Chapter 3 Methodology

Chapter guide

3 Methodology

3.1 The research problem

Table 1.3.1 and table 1.5.1 show the questions raised in this research. In order to answer these questions, the project outlined in this chapter was devised.

3.1.A The aim of the research

The aim of this project was to design, develop and implement a Web-based teaching resource for an undergraduate university course. This resource was then used as a vehicle for addressing the research questions outlined in chapter 1. By comparing the results obtained by students on the Web-based course with those obtained by students on the equivalent paper-based course, a measure of the efficacy of this method of teaching this course could be evaluated. By splitting the students in to groups according to their school background (resource disadvantaged *vs.* resource advantaged[1]) an indication can be obtained whether this method of teaching discriminated against either group.

3.1.B The objectives of the research

In order to meet the aim outlined in section 3.1.A, the following objectives had to be achieved.

Web-based course development

- Evaluate hardware and software requirements for a Web server;
- evaluate tools for Web page design and development;
- design Web-based course pages which met the same criteria as the equivalent paper-based course;
- develop the Web pages using suitable software and submit these to colleagues for peer review;
- change the Web pages according to peer review suggestions;
- implement the Web pages on the Web server and test the response of the Web server under heavy load; and
- grant students access to the course material.

[1] Resource advantaged (Ra) and resource disadvantaged (Rd) were defined in Table 1.4.2.

Web-based course evaluation

- Evaluate students' assignments;
- evaluate students' tests and examinations;
- evaluate students' time management skills;
- analyse and evaluate Web server logs; and
- develop, administer and evaluate a questionnaire which probed students' opinions about the Web-based course.

In sections 3.3 and 3.4 the objectives discussed above will be examined in more detail, but firstly, the Problem Solving Skills module of the Science Orientation Course, SCI 152, will be discussed in section 3.2.

3.2 A description of the Problem Solving Skills module of the Science Orientation course

The background to the Science Orientation course was discussed briefly in section 1.4, *Historical overview of the Science Orientation course*. In this section, more details of the course content, especially the Problem Solving Skills module (SCI 152), and the participants will be given.

Originally, the Science Orientation course was implemented to give students from disadvantaged communities skills, which they should have received at school, necessary to successfully complete degrees in the Sciences. Table 3.2.1 shows some of the skills covered in the Science Orientation course, with their current module numbers. Historically, all four modules ran concurrently over one academic year, with an examination being written at the end of that academic year. Currently, the modules SCI 152 and SCI 153 run in the first semester and SCI 162 and SCI 163 in the second semester. An examination terminates the modules at the end of the respective semesters.

Table 3.2.1 Study skills covered in the Science Orientation course

Module	Module name	Brief description
SCI 152	Linear Problem Solving Skills	Includes elementary computer literacy, mathematical word-processing skills, Internet awareness and mathematical problem solving skills.
SCI 153	Academic Proficiency	Includes study skills, learning styles, time management and solving personal problems.
SCI 162	Non-linear Problem Solving Skills	The use of system dynamics to define and solve non-linear, multi-variable problems.
SCI 163	Basic Research Skills	Includes using the library, using books and journals, plagiarism and referencing and research methods used in science.

More information on these modules can be found at http://goldilux.up.ac.za/goldlab

In this study, only the section of the SCI 152 course, dealing with the Problem Solving Skills, will be examined. The Problem Solving Skills component of the SCI 152 lends itself to a student's first contact with Internet delivery of lesson material, in that most of the knowledge required to solve the problems, should be part of his or her background from school mathematics. In addition, the students already had some exposure to the Internet and the Web in the Internet awareness assignment in the SCI 152 module.

The next section deals with the type of student taking the Science Orientation course.

3.2.A Target population

As mentioned in the previous section, the course was originally limited to students, from communities disadvantaged by the apartheid education policies, who were interested in careers in science. These students were chosen on the basis of their scholastic achievements as well as selection tests and interviews, where their aptitude for science studies was measured. As mentioned in section 1.4, the original course was part of a bridging year between school and university, where the idea behind the bridging year was to improve the students' academic ability in the sciences. This was done in order to allow these students to perform at the same level in their first year, as students whose scholastic achievements were at the level required by the University of Pretoria. This objective was largely achieved, as a number of students from the bridging program obtained degrees in fields such as medicine and engineering.

During 1995, the management of the University of Pretoria decided to terminate the bridging program in the Faculty of Science, and in its place introduce an "extended B.Sc.". The idea behind the extended B.Sc. was that the first year was to be split over two years to allow academically weaker students a chance to acclimatise to the pace of university teaching. An advantage of the extended B.Sc. over the bridging program was that the students could accumulate credits toward their degrees in the first year. With the bridging program, no credits were awarded for subjects passed. The Science Orientation course was absorbed into the main stream of the University's academic activities (and some of its content was also included in academic offerings in other faculties) to become a credit bearing course. Although the extended B.Sc. was still aimed largely at students from disadvantaged communities, students from advantaged communities also began applying for this method of study in order to try and obtain access to faculties with more rigorous entrance requirements (such as medicine, engineering and veterinary science). The course was compulsory for these academically weaker students.

From 1998, Science Education students, doing the Bachelor of Secondary Education (Science) degree, had to include the modules SCI 152, SCI 153 and SCI 163 as part of

their degree program. The SCI 152 module was included as the Director of the Centre for Science Education felt that Science teachers should have exposure to alternative uses for computers in education (Braun, 2000). These prospective teachers should additionally be trained in deliberate problem solving processes which involve the simplification of a problem into small steps, before recombination into the larger solution (*ibid.* See also section 3.2.B Aims and objectives of the module). SCI 153, which focuses on study methods and study self management, is intended to benefit the student teachers personally, and in their future professional role as study facilitators (*ibid.*). The presence of these student teachers had a stimulating effect on the SCI 152 student group as a whole, as they tended to readily offer assistance to academically weaker students.

