CHAPTER 3

INSTRUCTIONAL DESIGN

FOR "RANDOM VARIABLES"

3.1 Introduction

The history of the University of South Africa (Unisa) dates back to the establishment of the University of the Cape of Good Hope in 1873. It was initially an examining and not a teaching university, with which several teaching colleges were affiliated. In 1916 this institution became known as the University of South Africa. At this time, the affiliated Victoria College and South African College became respectively the University of Stellenbosch and the University of Cape Town. In 1946 Unisa was officially established as a distance teaching university.

Unisa caters for the student unable to attend a residential university - the community-bound student. There are also those students who prefer to pace themselves and to study independently. Unisa is one of the largest universities in the world and offers distance teaching up to doctoral level in a wide variety of disciplines (Unisa, 1993/ 1994).

According to Holmberg (1989), distance education is education which is not under the continuous, day-to-day supervision of tutors in face-to-face tuition sessions, but which does offer the planning, guidance and support of an organisation.

Unisa strives to take the "distance" out of distance education by promoting what Holmberg (1989) calls a *"guided didactic dialogue"* (p.22). In line with this approach, Unisa has established learning centres regionally where students can benefit from contact with tutors and peers. The slogan of the learning centres is *"Taking the distance out of distance education - a responsive and integrated approach to learner support*" (Poster at Unisa).

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The dominant medium is print: study guides and tutorial letters form the main components of a typical study package. Other media are increasingly being integrated into this package: audio cassettes, Radio Unisa, teleconferencing, videos and computer-assisted learning. In 1995, Unisa introduced 'Students-on-line', a service whereby students who have access to a computer and a modem are able to communicate with their lecturers via e-mail and access their results and the library electronically.

Examinations are held in over 450 centres throughout Southern Africa, Africa and overseas. Unisa envisages that the advantages of distance education will enable the University to respond to the increasing demand for tertiary education (Unisa, 1993/1994).

3.2 Rationale for the development of "Random Variables"

In line with Unisa's policy of taking the distance out of distance education, the Department of Statistics at Unisa decided in 1994 to investigate the use of computer-assisted instruction.

Statistics is a subject which lends itself to computer-assisted learning. It has a core of fundamental concepts and techniques which to a large extent are common across institutions and curricula, thus affording the potential for sharing resources and learning materials. It is a subject particularly suited to graphical representation - indeed the graphical representation of data is at the heart of the subject. Statistics is a subject that is

> *"studied and understood by explorations that are numerical and algebraic. The computer can take the role of informer, illustrator and experimental tool"* (Bishop, Beilby & Bowman, 1992, p.131).

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In the same vein, du Plooy and de Villiers point out that

> *"computer science lends itself to animation, simulation, and improved ways of presentation to students, which makes it an ideal subject to teach via CAI"* (du Plooy & de Villiers, 1992, p. 10).

The same can be said of Statistics as an academic discipline, which involves both the presentation of theory, and the need for the student to apply the theory in the solution of practical problems. Not only does the student need practice in problem solving, but he or she also requires immediate feedback to reinforce correct answers and to remediate incorrect responses. Such interaction is particularly difficult to achieve in a distance education scenario, unless one turns to the computer as a supplementary learning medium.

In 1994 the author was approached by the Department of Statistics at Unisa and asked to design and develop computer-assisted tutorials (CATs) to supplement the study-guide for the first year statistics module, STA101-H. Her background in Mathematics, Statistics, Education, as well as computer-assisted education meant that it was possible for her to tackle both the design and the development of the CATs required.

In line with the research done at Unisa by de Villiers, Pistorius, Alexander and du Plooy (1992), the Department of Statistics agreed with two points in particular:

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1. CAI should be used as a supplementary resource, to be augmented by and supportive of the traditional written word and other appropriate media. In view of this, CAI is never a solution on its own, nor does it replace study guides, text books and contact with the lecturer.

This multiple media approach is illustrated in the diagram below:

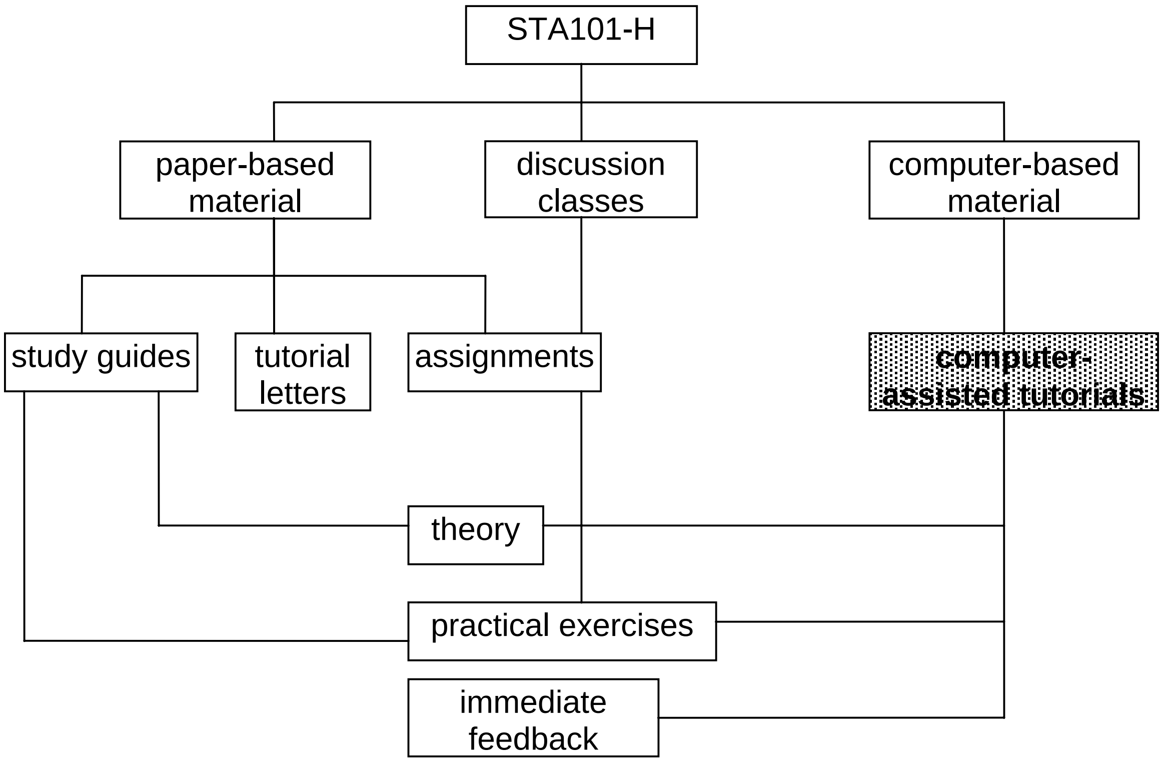

Figure 3.1 **Study package for STA101-H at Unisa**

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2. The design and development of customised CAI is most successful when undertaken by a team, consisting of at least subject matter experts, instructional designers, programmers and graphic artists (Alessi & Trollip, 1991; de Villiers et al, 1992; Kontos, 1984; Faiola, 1989). In this project the courseware development team was made up as follows:

