Design and Development of A Computer Assisted Instruction Package for Engineering Students

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Abstract: This paper presents the author’s experience in designing and developing a computer assisted instruction package for teaching multiple integrals to engineering students

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1. Introduction:

The importance of Mathematics in Engineering and science is well recognized. Usually a first course in mathematics is about a study of mathematical methods. These are techniques or tools which students will be expected to be able to apply in other engineering modules later in their degree program. Mathematics has always been a core subject in the engineering curriculum. The central role played by Mathematics and Mathematical methods in all areas of Science and Technology, necessitates the importance of providing engineering students with a sound and wide mathematical background. With the increasing emergence of new, challenging interdisciplinary areas of study, new problems are generated

1.1 Technology in Teaching Mathematics

Many a time students find lengthy and abstract topics boring or feel that they are irrelevant. At such times teachers try to resort as much as possible not to deal with theory and only with examples. Therefore it has been felt here that with the use of the CAI even abstract ideas such as examples in Heat, Mechanics and Electricity can be given a more concrete form thereby increasing the interest level of the students. There are many studies aimed at the usage of information technologies in science education. Kelleher,[9] 2000, indicated the use and usage of different methods of information technology in his study. The usage liveliness, motion, colour and sound in giving the science topics provided abstract science concepts to be understood better and success to be more in interpreting diagrams or solving problems.

Henry Pollak from Bell Laboratories has been quoted as saying "With technology - some mathematics becomes more important, some mathematics becomes less important, some mathematics becomes possible" (Cohen, 1995). The potential of visually representing abstract mathematical ideas appears to offer promise to educators who realize the computer’s capabilities.

Computer based instructional materials offer great potential for engineering education. Using readily available development software, sophisticated graphics and animations can be created to present engineering topics in ways that are not possible within the confines of the traditional textbook and lecture format. [5] to be effective the software must use the capability of the
computer to engage and stimulate students, both visually and through interaction and feedback.

1.2 Rationale for Developing a CAI Package

- CAI is an efficient way to deliver content. The content equivalent to a one-day traditional lecture can be delivered in as little as one hour using multimedia. There are several studies to indicate that multimedia instruction considerably reduces learning time.
- CAI instructs learners with the same material, presented in the same manner, from learner to learner. The same consistent and technically correct message is received by each learner.
- Content delivery is ensured to be consistent and reliable and does not change in quality depending upon the class or the instructor.
- CAI encourages interactivity in the learning process. This in turn reinforces the learning content and helps the learner to retain the message. A learner can continually go back to the multimedia instruction in order to reinforce the message.
- CAI allows learners, who typically have different abilities and knowledge levels.[13,14]

2. Design and Development

Stages of the CAI Package:

2.1 Development of Modular Structure

Fig. 1. Modular Structure

The description of the five Modules is as follows:

Module 1 - Concept of Integration and its applications

a) Integration
b) Methods of Integration
c) Different types of mathematical curves
d) Rectification of curves

Module 2 – Multiple Integrals

a) Concept of double and triple integrals
b) Geometrical representation
c) Properties of the double integral
d) Method of finding the limits of integration
e) Direct evaluation of multiple integrals
f) Evaluation of multiple integrals when the limits are not given

Module 3 - Change of order of integration

a) Need of changing order of integration
b) Sketching the region of integration
c) Finding new limits
d) Problems on change of order

Module 4 - Double integrals in polar co-ordinates

a) Definition of polar co-ordinate
b) Change from Cartesian to polar form
c) Direct evaluation of the double integrals
d) Evaluation of integrals when the limits are not provided

Module 5 – Applications of multiple integrals

a) Area
b) Volume
c) Mass
d) Centre of Gravity
e) Moment of Inertia

2.2 Modeling the End-user

Here a profile of the target audience is created. Successful design results from a sensitive approach to one's subject: trying to see things from the point of view of the end-user, taking into consideration their needs, expectations and motivations, and communicating in a language appropriate to the target user(s). The problem is a complex one, made more difficult by the fact that different people learn best in different ways. If the designer proceeds with the aim of trying to make life simpler and easier for the end-user, even though that means extra design work, the result should be greater user motivation and more effective learning and use of the interactive system. There is an important need, then to accurately model or profile of the end-user,
refining the model as the design process proceeds and feedback is obtained through the process of testing and evaluation.

Questions to be answered about the target audience which help in building a model of the user (or user profile) include the following:

- **Age:** what is the average age or age-range of anticipated users?
- **Background:** Is information available about the backgrounds of the user which might help in answering further questions?
- **Interests:** what are the interests of potential users.
- **Skills:** what are the background skills and level of knowledge of users regarding the proposed content of the resource?
- **Media sophistication:** what are the background skills and level of knowledge of users regarding the proposed medium -- multimedia and the use of computers?
- **Special Needs:** Does the user have any special needs which may affect the presentation of information, and any input-output resulting from user interactions?
- **Site:** Where is the resource to be used: home, classroom, workplace, public space?
- **Contact Time:** What is the expected contact time with the resource?
- **Learning context:** Is there to be only one type of end-user or will there be several? How will the system be used: by one user or by several users simultaneously? Is the resource to be used as a presentation device by a teacher/trainer, as an aid to group discussion, in single-user standalone mode, or across a network?
- **Diagnostics:** is diagnostic feedback about user performance desirable?
- **Password protection:** Are interactions by the user to be stored and monitored?
- **Confidentiality:** If interactions are to stored, is it likely that materials will be of a confidential variety and will this come under the provisions of the Data Protection Act?
- **Distribution medium:** will the materials be stored and accessed in standalone fashion or across a network?
- **Support Materials:** Is the resource to be used alongside other learning materials and, if it is, is its role supplementary or central to the learning experience?
- **Will the needs of each user-type change over time, either as a result of interacting with the system or independently of the system[15]?