With the modularisation of the Science Orientation course in 2000, and the addition of compulsory computer and information literacy to the University of Pretoria curriculum, further changes to the composition of students taking the SCI 152 module was noted. Several top students started taking the SCI 152 module voluntarily, as they felt this would pose more of a challenge than the generic computer and information literacy modules of the University.

Starting in 1999, lecturers at the University of Pretoria began experimenting with Web-delivery of course and lecture notes as well as assignment material, in undergraduate courses. The reasoning was that this method of teaching

- had been successfully used in several post-graduate courses (*e.g.* Cronjé 1997; Cronjé & Clarke 1998);
- was "cheaper" in that duplicating costs were avoided;
- was driven by a directive from the management of the University for lecturers to implement some form of technology-based teaching in their courses (van Harmelen 1997).

The author decided to use this method of delivery for the Problem Solving component of the SCI 152 course in 2000, for further reasons

- lecture space was unavailable for the larger student group taking the course;
- no definitive research was available on how successful this method of lesson delivery was for academically weaker students, with little or no computer background.

Table 1.4.2 (repeated below) shows how students were grouped for the purposes of this study. This grouping was necessary in order to see the effect of scholastic background on the students' ability to cope with this different method of teaching.

Table 1.4.2 Group definitions used in this study

Group name	Group abbreviation	Definition
Resource advantaged learners	Ra	Learners from schools with resource centres, who have had to use the resources, with minimum input from the teachers, to complete tasks.
Resource disadvantaged learners	Rd	Learners from disadvantaged schools without resource centres. In these cases, learners have to rely solely on teachers as a source of information.

In assigning students to these groups, the author first used the apartheid education system divisions: those from the former white provincial education departments and those from the former Department of Education and Training (DET). However, extensive interviews with students showed that those from Coloured and Asian communities (who fell under the former DET) were actually Ra learners in that their schools were better equipped than those in the Black communities. From the interviews with the students, it is interesting to note is that in spite of government funds being taken away from Ra schools, no corresponding improvement in the resource capabilities of Rd schools has been seen since the change of government in 1994. An advantage of using this categorisation is that Black scholars attending Ra schools could be included in the Ra category. However, during the period of the Internet delivery of lesson material in this study (2000 and 2001), no students on the course, from Black communities attended Ra schools. The severe disadvantage that students from Rd schools were at was seen during "open book" tests on the paper-based course (1997-1999). These students had no idea how to find information from a textbook. The index to the book was as foreign to them as the content of the book.

3.2.B Aims and objectives of the module

The aim of the Problem Solving Skills component of the SCI 152 module is to teach the students how to analyse and solve scientific problems.

The objectives of the Problem Solving Skills component of the SCI 152 module is for the students to

- analyse a geometry problem;
- break the problem down in to sub-problems;
- solve the sub-problems; and
- synthesise the solutions of the sub-problems to obtain the solution to the main problem.

Emphasis is placed on the use of algebra, trigonometry and Euclidean geometry in solving the problems. The mathematical concepts covered are extremely important in physics, but the general strategies followed can be adapted to any scientific field. The course was

designed to use, and build on, the students' existing knowledge of mathematics, by carefully providing the information necessary for the students to develop the required problem solving skills.

3.2.C Module content

The paper-based course consisted of a weekly 40 minute lecture followed by a four hour practical in which the computer language Logo was used as an aid in solving mathematical problems. The lecture was a discussion of the previous week's problems, new Logo commands (if any) and hints on solving the current week's problems.

In creating a Web-based resource for the course, care had to be taken that sufficient information was available to the students so that the lecture could be omitted. Thus, the Web-based resource had to contain detailed solutions to earlier problems, which included the mathematics behind the problem, as well as well-structured examples to assist the students in solving new problems.

The table below outlines the content of each assignment.

Table 3.2.c.1 *SCI 152 assignments*

Assignment no.	Assignment title	Brief description
1	Introduction to Logo	Introduces the student to the Logo environment and basic Logo commands.
2	Using colour & Regular polygons	Exercises in using commands to draw in colour are given as these are necessary for the Church Project. This is followed by questions to guide the student in discovering geometrical properties of regular polygons.
3	Using REPEAT & Rotating regular figures	REPEAT is used as a tool in generating regular polygons by repeating simple commands. Nested REPEATs allow complex figures to be produced. The generation of complex figures by nesting commands is the foundation for synthesising the solution to a problem from component solutions.
4	"Circles"	Many-sided regular polygons give the illusion of circles. However, the line segments in these regular polygons results in more complex geometry than that of simple circles.
5	Procedures	Procedures give students a means to generate their own Logo commands from basic Logo commands. Procedures simplify the synthesis of solutions to complex problems.
6	Procedures and variables	Manipulation of variables allows procedures to be re-used when drawing figures of different sizes.

The problems in each of these assignments may be viewed with an Internet browser on the attached CD under the folder "SCI152 Web pages". A solutions page for each assignment is linked to the relevant assignment page.

The final assignment for the course is for each student to draw a church using Logo. The objectives behind this are threefold:

- to test whether the student could use the problem solving strategies provided by the course, independently of the other students;
- to force the student to analyse a problem **before** attempting to solve it (*i.e.* recognise the component problems); and
- to synthesise a solution from the analysis of the problem.

