GeoQuest:

An interactive multimedia program

for introductory Earth Science education.

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ABSTRACT

I have developed an interactive multimedia program in introductory Earth Science aimed at Australian high school students aged 12-16. The program, GeoQuest, is a role-playing exercise intended as a supplementary learning resource for home and classroom use. Research into the use of interactive multimedia, and evaluation of the program by high school science teachers, indicated interactive multimedia provides a useful alternative to traditional text-based and lecture presentations that can alienate some students from Earth Science.

High school classrooms where Earth Science is taught face scarce resources in teacher expertise, time and money, and may be unable to provide practical Earth Science activities, such as field trips. A role-playing style interactive multimedia program can provide an alternative or supplementary learning experience in geology where access to field trips or laboratory equipment is limited.

Evaluation of the program indicated that the product was a useful resource specifically because it could collate a series of unrelated experiences in introductory Earth Science education into something meaningful for the student. Interactive multimedia is recommended as one way of providing a fun and different approach to geology for the first time Earth Science student.
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WHY MAKE AN INTERACTIVE MULTIMEDIA MODULE FOR EARTH SCIENCE?

Fewer students are taking up the option of doing introductory Earth Science in high schools in Australia. The number of enrolments is lower than those in Physics, Chemistry and Biology, and while enrolments in these subjects are increasing, Earth Science enrolments continue to decline. Earth Science in high schools can often be the only contact that people have with geology, before moving on to non-science or other science careers. With fewer people familiar with geological processes through plummeting enrolments at high school, the public awareness of geology suffers.

In addition, funding is decreasing for university geology courses and for Geoscience Australia (previously the Australian Geological Survey Organisation), and Australia's largest science research organisation, the Commonwealth Science and Industrial Research Organisation (CSIRO).

Science funding cutbacks throughout Australia have provoked debate about the importance of putting money back into scientific process. Addressing the lack of funding for science in Australia is part of the role of science communicators, people employed in raising the public awareness of science.
One way of raising awareness of a science and its importance to the economy is through education at high schools. What can be done at this level to give awareness of science, specifically geology, a much-needed boost?

Attitudes of high school students (and grown up high school students) towards science education, particularly Earth Science education, can include the perception that it is boring and difficult. Earth Science involves memorising many scientific names and formulas. But Earth Science also has an immediate and obvious relevance, in that it describes the world around us; the interactions of systems, such as the carbon cycle, which are relevant to our continued survival as a species. It includes the study of marine geology, which can give us an insight into the effects of global warming. Natural hazards such as earthquakes, volcanoes, tidal waves, landslip and erosion all occur because of geological processes. It is also the basis of the multi-billion dollar Australian mining and petroleum industry. There is a need for awareness of geological issues in land management and planning, emergency services, studies of the environment and outer space.

The study of geology incorporates knowledge from physics, chemistry, biology, geography, mathematics and environmental science. It involves the scientific process, but is less mathematically rigorous that maths and physics and is visually interesting, which could make it more appealing to the reluctant science student. The nature of Earth Science can be utilised in high school education to increase awareness of the scope of geology in a positive way.
With the advent of the computer age, a multitude of possibilities in teaching and learning has been opened up to us. We can calculate faster, communicate faster and visualise things in a very different way from in the past. More and more computers are being used in Australian high schools as teaching tools. One of the ways computers can be used is through interactive multimedia, software that conveys information using audio-visual technology and hyperlinks.

Interactive multimedia is currently being used in schools worldwide for Earth Science education. Geological processes, which operate over vast scales and unimaginably long times, are particularly suited to representation via animation or video. So why not just make another great Earth Science video?

Utilising the hyperlinks in an interactive multimedia program can enhance interactivity in an Earth Science course. Interactive multimedia programs that present Earth Science as a virtual field trip or a role-playing game allow geology to be presented as a challenge and a puzzle, and provide variety to the traditional lecture format. The implementation of a different learning mechanism could change attitudes towards studying geology.

In this thesis I examine research for and against implementing interactive multimedia in introductory Earth Science education. I evaluate the use of interactive multimedia to understand whether multimedia assists teachers in high school Earth
Science education, and examine whether there is a benefit in using interactive multimedia (IMM) in Earth Science.

This information is used as the basis of the development and evaluation of an interactive multimedia program directed at Australian Earth Science students at the high school level. The assessment of the program by a group of high school science teachers provided feedback for further development of the program.

**Purpose of the study**

The purpose of the study is to develop an interactive multimedia program in Earth Science aimed at Australian high school students. The program is intended as a supplementary learning resource in introductory Earth Science to provide familiarity with Earth Science practises, and the roles of professional geologists.

As part of the development of the program I examined research on the use of interactive multimedia in schools, specifically in Earth Science education, and evaluated the interactive multimedia program with high school science teachers.

**Research Questions**

• Is interactive multimedia being used for the teaching of Earth Science in Australian high schools?
• Do the characteristics of interactive multimedia facilitate teaching introductory Earth Science?

• How can a role-playing, quest-solving interactive multimedia program be developed to provide a teaching resource for introductory Earth Science education?

Limitations of the study

Interactive multimedia requires substantial time and money to develop. The considerable investment needed to develop interactive multimedia is a limiting factor to implementing interactive multimedia in high schools.

The attitudes of students towards the program developed will not be examined. The scope of this study restricts an extensive survey of students using the program. A further study could involve comparison of several types of multimedia, the use of the web, and other innovative uses of the computer in education.

Overview of the study

In Chapter 2, I examine the state of Earth Science education in Australian high schools. Research indicates that the decline in enrolments in Earth Science and the
lack of coverage of Earth Science education in schools could stem from a need for alternative teaching strategies. I discuss the implementation of interactive multimedia as a tool for teaching, and take a look at whether multimedia is being used in schools. I examine the types of interactive multimedia available in Earth Science. I review research for and against the use of interactive multimedia in high school education.

In Chapter 3 I present the method of the design of the interactive multimedia program, and discuss the method for evaluating this program. The aims and learning outcomes are presented along with a brief discussion of the structure and content of the interactive multimedia program developed.

In Chapter 4 I present and discuss the results of the evaluation of the program. The sum of information gathered is used in the following chapter to evaluate the use of interactive multimedia in teaching Earth Science, and the effectiveness of the program developed.
Chapter 2

INTERACTIVE MULTIMEDIA IN EARTH SCIENCE

In this chapter I examine the state of Earth Science education in Australian high schools. In exploring the possibility of a need for alternative teaching methods in Earth Science, it is necessary to survey what is being done in geology, including the use of interactive multimedia for teaching Earth Science. Research into interactive multimedia (IMM) is reviewed to decipher arguments for and against the use of IMM as a teaching aid. These arguments will provide the point of departure for the development of an IMM module in introductory Earth Science.

The State of Earth Science Education

Science enrolments have been declining steadily since the 1970’s, despite an overall increase in the number of enrolments at high school. There has been a national increase in participation in upper secondary school education, but a drop in participation in science education, particularly the 'standard' sciences, or public examination subjects (PES), such as physics, biology, geology and chemistry (Dekkers and De Laeter, 1997). Geology has consistently had the lowest enrolment numbers of the four standard science units. Dekkers and De Laeter (1994) note that by 1992, Earth Science enrolments in ACT high schools had dropped to just 43.65% of the number of enrolments there were in 1976. By 1995, there was only
33% of the number of students enrolled in Earth Science compared to 1976 levels (Dekkers and De Laeter, 1997). Of the other three PES science units, the subject with the next lowest enrolments overall, physics, in the same period saw enrolments increasing by 162.9%.

The result of this decline in enrolments, as noted in Henderson, Leitch and Denham (2000), is that high schools have subsequently reduced the level of coverage of Earth Science topics:

Very low numbers of students [are] studying Earth Science at senior high school level, with some states eliminating Earth Science courses entirely from their senior science programs (Henderson et al., 2000, p.6).

From being a core science unit (compulsory unit) in 1996, Earth Science is now only a minor and relatively small enrolment subject Australia wide (Dekkers and De Laeter, 1997). In many Australian high schools Earth Science is either a non-compulsory unit, is combined with other courses, or is no longer offered to students at all (Dekkers and De Laeter).

In 1994, the then Federal Opposition spokesman on Science and Technology, Peter McGauran said:
that geology was almost extinct as a school subject in South Australia, Western Australia and Queensland. Only New South Wales and Victoria had maintained a small core of support (Dekkers & De Laeter, 1996, p.20).

Dekkers and De Laeter (1994, 1997) note it is likely that Earth Science may disappear as a separate subject in some states and territories, including the ACT, in the near future.

Where Earth Science is still offered in Australian high schools, there is a limited coverage of topics (McQueen and Perkin, 1992). In the curriculum for high schools developed by the Australian Science Teachers Association (ASTA) in 1998, it is recommended that Earth Science be merged with Environmental Science in an attempt to make geology more relevant, and to integrate what were traditionally geography topics into a more holistic Earth Science topic. As Earth Science is increasingly combined with other courses, some aspects of geology are no longer being taught (R.A. Arculus, personal communication, November 7, 2000).

Interviews with Professor Richard Arculus of the Australian National University Geology Department, a regular first-year lecturer and one-time head of department (Appendix A), and Gary Lewis, head of the Education section of Geoscience Australia (Appendix B), revealed that merging Earth Science topics with other, more environmentally-based subjects can ensure geology will continue to be taught

The drop in enrolments and the decline of coverage of geology in the secondary school systems is a growing concern for members of the geological community in Australia (McQueen, 1993). In 1992 parts of the Geological Society of Australia in the ACT formed an organisation known as GEOLACT, an ACT-based geology society that encourages interaction between educational and professional geology. One of their first jobs was to survey schools to determine the state of Earth Science in schools. The GEOLACT survey in 1992 revealed:

Of the 9 high schools... which responded [of 19 in the ACT], 3 have a significant coverage of earth science in their general science course and 6 have some coverage (McQueen & Perkin, 1992, p.35).

Bakri (2000) notes that the decline in Earth Science education at high school level is symptomatic of the problem facing the broader geology community. Earth Science, like most sciences, has received funding cuts at all levels, in university, government agency (Geoscience Australia), industry, and in other research and development. In an open letter to the Prime Minister, the President of the Geological Society of Australia, Professor R. Henderson (1999) writes:
The 1999 Federal budget which brought a significantly reduced funding level for the Australian Geological Survey Organisation follows outcomes from a number of Government actions which have weakened Australian capacity in Geoscience. . . the last two years has seen a markedly diminished interest in exploration by resource companies across the board and a very serious loss of professional geoscience staff and commitment to research and development within Australia (Henderson, 1999, p.5).