The average age of the users is 18-21. The potential users want to understand and visualize the process of multiple integration and also their relevance in real world applications. The author (designer) aims to meet the student’s needs, which allows the student to get a Virtual peep-in experience of an integral! For this purpose the Multimedia system was selected and the envisaged site is the classroom. Students of engineering have a basic understanding of calculus studied at the 10+2 level. Most of the students are also familiar with computers their awareness ranging from basics to highly skilled (programming).

### 2.3 Drawing up a rule set

Drawing up a rule set is a stage in the development of instructional course; Rules tend to have a far greater degree of specificity. A rule set includes all the steps of the procedure plus explanatory information and background details. Writing the rule set helps the designer of the programme in a number of ways. First it enables the designer to fix the beginning and ending points of the topic, second, a complete rule set is the framework upon which the final programme is constructed. This applies to examples, exercises, and graphical illustrations. As per the rule set the author analyzed the content and sequenced the frames first under the heading of Module 1, 2, 3, 4 and 5 and then into sub-modules. The rule decided was that the teacher will start from the Table of contents and then will proceed sequentially from one module to another module. The user would be able to navigate back and forth using the navigation tools provided.

### 2.4 Storyboarding

A storyboard describes everything that will be contained in the package -- what will be the appearance of the menu, which images (still and moving) will be seen when and for how long. So the storyboards are the blueprints for the multimedia project. These rough sketches bring together all the elements with the controls and depict the sequence of the action. First the storyboards were prepared for all modules.

Fig.2.Storyboard Figure
2.5 Sequencing the programme structure

The author (designer) arrived at a reasonable sequence for teaching, by inspection and by discussion with colleagues and experts in the subject matter. Some guidelines for sequencing of instructional design were observed. A few of these are summarized by Dean Christopher and Whitlock Quentin (1988). These guidelines are as follows:

- Proceed from simple to complex.
- Place procedural skill and knowledge in job performance order.
- Introduce pre-requisite skills prior to the time when they must be combined with other skills and than applied.
- Incorporate the relevant knowledge or skills in the task in which they are most likely to be used.

2.6 Report on Destination Site

In designing any interactive system, consideration should be given to the physical environment within which the system is to be used. At the most fundamental level, any health and safety legal requirements must be recognized and observed. Here are some recommendations as to the type of questions to address. [16]

- Where will the system be used: within the home, at work, in a public gallery or arena, or in a dedicated learning environment such as a classroom?
- Will it be a fixed or portable system?
- Will the user be standing, or sitting or lying down?
- Will it be observed by one or several users simultaneously?
- Can ambient lighting be adjusted by the user?
- Is ambient sound a problem in the sense that may distracts or annoy the user?
- Can ambient sound be adjusted by the user? In certain environments, user headphones may be required.
- Will the space be sufficiently ventilated to prevent the equipment from overheating and to ensure the comfort of the user?

2.7 Designing screen from frames

A Multimedia presentation is made up of a series of individual "frames." Those frames have accompanying text or audio narrative and they are presented in sequence. A module consists of series of frames. Some of these will be criterion frames, teaching frames and some testing frames.

Criterion frames are written before the teaching frames. These frames test the teaching points and no reference material is used in the frame.

Fig.3. Criterion frame

Teaching frames contain all the information needed to complete the course.

Fig.4. Teaching frame
Testing frames

Teaching frames are associated with testing frames. Testing frames can have help and hint frames with them. These can be in the form of prompt or a clue. Anticipated wrong answers must be handled properly.

Fig. 5. Testing frame

Once the frames are designed, they are converted in a useful manner for screen display. Therefore screen layout forms are designed at this stage.

2.8 Screen layouts

This refers to what is displayed on the screen of the terminal. A few simple rules for good design are stated by Woodhouse David and McDougal Anne (1986). They are as follows: 1) Consistency from one screen to the other.2) Arrangement of statements in the same order as action to be carried out.3) Avoiding excessive abbreviation.4) Use spacing generously and wisely.5) No cluttering of the screen with too much information, or too great variety of symbol, colour or script or inverse colour blocks.

Fig. 6. Screen Layout

In general, the minimum amount of information necessary to achieve the purpose is displayed. A small amount of graphical or textual information clearly and effectively presented in more likely to promote understanding.

2.9 Text

Inclusion of textual information in multimedia is the basic step towards development of multimedia software. Text can be of any type, a word, a single line, or a paragraph. The text used is of different type, size, color and style to suit the requirement of the CAI package.

2.10 Graphics and colour

The human mind responds well to images, hence a subject is better explained with a pictorial/graphical representation, rather than as a large block of text. This aids in developing a “clean” multimedia screen. A large amount of text makes for a dull presentation.

Fig. 7. Colour Example of one slide

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2.11 Animation

Moving images have an overpowering effect on the human peripheral vision. According to Reeves (1998), animation learning can stimulate more than one sense at a time and that may be more attention-getting and attention-holding.

2.12 Timing

Allowing the user to control when changes to the screen display take place, and at what speed, makes a programme more flexible for use with a wide range of learners of different abilities.

2.13 Audio
Audio definitely succeeds in attracting the attention of the audience, however sound effects should be used judiciously as they may distract the learner from the main message. Hence, sound effects must not be used wherever unnecessary.

Conclusions

References:

1. David Bergamini and the Editors of Time Life Books.
2. T.A.Philpot,Nancy Hubbing and others,Computer based Instructional Media for Mechanics of Materials