It must be stressed that programming in Logo is not the aim of the course. Logo is merely a tool used to test solutions to the mathematical problems. Out of the more than 300 basic Logo commands only 18 are used in the course and very few students experimented with other commands.

3.2.D Method

The practical sessions of the Problem Solving Skills module (SCI 152) took place in the Gold Fields Computer Centre at the University of Pretoria. This centre is open from 07:30 to 20:00 each weekday during the academic year. Students registered to use the centre were able to do so at any time during these hours, provided that the centre had not been reserved for other activities. Figure 3.2.d.1 shows the layout of the Gold Fields Computer Centre. Each X on the diagram represents a computer. The author's office is one of those shown in the figure, giving an idea of the close proximity to the students. This has both advantages and disadvantages:

- one advantage is that help for the students was always close at hand;
- a disadvantage is that the students found it easier to ask for assistance rather than try to puzzle through any problem on their own. This problem was exacerbated by the fact that the author's office has a window facing into the computer centre (which can be seen in the second photograph in figure 3.2.d.2).

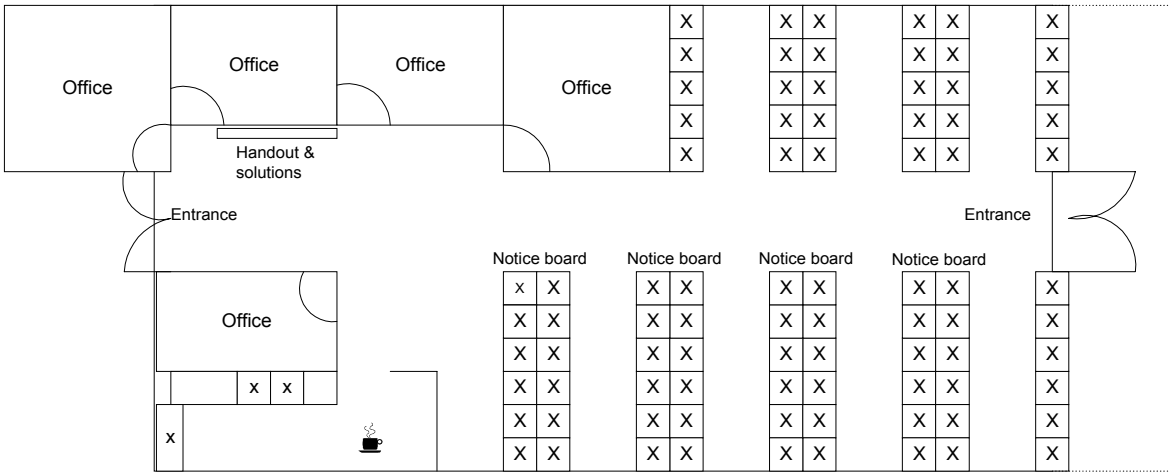

Figure 3.2.d.1 The layout of the Gold Fields Computer Centre (from Steyn, 1998)

Early in 2002, the Gold Fields Computer Centre moved to new premises on the University of Pretoria campus. Although the dimensions of the new Centre was not the same as the old one, the layout remained similar in that the same benches and cubicles were used in the new Centre. The photographs in figure 3.2.d.2 show SCI 152 students working on their assignments in the new Centre. (Views of the old Centre can be seen in the video clips on the attached CD as well as from photographs in Steyn, 1998.)

As mentioned in section 3.2.C, the paper-based course consisted of a 40 minute lecture followed by a four hour practical session each Wednesday of the semester. During the practical session, the lecturer and tutors (one tutor per 12 students) were present to assist the students in creating their solutions to the problems. The student-student and student-tutor interactions (as well as student-lecturer interactions) shown in the photographs and in the video clips on the CD, took place throughout the pratical session. Most of the students managed to finish their assignments within the practical period, but those who did not, were allowed to finish it in their own time before the deadline on the Friday following the practical session. In this case, it was normally the weaker students of both the Ra and Rd groups who required the extra time to complete their assignments. These students normally tried to finish their assignments in free periods, but had to rely heavily on the lecturer for assistance in completing these.

	A photograph showing mixed race and gender SCI 152 students working on an assignment...
	...the author's office on the right of the photograph showing the window looking out into the Centre...
	...two tutors (both standing) giving advice to students.

Figure 3.2.d.2 Photographs of students working in the Gold Fields Computer Centre

With the Web-based course, students were free to work on their assignments at any time, however, the tutors were only available during the normal practical period on Wednesday.

In both years that the Web-based resource was used, most of the students of the Rd group were present during the practical period, whereas students of the Ra group were inclined to skip the practical session and then cram to complete the assignment before the deadline. Of the entire group, only a few students of the Ra group tried to work ahead, in spite of the need to gain time to complete the Church Project satisfactorily.

3.3 Web-based course development

3.3.A The Web server

The Web server used in this study was built by the author from spare parts for the student workstations in the Gold Fields Computer Centre at the University of Pretoria. It has the following specifications:

- 100MHz Pentium 1 processor;
- 32MB main memory;
- 6GB IDE hard disk;
- 10Mbit/s ethernet card.

Linux (http://www.linux.org) was used as an operating system for the Web server. The only other option considered was Microsoft NT. This was precluded because of its rather excessive hardware requirements. Furthermore, Linux is available at no cost, as is the Web server software, Apache (http://www.apache.org).

