

Conveying Actuarial Concepts

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Abstract

Last year, at the 1991 ARC, Shapiro (1991) presented a paper which discussed his perception of the role of multimedia in the education of future actuarial students. Many of the comments he received about the methodology were concerned with the cost of implementing the technology since, among other things, his presentation workstation included such peripherals as a laserdisc player.

This paper is a response to those comments. Its purpose is to show that, at relatively low cost, computer assisted instructional (CAI) techniques can materially improve both classroom instruction and independent study. The discussion is limited to the material used in the mathematics of finance course at Penn State.

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Introduction

Last year, at the 1991 ARC, Shapiro (1991) presented a paper which discussed his perception of the role of multimedia in the education of future actuarial students. Many of the comments he received about the methodology were concerned with the cost of implementing the technology since, among other things, his presentation workstation included such peripherals as a laserdisc player.

This paper is a response to those comments. Its purpose is to show that computer assisted instructional (CAI) techniques can improve classroom instruction considerably at relatively low cost. To accentuate this proposition, the techniques discussed in this paper were presented at the 1992 ARC using only a notebook computer, an overhead projector and a computer projection plate.

Also, as noted in the paper, these CAI techniques can be readily adapted to self-instructional modules for independent study use. In the author's view, both the presentational and self-instructional techniques are potentially more effective than conventional classroom methods as a means to illustrate and convey ideas.

The discussion is limited to the material used in the mathematics of finance course at Penn State.

Basic Presentations Modes

Generally speaking, the five basic presentation modes used for actuarial science instruction are:

- 1 Basic representation, which shows the relationships underlying the basic concept being considered;
- 2 Time diagrams, which show the relationship between time and the concept being considered;

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- 3 Tables, which show relationships through numerical comparisons;
- 4 Analyses, which uses graphs to study the sensitivity of a concept to its parameters; and
- 5 Symbols, which are used to teach students actuarial notation.

The following pages show a CAI example of each of these presentation modes and discusses some of their characteristics.

Basic Representation

The most basic representation is one which shows the relationships underlying fundamental concepts. In Figure 1, for example, the components of a simple financial transaction are depicted. Most of these pages can either be used for classroom presentation or independent study.

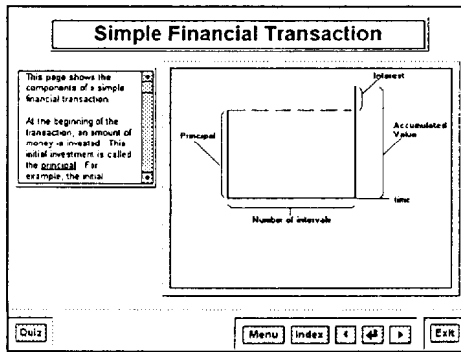


Figure 1: Basic Representation

In its simplest form, this environment represents an improvement over conventional blackboard drawings in that it shows the concept in a precise and dynamic way. Blackboard drawings are static and often times their clarity is dependent upon the instructor's ability to draw. To a greater extent, the CAI environment provides the actuarial student with animated and/or graphical representations of concepts or relationships unmatched by conventional classroom instruction. Similarly, it is an improvement over traditional transparencies and slides because cuing devices such as animation and highlighting are built into instruction and are controlled by the instructor. For example, when the mouse passes over the caption "principal" the vertical line which depicts the principal turns red. In this way the presentation material is structured to help students attend to important concepts.

It has been noted that elaborated text may promote learning for specific instructional goals (Reder, Charney, & Morgan, 1986). Thus, textual information is supplied at the left hand side of the figure to describe the concepts depicted in the figure. What differentiates this textual information from that in a textbook is that users, by clicking key words, have instant access to important definitions, elaborations and examples. Moreover, as an aid to the student, when the mouse passes over underlined text, such as the word "principal," the corresponding item in the figure is highlighted. In this way the relationship between the text and the figure are coordinated and made apparent to the student.

Time Diagram

Perhaps the most common representation in mathematics of finance is the time diagram. A simple example is shown in Figure 2, which depicts the accumulation at time 1 of an amount invested at time 0.

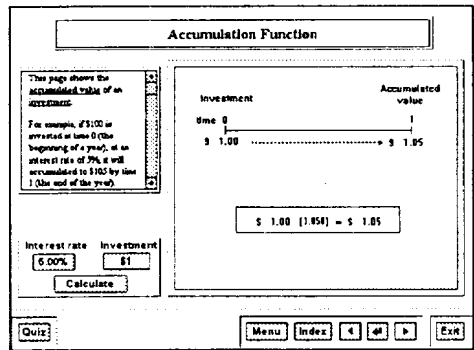


Figure 2: Time Diagram

As indicated, the instructional capabilities of the time diagram page are similar to those of the basic representation page. However, the time diagram page has some additional attributes worth noting.