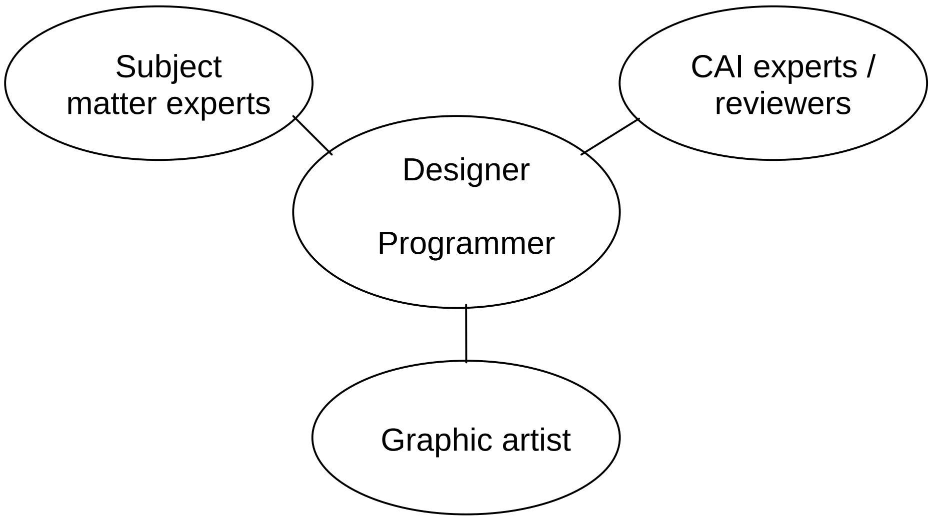

Figure 3.2 Composition of the courseware development team

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3.3 Instructional design process

3.3.1 Theoretical model

Various different models of the instructional design process have been proposed (Alessi & Trollip, 1991; Lee & Mamone, 1995; Main, 1993). The theoretical framework used as a basis for this study is represented diagrammatically by Hodgkinson's "Daisy Model" shown below:

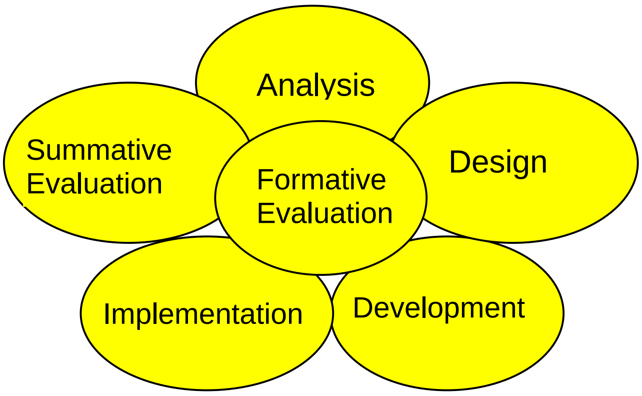

Figure 3.3 The "Daisy Model" of the instructional design process (Hodgkinson, 1996)

Starting with analysis, the instructional design process is cyclical and ongoing. Formative evaluation is at the centre, since it is revisited at various stages, in polishing and refining the product. Formative evaluation thus has an impact on all stages of the instructional design process.

This theoretical model was adapted for use in this study, with different emphases being accorded the various "petals", as discussed in the next section.

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3.3.2 Adaptation of the theoretical model

This study follows the path of the analysis, design and development of customised CATs for the Department of Statistics. It emphasises the formative evaluation that took place at each stage in the cycle. It does not consider summative evaluation, which constitutes a topic for further research. Therefore the summative evaluation petal has been removed in Figure 3.4 below, and the sizes of the remaining petals indicate the relative extent of each stage .

In "zooming in" to the formative evaluation stage of the "Daisy Model", we define the following micro-stages, which show how formative evaluation was operationalised throughout the process.

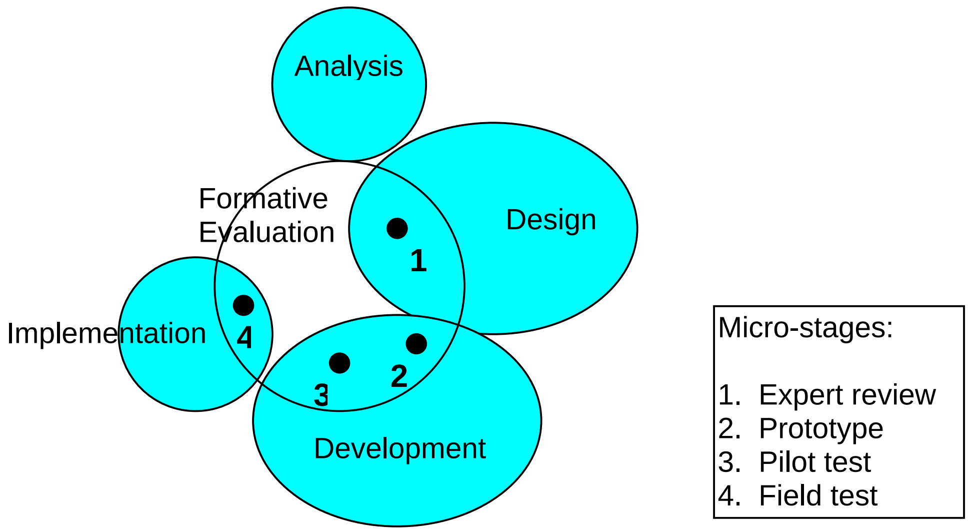

Figure 3.4 Adaptation of the theoretical model

The four micro-stages in this adapted model are discussed in detail in Chapter 4 (Research Methodology).

The remainder of this chapter discusses the main stages of instructional design, with respect to this study, namely formative evaluation, analysis, design, development and implementation. We start with formative evaluation in general, since it affects each part of any instructional design model. In fact, Reeves (1993a) calls formative evaluation *"the essential lifeblood of the instructional development process"* (p.15.11).

3.4 Formative evaluation

Beyer defines formative evaluation as follows:

> *"Formative evaluation, simply put, means evaluating or assessing a product **while** that product is in the process of being created and shaped"* (Beyer, 1995, p.7),

and he points out that

> *"formative evaluation is **ongoing** in that it occurs repeatedly, at various stages throughout the development process, from the design or platform stage through the prototype (draft), pilot, and field trial stages of the product"* (Beyer, 1995, p.7).

It can be seen that the four micro-stages

1) expert review
2) prototype
3) pilot test
4) field test

in the instructional design model for this study (Figure 3.4) are modeled on those mentioned above by Beyer (1995).

According to van Niekerk (1995, p.103), *"formative evaluation refers to the evaluation of the instructional process while it is being carried out with the aim of improving or changing the course."* A function of formative evaluation is to determine whether the instruction really helped the student to achieve learning objectives. Van Niekerk goes on to list the characteristics of formative evaluation:

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"Formative evaluation

- *is usually done by the course writer;*
- *is usually not a large-scale effort;*
- *may or may not be costly;*
- *often uses descriptive statistics;*
- *is driven by decision-making and operational constraints of the organisation; and*
- *relies heavily on monitoring and performance indicators of short-term effects"*

Van Niekerk (1995, pp.103-104).

Van Niekerk also maintains that formative evaluation should be a regular and integral component of the course design process.

3.5 Analysis

3.5.1 Target population analysis

Unisa has a long-standing tradition of providing education to disadvantaged students. These may be students

> *"who have neither the means nor the opportunity to attend a residential university: women at home, older people wishing to make their retirement more meaningful, men and women who wish to make a career change but do not have the required academic background to do so, and even people in prison and youngsters doing military service"*
> (du Plooy & de Villiers, 1992, p. 7).

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In 1995 Unisa's student body numbered approximately 128 000 (Unisa, 1995). Male and female students are represented in almost equal proportions. The average age is 32 years, ranging from 17 to 84. In 1995 the home language distribution of Unisa students was as follows:

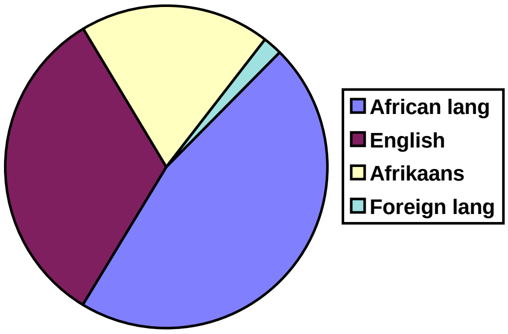

Figure 3.5 Language distribution of Unisa students in 1995

Geographically, the majority of Unisa's students reside in the Republic of South Africa, with approximately 3760 students in the rest of Africa. There are also about 1200 students in overseas countries.

