have projection equipment but it is essential to at least be able to display videos and other MM materials on a computer screen. Since lab work is often done in small groups, this is usually quite adequate as a delivery system. Students also need access to engineering design and simulation packages in the lab. We have started to link our data acquisition equipment to networked lab computers so data can flow from the sensors to the lab computer, to the network and thus to the students' computers or the classroom for follow-up discussions.

The laboratory assignments can be presented using MM. Critical procedures can be videotaped and made available to students to review during the laboratory. As noted above class presentations can also be reviewed to check the design calculations and theoretical background for the lab.

Student Evaluation using Multimedia

When the MM modules include evaluation sections, students can use these to help determine how well they have learned the subjects. Two types of evaluation can be included with each module, a practice section and a formal evaluation section. The practice section is for self evaluation, to help students know when they have learned the required principles. This might consist of a series of questions and problems, with answers that are available on request. Students can practice working problems, then refer to the worked solutions to check their work. When they feel confident, they can then log into the formal evaluation section. There they are presented similar problems, with their solutions stored in a locked file for review by the instructor. The gage for this evaluation can be set by the instructor, by including problems of the required difficulty with each module.

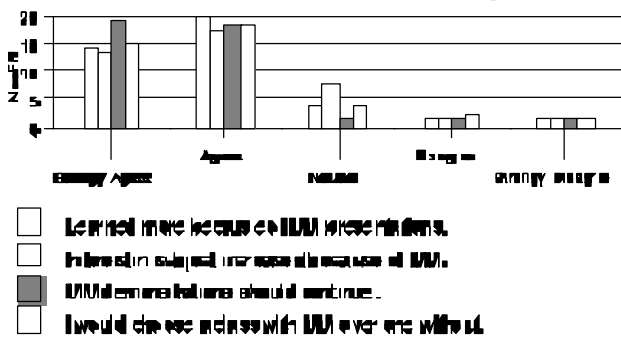
Testing using MM systems has a disadvantage in that students have to be completely computer literate to use them for more than multiple-choice or other objective tests. They cannot draw freehand sketches or make marginal notations very easily. There are also some significant advantages. Objective tests can be very flexible and can be graded immediately for instant student feedback and review. Students can use the full power of the computer for open book tests and they have calculation software, and wordprocessors to develop and submit their answers.

Student Reaction

Lectures accompanied by MM presentations have been used during the past two years in the EET program at BYU. Surveys were conducted in some of these classes to determine the effectiveness of using MM from the student's perspective. Some of these students have had classes from the same instructor both where MM was used and where it was not used.

As shown in figure 1, students agree that they learn better with MM materials being included in the class and that their interest in the subject also increases. The correlation between these two is not unexpected. Students also indicate that they would preferentially choose classes which include MM materials. Given these responses it is not surprising that they feel that the MM teaching program should be developed further. It is obvious that students enjoy classes using MM. In addition to this we have observed that classes containing MM materials seem to be easier and quicker to teach. The students seem to understand topics faster and more thoroughly.

MM Presentations Student Survey

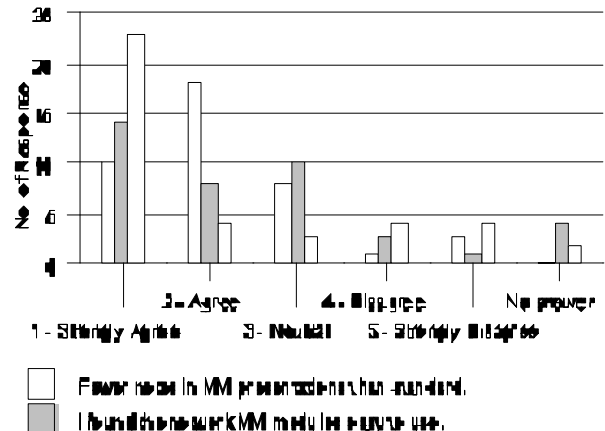


Improved Learning Responses

It also appears that students regard the modules as part of their class notes. Figure 2 shows that they took fewer notes in class and used the MM modules via the network.

The students indicated a more mixed response to the question of how easy the modules were to use and that is a cause for concern, particularly if the students are taking fewer notes. For the students to rely on MM "texts" it is essential that the students have excellent access to the modules while studying for tests, and, for open-book tests, while taking tests. Clearly there are potential logistical problems here.

MM Presentations Student Survey



Overall feedback from students has been very promising and certainly encourages us to continue to develop these methods.

Conclusions

After using well-prepared MM in class room applications, the contrast between lecturing with and without MM is significant. With the aid of MM there is more communication, more learning, and more satisfaction in the subject from both student and teacher perspective. MM is the next generation of teaching aid, replacing overheads, slides, and videos with active and interactive modules. Advantages for the student are clearer presentations and increased interest, resulting in increased learning. Advantages to the instructor are better preparation and presentation, resulting in increased communication of technical subjects.