Henderson et al. (2000) note that as well as a decline in funding for research in development, the major problems facing geology includes the decline in staff numbers, the decline of enrolments, and the merging of Earth Science with other courses.

In the proceedings of the Third International Conference of Geoscience Education in Sydney in January, 2000, Bakri notes the consequence of this decline in funding levels and the downscaling of Earth Science departments, is that geology has become less relevant to the wider community.

**Why the Decline in Enrolments?**
Arculus emphasises that studying Earth Science at high school is not necessary for students intent on a science degree (R.A Arculus, personal communication November 7, 2000; Dekkers and De Laeter, 1996), nor is it perceived to lead to practical work after school (Beasley, Butler and Satterthwait, 1994). A survey of Queensland students by Beasley et al., revealed:

They [609 senior science students from 26 high schools in Qld] perceive the present syllabus as having little direct relevance to the transition from school to work (Beasley et al., 1994, p.37).

Addressing the decline in enrolments at the high school level may be the solution to the greater problem of the decline in geology overall (Dekkers and De Laeter, 1996). Dekkers and De Laeter state:

Geology needs to enhance its public image in order that an awareness of geologically-related information is understood by the community. One way of achieving this is to have a greater proportion of its citizens undergo a course in geology at the secondary level (Dekkers & De Laeter, 1996, p.23).
Lawrance (1996) agrees that widespread support within the community for geoscience is best gained by education in high schools. She notes that to do this, some system is needed for the broader encouragement of high schools and high school teachers to include geoscience within the curriculum.

For the declining enrolments in Earth Science at high school to be addressed, the traditional way of teaching science needs to be examined. Luntz (1998) argues that the method of teaching science in general has led to the drop in enrolments in science.

While the slump in science enrolments probably has many causes, part of the problem seems to be that students perceive science to be too hard, too abstract and too alien (Luntz, 1998, p.16)

It is noted by Gunter (1993), Constantopolous (1994) and Lewis (G. Lewis, personal communication, July 21, 2000) that Earth Science education may be perceived as particularly rigorous and difficult. They note that methods of teaching Earth Science does little good and can actively "turn students off" geology (Lewis). The teaching of Earth Science traditionally requires an intensive load of information to be learned; rock names, mineral names, and their chemical and modal compositions. Constantopolous notes that this method of teaching Earth Science may be perceived as particularly tedious.
... the problem is that many students are not motivated, and to them the thought of wading through a pile of minerals is considered sheer torture (Constantopolous, 1994, p.261).

Is this "torture" the best approach in teaching introductory geology? Gunter (1993) thinks not:

There are so many nouns in the sciences that the entire class could be spent defining them and making the students memorise them, but little good comes from such activity (Gunter, 1993, p.133).

Lewis (G.Lewis, personal communication, July 7, 2000) notes that introductory Earth Science teaching methods can often actively turn high schools students off geology:

... the first thing [in geology] they hand out is piles of minerals and say lets do rock tests and identify these rocks and minerals, and kids get turned off by it.
This information-rich method of learning has also been criticised by Novak (1999) who believes that currently there is no active learning going on in Earth Science at all. Teachers themselves see Earth Science as lacking in relevance for students (Lawrie et al., 2000).

There was consensus among the student respondents to the survey by the Geological Society of Australia (McQueen and Perkin, 1992) of the need to make geoscience more pertinent to everyday life.

Despite the difficulties perceived in introductory Earth Science classrooms, there is evidence for the continued interest in geology by high school students (Boylan, 1996; McQueen and Perkin, 1992). Boylan did a survey of initial preferences for 499 Australian first year high-school students in science education. The two topics of highest interests were both geology subjects. McQueen and Perkin also note that teachers in the ACT perceived students in high schools as having a substantial interest in Earth Science topics.

_A Lack of Experts_

An experienced and enthusiastic teacher can make Earth Science interesting and relevant (R.A Arculus, personal communication, November 7, 2000). Arculus notes that phobias of science may be brought about by experience with teachers who may not have the expertise in teaching that particular science. McQueen (1993),

Lack of experience in geology can lead to Earth Science being taught with little enthusiasm, doing nothing to stimulate student interest (R.A Arculus, personal communication, November 7, 2000). A survey of ACT secondary science teachers by the Education Subcommittee of the Geological Society of Australia’s ACT Division and SEA*ACT (Science Educators Association of the Australian Capital Territory), revealed that most respondents found Earth Science interesting and stimulating, but problems arose when teachers who did not have Earth Science in their training were required to teach the subject (Lawrie et al., 2000). These teachers felt less confidence in teaching Earth Science.

*Not Enough Money*

A further hindrance to teaching Earth Science is that it requires a certain amount of expenditure on materials or excursions. The expense of field excursions and laboratory equipment in Earth Science is significant (R.A Arculus personal communication, November 7, 2000; Smith and Abley, 1996). Moore (2000) notes that field excursions are under threat due to the recurring costs involved. Smith and
Abley (1996) observe that laboratory equipment can be prohibitively expensive for high schools. Smith and Abley comment:

Instrumentation costs for modern mineralogy are high. Currently, a powerful desk-top computer may cost less than, for example, a student petrographic microscope, or a handful of crystal-structure models (Smith & Abley, 1996, p.189).

Smith and Abley's comments indicate that due to cost considerations, schools may be more likely to buy personal computers than geological equipment.

Research shows that the expense of Earth Science is one of the limiting factors in Earth Science education, discouraging student participation. Without funds and teacher expertise, the trend of falling enrolments is likely to continue (Dekkers and De Laeter, 1994).

**Geology is Boring**

It is crucial to note that, particularly for non-scientists, the current methods of teaching Earth Science can isolate some students (Bakri, 2000). Bakri comments:
... the current geoscience education has contributed to the
creation, inadvertently, of rigid walls around the discipline
which inhibited non-geologists taking interest in, or even
making attempt to understand geology (Bakri, 2000, p.1).

To address the different needs of students learning introductory geology concepts,
the traditional methods of teaching geology needs to be reviewed (Bakri, 2000;
Gunter, 1993). Teaching mineral and rock identification with the traditional method
has proved a problem in motivating both geology majors and non-majors
(Constantopolous, 1994).

Lewis suggests that rather than focusing on information-intensive strategies for
learning minerals, Earth Science should be made more relevant (G.Lewis, personal
communication, July 21, 2000). Lewis comments:

I think if we can get people turned on by making it relevant,
interesting and fun in the early years, then that will be the
battle won... how we do that is more difficult.

The need to address the problem facing Earth Science in Australian high schools
has led to several actions being taken by academics, professional geologist and
government agencies. Below I evaluate the use of interactive multimedia as part of
this process, and look at reasons for and against using IMM to address the problems geology is facing.

**What is Interactive Multimedia and what is its role in Earth Science education?**

**What Is It?**

Interactive multimedia (IMM) has been employed in Earth Science classrooms in several forms. An examination of the types of IMM used to teach geology follows, but first, what is interactive multimedia, and can it become a useful tool in the modern classroom?

Kristina Hooper in 1988 wrote of interactive multimedia:

They are somewhat like books, but not quite. Sometimes they are more like movies, but then they change in character to become more encyclopaedic or interactive (Hooper, 1988, p.317).

Yet when one seriously attempts to design “interactive experiences” that incorporate the aforementioned concepts, it becomes less and less clear just what we mean by the word “interactive” and whether or not we are all talking
about the same thing. More critically, it becomes unclear whether interactive necessarily implies something that is good . . . (Hooper, 1988, p.320).

Interactivity in multimedia is the input required by the user in exploring a computer module. Shapiro (1994) says interactive multimedia, or hypermedia as it is sometimes called, is essentially a large collection of text, graphics, sound resources, demonstrations, and video displayed on a computer. Regano (in press) writes:

The essence of interactive multimedia is to combine the benefits of more traditional learning styles into a self-teaching module that imparts knowledge through stimulation of sensory channels (Regano, in press, p.14).

What’s Available?

Modules may have several different ‘mapping techniques’, that is, different methods of navigating through a program. Modules may be linear, encyclopaedic or hypertext driven. Linear modules, like books, simply involve passing from one ‘page’ of information on a computer screen to the next. Encyclopaedic modules have a series of definitions presented, and usually a searchable database. Hypertext modules allow the user to choose their own path through areas of interest, similar to
navigating most Web pages. The types of interactivity in multimedia resources examined as part of this thesis are listed in the following table.

Table 1: Interactive multimedia styles with example references.

<table>
<thead>
<tr>
<th>Interactive multimedia style</th>
<th>Program references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial-style presentation including text, animation, video and hyperlinks.</td>
<td>Clarke, Hubble and Dunkley (2000); Edwards, Bryon and Sowerbutts. (1996); Kallio and Peltoniemi (1995); Renshaw and Taylor (2000); Wolters, Shaffer, Cerveny and Barnhill (1996)</td>
</tr>
<tr>
<td>Reference tool, searchable database, or tool for access to a large bank of information.</td>
<td>Hounslow (1996); Maryland Earth Science website; United States Geological Survey website</td>
</tr>
<tr>
<td>Calculator or identification tool.</td>
<td>Ogilvy (1979); Smith and Abley (1996)</td>
</tr>
<tr>
<td>Game-style or role-playing module.</td>
<td>Australia on CD: An Australian Federal Government Initiative: “Ingenious”; Astronomical Society of the Pacific: “Earth Quest”; Bursik,</td>
</tr>
</tbody>
</table>

A limited look at the Web resources, IMM and other software available in Earth Science (see Appendix C), reveals that most computer-based learning tools are either text-based programs, with linear-style navigability and some video and animation, or a game or role-playing style programs. Other resources include searchable databases designed for assistance in rock and mineral identification, and calculating aids and tools for checking work (for example Boger and Boger, 1994). Steel (1995) writes that there are an increasing number of computer-aided learning tools in science and describes the use of authoring packages to create multimedia presentations tailored to specific lecture courses.