As de Villiers (1993) reports, Unisa students are heterogeneous with respect to race, language and academic background.

The subjects of this particular study include both male and female post-secondary students studying Statistics at first-year level in the Faculty of Science at Unisa. Approximately 400 students register for STA101-H each year, with around 300 writing the final examination. Although the entrance requirement for this course is matriculation mathematics, the students exhibit a wide spread of existing mathematical ability and prior knowledge. This is a common problem in adult education and is

> *"exacerbated in a society with a mixture of first-world and third-world students and a very uneven standard of high school education"* (Alexander, Pistorius, du Plooy & de Villiers, 1992, p.19).

Particular care, therefore had to be taken in the design of the CATs required by the Department of Statistics. Cultural, language and age differences had to be taken into account. For example, when using examples such as tossing a die, or selecting a card from a pack of playing cards, the option had to be provided for the student to access further information on these activities, with which they may or may not be familiar.

Figure 3.6 Example of a pop-up help window from the tutorial on Probability

Isaacs (1990) comments that the use of 'pop-up' dialogue boxes and windows is an attractive method for making comments or offering help without disrupting the screen display. This feature also offers an additional degree of student control in that the help pop-up window is readily available for those students who choose to access it.

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3.5.2 Subject matter analysis

The content of the course is well-defined and clearly laid out in the study guide for STA101-H. The intention was that the content of the CATs should closely mirror that in the study guide and should make use of the same conventions with respect to statistical notation. The CATs needed to supplement and reinforce the content in the study guide, without becoming "*electronic page-turners*" (Delpierre, 1991, p.63).

The author therefore used the structure of the study guide as a basic framework for the content. One (or more) CATs were designed and developed for each chapter in the guide. The topics within the chapter became the choices on the Main Menu in the CAT. Sub-menus were introduced where necessary to subdivide the content into manageable "chunks", in order to increase the capacity of short-term memory (Kozma, 1987). The Main Menu and a sub-menu are shown in Figures 3.7 and 3.8.

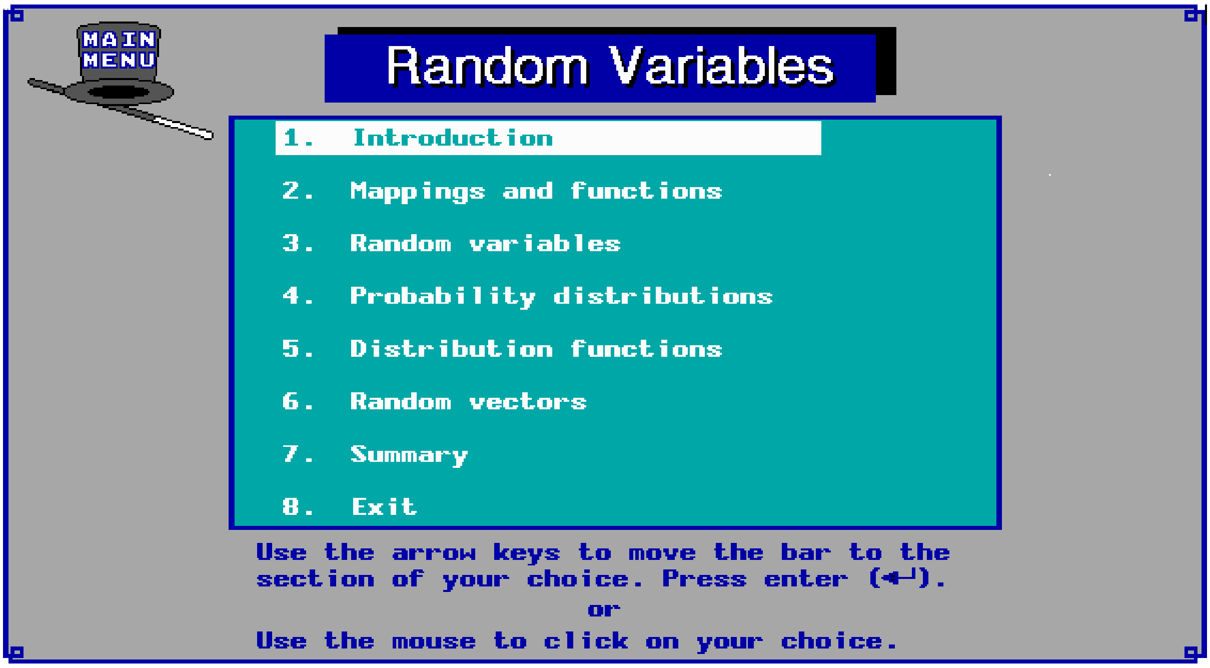

Figure 3.7 The Main Menu

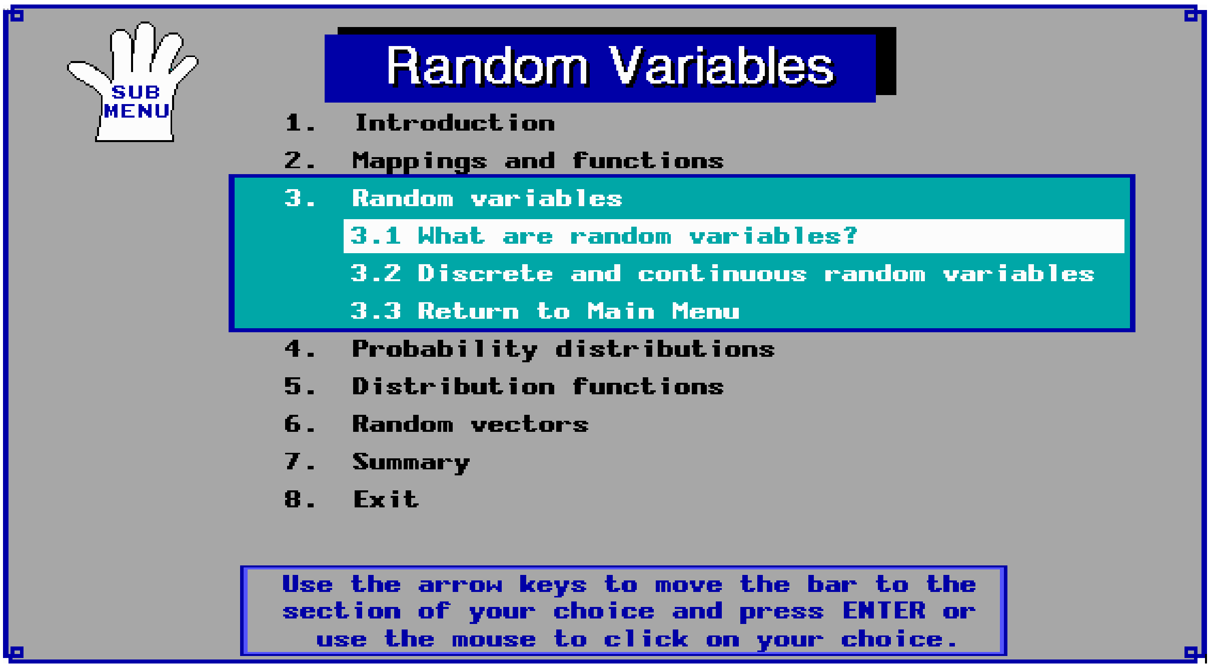

Figure 3.8 A sub-menu

In order to expand the subject matter and provide a variety of examples and exercises, the author consulted a variety of text books (Megeath, 1975; Mendenhall, 1990; Quirin, 1978; Steen, 1982; Triola, 1980). She also consulted various experienced subject matter experts (Fresen, 1995; Jordaan, 1995; Debba 1995) in order to discover approaches and techniques that they had used successfully in teaching the abstract concepts inherent in the subject matter. This approach is elaborated further in section 3.6.1 (Instructional strategy).

