Chapter 1 Introduction

Chapter guide

1 Introduction

1.1 Introduction

> *... the Internet is making it possible for more individuals than ever to access knowledge and to learn in new and different ways. At the dawn of the 21st Century, the education landscape is changing. Elementary and secondary schools are experiencing growing enrollments, coping with critical shortages of teachers, facing overcrowded and decaying buildings, and responding to demands for higher standards.* (WBEC, 2000: i)

This excerpt from the Web-based Education Committee (WBEC) report, and many other articles in the current literature, say a great deal about using the Internet (and more specifically the World Wide Web) as a learning and teaching tool. However, little quantitative work has been carried out in this field. Most reports are based on very small sample sizes which often casts doubt on the validity of the findings (IHEP, 1999).

In this study an attempt is made to make the data and findings more representative by using a sample of more than 200 students and a study period of five years. All four of the research methodologies recommended by the Institute for Higher Education Policy (IHEP) (IHEP, 1999)[1] are used in this study. Science Orientation, an undergraduate course offered in the Faculty of Natural and Agricultural Sciences at the University of Pretoria, was used to test the questions outlined in section 1.5. The answers to these questions are then extrapolated in an attempt to find solutions to the major questions outlined in section 1.3. Patterns in the data are examined, rather than a rigorous statistical analysis, in order to interpret the findings.

In the next section, a brief history of the World Wide Web is given in order to demonstrate the relevance of this research. This is followed by the major research questions that focus on the Web as a delivery medium of learning material. Then follows a discussion of the course on which this report is based, and the project specific research questions.

1.2 Historical overview of the World Wide Web

Since the invention of the World Wide Web by Tim Berners-Lee in 1990 (CERN, 1997), its uses (and usage) has grown beyond all expectations. Originally designed as a means

[1] Descriptive research, case studies, correlational research and experimental research.

for physicists to communicate their research findings electronically (CERN, 1997), it soon became apparent that the Web could be an important tool for information scientists, especially for those working on hypertext systems. With the development of a graphical user interface for the Web browser in 1993 (Basch, 1998; Gromov, 2000), the Web became more accessible to everyone. From 50 servers in 1993, the World Wide Web grew to more than 650 000 servers by the end of 1997 (CERN, 1997). Currently, there is no accurate measurement of the number of Web servers in the world, let alone the number of Web pages. With this surfeit of information available on the Web, information and computer scientists realised as early as 1993, the need to catalogue the information in order to make it more accessible (Sonnenreich, 1998). The Executive report of the School of Information Management and Systems of the University of California Berkeley maintains

> *The world's total production of information amounts to about 250 megabytes for each man, woman, and child on earth. It is clear that we are all drowning in a sea of information. The challenge is to learn to swim in that sea, rather than drown in it. Better understanding and better tools are desperately needed if we are to take full advantage of the ever-increasing supply of information...* (SIMS, 2000).

Initially, access to information on the Web was by "word of mouth", where useful sites were shared amongst interested people by Email and through UseNet special interest groups. In order to make this information accessible, several universities started developing software which attempted to index the Web pages available at the time. These programs had quaint names such as *Veronica*, *Jughead*, *Wanderer*, *Webbots* and spiders, but eventually all became known as search engines. The biggest disadvantage of these early search engines was, that in doing their indexing, they consumed more Internet bandwidth than the users. It was only once the Internet bandwidth increased and the search engines moved off university computers into the corporate world, that the World Wide Web became an effective research tool (Sonnenreich, 1998).

Once control of the Web moved away from academia, business realised its importance mainly as an advertising medium (Basch, 1998). However, in 1994, Pizza Hut became the first Web-based store to open. Shortly thereafter, the first Web-based banking system went on-line (Basch, 1998).

In addition to the information available on the World Wide Web, its hypertext roots give it a strong educational foundation. Firstly, hypertext is said to match human thinking in that memory is organised in a semantic network where concepts are linked together by associations (Kearsley, 1988 as cited in Alexander, 1995). Secondly, as hypertext is a linked system based on semantic structures, it can be mapped onto the structure of the

knowledge representing it (Jonassen, 1988 as cited in Alexander, 1995). Hence it is easy to see why Web-based teaching has become so popular. The most common method of Web-based teaching is to put lecture notes and tutorials on Web pages with links to other useful pages elsewhere in the world (Sheard *et al*, 2000). In this way a learner can follow information paths in a way which is unique to him or her (Alexander, 1995). The biggest advantage of Web-based teaching is that course material is available to the learner anywhere and at any time, provided that the learner has access to the Web.