The game or role-playing style CD-ROMs have navigable pages of text, image and animation where students interact with the module using hypertext driven presentation. Students take on the role of certain science professionals. The role-playing IMM ‘Ingenious’ (produced by Australia on CD: An Australian Federal Government Initiative) won best education title in the 1997 ATOM awards, and a brief overview of the game is pertinent to this thesis as an example of a successful role-playing IMM program.
‘Ingenious’ is an Australian CD-ROM aimed at 8-14 year-olds. The content is presented as a series of missions to undertake, in which the user role-plays as a scientist in one of five areas of expertise. There are a number of different missions to complete in various scenarios which provide an excellent motivational and feedback mechanisms for the user. For example, environmental issues are explored with the user placed in the context of an environmental emergency. The information contained could not be presented as efficiently and in such an engaging manner in another medium. The module is well produced and would compare favorably to computer games that the target audience may be familiar with. Content was developed by Ian Allen of the ABC and Questacon — the National Science and Technology Centre, and advised by the Australian Science Teachers Association (ASTA), ensuring the content is relevant to the curriculum. While the program may have limited use once the ‘missions’ are completed, it also contains much additional information and could be used as an information resource with other projects.

The use of portraits of real scientists, realistic news updates and the existence of ‘game time’ all add to the ‘realism’ of the virtual experience. A familiarity with scientific equipment otherwise unavailable to students, such as meteorological or astronomical devices, is another benefit. The cartoon-like graphics and extensive use of sound, animation and video combine with the role-playing aspect to make it
extremely engaging. Although it may be confusing for the first-time user, it provides an excellent introduction to the range of activities involved in science.

**Why Use Interactive Multimedia to Teach Earth Science?**

Do we really need interactive multimedia? Haven’t we been doing all right up until now? Teaching science in the traditional format has a strong core of support, exemplified by the editor of the Journal of Geological Education, James Shea (1996).

> My own feeling on this matter is that reading always has been and still is a very efficient and effective way to learn.

(Shea, 1996, p.242)

Providing students with a computer, access to Internet or CD-ROM-based information will not magically make them learn more, believes Shea (Butler, 1999). Shea doesn’t deny, however, that there is a move toward utilising computer-based learning experiences in Earth Science at the high school level:

... computer-based education is seen as a way to get more students actively involved in ‘doing’ science in collaborative groups solving real or temporary problems rather than memorising outdated factual material from
textbooks and lectures delivered by aging professors
(Butler, 1999, p.621).

McQueen (2000) asks doubtfully if field-related geology subjects can be taught more effectively and more efficiently in an educational environment where a lack of funding for geology and computer-based 'virtual' learning is "becoming the fashion" (McQueen, 2000, p.88).

In opposition to Shea and McQueen, Sculley (1988) believes that there is a benefit in giving students access to IMM rather than providing them with straight text-based information. Prothero (2000) agrees that active participation in science activities is more effective in teaching science literacy than "telling students about science in a lecture" (Prothero, 2000, p. 650). Arculus (R.A. Arculus, personal communication, November 7, 2000) notes that while multimedia cannot replace the real experience (of field trips), it is better than looking at a series of pictures and descriptions on a "static page".

Learning Science Actively

As mentioned, science, and particularly Earth Science, has been perceived as alienating some students (Luntz, 1998), because of the emphasis on learning facts. Students' varied learning abilities and preferences are not being catered for by the current teaching styles in some schools (Boylan, 1996; Constantopolous, 1994;
Dekkers and De Laeter, 1996; Moore, 2000; Renshaw and Taylor, 2000). Moore writes that it is necessary to promote a learning style that allows for different frames of reference, different learning speeds and styles, and different prior knowledge, an approach termed constructivism:

The teacher needs to recognise that students have different frames of reference and hence flexible learning paths are required to present information in a variety of ways to facilitate student understanding . . . (Moore, 2000, no page number)

Maor and Fraser (1994) note that one of the advantages of using IMM in the science classroom is that it allows for different styles of learning and different levels of understanding to be addressed. Boger and Boger (1994) note:

Students learn at different rates and by different methods. Interactive computer applications allow students to proceed at their own pace and access information as needed (Boger & Boger, 1994, p.463).

Bursik, Hodge and Sheridan (1994) believe that IMM can address learning disadvantages of students with no science background. They used an IMM program to help students develop an understanding of scientific inquiry in laboratory.
exercises. Gunter (1993) believes that demonstrations using multimedia also take advantage of the fact that most people are visual learners. As well as visual images, however, IMM can also contain text, and sounds, important for teaching visually impaired or hearing-impaired students.

Others in Earth Science education, however, question if we really know enough about how students learn through conventional media to launch into "new, less stable technologies" (Edwards et al., 1996, p.314).

Edwards et. al. (1996) and Shea (1999) do not have confidence that IMM can make students "magically" learn, but in other areas educators such as Michael J. Smith, Director of Education at the American Geological Institute, clearly believe that IMM has a place in the introductory Earth Science classroom. Smith (2000) recommends teachers of EarthComm (community and geology course) use interactive technologies:

... [to] pique student interest and engage students in constructivist guided-inquiry activities that help them develop knowledge and understanding of practical essential Earth science principles and practices (Smith, 2000, p.120).

*Group Learning*
If there is sharing of computer resources, which may well be the case where access to computers is limited, students can work in groups using IMM. Group learning is listed as part of the New South Wales Earth and Environmental Science Syllabus for 17/18 year olds (Hafner, 2000) and is facilitated by using multimedia (Constantopolous, 1994; Edwards et al., 1996; Moore, 2000).

**Interactivity**

Hooper (1988) believes that the interactive nature of the multimedia presentations encourages student interest, which enhances learning. However she also strongly believes that interactivity is an insufficient condition for a beneficial learning experience:

> Anyone who has looked at run-of-the-mill computer software or branching videodiscs that continually interrupt the viewer with multitudes of unappealing choices understands that interactivity is not a sufficient condition for a good experience (Hooper, 1988, p.320).

As Shea notes (1999) computers alone do not provide motivation to learn:

> The fundamental problem with computer-based education, particularly with Internet-based education, is that the aspect
of education that computers are best at, providing information, is simply not the problem... we cannot expect that turning students loose on computers will by itself result in education. (Shea, 1999, p.622)

The level of interactivity in any learning-based computer technology can vary greatly, and it is not always certain what is meant by ‘interactive’. What does it mean to be truly interactive? Is it good or bad? Novak (1999) quotes Schick (1995) in saying that “visiting” Web pages by pointing, clicking, reading and viewing can only engage learners superficially (Novak, 1999).

Kastens, Van Esselstyn and McClintock (1996), however, argue that the interactivity in multimedia provides a method for engaging introductory Earth science students that are alienated by current teaching practises.

One useful feature of interactivity in multimedia is that it can be used to provide continual and immediate feedback (Moore, 2000). Steel (1995) notes that using computer-aided tools within the classroom provides positive feedback to students. Steel also notes that teacher response to this positive feedback has been an experience of greater interest in the classroom. Boger and Boger (1994) used an IMM program on geology laboratory exercises in the classroom, because without this interactivity, performance feedback to students was not immediate.
With limited teacher resources, the ability of IMM to respond to a student or group of students is a benefit. On the other hand this could reduce the extent of person-to-person contact, and Arculus notes that we are attuned to learning from listening to people (R.A Arculus, personal communication, November 7, 2000). Arculus believes that the usefulness of IMM may be enhanced when used in conjunction with relevant lecture courses.

**Knowledge Base**

IMM has a vast potential for storing knowledge and provides a readily accessible bank of information (Gunter, 1993; Rodrigues, 1997). Gunter notes that computer demonstrations and interactive multimedia can convey more information than text. Many IMM programs utilise the fact that interactive multimedia on CD-ROM provides access to large amount of information (see Appendix C).

**Representation of Spatial and Time-extensive Concepts**

Some of the advantages of using IMM in the classroom are specific to geology. There is the ability of technology to compensate for the huge timescales and vast regions over which geological process operate (Smith, 2000). Kastens et al. (1996) note that relative to other fields, Earth Science is particular suited to the implementation of interactive multimedia, as Earth Science information centres on
visual data such as shapes and spatial relationships, and incorporates changes across vast periods of time and space that cannot be reproduced in the laboratory.

The importance of IMM in modelling dynamic Earth systems in an Environmental Geology course is described by de Wet (1994) and Smith (2000) who notes that it is important to be able to show how these geological processes operate. Smith states:

Students should understand how technology increases our ability to understand the geologic history, beauty, complexity, and dynamic processes of change in the Earth system on time scales from less than a second to billions of years and spatial dimensions from subatomic to the scale of the universe (Smith, 2000, p.120).

*Utilising Hyperlinks*

The process of doing geology often involves the visual transition between a number of 2-dimensional representations of 3-dimensional areas. For example, understanding an aerial photograph to help determine the underlying geology of the landscape. Kastens et al. (1996) record the importance of multimedia simulations in understanding basic mapping concepts and believes that the use of hyperlinks can aid students in making the visual transition from 2D to 3D, and accelerate the
acquisition of map skills. Hyperlinks connect related areas of information, as well as providing users with different options in moving through information.

_A lack of Time and Money_

The Centre for Educational Research and Innovation Organisation for Economic Cooperation and Development first noted in 1976 that cost and time considerations may be improved by use of the computer. Edwards et al., in 1996, confirm there is a financial advantage to computer-assisted learning. With fewer funds available, a simulation may be the only experience that students have in high school of using equipment such as the petrographic microscope, or going on a field trip. Smith and Abley (1996) believe computer technology can reduce costs involved with using scientific equipment by simulating some of their functions. Arculus (R.A. Arculus, personal communication, November 7, 2000) also notes that where each field excursion is a costly one-off experience, a video or interactive multimedia simulation of a field trip is something that can be used repeatedly.

Kallio and Peltoniemi (1995) similarly see the implementation of computer technology as a solution to the need to observe expenses:

The current need to keep expenses low without sacrificing quality in higher education has put educational institutions into a difficult situation everywhere. One attempt to solve
the problem has been the introduction of new information technology into teaching (Kallio and Peltoniemi, 1995, p.11).

Although the cost of computers and interactive multimedia is hardly insignificant as both Arculus (R.A Arculus, personal communication, November 7, 2000) and Lewis (G. Lewis, personal communication, July 21, 2000) note, Hamilton (2000) thinks computers will inevitably playing a bigger role in teaching, spurred on by the cost saving that virtual laboratories can make, but adds:

Hopefully they will not completely replace real laboratories (Hamilton, 2000, p. 41).