[For the record, the Web server has been running continuously since December 1999, with two stoppages. One due to a power failure and the second when the Gold Fields Computer Centre moved to another building on the campus of the University of Pretoria. No malfunctions were experienced during the periods when the course was active and there was never any noticeable delay in downloading the pages, even at times when all the students were active.]

3.3.B Web page design tools

Several WYSIWYG Web page design tools were evaluated for use in developing the Web course pages. These were:

- Microsoft Frontpage;
- Microsoft Frontpage Express;
- Netobjects Fusion.

Microsoft Frontpage Express was chosen as it was available at no charge as part of Microsoft Internet Explorer 4. Frontpage Express also had the advantage over the other

two products in that its HTML editor was far less limited in that special HTML codes used by WYSIWYG controls were not hidden.

3.3.C Design and development of the Web pages

A great deal of care had to be taken in designing the Web pages to ensure that sufficient information was available for the students to complete the course successfully. The pages had to fall into at least Level 3 of Harmon and Jones Levels of Web usage (Harmon & Jones, 1999) as the students were expected to obtain most of the course content from the Web. However, several factors influencing Web-based instruction on Level 3 that Harmon and Jones identified (Harmon & Jones, 1999), did not apply to the SCI 152 course. Table 3.3.c.1 shows the Harmon & Jones Level 3 factors influencing Web-based instruction, and those that applied to the SCI 152 course.

Table 3.3.c.1 *Factors influencing the SCI 152 course on Harmon and Jones Level 3 Web usage (after Harmon & Jones, 1999).*

Factors	**Harmon & Jones Level 3**	**SCI 152**
Distance	Medium	Low
Stability of material	Dynamic	High
Need for multimedia	High	Low
Need for student tracking	High	Medium
Number of students	Large	Large
Amount of interaction	Low	Medium
Social pressure to use Web	Medium	Medium
Need for off-line reference	High	Medium
Infrastructure	Moderate	High
Comfort levels	Medium	Medium
Access	Moderate	High

In the table, the "stability of material" had to be high in order to make comparisons with the paper-based course. By "amount of interaction", Harmon and Jones referred specifically to email, chat rooms and bulletin boards, in other words, peer interaction rather than interaction with software. This electronic interaction was not necessary on the SCI 152 course as most of the students completed their assignments in the Gold Fields Computer Centre, which meant students could interact directly with each other when necessary.

As most of the interaction was not with the Web pages, but rather with the PC Logo software, the design of the SCI 152 Web-based course falls into the category of page-

based Web instruction (Barron, 1998). The advantage of page-based Web instruction is that it makes use of standard HTML code which can be read in any browser (Barron, 1998). Including non-standard interaction on the Web page would require the use of browser plug-ins[1]. These plug-ins are not always compatible with all browsers (see, for example Jones *et al*, 2000).

In designing the Web pages, the author followed the recommendations of Nielsen (2000) in keeping the interface as simple as possible. This was in order to keep the students' attention focused on the academic information contained in the pages. Figure 3.3.c.1 shows the simplicity of the Index page.