3.5.3 Media analysis

In 1989 the Department of Computer Science and Information Systems at Unisa developed a "Computer Concepts" course using CAI as part of the study material (Alexander et al., 1992). The enthusiasts in that department established a centre of CAI expertise called CENSE, the Centre for Software Engineering. CENSE includes a team of designers, programmers, evaluators and a graphic artist. They also established project management structures, which have been successfully implemented in the distance education setting (Pistorius, de Villiers & Alexander, 1992).

> *"We were determined to produce high-quality courseware by planning properly and by following systematic design methods. Thorough preliminary planning was done before we finally set up a course in which a significant percentage of the tutorial package consisted of CAI courseware"* (Pistorius, du Plooy, Alexander & de Villiers, 1992, p.13).

It was clear that the material in the first year Statistics module, STA101-H lent itself to the medium of CAI, and in view of the success achieved by the above-mentioned team, there was little doubt that the same procedures and media would be desirable for this project.

Hardware

Unisa has established micro-computer laboratories for the use of students in Pretoria, Cape Town, Durban and Pietersburg, so no financial outlay for hardware was necessary. Students are encouraged to purchase the computer-assisted tutorials on diskettes, which are sent to them through the post, so that they can work through them in their own time on their own computers. Alternatively they can make use of the regional computer laboratories at no charge.

This form of decentralised CAI imposes two immediate constraints (de Villiers et al., 1992). Firstly, because the students are using a wide variety of computer hardware in their homes or work places, many of which may be of fairly limited capacity, designers and developers need to be aware of the fact that animations may be frustratingly slow, the number of colours and screen resolution may not be adequate, and video and sound can generally not be considered. Secondly, since the computers are not linked to a network, record keeping and monitoring of students' progress is difficult to achieve. The Unisa teams are investigating downloading the courseware and gathering performance data via a communication network (de Villiers et al., 1992), which should be more easily enabled today with the proliferation of e-mail and the Internet among the general population (Gates, 1995).

Software

In selecting an authoring system, several aspects need to be considered. Alessi and Trollip (1991), classify classical computer programming languages, authoring languages and authoring systems on a continuum (see figure 3.9). Each extreme of the continuum offers different strengths and advantages, which need to be considered in the light of the needs of each individual development project as well as the resources available.

Programming Languages e.g. Basic, Pascal	Authoring Languages e.g. TenCore	Authoring Systems e.g. Quest

greater flexibility	easier to
learn	
lower cost	easier to use
more expertise available	faster development
more transportable between platforms	facilitate multimedia development

Figure 3.9 Continuum of authoring systems
(Adapted from Alessi and Trollip, 1991, p.342)

Authoring systems can be frame oriented (e.g. Quest), object oriented (e.g. Quest), event oriented (e.g. Authorware Professional) or code oriented (e.g. TenCore), each orientation offering various strengths and weaknesses.

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Cronjé (1996) summarises authoring systems according to the categories shown in the following diagram:

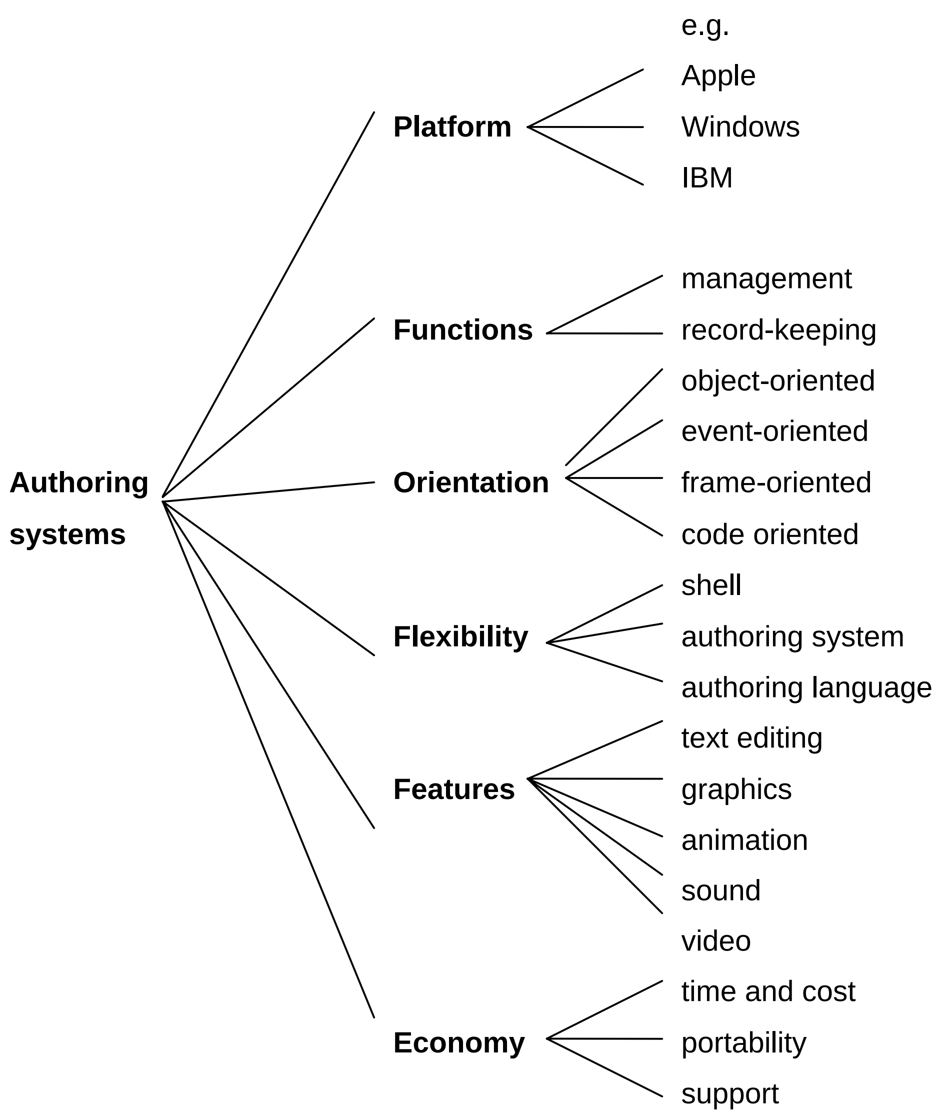

Figure 3.10 Features to consider in the choice of an authoring system (Cronjé, 1996)

The authoring software, TenCORE (Computer Teaching Corporation, 1993), was already in use by CENSE at Unisa, and the Department of Statistics was able to make use of one of their licenses. TenCore is classified by Alessi & Trollip (1991) as a *"code-oriented authoring system",* which means that *"a substantial part of the development is programming of the classic type, writing lines of computer commands...".* TenCore is not one of the recent generation of object oriented authoring systems such as Quest (Allen Communication, 1994), which facilitate multimedia development.

The requirement of the Department of Statistics was for customised CATs, which closely mirrored the content covered by the study guide. This customisation required the programming of specialised statistical routines and response judging routines. Furthermore there were no immediate time constraints in producing the tutorials: therefore TenCore, with its greater degree of flexibility was thought to be a suitable choice of authoring system.

An example of a specialised question, where the student is required to key in the elements of a set, is given in Figure 3.11. Programming in TenCore allows the system to check for the correct elements, as well as the required number of semi-colons and to give appropriate feedback for various anticipated student responses.