A problem faced by the IMM manufacturer is student access to computers, whether the school has a computer, where it is and how much time students get on it. Access to multimedia in some cases could be as restricted as access to teaching materials may be. Lewis (G. Lewis, personal communication, July 21, 2000) explains that Geoscience Australia has steered clear of computer-based education programs because most schools still predominantly use textbooks:

... schools are not using those resources [IMM] as much as they are using the regulation printed resources of a textbook.
Further, there is difficulty in getting the IMM to classrooms in the first place (Novak, 1999). Similarly Renshaw and Taylor (2000) record that CD-ROM materials receive isolated use due to problems with dissemination:

The mere availability of software does not ensure its use (Renshaw & Taylor, 2000, p.677).

The cost of making the IMM module in the first place could be $700,000 or more (S. Stocklmayer, Director of the Centre for Public Awareness of Science at ANU, personal communication, May, 2000). Dewey (1999) suggests this could be better spent in current school programs such as field trips. Dewey writes in his reply on receiving the Wollaston Medal given by the Geological Society of London:

In this connection, a new horror is with us — the virtual field trip. It is strange that 300,000 [pounds] can be found for a pilot study of virtual field trips but that real fieldwork is seen commonly as old-fashioned and a drain on resources. This Mickey Mouse nonsense has to be stamped out (Dewey, 1999, p.44).

Overcoming the cost problem may be only a matter of time for IMM, if it can prove its own worth, as Hooper (1988), suggests:
Recent histories of computer purchases in schools suggest optimism; schools will find new ways to finance hardware when it is shown that the materials delivered with these technologies are important to their business of teaching and learning (Hooper, 1988, p.326).

Considering the level and extent of computer applications available, if an education IMM is going to appeal to a broad student market, it must have a reasonably high level of quality. Kluth and Wilbur (2000) note that audiences have high expectations for technical quality, based on experiences with TV and movies. No educational CD-ROM technology is going to have the millions of dollars funding required to compete in terms of quality with your average computer game (S. Stocklmayer, personal communication, October, 2001). How long does an educational CD-ROM last before it becomes technologically obsolete? What about changing computer requirements? The longevity of the program is a consideration in deciding if time and money are better invested in the development of an IMM or on alternative student teaching projects.

*A Lack of Expertise*

A lack of expert knowledge in utilising Earth Science equipment in high schools, and for conducting field excursions has already been noted (Dekkers and De Laeter,
1997). As Arculus (R.A Arculus, personal communication, November 7, 2000) suggests, IMM may best be used to supplement teaching where expertise in geology is lacking in secondary education.

Lewis (G. Lewis, personal communication, July 21, 2000) notes, however, that there may be problems with a lack of expertise in ensuring the use of CD-ROMs in the classroom:

... that schools didn’t have the laboratories with the equipment set up to run a CD, that’s becoming less and less of an issue, but its probably an issue of having them but not having the teacher training, not having access to them, steering teachers away from using CD-related, computer-related resources as specific teaching tools.

Real versus Virtual

Dekkers and De Laeter (1996) note that Education Departments do not encourage students to study geology because of problems in organising field trips. In these cases virtual field trips may be the only experience of practical field geology available.
Crucially, there is a need to relate the virtual experience to a "real-life" experience, as evidence suggests that there is a disassociation of information learned through virtual experience versus real experience (de Wet, 1994; Rodrigues, 1997). According to Rodrigues:

...one of the problems stems from linking what students often perceive as abstract, because they are simulations, to the real situation. There needs to be plenty of opportunity to discuss and share ideas and relate the simulation back to real situations. (Rodrigues, 1997, p.38).

In concurrence, de Wet (1994) states that students, especially at the introductory level, often do not understand the connections between the real world and computer models. Arculus (R.A Arculus, personal communication, November 7, 2000) believes the best use of a simulated field trip module would be used best as a post-trip exercise to reinforce ideas learnt.

Replacing the field trip with its virtual counterpart is unpopular with Winchester-Seeto and Hart (2000):

It has been suggested that to save money, field-based education could be replaced by computer simulations.

Computer simulations can be a valuable educational tool
for some situations, and to teach some points, but they can never replace the educational experience of going to the field. Any computer simulation, or indeed a video or a slide show, can only be an abstraction of reality, and, by necessity a simplification of reality (Winchester-Seeto & Hart, 2000, p.149).

For instance, Edwards et al. (1996) encouraged the use of computers for thin section viewing instead of petrographic microscope. But how will a student know what to do when given a real petrographic microscope? A student cannot master a petrographic microscope without experience at the actual equipment. The comments by Winchester-Seeto and Hart (2000) highlight the need for continual reinforcement of ideas gained through a simulation with their real-life equivalents. In preparation of the interactive tool designed to help students translate from maps to reality, Kastens et al. (1996) specifically state that they do not intend IMM to replace a real-life scenario:

In no sense do we envision our application as a complete substitute for field-based map exercises; we think all students should use and make maps in the real world as part of their precollege education (Kastens at al., p.531).

Interactive Multimedia Program Styles

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There are several interactive multimedia programs available for Australian high schools. Examination of these programs showed that role-playing or game-style modules were considered an effective use of multimedia. Using the role-playing style in IMM has been established as a relevant multimedia structure by programs such as the award-winning IMM 'Ingenious', and the acclaimed program 'Volcano!'.

The game-style presentation provides an impetus for the student to become actively engaged in the learning process. It raises awareness of the range of roles involved in Earth Science professions, and provides familiarity with the context in which geological equipment is used.

The question I frequently asked people before undertaking this project was “Did you do geology in high-school, and what do you remember?” The response was the recollection that geology is all about classifying rocks. The success of 'Ingenious' suggests that a multimedia program based on the role of an Earth Science professional could give students a broader knowledge of what geology is about.

In summary, interactive multimedia can be a useful tool for Earth Science education in providing an involving alternative to the fact-based learning process that characterises the introductory Earth Science classroom. It can help students learn at their own pace, and in a variety of ways. IMM can provide feedback throughout the use of the program.
Some aspects of IMM are particularly useful for translating concepts that operate over complex spaces and long times, for making transitions between 3-dimensional and 2-dimensional spaces, which are all aspects of geological education.

IMM can provide familiarity with geological laboratory equipment and field experiences, whose use is limited in Australian high schools by time and cost considerations. To avoid dissociation between the situations presented in IMM and other learning experiences, however, it is necessary to make the link between the virtual field and lab experiences and real scenarios. It has been suggested that IMM may be utilised most effectively as a tool for reinforcing ideas learned in introductory Earth Science, and as a method of providing an alternative format for these ideas.

This chapter described the decline in Earth Science education, evident in the dropping enrolments in Earth Science at high schools. There is a lack of coverage of Earth Science in Australian high schools, with the topic sometimes disappearing entirely from the secondary school curriculum.

Broader problems face Earth Science, including a lack of funding for universities and for government organisations. There is a perceived lack of relevance of geology education to the student seeking employment or entrance into University. Research has shown that directing attention towards maintaining enrolments at a high school may address these problems.
It has been shown that traditional methods of teaching geology are perceived to be problematic, and there are calls for alternatives to the traditional methods of teaching Earth Science.

Several groups are promoting geology in education through the use of IMM. IMM is used in education, and this chapter has examined the nature of IMM, and arguments for and against the use of IMM as a learning tool.

In Chapter 3 I will discuss the methods employed to create a relevant IMM module directed towards Australian high school Earth Science students, and the method of evaluating the resulting product.
Chapter 3

METHOD OF DEVELOPING AND EVALUATING AN INTERACTIVE MULTIMEDIA PROGRAM

The following chapter details the method for designing and developing an interactive multimedia learning resource for Earth Science. The nature, content and structure of the program are discussed as well as the method of evaluating the program.

Specific aims

The specific aims in making the interactive multimedia program GeoQuest are to provide Australian high-school students with an awareness of the scope of geology, a familiarity with the career prospects, and to create a different teaching resource that engenders a positive recollection of students' first encounter with geology.

Audience

The program is intended for high school age (12-16 year old) Australian students for use both at home and in the classroom or library.
Learning objectives

The learning objectives are a familiarity with the tools used by geologists, and an understanding of the tasks carried out by geologists, as well as familiarity with some introductory geology concepts. The user should become aware of some introductory geology techniques, such as field exploration, identifications of minerals, and the use of identification tools, and become familiar with some of the different roles involved in professional geoscience.

Where Would the Program be used?

GeoQuest is not intended to stand alone as an Earth Science teaching tool. Neither is it meant to replace field trips. It is intended as a tool that can supplement learning gained through field experience, especially where access to geological equipment and field trips is limited by cost or other factors.

GeoQuest could be used as a pre or post-trip overview in cases where field trips were otherwise unavailable, or as a summary of various introductory geology concepts to tie-up a relevant lecture session.

What Should Be in the Program?
In making the program, I considered the topics of geology that are covered in introductory geology texts, such as Chernikoff and Venkatakrishnan (1995), Davis and Reynolds (1984), and Bradshaw and Weaver (1993). These are commonly used in Australia as introductory geology texts.

The program is not intended as a comprehensive learning resource for introductory geology topics. Accompanying texts or lectures could provide students with further information on these. The emphasis of the program should be the ability to 'try out' being a geologist.

**Brief Overview of the Program**

The program GeoQuest contains four sections or 'quests': 'Gold!', 'Extraterrestrial', 'Ancient seas' and 'Earthquake!'.

'Gold!' is an exercise in site exploration and mineral identification based on a field excursion — a virtual field trip. The user first collects samples from different areas, then identifies these samples in a virtual laboratory. The role-playing experience is thus one of an exploration geologist searching for gold.

'Extraterrestrial' explores the planetary structures of the Earth and the other planets of the Solar System. The role-playing experience is of a planetary geologist undertaking a virtual trip through space, visiting each of the planets in turn and
discovering the geology of the planets and asteroids, with the goal of finding potential resources for mining. As well as highlighting the geological differences between the Earth and other planets, this stimulates the imagination and highlights the importance of geologists in real-life space exploration.

'Ancient seas' is a virtual trip back through geological time. The user discovers the geological history of a column of sedimentary and volcanic rocks, 'visiting' the period of deposition by clicking on the different rock types. A simulation of a trip deep underwater then shows processes of fossil deposition, types of sedimentation, or vulcanism, depending on the rock type chosen. The time-extensive process of the creation of these rocks is represented by short pieces of animation. Many professional geology careers involve examining the geological history of an area.

'Earthquake!' presents the user with an emergency earthquake scenario in which the user, role-playing as a seismologist, learns and uses techniques to pinpoint the location of a potential major earthquake. The learning objectives are a familiarity with seismology, plate tectonics and faults, and an awareness of the importance of seismology to the process of predicting earthquakes.