To depict the relationship between interest rate, investment and time, three buttons located under the text field can be controlled. As suggested by the captions of the top two buttons, both the interest rate and the initial investment can be changed. The button labeled "calculate" performs a calculation and based on the input values, presents an animated flow diagram. In addition, to represent the relationship between the flow diagram and the underlying equation, a calculation box appears in the figure as a rectangle containing the equation. Not only do the values in the flow diagram change when the calculation button is pressed, but the values in the calculation box change as well.

Tables

Tables are another useful instructional device. An example of such a table is shown in Figure 3, which compares accumulated value under simple and compound interest. Once again, the interest rate can be varied to facilitate sensitivity study.

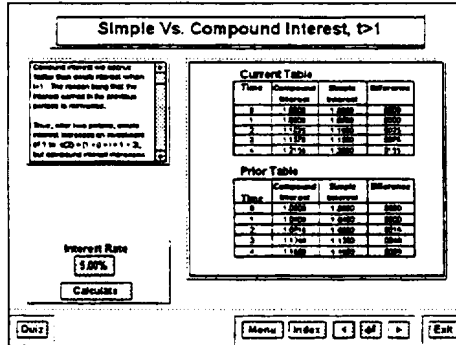


Figure 3: Tables

As a presentation aid, passing the mouse over a cell of the table, highlights the cell and/or activates a popup window. This is especially useful in class lectures where the instructor needs to draw attention to a specific cell for discussion purposes. In the self instructional mode, cell highlighting is accompanied by a cell definition. As individual cells are highlighted an explanation of each is presented. In this way the relationships between, cell data, the table, and input values are put into a conceptual framework for students. Also, as an aid to sensitivity study, when the interest rate is changed, both the current values and the prior values are shown. By allowing students to make comparison between the current and prior values, the impact of the change is easily communicated.

Analysis Page

A page which superbly shows the potential of the computer assisted presentation technique is our analysis page. An example of this page is Figure 4, which shows the accumulation function under compound interest.

At the top left of the page is the general category of the page. In this instance, the general category is "Accumulation Functions". Just below the general category is the subcategory. Here, the subcategory is "Compound Interest". These titles, among other devices help to gain students' attention and orient them in advance of lesson segments (Hannifin & Hooper, 1989).

The next item is the example, which is intended to show a simple representation of the topic. Here, as indicated, the example shows the accumulated value of \$1 after four years, at a compound interest rate of 5% per year. Clicking on the "Example" button activates the example and shows in a step-wise progression how the time diagram is drawn.

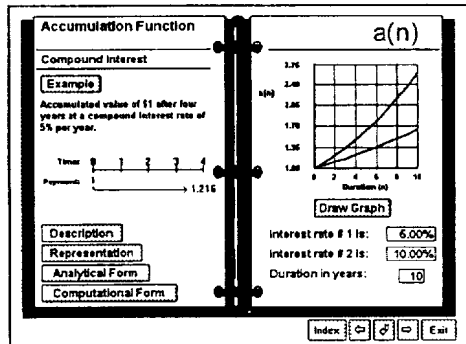


Figure 4: Analysis Page

The "Description" button provides a verbal description of the topic. In this instance, clicking the button provides a description of the accumulation function under compound interest.

In nonquantitative classes, the instructor would now go to the right-hand side of the page. In quantitative classes, the three buttons at the bottom of the page would now be explored. The "Representation" button provides a general representation of the topic. Here, it shows the accumulated value of an investment of 1 after n years. The "Analytical Form" button gives an equation for the function based on the general representation. Finally, the "Computational Form" gives the equation used for computational purposes.

At the top right of the page is the symbol which represents the topic. In this instance, the symbol is $a(n)$. The rest of the right side of the page is used to investigate the sensitivity of the symbol. There are two steps to this process: (1) set the values of the parameters, and (2) click the "Draw Graph" button. In this instance, there are 3 parameters: interest rate # 1; interest rate # 2; and the duration. They are initially set at 4%, 6%, and 20 years, respectively. Clicking on the "Draw Graph" button draws the new graph based on the settings of these parameters.

Symbols

Invariably, a portion of the class time in an introductory class in actuarial science is

devoted to teaching actuarial notation. The computer assisted instruction is ideally suited to this task.

A simple example of using computers to help teach actuarial notation is shown in Figure 5, which depicts a logical tree that can be used for this purpose. As indicated, it consists of two rows, each of which has two options. More sophisticated trees have more branches.