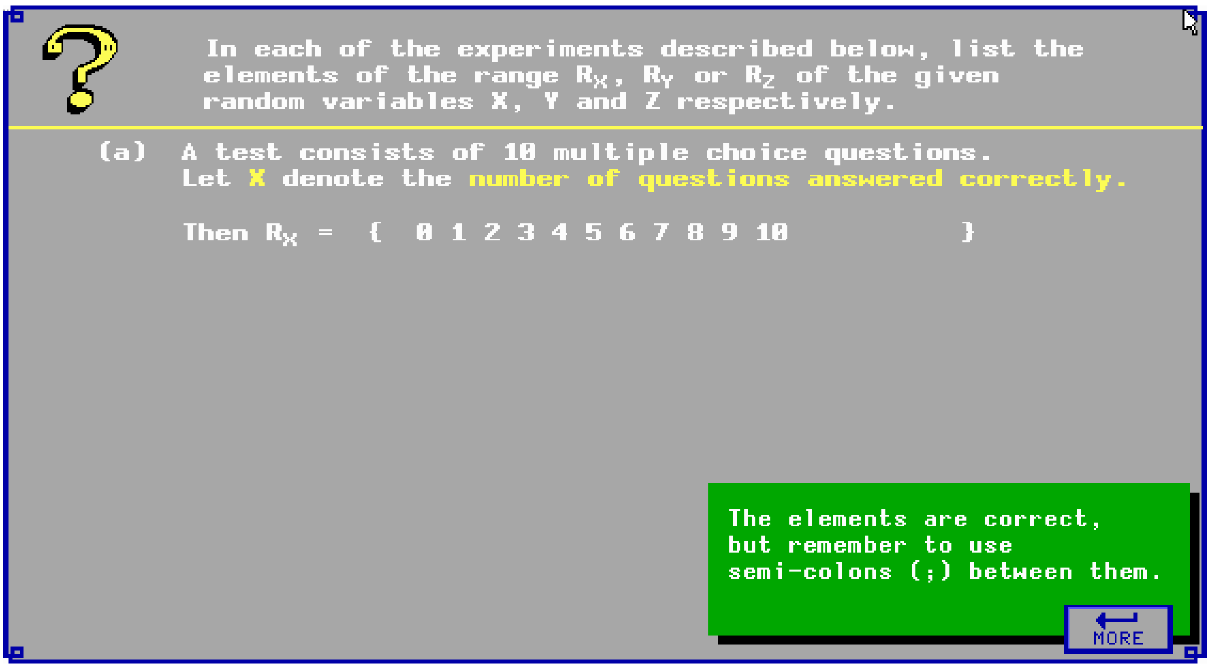

Figure 3.11 Example of a specialised student response

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There was no immediate time constraints in producing the tutorials: therefore TenCore, with its greater degree of flexibility was thought to be a suitable choice of authoring system. Another feature in favour of TenCore is that the final CAT is produced as a single binary file, together with one fonts file and two system files can usually fit onto one high density diskette. This simplifies the production and distribution of diskettes to students studying at a distance and maintains costs at a minimum.

3.6 Design

3.6.1 Instructional strategy

In the distance learning situation, interaction for the student is generally limited. The student interacts with the information provided in the study guide, with limited written or telephonic contact with the lecturer. Assignments are submitted, but the student usually has to wait several weeks before obtaining feedback. There is little opportunity for cooperative learning or "*positive interdependence*" (Johnson and Johnson, 1991, p. 127) and exchange between students.

The subject of Statistics in particular, is generally presented in a very formal and distant way. Definitions, formulae and theorems are presented and the content is rather abstract and theoretical. The module STA101-H is the first exposure for Science students to the subject of Statistics. The study guide is content-based and tends to be rather stark and lacking in introductory and motivating material.

Thus the need was identified to make the content more meaningful and understandable to the students. It was clear that the CATs should not be electronic versions of the study guide, but should provide the "*cognitive strategies*" or "*instructional scaffolds*" (Rosenshine & Meister, 1992, p.26) necessary to encourage intuitive understanding of basic concepts.

Möller (1993) describes the ideal of imitating human interaction using electronic media:

> *"A good way to ensure concise, but very effective communication, is to compare the computer to that excellent instructor who explains, gives directions, exposes new knowledge in a structured manner, rather than to the excellent textbook or encyclopaedia"* (Möller, 1993, p.26).

The rationale behind the design of the tutorials therefore, is that they should encourage intuitive understanding of the underlying concepts, such as

> "What really is a random variable and how and why does it originate?"
> "What is a probability density function?"
> "How do we generate a probability density function?"
> "What does a probability density function look like and how can I remember what it is? "

How then did the author go about moulding and presenting the content for the instructional purposes of reducing cognitive load (Fleming & Levie, 1993) and enhancing basic understanding? The instructional strategy included the following features:

- the use of a theme character (white rabbit) to conduct a personal dialogue with the student (human-computer interaction: Jih & Reeves, 1992; Marchionini, 1992);
- the alternation of deductive (from the general to the particular) and inductive (from the particular to the general) approaches;
- the use of everyday examples, such as the number of children in a family, the distribution of marks in a test etc., so as to provide situated and meaningful learning experiences (Merrill, 1991; Reeves, 1993b);
- repetition of familiar examples and diagrams to reinforce understanding and enhance retention (Bangert-Drowns & Kozma, 1989);

- step-by-step build up of concepts ("chunking" - Kozma, 1987; Fleming & Levie, 1993; Faiola & DeBloois, 1988);
- colour coding and consistency (Faiola & DeBloois, 1988);
- textual, pictorial and other cues, such as arrows, labels, shading and highlighting (Beck, 1991);
- learner control in being able to access help windows, replay screens etc. as and when the individual student requires it (Caffarella, 1987);
- building on previously learned knowledge (Caffarella, 1987; Alessi & Trollip, 1991) that was acquired in the study guide and earlier CATs in the series;
- orientation information, such as headings on each presentation screen, and the "Where am I?" feature for the student to keep track of his progress through the material;
- the extensive use of graphics, to which the subject matter particularly lends itself, since pictures and diagrams are more memorable than words (Mayer & Gallini, 1990; Fleming & Levie, 1993);
- the use of animations to illustrate concepts and relationships in a manner that is not possible with the written word (Rieber, 1990).

Many of these features can be seen on the screen prints included in this chapter. An example of an animation routine is discussed below.

In the study of random variables, two of the key concepts are the creation of the probability density function (p.d.f.) and from this, the creation of the cumulative distribution function (c.d.f.). In order to strengthen the students' understanding of how the c.d.f. is generated from the p.d.f., a computer animation was used to illustrate this practically. The full impact of the animation can be seen by running the tutorial on the enclosed diskette. Figures 3.12a and 3.12b show the beginning of the sequence (the p.d.f.) and the final screen (the c.d.f.).