In each of these scenarios the user will be placed in the perspective of a geologist with an area of particular expertise, utilising geological techniques to explore and achieve goals. Completion of these goals provides an independent mechanism for feedback.
The section of GeoQuest developed as part of this thesis is the 'Gold!' quest. A structure map of the program is included in Appendix D. The introductory geology topics to be covered in the program are summarised below.

Table 2: Coverage of Introductory Earth Science Topics in the program.

<table>
<thead>
<tr>
<th>Introductory Earth Science topics</th>
<th>Text reference</th>
<th>NSW 2000 curriculum focus and skills</th>
<th>Coverage of topic in GeoQuest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geological</td>
<td>Davis and</td>
<td>Focus:</td>
<td>'Gold!' — a</td>
</tr>
<tr>
<td>Mapping</td>
<td>Reynolds (1984)</td>
<td>Geological map and aerial photograph helps the user determine where to look for gold. No actual mapping will be done though this could be included in an extended version.</td>
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</tr>
<tr>
<td>Skills:</td>
<td>- Planning and conducting investigations. - Developing scientific thinking and problem solving techniques.</td>
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<tr>
<td>Focus:</td>
<td>'Extraterrestrial' and 'Earthquake!' — A 3D animation of the structure of the Earth allows the user to explore the structure of</td>
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<tr>
<td>Course</td>
<td>Focus:</td>
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<tr>
<td>Geology of the planets</td>
<td>- implications for society and the environment</td>
<td>- planning and conducting investigations.</td>
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<td></td>
<td></td>
<td>- working individually and in teams.</td>
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<tr>
<td>Plate tectonics</td>
<td>Focus:</td>
<td>Skills:</td>
<td></td>
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<tr>
<td></td>
<td>- nature and practice of science.</td>
<td>- communicating</td>
<td></td>
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</tr>
</tbody>
</table>
| **Folding and faulting** | Chernicoff and Venkatakrishnan (1995) | Focus:  
- nature and practice of science.  
Skills:  
- communicating information and understanding. |
| --- | --- | --- |
| **Earthquakes and volcanoes** | Chernicoff and Venkatakrishnan (1995) | Focus:  
- nature and practice of science.  
- implications for society and the environment | 'Earthquake!' — pin-point the epicentre of an earthquake.  
'Adjacent seas' — animation of mid-ocean ridge |
<table>
<thead>
<tr>
<th>Fossils</th>
<th>Chernicoff and Venkatakrishnan (1995)</th>
<th>Focus:</th>
<th>Skills:</th>
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<td>- nature and practice of science.</td>
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<td>- communicating information and understanding.</td>
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<td>- developing scientific thinking and problem solving techniques</td>
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<tr>
<th>Processes of sedimentation</th>
<th>Chernicoff and Venkatakrish</th>
<th>Focus:</th>
<th>'Ancient seas' — process of sedimentation</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- nature and practice of science.</td>
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<tr>
<td>Presented as text and animation.</td>
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<td>Skills:</td>
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<td>- communicating information and understanding.</td>
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<td>- developing scientific thinking and problem solving techniques</td>
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<th>Focus:</th>
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<td>- nature and practice of science.</td>
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| not included – rock identification techniques will not be covered as this information-extensive subject is an impediment to the game mode. This could be included in a supplementary text. |

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<th>Skills:</th>
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<td>- planning and conducting investigations.</td>
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<td>- nature and practice of science.</td>
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<td>- nature and practice of science.</td>
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How Does the Content of the Multimedia Program Fit in with the Syllabus?

The NSW 2000 science syllabus for years 7-10 involves further development in skills of planning and conducting investigations, communicating information and understanding, developing scientific thinking and problem-solving skills and working individually and in teams. In the 'Gold!' section, the program fits with the syllabus as follows:

- planning and investigation is involved in using the mineral information and map of the area to assist in the search for gold
- communicating and understanding information is undertaken through the mission statement and field guide. Information is gathered from the mission statement, minerals poster and geological map and the input of information communicated through the field guide
- scientific thinking is developed in identifying mineral samples and in doing so, students will gain a familiarity with the tools of identification, the microscope, magnifying glass, and streak plate, the Mohs Hardness test, and the technique for determining specific gravity
- problem solving skills are part of the role-playing format
- students are able to work individually or in teams at the module
Additionally the syllabus lists as practical experiences emphasising hand-on activities:

- undertaking laboratory experiments
- undertaking fieldwork
- researching using the library, Internet and CD-ROMs
- using computer simulations for modelling and manipulating data
- using animation, video and film resources to capture/obtain information not available in other forms.

In these ways the module fits in with the NSW syllabus, thereby making it possible to incorporate use of the module within the Earth Science teaching program.

**How should GeoQuest Look?**

A page by page synopsis of GeoQuest is presented in Appendix E. The setting is in southeast Australia, as the focus of this research was Australian high school education in NSW and the ACT.

Briefly, students move from the introductory screen demonstrating the extent of the program, to one of the four specific quests. The section developed, 'Gold!', begins in a virtual laboratory, where several tools of mineral identification are present: a Mohs Hardness test, a microscope and magnifying glass, a streak plate, and equipment for calculating specific gravity. This provides familiarity with some of
the tools used in mineral identification. Two traditional identifying characteristics, the property of lustre and cleavage, are not included. The property of lustre is not included as an identifying characteristic due to the difficulties in showing this on computer screens of variable brightness. The use of cleavage as an identification tool is not included as this is something lends itself to 'hands-on' teaching techniques. Accompanying text or hyperlinks could provide information on these.

Information about mineral identification is contained in the poster on the wall of the virtual laboratory, a familiar place to search for information. All of the minerals featured in the module are listed with their various identifying characteristics. There is a geological map on the wall of the site where the user can look for gold. This highlights the role of geological maps in geological exploration. An extended version could include creating a geological map of the site.

The mission statement contains information on how to play the game, as well as hints about gold formation processes to indicate the best places to 'visit'. A door in the wall of the laboratory leads to the next screen.

The next screen contains a large aerial photograph, a field bag, and buttons that bring up the geological map and lead back to the lab. The aerial photograph represents the kind of terrain that is familiar to those who live in the area; the features are features that could be recognised in the real world. Granite occurs as outcrops on hills, and the valley is an alluvial plain, as you might expect in reality.
This familiar geology will be presented to reinforce the connection of the virtual field trip with a real world scenario. A larger version of GeoQuest could have terrain particular to each state, this could additionally make students more familiar with the variety in the Australian landscape.

By clicking on the aerial photograph, the user 'moves' to different site areas, returning to the 'whole site' area by clicking a smaller version of the aerial photo on the top left of the screen. 'Moving' from one site to the next causes images to come up of site photos of particular areas — alluvial plains, granite hills and basalt hills. Clicking on these site photos allows the user to 'collect' a hand specimen containing certain minerals. These mineral samples can then be stored in the field bag. The field bag also contains a field book in which the user records mineral properties. Identification of the samples is carried out back in the lab and recorded in the field guide.

At the end of the program, the field bag can be 'handed in', and if the gold has been collected and the necessary identification properties recorded, the user will receive a suitable visual image of reward (such as money falling around the screen). Too much graphic-intent animation and sound are avoided in GeoQuest despite the fact that this could increase appeal to high school students. This is so the program is simple to navigate through and not confusing.
How are the Recognised Benefits of using Multimedia Included in the Program?

As part of the development of the interactive multimedia program, recognised benefits of using multimedia in the introductory geology classroom should be examined. How and where the program includes the benefits to learning noted in the previous chapter is discussed below.

The Virtual Field Trip

The virtual field trip is an alternative or supplement to actual field trips. In any field trip, the student is able to use introductory geological concepts in a practical or hands-on learning experience. The virtual field trip similarly shows how these practical activities are involved in geology. It's also an experience in role-playing as a geoscience professional. Learning the context in which identification techniques are used can make learning these concepts more relevant to the introductory Earth Science student. The virtual field trip is incorporated in the 'Gold!' section of the program.

The Virtual Laboratory

Images of the identification tools in the virtual laboratory in the 'Gold!' section promote familiarity with tools that may not all be available in high school Earth Science labs.
Other features intended for the virtual laboratory include providing geological images that may not be available in high schools, such as petrographic thin sections.

**Representation of Spatial and Time-extensive Concepts**

One of the benefits of multimedia as a learning resource is the ability to present 3D concepts and time-extensive processes in a visually stimulating way. This will be utilised in GeoQuest by use of animation in the 'Ancient seas', 'Earthquake!' and 'Extraterrestrial' sections. Large-scale processes such as plate tectonics are included in the 'Earthquake!' section. The time extensive processes of fossilisation, sedimentation and vulcanism are included in the 'Ancient seas' section and planet formation is shown in the 'Extraterrestrial' section.

**Utilising Hyperlinks**

The process of doing geology often involves the visual transition between two-dimensional representations of three-dimensional areas. Multimedia has the ability to show the relation between different styles of information by using hypermedia links. The 'Gold!' section has links between the aerial photograph view and site images, and links between the aerial photograph and a geological map. The hyperlinks provide immediate connections between the 3D and 2D representations of the same area.
The relation of landform to rock type, and rock types to their mineral counterparts, is also hyperlinked. In the 'Gold!' section, a site photo of a rocky outcrop links to an image of a hand specimen containing specific minerals. Utilising the hyperlink structure, the section relates the acquisition of certain minerals to a common rock that they occur in. It also links between the rock type represented and the topographic appearance of a landscape typical of that rock type, for example, rounded granite boulders on the tops of hills and sands on flat alluvial plains.

An extended version of the 'Gold!' section could provide additional information on introductory geology concepts through hyperlinks without the information interfering with the role-playing style of the program.

*Role-playing Style*

GeoQuest is a role-playing, quest-solving style of IMM. This provides motivation to move through the program. The idea of 'looking for gold' provides an indication of why you learn mineral identification, and learn/memorise various mineral and rock properties.

The program shows a more holistic approach to geology, with individual geology subjects linked in a problem-solving format, rather than presented one after another as in a traditional lecture format. In the 'Gold!' section specimen identification and map reading are placed in context of what they are used for.
The 'role playing' style was chosen to increase personal involvement in the program, by encouraging students to complete a 'quest'. It is also intended to give the user familiarity with geological tools and the skills required of a geologist, rather than providing geological information that could be learned in other media. This is intended to help the student user translate from the 'what' to the 'how and why'.