Modern Web page development tools, such as *Flash* and *Shockwave* (www.macromedia.com), allow teachers to add programmed, interactive hypermedia to their pages. This interactivity is a shift away from the static nature of the original definition of the Web. Other tools include *WebCT* and *Blackboard* which allow the teacher to administer and manage courses via the Web.

According to the WBEC, "The World Wide Web is a tool that empowers society to school the illiterate, bring job training to the unskilled, open a universe of wondrous images and knowledge to all students and enrich the understanding of the lifelong learner." (WBEC, 2000: 1). However, the IHEP report on technology-based distance education cautions that learners require special skills, as well as sophisticated technical support, if Web-based learning is to succeed (IHEP, 1999).

In trying to map World Wide Web technologies to teaching and learning, especially in developing countries, several questions are raised. Some of these are introduced in the next section.

1.3 Major research questions

The following table lists the research question and sub-questions pertaining to Web-based learning and teaching in general, which will be addressed in this study.

Table 1.3.1 *Major research questions*

1. What is *information* and what is *knowledge*? • How do *information and knowledge* relate to *teaching and learning*? • How do *information and knowledge* relate to *the World Wide Web*? • What is the relationship between *the World Wide Web* and *teaching and learning*?
2. To what extent can Web-delivery of lesson material be used to address the education shortfall in disadvantaged communities? • How will students from disadvantaged communities cope with this method of lesson delivery?

In order to find possible solutions to the second question, it is necessary to use a study on a smaller scale in which the target population is represented. Students on the Science Orientation course in the Faculty of Science at the University of Pretoria provide such a sample. An overview of the history of the Science Orientation course is given in the next section, with the research questions relevant to the Web-based presentation of the course given in section 1.5.

1.4 Historical overview of the Science Orientation course

The Science Orientation course was first implemented as an add-on to the bridging program (Project Renaissance[1]) of the Faculty of Science in 1994. The original reason for the course was to expose the students to skills required for successful study in the Sciences as well as to computer technology (hardware and software). With the poor level of mathematical reasoning skills that these students posessed, it became apparent that they needed assistance in developing problem solving skills, especially those involving logic. As an experiment, an introductory module in programming, using Logo as the programming environment, became part of this course. Logo was chosen for the following reasons:

- it has a strong mathematical foundation;
- the results of commands being executed can be seen immediately; and
- the language lends itself to analysis of geometrical problems and the structured synthesis of their solutions.

The Logo part of the course ran for eight weeks in the first semester, and consisted of a one hour lecture followed by a four hour practical each week. Another three sessions were then allowed for the students to complete a Logo project in the second semester.

In keeping with the original aim of Project Renaissance, the number of students on the course was kept below 40 to allow maximum contact time between the students and the lecturer/tutors. This contact allowed problems, encountered by the students during a practical session, to be discussed in depth, with staff guiding the students towards a successful solution of the problem at hand.

Prior to the 2000 academic year, lectures consisted of a discussion (in which the students were encouraged to participate) of solutions to the previous week's problems followed by a preview of problems in the current assignment. This preview would include a short discussion on new Logo commands, possible pitfalls in the problems and sometimes a hint or two. A practical worksheet was given to the students each

[1] Project Renaissance was an initiative of the former Dean of Science at the University of Pretoria, Professor Nico Sauer, to find potential science graduates amongst school leavers from the disadvantaged communities.

week, which meant that students worked through their practicals synchronously and linearly. This eased the workload on the lecturer and the tutors, as questions during a practical were all concerned with the same assignment.

In 1999, the Management of the Faculty of Science decided to modularise the course and double the number of students that could be admitted to the course. Both of these led to problems with the logistics of presenting the course.

- Modularisation meant the course was restricted to a single semester. As mentioned earlier, prior to 2000, the students were allowed time at the beginning of their second semester to complete their LOGO projects. This time would thus have to be telescoped into the first semester so that the students could complete the module in a single semester.
- The increase in the number of students meant a loss of the one-to-one contact time between the students and the lecturer/tutors. It also meant that the lecture hall used prior to the 2000 academic year was too small to accommodate all the students. With the high premium on lecture room space at the University of Pretoria (van Harmelen, 1997: 56), especially those with network connectivity and data projection facilities, this problem was critical as some students had to sit on the floor during the computer literacy lectures in 2000.

To overcome these problems, the author decided to experiment with Web-delivery of the lecture material and the assignments. The advantages of this were fourfold:

- the practical session would be extended by an hour which would mean that the lecturer/tutors would be able to spend more time with the students;
- students could be encouraged to work asynchronously as all assignments would be available at the start of the course;
- students would have to learn some form of time management to complete their assignments and project on schedule; and
- the students' computer literacy experience would be extended to include Web-browsing.