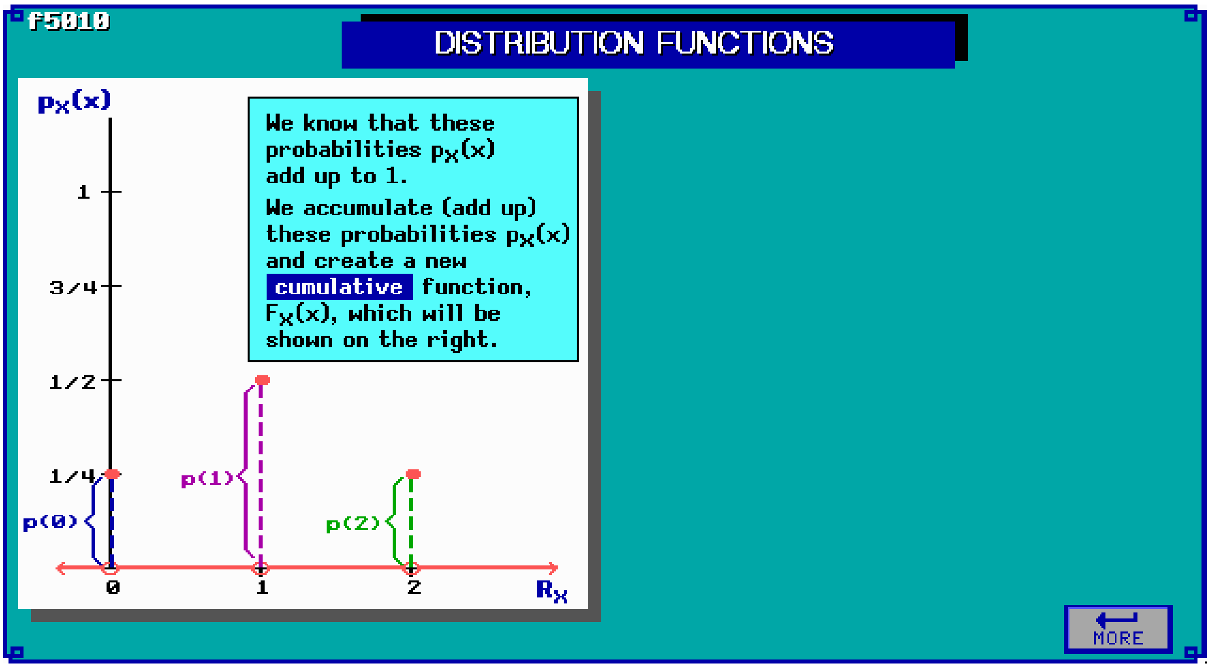

Figure 3.12a Screen showing the beginning of the animation sequence, the p.d.f.

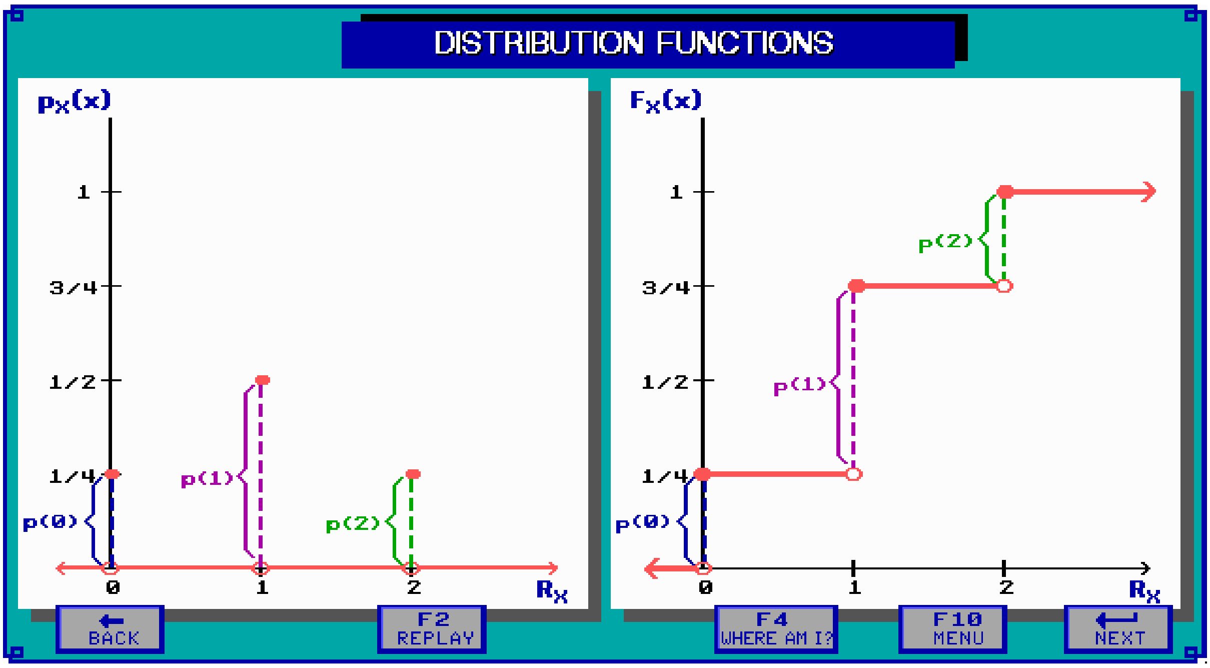

Figure 3.12b Screen showing the c.d.f. generated dynamically from the p.d.f.

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3.6.2 Design blueprint

In order to save time and endless reinvention and modification further into the development phase (Gery, 1988), it is advisable to document design guidelines or standards. The design blueprint for this project included the following specifications.

No sound or video

The CATs produced for the Department of Statistics tend to be linear, without sound or video. The latter constraint was imposed by the probable low standard of hardware on student home computers. De Villiers et al. (1992) found that the use of audio and video was neither necessary nor desirable for distance students in their field. Statistics is a subject not dependent on sound (as a language or music would be), and graphical representation and animation are more applicable than video.

User interface

The user interface of the tutorials is relaxed and conversational, with the intention of encouraging a feeling of personal involvement for the student.

Language

The tutorials are programmed in English only, with special care being taken to use clear and simple language and to provide pop-up help windows for words or terms considered difficult for non-mother tongue speakers of English. A glossary of statistical terms is available via a function key, as shown Iin Figure 3.13

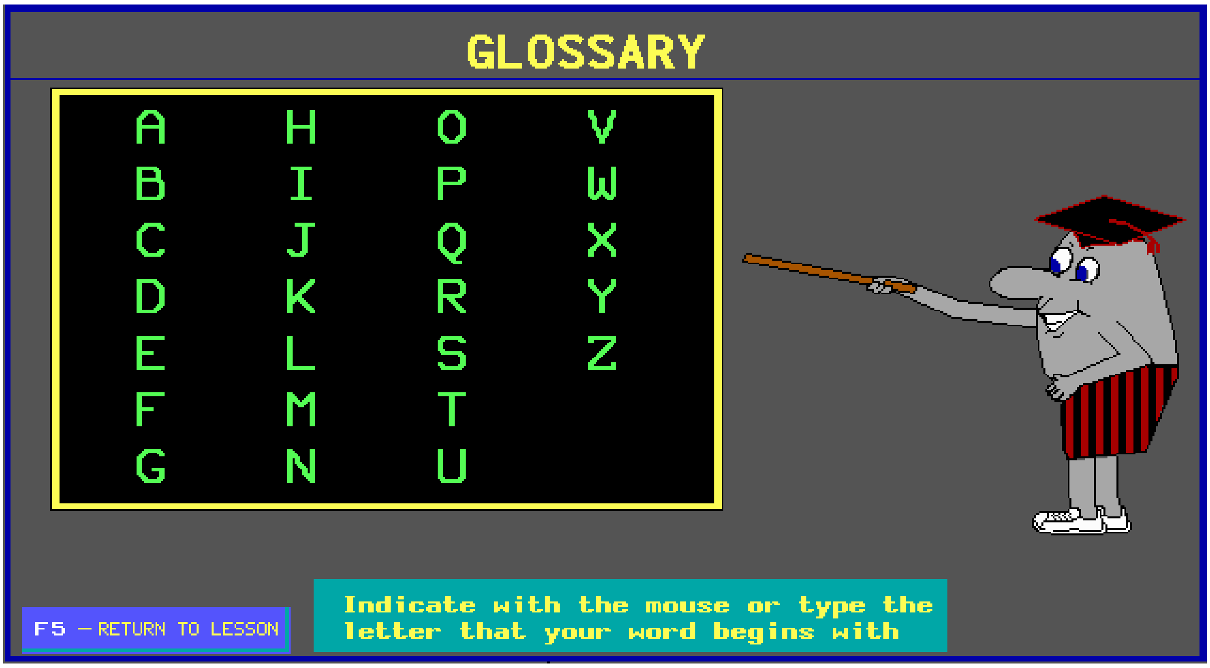

Figure 3.13 Glossary lesson linked to all the CATs

Menu structure

The CATs are designed around a main menu, with various levels of sub-menus available as dictated by the content. A navigational feature available via a function key is the "Where am I?" option. To prevent the learner feeling lost in the various menu levels, this feature shows a snapshot of the menu, with the current section highlighted, as shown in the example Figure 3.14. On pressing Enter, the student is returned to the screen from where he or she accessed this feature.