*Interactivity*

The nature of multimedia is to provide a range of options in moving between different areas of information. In the 'Gold!' section of the program, the user can research information on specific minerals through the minerals poster, or become involved immediately in the 'game', options suited to different learning styles.

GeoQuest presents introductory geology concepts as part of the professional geologist's task. Familiarity with field trips and with the functions of geological instruments gives students a taste of what geology is really like. This sort of experience may not be available to all Australian high school students, and this is what prompted me to use interactive multimedia as the tool for developing an alternative Earth Science learning resource.

*Web or CD-ROM?*
There are problems inherent in the dissemination of CD-ROM technology. How does the product get into schools? Where are copies kept? In the library? The classroom? What about remote areas, how can these places get access to interactive multimedia? The best method of dissemination could be through teacher packs promoted by educational or governmental organisations such as ASTA and Geoscience Australia.

I decided to design a CD-ROM for several reasons. CD-ROMs can display more visual graphics than Web pages. Web pages can only contain a few small scanned images, as graphics make the page slow to load. A game-based program such as GeoQuest requires a variety of visual graphics, which slows web download times for non-broadband connections. Web pages also tend to be less interactive, with video and animation also requiring longer download times.

CD-ROMs have a disadvantage in that physical dissemination is required, whereas Web pages simply need to be posted, however, if the CD-ROM is purchased the product is more likely to be used. The Web is more appropriate for information searching; indeed, it is in this that the Web is rapidly becoming predominant. There are many Web sites devoted to geology. A game-based program such as GeoQuest, however, is not an information-searching tool, but a role-playing exercise attempting to peak students interest. Due to the requirements of this style of IMM, the program was designed as a CD-ROM.
Method of Evaluating the Interactive Multimedia Program

Developed

The scope of this study does not allow for extensive testing of the interactive multimedia program GeoQuest with large student groups. A larger study could gauge the information students gathered through the use of the program, and a survey done before and after using the program could determine whether using the program generated a positive response. Ideally this could be done over a school year and the results of student learning compared with students from a class not using the program.

To provide some evaluation of the program and further directions for the development of the program, I held a focus group with four ACT high school science teachers to gauge their reactions to using GeoQuest.

The focus group was held with voluntary participants from a high school. The group spent 15 minutes exploring GeoQuest, then for 30 minutes engaged in discussion guided by a short questionnaire on the program. The teachers were provided with the questionnaire, information sheet and a consent form (see Appendix F), and the results recorded (see Appendix G).

The questions sought to evaluate if computers are used in class, what they are used for, whether this includes any programs similar to the one I developed. The
teachers' opinions on the relevance of the content and its presentation were gathered. Finally, I asked the teachers if they would use a program like this, and if they thought it was fun.

In evaluating GeoQuest, it is crucial to understand whether this kind of tool is already being used in high schools, or indeed if computers were being used at all. The teachers' perceptions about the relevance of the content and presentation to students can provide avenues for further development of the program. In asking whether GeoQuest is fun, I hoped to gauge whether the program will receive a positive response from teachers.

The greatest advantage of GeoQuest would be if students find it an enjoyable tool to use. Creating a fun learning experience for high school Earth Science has been the major impetus behind developing this project. Hopefully this will ensure that in later years students have a positive recollection of high school Earth Science.

In the next chapter I present the results of the evaluation of the IMM program and include as part of the chapter the developed product, GeoQuest.
Chapter 4

THE DEVELOPED MULTIMEDIA PROGRAM AND THE RESULTS OF EVALUATION

The evaluation of the interactive multimedia program GeoQuest is based on a trial and discussion of GeoQuest by a voluntary focus group of four high-school science teachers. During the focus group evaluation, the teachers reviewed the program for 15 minutes, followed by a 30-minute long discussion period.

Are Computers Used in High schools?

The focus group noted "we've certainly got computers in high school," however these computers tended to be situated in a separate laboratory. It was difficult for the teachers to incorporate computer use into practical work in science because of the physical distance between the computer labs and science labs. An unexpected benefit of the program discussed by the focus group was the ability to use computers to teach science without having to hold separate classes, one in a science practical lab, and one in the computer labs.

This teacher describes the difficulty of using computers to teach science:

The biggest restriction I see is that computers and science aren't related. I would like to do a prac where kids could
put their data into a computer as they go, to do the whole thing right there and then, rather than have to book in [to a computer lab], make sure that it’s a time soon after the prac [and] take them all up there. You have to do that individual, small, little task, it wastes the whole time! And you come back, and it’s two [lessons], instead of one lesson.

The type of class work computers were used for in the school included logging information, database manipulation and Power Point presentation. The software available included tutorial-style IMM presentations in chemistry and genetics.

Is Interactive Multimedia Used in High schools?

Some interactive multimedia is in use in the focus groups' high school. The response towards the two IMM programs being used by the teachers was positive in one case and negative in another. One teacher commented:

The Evolution one, the moths – that’s an interactive one and that’s absolutely brilliant. You’re actually playing predator and picking the moths off. The kid’s loved it.

However another teacher found the chemistry-based IMM prohibitively expensive for what it was. The program was a CD-ROM, purchased for $250, containing a
linear-style presentation with text, images and some animation. The teacher noted that the program was not sufficiently interactive. The teacher also commented that GeoQuest contained more interactivity:

Why can’t they [producers of the aforementioned program] do something more interactive like this [GeoQuest]?

Is GeoQuest Useful?

One of the ways in which the focus group found the program useful was in providing an alternative to the ‘true/false’ method of presenting science. Rather than learning a series of facts, the students could be engaged in determining information through discussion and problem-solving techniques. The teachers commented:

They [students] like it to be ‘yes or no, positive or negative’ not a shade in between. This [GeoQuest] would bring out ‘well maybe it’s grey, maybe it’s green, [the streak on the streak plate] it’s hard to tell’, and they’d have to look at a couple of different possibilities.

There’s a whole other level of thinking [in GeoQuest], trying to pull all the results together, to come up with a solution to the problem.
It was noted by the focus group that there are difficulties in providing practical lab work and field trips to students in high school. One teacher talked about the limits of the practical geological experiences that were part of the coursework. The field-based section of class work involved placing rocks on clipboards around an area outside. The clipboards were set up at various angles so that students could measure strike and dip. The teacher noted of this simple experiment:

... takes a bit of time to set up, and that's the only sort of practical fieldwork we do in the school environment.

It required a double lesson to do this experiment.

The low level of practical work offered was not due to a lack of equipment; the school had a lot of geological equipment available for students. The problem was in utilising this equipment, as one teacher put it, "the problem is trying to apply all that sort of thing [equipment]."

The teacher saw GeoQuest as an opportunity to relate the use of geological equipment to the functions involved in professional geosciences, particularly for those with no experience of geology. The teacher commented:
For those who are not experienced in geoscience that [GeoQuest] would be ideal – to see what a geoscience professional does, why they use this equipment.

**An Alternative to Field Trips**

The focus group noted that the kind of field trip experience that could be provided in high school would not necessarily be a realistic experience due to the lack of good geological sites within easy travelling distance. One teacher noted:

... if we were to do a field trip in a high school environment it would be quite artificial, there is a limit to the things that we could do.

Another comment was that field trips could be over-rich in information, with little to relate the information learned to the experience of a geologist.

The problem with the field trip that I see, apart from the usual sort of logistical problems, is the amount of information and the type of information that the kids would really receive...
Also the teachers commented that there is a limit to the amount of information that could be covered in just one field trip:

So many individual things you couldn’t possibly put them all in one field trip.

You’d need a week-long excursion to south-east NSW, and visit site after site after site.

As field trips weren’t incorporated into the Earth Science teaching program at the high school at which the focus group taught, GeoQuest was seen as an alternative to providing a class with a field trip.

It’s [GeoQuest] a very stimulating environment, because in schools it’s not realistic to go out to alluvial plains to gather samples.

GeoQuest was seen as a way of giving students experience of the role of a geologist, particularly since a real field trip wasn't available.

Software such as this is a good way of giving kids a similar experience, to the way in which a geologist would work out in the field without taking them out in the field.
How Would the Program be Used?

The program was recommended for use in conjunction with a relevant lecture program, as something that 'pulls together' geological techniques learned in class. The function of the program was seen as giving an example of a 'real life situation' for a geologist, rather than introducing new information.

...once you go into that sort of thing [lectures on basic geology], then you would apply 'what does a geologist do', what does a geoscientist do and that's where this thing [GeoQuest] would come in.

Providing assessment sheets with the program was seen as a valid way to incorporate it into the classroom. One teacher noted, "this is something that they could hand in for assessment."

Relevance of Content

The content of the program was seen as relevant by the focus group, as it includes topics that were being taught in class. As mentioned, the program was seen as relevant in providing the experience of being a geologist.
I would see it [GeoQuest] as an advantage because it actually brings together everything as far as a career opportunity is concerned. It also relates to the real-life situation, of what an actual exploration geologist does.

Further Improvements and Problems with the Program

It's been noted that the focus group recommended the use of assessment sheets in conjunction with the program.

... having a photocopyable sheet with that [GeoQuest] would be really good.

It was also mentioned that a screen-by-screen guide in the form of a set of handouts would be a good idea. The development of a booklet containing a screen-by-screen guide to the program and assessable handouts could be incorporated in an extended version of the program GeoQuest.

One problem noted by the focus group were the large wads of text in the program, which could discourage students of that reading level. It was suggested that this information would be better stored in hyperlinked words, similar to websites, so that the information was there for those students that searched for it, but wasn't stopping students moving through the program.
The teacher commented:

... a lot of the instructions seem to be about this much [wide distance] reading. Now I know a lot of my year eights will baulk at that. They just click everywhere and find where they want to go. I mean a lot of them won't read at all. Some of them just won't. They're used to games that are self-explanatory. And they just click. They just click until they find where they want to go. So that would be one suggestion that I have is less instructions on the screen.

This also makes the point that students are familiar with games that don't involve large amounts of text for instruction on navigation. To address this issue, several of the screens in GeoQuest were changed to a no-text versions. The other screens remain with the original amount of text for comparative purposes. An evaluation by students aged 12–16, including a comparison of the text and no-text versions is recommended, but is beyond the scope of this thesis.