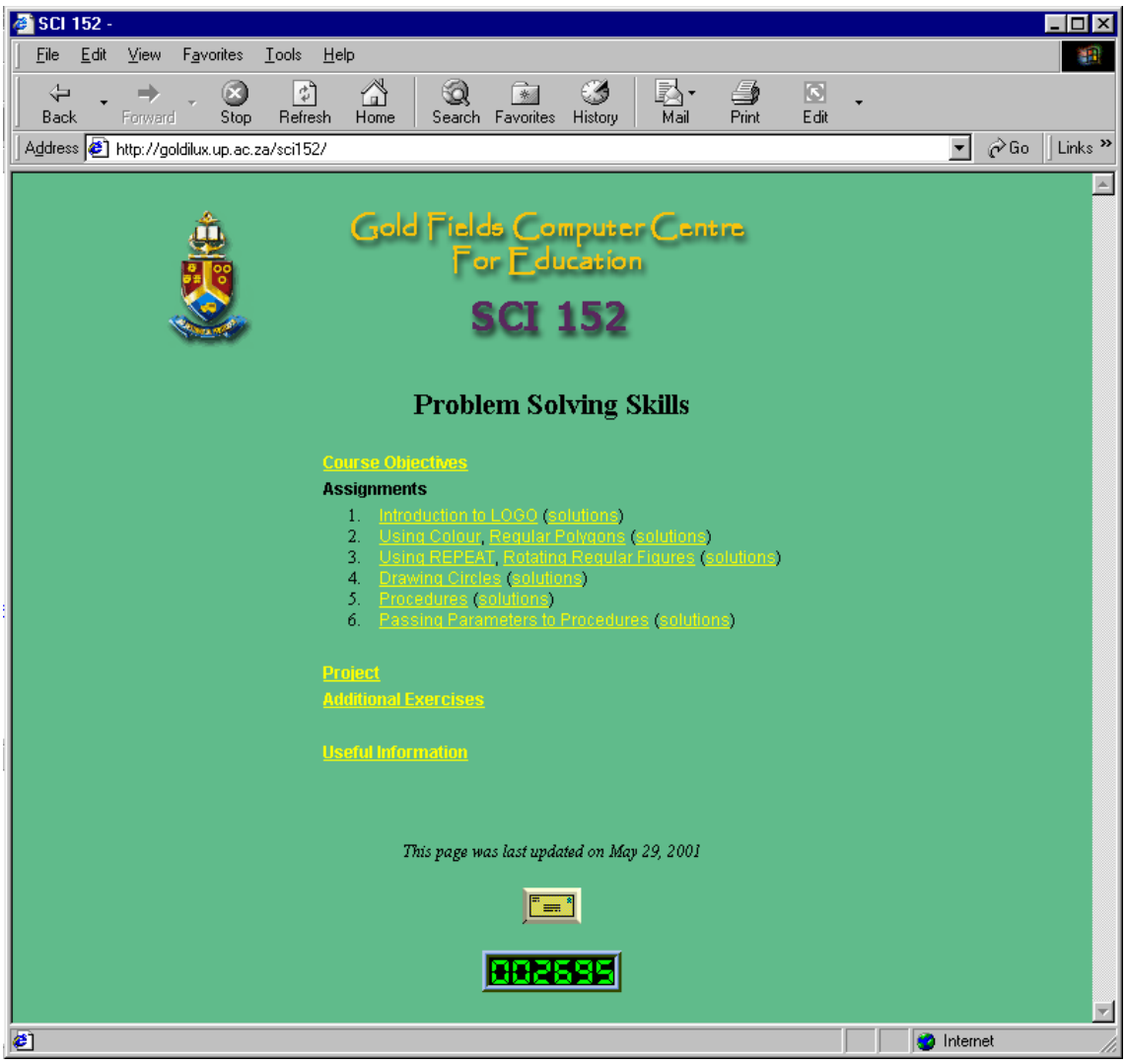

Figure 3.3.c.1 *The Index page of the SCI 152 Web-based course*

[1] A plug-in is a software module which has to be loaded onto the workstation, in order to obtain the effect envisaged by the Web page developer.

Web pages need to download quickly in order to maintain the user's interest (Nielsen, 2000:46). Excessive use of pictures increases the download time of the page. As diagrams were important in describing the assignments in the rest of the course, the first page was designed with a minimum of images so as to download quickly. This was to ensure that the users could interact with the information as fast as possible (Nielsen, 2000:50). There are only three image links on the Index page:

- the University of Pretoria emblem, which links to the University of Pretoria homepage;
- an image iconifying the name of the Gold Fields Computer Centre which links to the homepage of the Centre;
- an envelope icon which links to the author's email address.

Using pictures as metaphors to site navigation are sometimes useful, but these are often overused leaving the visitor to a Web site uncertain as to what should be done (Nielsen, 2000:180). A literal design of links usually makes the Web page easier to use (Nielsen, 2000:182-187). Certain icons could also be offensive to users from different cultural backgrounds, so the imagery behind the icon should be thoroughly researched before being used (Nielsen, 2000:315). In this study, students were from many different cultural and religious backgrounds so the use of icons as links was avoided as far as possible. Apart from those mentioned, only three further icons were used on other pages:

- a left arrow to move back to a previous assignment;
- a rectangle to move back to the Index page; and
- a right arrow to move forward to the next assignment.

Mouse flyovers were used to indicate the task assigned to these icons.

Other links shown on the Index page depicted in Figure 3.3.c.1:

- The course Objectives link, and the corresponding Objectives page, was included on the advice of one of the peer reviewers.
- The links to the solution pages were added to the Index page after the due date of each assignment. In 2000, the links to the solution pages were only available on corresponding assignment pages. As students appeared not to have used the solution pages, it was decided to add these links to the Index page as well, in order to make the existence of these pages more obvious.
- The Useful information page was included to act, amongst other things, as a bulletin board for important dates and announcements. (A similar idea to the "Notice Board" used by Ward & Newlands, 1998.)

In keeping with the guidelines given by Barron (1998), the pertinent information on the Index page can be viewed without having to use a scroll bar, even on monitors using a resolution of 640x480 pixels.

Figure 3.3.c.2 shows the introduction to the second part of Assignment 3, with guidelines that could be used in solving the problems that follow.