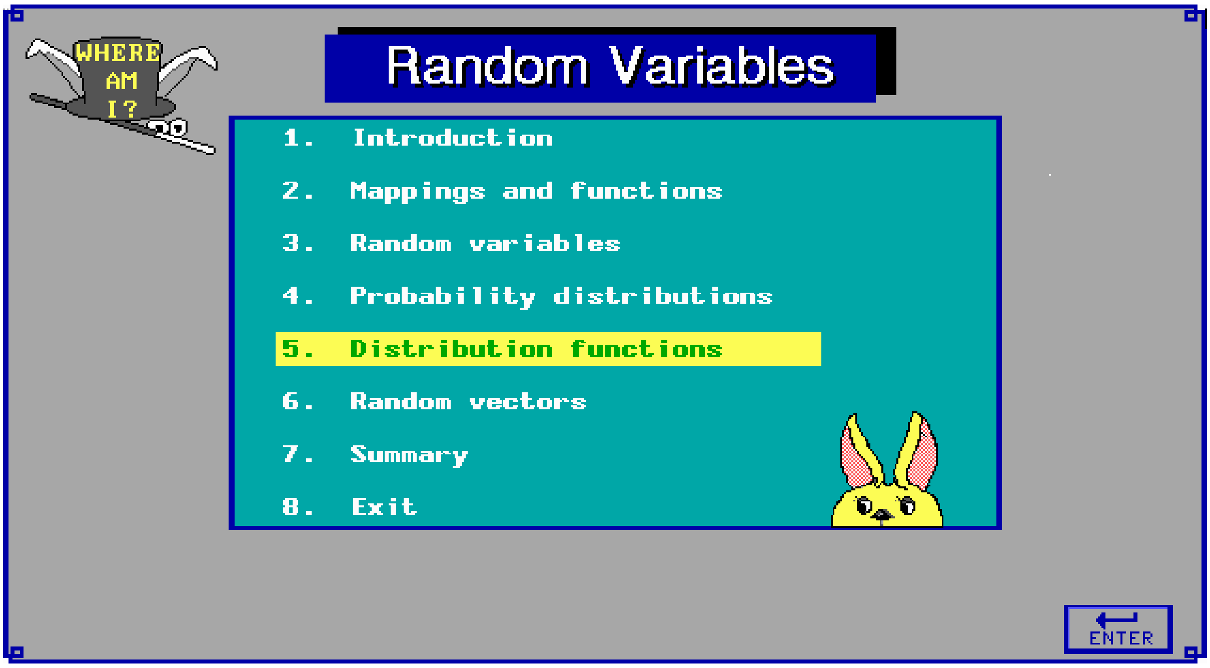

Figure 3.14 The "Where am I?" feature

Navigation

For ease of student navigation, it was decided to make the **Back** (return to previous screen) and **Next** (continue to next screen) keys available on almost every screen. The only time that the Back key is not shown as an option is on the first screen of a new section, when Back simply returns the user to the menu screen from which a selection was made. On pressing Next at the end of a section, the user is likewise returned to the menu. The option to return to the Menu is always available. The option to escape or quit the programme is available from the Main Menu.

All the navigation options are shown as icons on the lower section of the screen. These icons are clickable, or alternatively activated via named function keys. In order to accommodate student needs and preferences, it was decided that the CATs should allow for both mouse and keyboard use.

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Fonts and colours

Three sizes of font are used consistently: standard font for the majority of the text, a larger font for headings and a smaller font for superscripts and subscripts necessary in mathematical formulae. The colour choice is consistent, as is the screen layout, with predetermined positions for headings, pop-up windows, icons and feedback boxes.

Tutorial mode

In typical tutorial mode, after the presentation of a section of theory, the learner is given one or more questions to answer. The question screens are identified by a change of background colour and a large question mark in the top left hand corner.