The focus group commented that the navigability of the program would be difficult for students, and recommended that guidance through the program was needed. Comments included: "A geologists knows what he’s doing, kids won't," and "I get lost in these."
Some of the ways it was suggested that navigation could be improved included having a map of the structure of the program at the beginning, and having parts of the map highlighted as the user moved through the program, so that it was easier to see 'where you're at' in the program. This could make it clearer what the next step in the program involved, and how close the user was to completing the program.

Another way to improve the navigability that the focus group noted would be to include a menu down the side of the screen. The structural map of the program has been included as part of this thesis and is provided in Appendix D. A menu could make the information contained in the structural map readily available. To include the menu containing highlighted levels was limited by the software available to make the program and the complexity of adding these features in.

A further suggestion for improving the program was to network the program so that students could play against each other. The competitiveness of this was seen as a way to motivate the students to complete the program before other students.

Would the Teachers Use GeoQuest?

The consensus among the focus group was that the program would be useful and would receive a positive response from their students.
This [GeoQuest] is the sort of thing that the kids will respond really well to.

The problems with navigation and excess information could, however, present problems when used by students unfamiliar with processes of 'doing' geology.

As a response to the focus group, I changed two of the screens in the 'site' section of the 'Gold!' quest. When visiting the 'site area' from the 'lab', a screen of text previously appeared indicating how to visit a specific site, and why the user might like to explore that particular area (granite hills, basalt hills, alluvial plains). This was removed. An additional screen of text was removed from the 'alluvial plains' section detailing how to take a sample from that area, and what the geology of that area was. Similar text screens are still present on the 'basalt hills' and 'granite hills' sections of the site area.

Another recommendation from the focus group was the construction of a structural map of the gold quest section of the program to be included through the use of a menu on the main screens. A structural map is presented as part of this thesis (see Appendix D), but was not included in the program itself. The suggestion made by the focus group, that parts of the structural map were highlighted depending on 'whereabouts' of the user, was not possible to incorporate due to the limitations of the software used to make the program, and the programming skills of the author. Other possibilities for including the map could be a pull-down menu function or a
permanent button similar to the quit button, leading to a new screen. A student study group could further test these possibilities.

Other changes recommended by the group but not developed as part of this thesis were the inclusion of hyperlinks on geological terms throughout the program (such as streak, hardness, etc), assessable sheets related to the program, and the ability to play networked games. These changes could be included in an expanded version of GeoQuest and evaluated by a group of high school students but this is beyond the scope this thesis.

The focus group concluded that the program was a useful resource. Specifically this is because GeoQuest offers the opportunity to collate a series of unrelated experiences in introductory Earth Science education into something meaningful. Using the program brings together the information gathered in lectures and presents a simulation of a 'real-life' situation for a geoscientist.

In the final chapter I discuss the evaluation of IMM as a teaching tool, specifically for introductory Earth Science.
Chapter 5

REVIEW

The decline of geology in education can be summed up by several trends: the continuous decline in enrolments in Earth Science at high school level; the lack of coverage of Earth Science by high schools; and the lack of funding for geology at all levels. With less people going into Earth Science at high school, there is a decrease in the awareness of what geology is about and how it benefits the wider community. For geological organisations and departments in search of funding, the general attitude people have of geology is important. A greater awareness of geology and its role is necessary if the geology community is to try to boost funding levels in the private and public sectors.

The need to increase awareness of geology can be addressed at the high school level. Increasing the level of enrolments in Earth Science at the high school level could increase the general awareness of geology. There are difficulties, however, in presenting geology as relevant and interesting to the high school student. The reasons noted for this included the perception of geology as a boring, information-intensive subject, the lack of expertise in teaching geology at the high school level, and a lack of time and funding for practical geological activities to be incorporated into the teaching program. Additionally, students had the perception that high school level Earth Science does not lead to work, also it isn't a prerequisite for entry to Earth Science at university.
Since its introduction less than ten years ago, interactive multimedia has been utilised to an increasing extent for education purposes. Research has shown that interactive multimedia can cater to varied learning preferences in individual and group learning situations, and provide an instantaneous feedback mechanism. Multimedia can provide access to varied styles of information using hyperlinks, text, video and animation. Role-playing style IMM offers a virtual experience of aspects of Earth Science that cost and time considerations prevent, such as field trips and use of laboratory equipment. IMM is well suited to the representation of time-extensive and complex spatial processes, through the use of video and animation. Moreover, it can make learning experiences interactive, to allow students to explore phenomena at greater or lesser depth. Hyperlinks connect areas of information to give a visual reminder of how the information fits together.

A variety of interactive multimedia exists for teaching introductory Earth Science, which engages the users in different ways: as an encyclopaedic search tool; a knowledge database; or a teaching module combining text, hyperlinks, video and animation. Of the latter style, role-playing presentations have proved successful. As part of this thesis, an interactive multimedia module providing a role-playing experience in geology has been developed, and evaluated by a small group of ACT high school teachers.
Learning bits and pieces of mineral identification in high school does not provide students with a full understanding of the use of mineral identification in geology. It is crucial for students of high school age, who may never meet geology again in their lives, to have an idea not only of what geology is, but also how it is done, and what it is used for. Students need to see the relevance of geological information to gain an awareness of how it is important to society.

One of the benefits of GeoQuest noted by the focus group was that the program provides students with examples of the role of a professional geologist in the field. Students are able to engage with the roles of an exploration geologist. This provides awareness of the scope of career prospects in geology, as well as the importance of the roles geologists play in the community.

The virtual laboratory and virtual field trip allows students to become familiar with the setting in which introductory geology processes operate. The section of GeoQuest that has been developed presents hyperlinked information on mineral identification and its role in mineral exploration. The information is cached in the form of a quest to undertake, not as a separate series of lectures. This broader familiarity with geology rather than its separate components is intended to make the geology more relevant to the student.

One of the limitations of the program noted by the focus group is that the program may be too confusing for those unfamiliar with any introductory geology concepts.
While this is not a problem if the program is used at the end of a relevant lecture course, as suggested, this could be a disadvantage for distance and home education purposes. Further testing with the appropriate age group for classroom and home use would be needed to establish if the style and content of the program is relevant and could suit the needs of all students.

In the development of GeoQuest the emphasis has been on providing a way of bringing together geological concepts in a role-playing format, rather than having a comprehensive coverage of introductory geology. Evaluation by the focus group indicated that this kind of tool would be most useful as a way to present a broader view of what is involved in geology, rather than a comprehensive introduction to geology. Other forums for finding out more about geological processes already exist.

The most appropriate place for GeoQuest could be as part of a teaching package, intended for classroom use, with supplementary information on holding a real field trip, and using real geological equipment. As suggested in the focus group, the program is most useful as a summary presentation to bring together the disparate elements learned in introductory geology at the end of a lecture course.

Computer-literate students are familiar with the motivations and processes of game playing, and this translates well into education in the case of geology. Often geology is presented as a puzzle or mystery to solve, due to the nature of its
investigations. Presenting geology in this way gives the student a natural reward on completion of the puzzle. By utilising this game-style presentation, educational interactive multimedia, such as GeoQuest, becomes more engaging to the student than the process of receiving geological information as a series of facts.

One of the limitations of the program is the cost and time involved in making a CD-ROM in the first place. Larger organisations, possibly mining companies, could possibly invest in developing the program. It would be a large part of the budget of educational organisations and faculties, or the education budget of government organisations such as Geoscience Australia.

There may be difficulties with the dissemination of CD-ROMs. In schools copies could be available to libraries or certain teachers who undertake geological education. Dissemination for home use could be more problematic, and the marketing and mailing costs would need to be considered as part of the costs involved in developing IMM on CD-ROM.

The indications both from the focus group and other research is that IMM is used in many classrooms, and in fact it was suggested by the focus group that IMM could overcome problems in combining practical science activities with computer use. An additional incentive to include GeoQuest in the high school curriculum that the focus group noted would be the development of assessment sheets to go with the program.
Further directions for the development of GeoQuest suggested by the focus group included networking the software to enable the game to be played on several machines, and thus encourage competitiveness in the classroom situation.

Consideration of the amount of text and ease of navigability in the game led to several screens of the program being revised. Comparison of these screens with the text-rich versions could be undertaken with further market research. Other revision suggested was not possible due to the complexity of adding in functions such as a menu within the program, but is something that could be incorporated by a multimedia professional.

Further marketing research with students of appropriate age levels could assist in developing the three other sections of the program and ensure that the program has the appropriate look and feel for students aged 12-16.

Although interactive multimedia can cater to different learning styles, some people simply prefer textbooks, which are also more portable than computers. The virtual experience will always have opponents that point out the disassociation between the virtual experience and reality, and the lack of the one-on-one teaching experience that the traditional lecture format can provide.
The important question is would students be interested in involving themselves in GeoQuest? Teachers' opinion was that an interactive, role-playing experience providing a summary of geological concepts would be engaging to students. A further study to gauge student opinions of the program and its usefulness in the high school Earth Science program would provide other avenues for continued development of the program.

The partial development of an interactive multimedia program in Earth Science has been completed and the results of evaluation have provided initial encouragement, as well as avenues for improvement. Interactive multimedia is recommended as an engaging learning tool that could help to address the issues facing Earth Science at the high school level. A role-playing IMM is a relevant approach to linking introductory geology concepts and demonstrating that learning in Earth Science really can be fun.
BIBLIOGRAPHY


ABC, Questacon – The National Science and Technology Centre, Radiant Productions.


Clarke, G. L., Hubble, T. C. T., & Dunkley, D. D. (January, 2000). HYPERPET: A Web-based optical petrology tutorial package or Quicktime and HTML come to the rescue in the teaching of mineral


Heather Catchpole: I have been reading a lot about geology combining with environmental science and SREM, is that likely here [ANU]?

Richard Arculus: I know that the high-school certificate in Earth Sciences offered now is becoming much more environmentally linked, Earth Science is basically no longer three rocks in a box and a fossil, it's much more.

HC: Yes, it seems to be learning about salinity and other stuff . . .

RA: Yes and I think its great, I think it's a really good idea. It seems to me there are ways of making Earth Sciences deadly boring, like any subject and also can be fascinating, you know, because you live with it. It's an everyday experience for people, living in their environment. It's stunning that people can make a topic at high school, intrinsically that's got so much to offer, boring. I've been talking to a high-school teacher actually, at one of the Western Sydney high schools and we've talked about the new syllabus, I think its great. This unit we're teaching [minerals and resources], it's supposed to get a perspective on stuff that the students haven't been getting though the REM [Resource and Environmental Management] degree, that was the idea. If you're going to have something called a Bachelor of Resources and Environmental Management, whether you like it or not, whatever one's perspective on mining and coal, I mean, you have to talk about it, and why it is
that people are using coal. So that was our attempt, to get an informed perspective on this aspect of resource use into that degree.