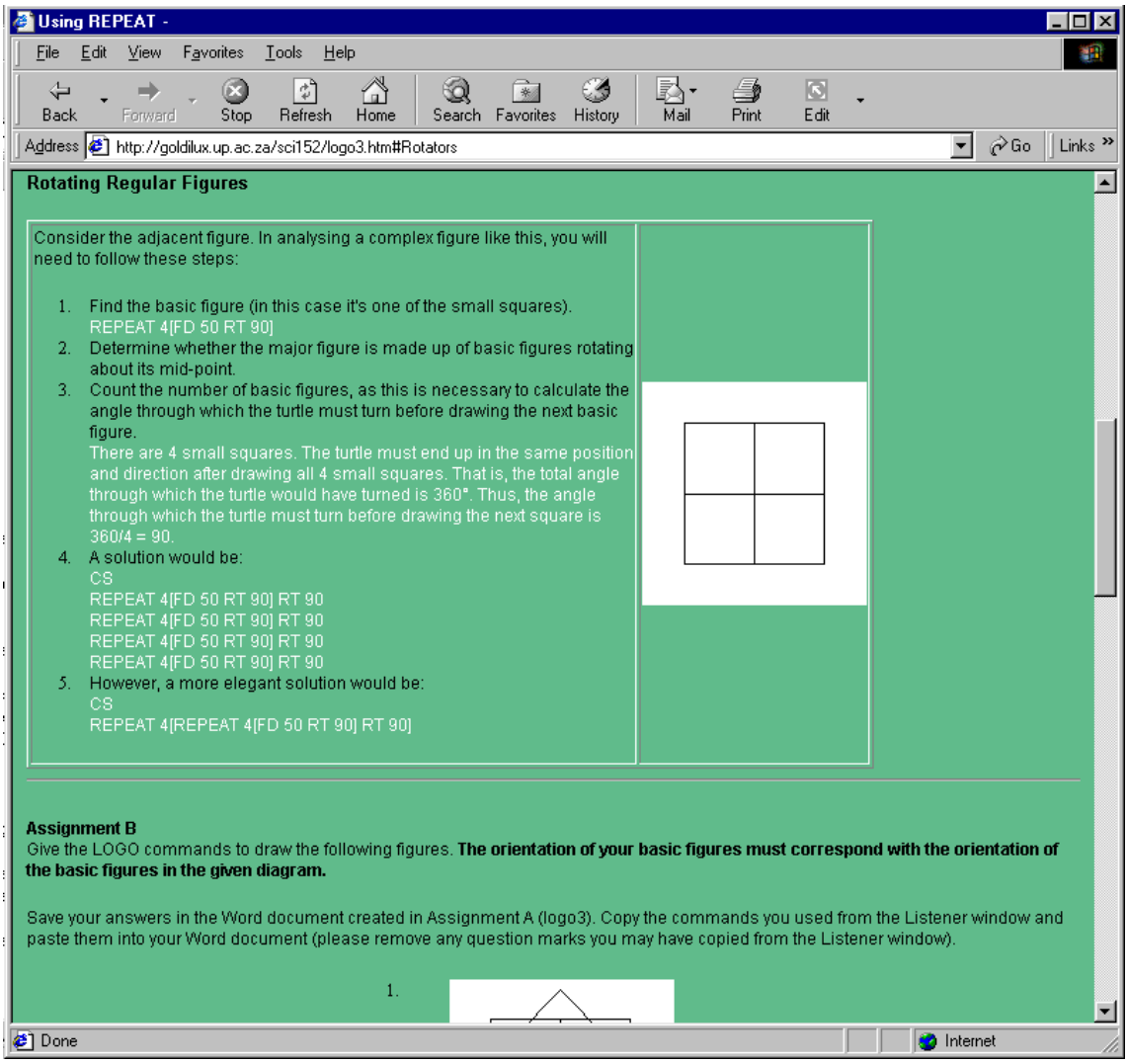

Figure 3.3.c.2 *Part of the Assignment 3 page*

In designing the pages, careful consideration was given to the use of colour (Barron, 1998; Nielsen, 2000:125). The green background was used specifically in that it provided sufficient contrast for both black and white text as well as the yellow used to indicate linked pages. The white text was used in an attempt to make it difficult for the pages to be printed. By default, Web browsers do not print the background colour, hence white text would not be visible on a white printed page. Normally, the first thing that students will do in attempting an assignment is to print the Web page (Ward & Newlands, 1998; Sheard *et al*, 2000). Students prefer the portability of a printed document (Harmon & Jones, 1999). The author found that he had to restrict student access to the printer in the Gold Fields Computer Centre as the students wasted large quantities of paper in repeated printing of assignment pages. According to De Villiers (2001a), the Department of

Telematic Learning and Education Innovation, who are responsible for Web-based teaching at the University of Pretoria, recommend that all Web pages used for teaching should be "printer friendly". However, in making this recommendation, they make no suggestions as to who should bear the cost of printing these pages. Furthermore, implicit in this recommendation is that students have access to a printer. This is certainly not the case as, before the author restricted access to the printer in the Gold Fields Computer Centre, students on the SCI 152 course often printed Web-based course pages for students on other courses.

Figure 3.3.c.3 shows part of the solution page to Assignment 3.