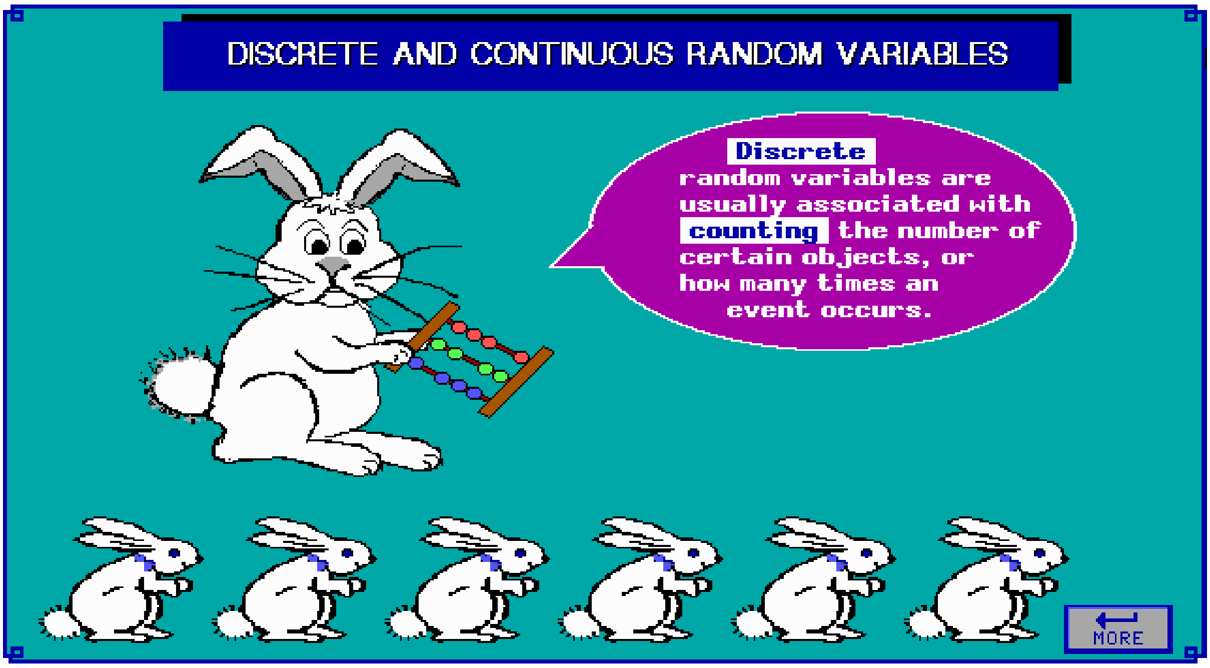

Figure 3.15 Example of a presentation screen

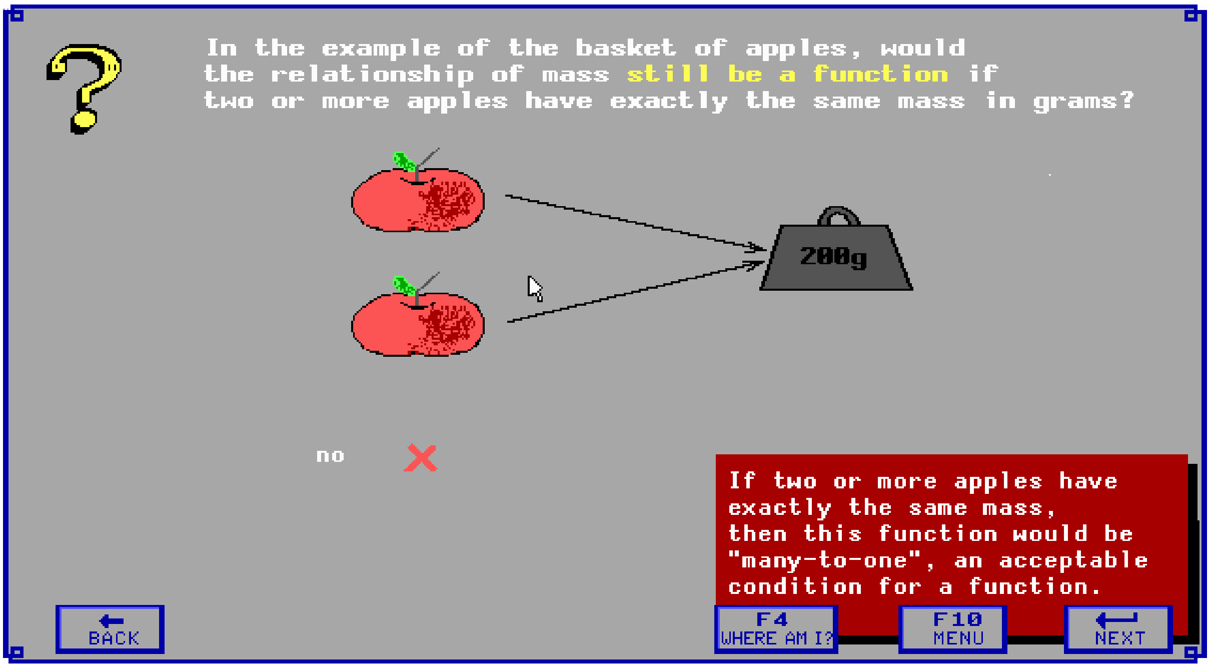

Figure 3.16 Example of a question screen

3.7 Development

3.7.1 Flowcharting

The structure of the study guide was used as the basic framework for the content of the CATs. The menu structure therefore reflects that in the study guide. Where necessary, additional sections were added in order to reinforce prior knowledge (e.g. the topic of "Mappings and Functions" was included, since this prior knowledge is necessary in order to understand the definition of a random variable as a function).

The flowchart of "Random Variables" is included in Appendix D.

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3.7.2 Storyboarding

Detailed storyboards were drawn by hand for every screen of each tutorial. Two types of customised storyboard forms were used: one for presentation screens, with space for comments about layout, graphics, animations etc., and one for question screens, with space for correct, incorrect and unexpected answers and feedback. These storyboards were kept in a separate folder per tutorial, together with the timesheets of all team members involved, so that an estimate of the time taken for the development could be made.

Each CAT revolves around a particular theme character, to engage in dialogue (one-sided) with the student and to provide light relief where necessary. The theme character in the “Random Variables” tutorial is a white rabbit, which appears in various guises, using the theme of magic: a magic wand, a magician’s hat, etc. Rough graphics of the theme character were indicated on the storyboards. The CENSE graphic artist then developed these in a graphics package and gave them to the author in *.pcx format.

3.7.3 Authoring

The author “authored” (programmed) the CATs in TenCore. This involved generating the code for each screen, producing diagrams and other graphics with the TenCore graphics editor where necessary and importing and modifying the computer graphics of the theme character.

The author tested each tutorial thoroughly from the technical point of view, trying to anticipate possible student responses and ensuring that there were no programming hitches.

On completion of the computer-based material, master diskettes of the CATs were produced. Each tutorial is available on either 360K floppy diskettes or 1.4 Mb stiffy diskettes (according to the needs of the students) and is accompanied by an installation booklet (reproduced in Appendix C). The installation booklets were designed by the author and produced by Unisa Press.

3.7.4 Description of the product and supporting material

The total package will consist of nine CATs, although this research report focuses on one, the sixth in the series, namely "Random Variables". The tutorials are optional extra study resources, and students may purchase any or all of them, with the proviso that lesson 2 (Probability I) is a prerequisite for lesson 3 (Probability II), and lesson 6 ("Random Variables") is a prerequisite for lesson 7 ("Descriptive Measures").

The design and development cost for six CATs was approximately R70 000 for 24 months of part-time work. This does not include the services of the graphic artist nor the time taken by the full time Unisa staff members, both subject advisors and CAI experts.

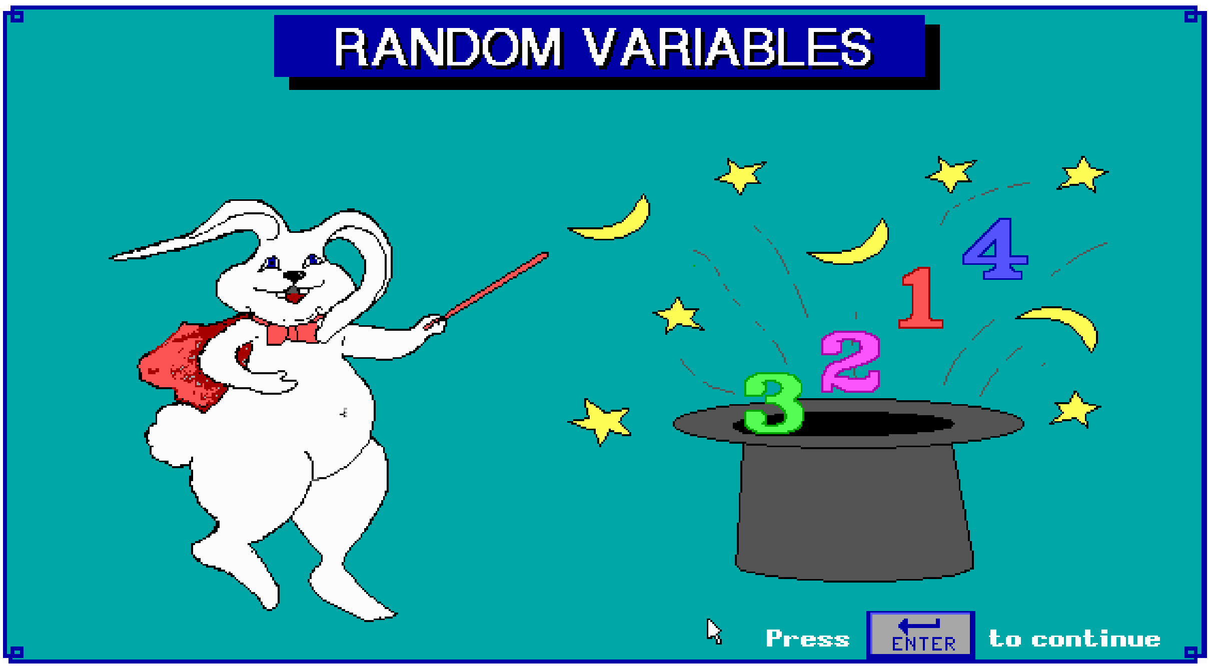

Figure 3.17 Title screen of "Random Variables"

Figure 3.18 Credits screen of all the CATs

3.8 Implementation

On completion of the first six CATs in March 1996, they were implemented with the student population in two ways:

1. The CATs were sent to the micro-computer laboratories at Unisa in Pretoria, as well as at the regional offices in Cape Town and Durban, with instructions to the laboratory supervisors as to how to install and run them. They are available for student use at no additional cost.

2. Students registered for STA101-H in 1996 were advised by tutorial letter of the availability of the CATs at the Unisa computer laboratory, as well as of the fact that the CATs could be purchased from Unisa Press at the cost of R25 per tutorial. Each tutorial is available on either 360K floppy diskettes or 1.4 Mb stiffy diskettes and is accompanied by an installation booklet.
Telephonic support is offered to students by the subject advisors and the developer.

3.9 Summary

In 1994, the Department of Statistics at Unisa embarked on developing customised Computer-assisted Tutorials (CATs) as a supplementary, optional learning resource for the first year course STA101-H.

Being a course offered at a distance, special care was taken to design the CATs in such a way that the unique features of the computer, such as graphical display, animation and immediate feedback, would provide cognitive support and interaction for students normally studying in isolation.

This research report is the formal report on the analysis, design, development, implementation and formative evaluation of one of the CATs, “Random Variables”. All nine CATs, which will make up the final package, follow the same overall instructional strategy, design blueprint and development process.