Furthermore, Web-delivery of course material is in keeping with the telematic teaching approach advocated by the University of Pretoria (Anon, 2001a) to promote flexible learning patterns by students of the University. Such flexible learning patterns should enhance the students' ability and motivation to become lifelong learners.

Unfortunately, little research has been done on the influence of a student's background on his or her ability to successfully complete a course delivered by the Web. In order to see the effect of scholastic background on the students' ability to cope with this different method of teaching, it was necessary to group them according to some criteria so as to

be able to compare the results of the different groups. Table 1.4.1 shows how Herselman (1999) grouped advantaged and disadvantaged learners according to their access to resources.

Table 1.4.1 Group definitions from Herselman (1999)

Group name	Group abbreviation	Definition
Resource advantaged learners	RA	"...learners from favourable socio-economic environments in which they have ready access to electricity, water and food. ..."
Resource deprived learners	RD	"...learners from disadvantaged or deprived socio-economic environments where they often lack even basic amenities like electricity and running water. ..."

In this study, the students were also grouped according to their access to resources, but here a resource does not refer to a public utility, such as water or electricity, but rather to some form of study aid such as a library or an Internet connection at school.

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. Often these teachers lack suitable qualifications in their subjects.

The definitions given in the table were made on the basis of extensive discussions and interviews with the students on the SCI 152 course (and its predecessors) since 1994. These definitions will be discussed in more detail in section 3.2.A.

1.5 Research questions pertaining to this project

As a sequel to the research questions posed in Table 1.3.1, the following table is an outline of the research questions specific to the Web-delivery of the Science Orientation course.

Table 1.5.1 *Project research questions*

1. How did the students cope with the Web as a medium for lesson presentation? To what extent • did the students need face-to-face contact? • did the information in the Web pages meet the requirements for the students to complete the assignments? • could the students manage their time in the absence of formal lectures? • did the students use the study aid pages? ▪ Objectives ▪ Useful information
2. What were the students' attitudes towards Web-delivery of course material?
3. How did the digital divide affect the students' performance? To what extent • was prior exposure to computers beneficial in successfully completing the course? • did prior exposure to computers affect the students' ability to complete a solo computer-based project? • did open Internet access affect the students' performance?
4. Was there any difference in the ability of Ra and Rd students to complete the course successfully?

1.6 Limitations of the study

Limitations of this study, which must be borne in mind, are

- The Science Orientation Course discussed in this document was not a distance-teaching course, but rather a contact course delivered via the Web.
- The subject matter was limited to a highly specific area of mathematics.
- Questionnaires were completed only by students in 2000.
- Open Internet access was available to students in 2001 only.

1.7 Other research

The following table lists current, and recently completed, research projects on teaching and learning via the Internet, in South Africa. The data was compiled from a search of the Nexus research database at the National Research Foundation[1].

[1] http://www.nrf.ac.za/nexus The database query was carried out on 13 September 2001, with search terms "Web" and "Internet".

Table 1.7.1 *Current, and recently completed, research on teaching and learning via the Internet.*

Author	Title	Year	Degree
de Jager, A.	The use of the Internet as constructivist resource in the teaching the mole concept	1995	MEd
Owusu-Sekyere, C.	The application of computer technology in South African distance education.	1997	MSc
Brown, S.	A framework for Internet supported collaborative learning in South Africa.	1998	MTech
Butcher, N. & Roberts, N.	The Internet, satellite and the professional development of educators: building appropriate teaching and learning models.	1998	NDP
Cilliers, W.J.	Formative evaluation of an Internet-based introduction program.	1998	MEd
Clarke, P.A.	Telematic teaching of adults via the World Wide Web: a case study.	1998	MEd
Dickson, M.	Superhighway or cul de sac: the Internet as a tool for learning school mathematics.	1998	MEd
Nolte, M.	The use of the Internet in the integration of information sources for a first-year anatomy course.	1998	MEd
Pete, M.M.	The design and development of a resource-based, open learning system on the World Wide Web.	1998	MEd
Voster, B.	Possibilities and constraints of teaching adults on the World Wide Web	1998	MEd
Wissink, H.F.	An interactive, Internet-based, multimedia system for the delivery of masters degree modules.	1998	NDP
Botha, J.S.	How did a Web-based learning environment facilitate the development of critical higher-order thinking during the presentation of an MEd Computer Based Education course?	1999	MEd
Cloete, L.M.	The education and training of cataloguers through distance education: a Web-based model.	1999	DPhil
Davey, M.G.	Teaching the net generation: problems and possibilities of developing content for a language learning Website.	1999	MA
de Bruyn, A.M.	Guidelines for the use of the Internet in teaching.	1999	DEd
Lautenbach, G.V.	Learner experiences of Web-based learning: a university case study.	1999	MEd
Letshela, P.Z.	Rendering information services to rural communities through Web technology.	1999	DLitt et Phil
Delmont, E.	Development of Web-based teaching and learning resource materials.	2000	NDP
de Villiers, G.J.	Evaluation of the Web-based information resources to support learning: an exploration.	2000	MA
Lehr, R.H.	Web-based distance learning for power system engineering.	2000	MSc
Mabathoana, S.T.G.	The logistical and didactical support needs of computer-based education MEd learners who participate in Web-based courses.	2000	MEd
Ohlhoff, C.H.F.	The use of the computer in literacy research and teaching.	2001	NDP
Staak, L.P.	Hypertext and the act of reading and learning: a study of the use of hypertext on the Web in the secondary school English literature classroom.	2001	MPhil
van Ryneveld, L.	An exploration of cost-effective solutions for Internet based learning.	2001	MEd