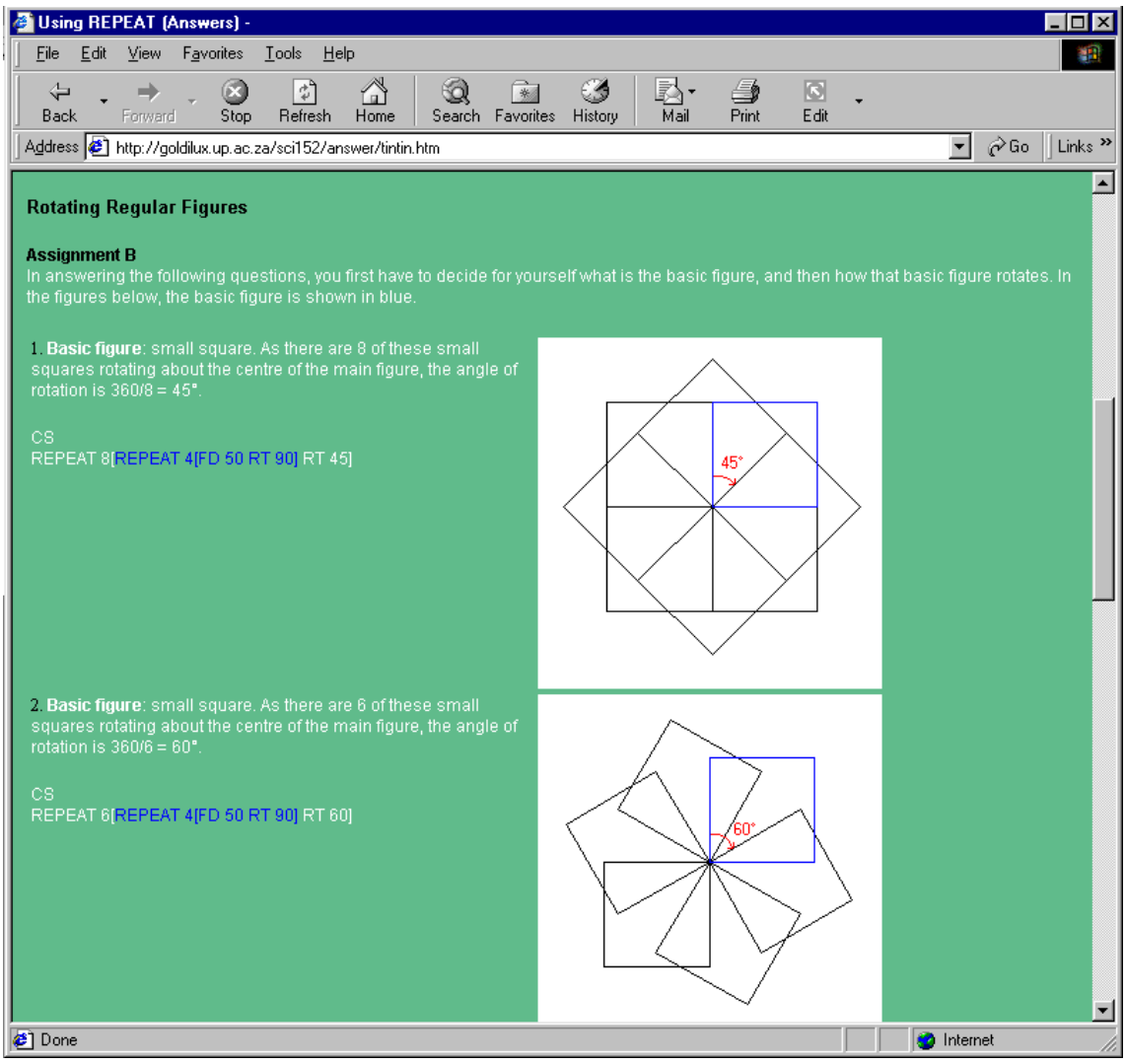

Figure 3.3.c.3 *Part of the solutions page for Assignment 3*

In making the diagrams, PC Logo was used to draw the initial image. This image was then edited in Microsoft Paint to show the important features in the diagram. The image was then converted to GIF format, for use on the Web, using Adobe Photoshop. The same

procedure was used in creating the diagrams used in the assignments themselves, except that it was not necessary to edit the diagram in Microsoft Paint.

As the solution pages were available on the Web server at the start of the Web-based course, it was necessary to use an unconventional naming system to prevent students from guessing the names of these pages. Unrelated (and rather obscure) comic strip character names were used for these file names. The Web server software was set up in such a way that it was not possible to obtain a listing of the file names through a Web browser.

Once the Web pages were complete and the changes recommended by the reviewers were made, the students were granted access to the course material. The next section discusses how the course was evaluated, and the tools used in the evaluation. Students' results were used as a means of testing the effectiveness of the Web-based resource as a teaching aid.

3.4 Web-based course evaluation

In this study, descriptive quantitative statistics, supported by qualitative analysis, was used instead of descriptive quantitative statistics triangulated by inferential statistics. In order to assess the students' ability in converting the information from the Web pages into knowledge which could be used in solving problems of the type presented in the SCI 152 course, it was necessary to compare their results with those of students on the equivalent paper-based course. In analysing the results of students' assignments, tests and examinations, use was made of arithmetical means and graphs to compare results across years. The arithmetical mean was used as it is

- unbiased,
- efficient and
- consistent (Berenson & Levine, 1986: 274-276).

Standard deviations, although calculated, were not used in this study. Using a standard deviation to test the variance of the data implies that the data fits a Gaussian distribution. The students' results were not Gaussian, but skewed towards higher marks. Analysis of variance was not used for the same reason. According to Berenson & Levin (*ibid.*: 479), analysis of variance requires that the data

- be normally distributed;
- have homogeneous variance; and
- be independent of error.

If the distribution of the data is far removed from Gaussian, the analysis of variance F-test should be used. However, if the variance within each group is not homogenous, the

F-test will also be seriously affected (*ibid.*). As the data used in this study did not conform to the requirements for analysis of variance, this test was not used.

Estes and Clark (1999) recommend that both formative and summative evaluation be used in assessing the effectiveness of a technology-based course. While formal formative evaluation *of the students* was not undertaken, the results of the students on the paper-based course can be interpreted as formative evaluation *of the course*. Similarly, the results of the students on the Web-based course are a summative evaluation of the Web-based resource.

3.4.A Evaluation of students' assignments

In keeping with the recommendations of Cronjé (1997), the deadlines given for the completion of assignments on a Web-based course were strictly adhered to. On completing their assignments, students saved them on a fileserver in the Gold Fields Computer Centre. These assignments were then allocated to tutors who marked them according to a memorandum which had been used for all the years in which the content of the course had remained constant (1997 to 2001). The results of an assignment, together with feedback, were returned to the students, on the fileserver, within two days of the deadline for completion.

3.4.B Evaluation of students' tests and examinations

As uniqueness of the questions is a prerequisite for maintaining the standards of tests and examinations, careful consideration had to be given to the complexity of the questions throughout the study period. The author worked in close collaboration with the external examiner of the course in setting up the questions so as to ensure that the level of difficulty was maintained. In order to make the marks as representative and unbiased as possible, all tests and examinations were marked by the author and thoroughly moderated by the external examiner. The same external examiner was used throughout the study period.

3.4.C Evaluation of students' time management skills

As mentioned in section 3.4.A, students saved their completed assignments on a fileserver in the Gold Fields Computer Centre. When a file is saved, the operating system includes a date and time stamp of when this task was performed. Analysis of these dates yielded an idea of how each student managed his or her time in completing the assignments.