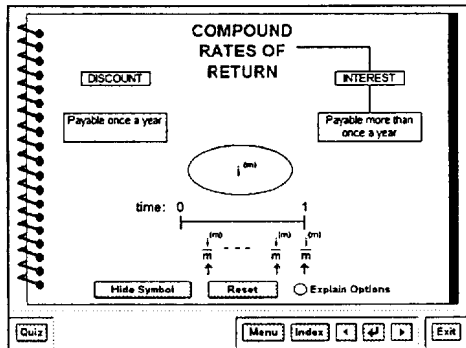


Figure 5: Symbols

To investigate a symbol, the students choose an option in each row by clicking the left mouse button over it. The students can then click on a button labelled "Flow Chart" if they want to see a clearer picture of what has been selected. Doing so, activates a line which connects the options and changes the caption of the button to "Reset." To see the symbol corresponding to the choices, the student clicks on a "View Symbol" button. The symbol will appear inside a yellow ellipse, and the caption of the button will change to "Hide Symbol." If the mouse is pointed at any part of the symbol, an explanation of that portion of the symbol will appear.

When the students feels they understand the symbols, they can test themselves by clicking on the "Quiz" button. There are two types of quizzes: (1) the students can describe the given symbol by selecting options from the table; or (2) they can create a symbol, using a palette of symbol pieces. In either case students are given immediate feedback as to the correctness of their answer and are given the opportunity to correct errors.

Summary

In traditional class lectures, information is typically disseminated from instructor to student with sometimes limited interaction. Analysis of input from many students is almost impossible to manage by a single instructor. Moreover, class materials often do not

accommodate individual learning styles and rates. They are usually geared to average students, neglecting slow learners, as well as the more advance student. These among a host of other educational problems confront today's educators. In an attempt to circumvent such problems at Penn State, efforts have been made to incorporate CAI lessons in actuarial instruction. From this work, several observations about the utility of CAI for instruction were made, some of which are presented in the following paragraph.

First, when used in its presentational mode, student input can be collected during class, analyzed and represented in graphical or animated form almost instantaneously. In actuarial classes at Penn State, for example, the instructor can question students in class and input their responses into the CAI software. The software can analyze the input and represent it graphically for the entire class to view.

Second, a host of media resources can be incorporated in class lectures and accessed non-sequentially to better communicate and reinforce concepts.

Third, in a self-instructional mode, CAI lessons result in increased student interaction. By interacting with the student the lesson adapts instruction to accommodate individual learning differences (Hannifin & Peck, 1988). Typically, the computer presents information to which students must respond. From the student's response the computer can provide immediate feedback; an essential element in the learning process (Walkin, 1982), and subsequently select and direct appropriate learning activities.

Fourth, CAI makes it feasible for several students to study distinct concepts at their own pace. While one student may feel comfortable advancing to more complex topic, another may wish to review fundamental topic areas. Likewise, a student who is interested in a specific topic can spend additional time investigating it without interfering or delaying other students.

Fifth, CAI instruction is consistent. With human instructors the quality of instruction can fluctuate from instructor to instructor or from class to class. CAI provides consistency and ensures that only relevant information is presented.

Sixth, student record keeping can be automated thus saving valuable instructor time. Currently, lessons are set up to track and evaluate student performance. This is particularly beneficial to instructors of large classes because they are freed from manually grading the bulk of students' work. Generally speaking, once in place, CAI on the whole represents significant time savings for the instructor (Varnhagen & Zumbo, 1990). Furthermore, it is relatively inexpensive, considering CAI for presentation purposes can be implemented with only a notebook computer, liquid crystal display panel and overhead projector.

Finally, CAI appears to have a positive effect on student attitude (Dalton, 1986; Varnhagen & Zumbo, 1990). Based on surveys, the CAI lessons used to teach actuarial students at Penn State had a positive effect on attitude. The majority of students surveyed

reacted favorably to the CAI experience.

Conclusion

This paper presented some techniques for implementing CAI in actuarial instruction in both a presentation and self-instructional mode. Several advantages were noted for using CAI to teach actuarial students. It was concluded that CAI implementation adds value not only from a cost perspective but from a time saving and educational perspective as well. The CAI classroom environment can transform conventional lectures into a dynamic interaction between instructor and students whereby student input is recorded, analyzed and represented graphically for class review. Moreover, CAI class materials can be made self-instructional to accommodate individual learning styles and rates. Regardless of the mode, presentational or self-instructional, it seems clear that CAI has the potential to materially improve instructional processes.

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