The table shows the high level of research interest shown in Internet-based teaching and learning at South African tertiary institutions, especially since 1998. Hence, the

research reported on in this document is relevant. By comparing the research titles in Table 1.7.1 with the research questions outlined in sections 1.3 and 1.5, one can see that these research questions are unique, yet topical to the work of de Villiers, Lautenbach, Voster and Cilliers.

Furthermore, the Web-based Education Commission of the United States government recommends that research into Internet-based learning needs to be expanded and revitalised (WBEC, 2000: 55). Much of the research into technology-based distance learning is inconclusive and more needs to be done (IHEP, 1999). Historically, research emphasis has been placed on the development of technology-based material rather than on evaluating the effects of technology on learning (Laurillard, 1993:223).

1.8 Data collection methods

The following tables show the methods that were used in answering the research questions outlined in sections 1.3 and 1.5.

Table 1.8.1 *Data collection matrix for the major research questions posed in Table 1.3.1*

	Literature survey	Interviews and discussions	Extrapolation[1]
1. What is *information* and what is *knowledge*?	❖	❖	
• *information/knowledge* related to *teaching/learning*	❖	❖	
• *information/knowledge* related to *WWW*	❖		
• *WWW* related to *teaching/learning*	❖	❖	
2. To what extent can Web-delivery of lesson material address the educational shortfall in disadvantaged communities?	❖	❖	❖
• Will *students* cope?	❖	❖	❖

[1] Data will be generated by extrapolating from the results obtained from the SCI 152 course.

Table 1.8.2 *Data collection matrix for the research questions posed in Table 1.5.1*

	Course results	Questionnaire	Web-server logs	Assignment hand-in date	Observation & discussion
1. How did the students cope with the Web as a medium for lesson presentation?	❖	❖	❖	❖	❖
• face-to-face contact	❖	❖			❖
• sufficient information in Web pages	❖	❖			❖
• successful time management strategies	❖	❖	❖	❖	❖
• use of study-aid pages		❖	❖		❖
2. What were students' attitudes towards Web-delivery of course material?	❖	❖		❖	❖
3. How did the digital divide affect the students' performance?	❖	❖		❖	❖
• prior exposure to computers	❖	❖			❖
• successful completion of a solo computer-based project	❖			❖	❖
• open internet access	❖			❖	❖
4. Was there any difference in the ability of Ra and Rd students to complete the course successfully?	❖	❖			❖

1.9 Thesis outline

The following table is an outline of the rest of the chapters in this report.

Table 1.9.1 *Thesis outline*

Chapter	Title	Description
2	Literature survey	A review of the relevant literature, including discussions of information, knowledge, learning and teaching as well as the design of Web pages.
3	Research methodology	A discussion and motivation of the methodology and tools used to collect and interpret the data in this study.
4	Results and discussion	An analysis of student results, student opinions and Web-server logs.
5	Conclusions and recommendations	Conclusions drawn from the results with recommendations on improving Web-delivery of academic material.

Supporting chapters include

- Future work
- Bibliography
- Appendices.

A CD, with an electronic copy of this document as well as non-standard references referred to in the text, is included in an envelope on the inside back cover.

1.10 Summary

In this chapter, overviews of the World Wide Web and the Science Orientation course were presented. From these overviews, research questions pertaining to this project were developed. In Chapter 2, relevant literature will be analysed in an attempt to find pointers to solutions to some questions, and to put the research into a theoretical context.