3.4.D Analysis and evaluation of Web server logs

The Web server software used in this study, Apache, generated a record of each file downloaded from the Web server. These records include the IP[1] address of the computer requesting the download, the name of the file being downloaded and the date and time of the download request. [Note: the IP address of a computer is unique and is usually assigned by the ISP[2] when the computer connects to the ISP. In the Gold Fields Computer Centre, the IP addresses of the workstations were assigned by the author and fixed to the MAC[3] address of the ethernet card in the workstation.] However, one should be aware that the Web server was not only used for the SCI 152 course, but also for other Web sites associated with the Gold Fields Computer Centre. All the traffic for these sites were also recorded in the log file. These extra records made the log file large and cumbersome to inspect and had to be removed manually before the course data could be evaluated.

The Web server logs were used to analyse the hits on the following pages of the SCI 152 course:

- Index
- Objectives
- PC Logo familiarisation
- Solutions
- Additional assignments
- Useful information.

In addition, the logs were used to track the pages accessed by students during the course of the examinations.

3.4.E Development and evaluation of a questionnaire

A questionnaire was developed in order to test the students' opinions about the Web-based course, as well as their computer literacy levels. The questionnaire is given in Appendix 2 and will be discussed in more detail in section 3.5.

3.5 Questionnaire

The questions used in the questionnaire were based on the author's experiences and close contact with the students during the paper-based-course and the early stages of the Web-based course. A research journal, video footage of the students and notes made during

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[1] Internet protocol. The IP address is an eight digit hexadecimal number, broken down into four groups of two digits. The leftmost four digits usually represents the Internet domain of the ISP.

[2] Internet service provider

[3] Media access control: a universally unique 12-digit hexadecimal number assigned to each ethernet card by the manufacturer.

interviews with them provided the author with a great deal of background information for a reflective study. These reflections were used in designing the questionnaire.

In setting up the questionnaire, the author used experience gained in computerising and analysing psychometric tests. These tests, especially interest and personality tests, often use several questions to test a single trait. In the questionnaire used in this study, two multi-question response sets were used to probe single concepts, although the individual questions also yielded interesting information. The two concepts were

- computer expertise and
- attitude towards Web-based teaching/learning.

In spite of the misgivings voiced by Fresen (1996), most of the questions required a binary response (yes/no). Binary responses give the subjects no leeway in their opinions on the question. This was useful when building the response sets for the composite questions mentioned above.

3.5.A Computer expertise

In order to determine the effect of exposure to computers, prior to starting the SCI 152 course, on the outcome of the course, a series of questions were asked to assess the level of computer expertise of the students. The questions used for this, together with the weighting assigned to each response, are given in Table 4.3.a.1. Increased weightings used were for increasing complexity of the computer skill being probed. The weighted results for each question were then added to build a composite skill level for each student.

The effect of prior exposure to computers on the results of the students is then determined by averaging the examination results of students falling into each of the skill categories and plotting these averages as a histogram.

3.5.B Students' attitudes towards the Web-based course

Since the students may have been influenced in their response to a direct question concerning their attitudes towards the Web-based course, four questions were used in drawing up a composite response to this question. These four questions, together with their responses, are given in Table 4.3.b.1. As these questions had binary responses, one point was added for each response given in Table 4.3.b.1, and zero for the other. No weightings were used. This resulted in five categories representing the students' views of the Web-based course.

The effect of the students' attitudes towards the Web-based course on their results is then determined by averaging the examination results of students falling into each of the categories and plotting these averages as a histogram.

3.5.C Use of supplementary pages

In order for students to gain maximum benefit from a Web-based course, it is necessary for them to make use of the supplementary pages on the course Web site, such as the course objectives and the solution pages. These supplementary pages were mentioned in section 3.3.C *Design and development of the Web pages* and in section 3.3.D *Analysis and evaluation of Web server logs*. Questions concerning the use of these pages were also included in the questionnaire. Responses to these questions were compared with the number of hits on the pages.

3.5.D Time management

Several questions were included relating to how the students managed their time without formal lectures and practicals. The responses were used as part of the assessment of the students' time management skills mentioned in section 3.4.C *Evaluation of students' time management skills*.

3.5.E Administering the questionnaire

Immediately prior to the examination in 2000, all students were asked to complete the questionnaire. This time was used as it was the only period when all students were present in the same locality after completing the Web-based course. The students were also asked to include their student number on the questionnaire for record purposes. This provided a direct comparison between responses to the questions and marks used to evaluate each student. In an attempt to prevent the students from giving responses which they might have thought would influence the author in marking the examination, they were told that the questionnaire would only be evaluated in the semester following the examination. All students were allowed extra time to complete their examination.

Unfortunately, the same technique could not be used in 2001, as several students had another examination immediately after the SCI 152 examination. Students on the SCI 162 course were asked to complete a shorter questionnaire on the day of their project presentation. However, this group was a subset of the SCI 152 group and five months had elapsed since the completion of the SCI 152 examination. The author is of the opinion that this affected the credibility of many of the responses, so only interesting responses from this group have been discussed in section 4.3.

3.5.F Evaluating the responses

Responses were entered into an *Excel*™ workbook. The responses to each question were then counted, firstly for the student group as a whole and then for the two racial groupings used in this study. Histograms of these results were then plotted to compare the results. These histograms were used to qualify other results (assignments and the examination) obtained by the students.

3.6 Summary

In this chapter, methods used to collect data, outlined in Table 1.8.2, were presented. In addition, components required to support the project, such as the Web server and designing the Web pages were also discussed. These components were the foundation on which the Web site was built, and without an effective Web site, the project would never have reached fruition.

In chapter 4 the data collected in this study will be analysed and discussed.