**HC**: Do you think that kind of cross-teaching methods will get more people into geology?

**RA**: I think it's an advantage for the students to take it. It's an experiment this year. We'll see how it goes. There is another unit we are teaching with a SREM [School of Resource and Environmental Management] badge, which is Environmental Geology, which is taught jointly with Geography and Forestry. It's been subsumed into a SREM unit now that involves more of land management, water management, things like that. Since you went though here [1995 – 1998] there are more units being offered across the School of Resource Management and Environmental Science than there used to be, but there has been much more interaction formally between geography and geology just because historically that's how it used to be. But we've tried to do things . . . Tony Eggleton teaches a soils unit now with Richard Green, and previously in both departments, one taught a soils course and one taught a regolith unit. So I think this is all a good thing and it's better for the students to be able to take up the expertise wherever it is.

**HC**: Is geology at college a requirement for your [1st year] courses?

**RA**: No, we don't expect anybody coming in to First Year Earth Science to have done anything. We don't have a Chemistry requirement; we don't have an Earth Sciences requirement, nothing. We don't expect you to know anything. Anything you do know is a bonus.

**HC**: Is that what you generally find? Do people come in with any prior knowledge of geology?

**RA**: Oh yeah, some people come in having done high school Earth Sciences and know a lot about . . . in terms of what they are allowed to, what they've been given, but lots of people don't know anything. I mean it's quite interesting the fixist views . . . that's the wrong word to say. It's interesting
the, probably in any subject if you ask people, what's the intellectual baggage you carry around with you, your framework for living, I mean when you ask people about the moon going around the Earth, say, what's the orbital period for the moon around the Earth, very few people will tell you 28 days. They can absorb the idea that the Earth rotates, and that's why the sun appears to come around every 24 hours, but the moon? Doesn't that go round every night? No. Oh. So I think Earth Science is not alone. When you ask people what is your understanding of the structure of the Earth and you get people who can tell you in some detail what is there, and how we know, and some people have got no idea. They think its all soil. There's a few boulders in there but its all soil, oh yeah and there's a lake out there called the sea, but just generally I think the understanding varies from extremely limited to pretty sophisticated. But that's OK, just don't assume anybody knows anything and work with it. And we don't expect students in the second semester to have done the first semester. I think this university should have a completely liberalised first year. That the best thing we could offer them is eight separate units. Eight units, and they should all be different. No whole year units just go and try different things. Because you could come out of a high school or college where the teaching has been spectacular in chemistry or life sciences. And because of that, you think, oh I want to be a life scientist. And you don't know that, for you in fact, you're a budding psychologist, or a budding economist or whatever. And you're trapped. You can very easily get lured into first-year university; I'm in my comfort zone. I know all about DNA and the structure of plants so that's where I'm going to go. You didn't realise that your talents would have been better served becoming a psychologist.

HC: So you see it as a good age to peak students' interest?

RA: I think that's right, you come to university, you probably have a chance to be engaged with a subject. You also have a chance at being completely turned off, you're really still uncertain what you want to do, and you find perhaps that you're in units that you don't really like and you give up. Whereas you've been given the opportunity to try . . . if after eight units, you say I don't like any of this, fine. Go and do something else. But if you find there's a particular strand of stuff that excites
you and interests you, then you’ve been given the chance. I think the structures are pretty liberal, but they’re still many students taking year-long courses.

... And the chances are that you came out of secondary education with a physics phobia. Maybe, maybe that you’re just the kind of person that can’t handle it. There are plenty of avenues of life that you or I are incapable of doing. We try our best; you just aren’t going to be able to do it. Or not as well as other people. But some of these things might just be your experience with particular teachers of the lack of clicking in the way something is presented. But you’d be given the chance to try it again. Now if you were given the opportunity to look at a physics unit which is now taught by somebody else used to people coming with a physics phobia, now I don’t think you’ll be coming to this unit wanting to be a physicist... this is the essential first step in training in formal physics and therefore this is the syllabus we’re going to get through, by hook or by crook. I want to give you perspectives on what do physicists do. And they do teach units like that, there’s a unit called The Big Questions, which are like, the nature of mass, its almost a course in philosophy, what do you think is meant by mass, well I don’t know. So you can lead people along that track, without it necessarily being very dry and dusty and formal.

**HC:** So you can form your own ideas, instead of taking on a whole lot of other ideas. What do you use for teaching geology, we had Chernikoff [Geology, by Chernikoff and Venkatakrishnan (1995)], back in first year...

**RA:** We’ve got one for example underneath there we use in second year, Exploring Earth and that’s got all kinds of environmental stuff in it, we use a different one in first semester, which is called Environmental Geology and it’s an American text again but it includes a lot of the atmosphere, the way the oceans work, the biosphere, interactions between them all and solid Earth, so, I would say a holistic approach, a real attempt to draw in multiple strands of investigation. Get it all together. Any one of these things doesn’t go into great depth, inevitably it’s just the first cut, but you can look up any one of these and find a huge amount of literature on the topics in here, but it does its purpose, I think, for first year.
HC: Do you think that texts are still the most useful thing for a student to have, you know, to be able to take it home and read it again, and re-absorb it themselves?

RA: Well, I think it's hard to know. I think for myself, yes, because it's what I got used to. That's an individual thing. I was given a figure recently, that only 20% of the population, university population is capable of absorbing information from a written page. And 80% can't. 80% are the social animal who would understand things if I told it to you, or explained things graphically or however, I'm a big believer in multiple intelligences, people can do things differently, it doesn't mean to say that one way is stupid and the other way is clever, its just there are different ways of doing things. And how you absorb or can use information, there is enormously different from individual to individual. Now I reckon I have been one of the percentage of people who are quite capable of... give me some written material, and I'll be able to absorb it, at a level of not just regurgitating it but working with it, understanding what the principles are and using that as a framework to deal with problems as they arise. But lots of people can't. And I think the same would be true of... we put a lot of our stuff on the Web, all our first year stuff is on the Web. Its only different from a textbook in the sense that it gives links to other sites around the world where you can go. So instead of just a reference it picks another Website. It's not interactive, in the sense that you can sit down and do a personal assessment of how you understand it. So it's a textbook on a computer. Now that doesn't get you any further along the problem of absorbing information from written material any more than a textbook does. The only difference is you can take a textbook with you, whereas you have to be on a computer to get at the Web page. We don't have the resources to enhance the Web and I'm not sure, given we do have the advantage of residential students, why you'd worry. I think most people; most humans are social animals, they learn better from example and from spoken words than they do from reading stuff. I mean, from a very young age that's how you learn. You learn language not from reading a book; you learn it by listening to people. Most things that you would do, like if I told you we were going to have a course in car mechanics, we'd better have a car, because my telling you to read it out of a book, you really wouldn't get it. You wouldn't get the point. You really wouldn't trust yourself,
to go and change a spark plug. I know the tactile workbench is probably the way to go in the future, you can do it all by virtual reality, it gives you the resistance and the feeling of, well, chopping a body up. You can feel the resistances as your hacking through a ribcage, however that is an expensive route. I mean humans learn tactiley, visually, hearing, you use all your sense to absorb, just a written page . . . well the textbooks serve a function, they’re a reference, they can give you examples at greater length, than you could ever get through in a reasonable time just by talking. That’s what they are. And I don’t know, I don’t think they are going to go away for a while. I still think it’s an amazingly efficient way to have a source of information. After all, you think about the amount of information that might be encapsulated in a textbook, vast, it’s a very efficient data storage system, and portable. I wouldn’t like to think that all the information in the books around this room suddenly became only available on the Web, or you had to download it, and suffer the problems with crashes, or slowness of links.

HC: Yes, I find that insufferable, the slowness, I want it to be all there, immediately, like an index. What I am getting into, I’m doing the thesis on the use of IMM for teaching geology, because I am developing a CD-ROM with what has been called a virtual field trip on it, and I have found a lot of stuff [literature] that virtual field trips are never going to replace the real thing, I mean field trips are an amazing experience, its just another way I thought, especially for college, when you’ve got people teaching geology without the background just handing out photocopies and such, here is a picture of the environment like you would see outside your window, you go out there and you pick up a rock and you come back [to the lab] and look at different ways of identifying that, and you kind of get a familiarity with the Mohs hardness test, and various other tests as you go along. I thought maybe that would be a more memorable experience of geology in college. I am working on the premise that you say to people, what do you remember of geology in high-school/ college, I can’t remember myself what I did in geology in college . . .

RA: You probably would remember that experience better. I think it does have . . . well, the trouble is the expense of setting it up. These really are trivial costs, well, I’ll back up. It really is expensive
putting people in the field. You think of the infrastructure of a field trip for real, that’s not expensive, but it’s also one-off. You never capture it. You have to repeat it. It’s an experience for that time and place. Now the idea that somehow you can capture it, with video footage, is not as good as being there and touching it yourself, and having to look around you and deal with all those things, but on the other hand, it better than, I think, than looking at a series of pictures and a description in a book. It has to be. It’s not the real thing but its better than a pretty static printed page. So yes, virtual field trips. There’s quite a few of them.

HC: Have you seen some around?

RA: Yes. I was interested to find there were some structural geology ones. If you go onto the structural geology Web, which is where I stumbled onto this, there was a pretty good one through the Appellations. Now, I suspect though, because I’ve actually been onto Interstate 80 and looked at that stuff for real, in person, that it made it more interesting looking at these photographs of it, and what the expert had to say. But on the other hand, if you’ve never been there, its pretty good, you know, you’re getting a talking head and a look at the outcrops, and discussions about it. It’s not bad. I don’t know if I’d remember it as readily as if I’d been on the trip, but the reason you don’t, I suspect, is because there are other kinds of linkages that make you remember field trips. Like, just how bad you were feeling, or what you had for breakfast, you’d have things that reinforced the memory that you don’t get on a CD, unless you happen to be playing a particular type of music at the same time as you’re supposed to be watching this virtual field trip. On the other hand, it’s not bad.

HC: I think especially for things like going to see pillow basalts that would be nice, you know if you were in a submarine and you could go and see the pillow basalts...

RA: That’s right. After all, very few people have actually done this. So you could say, yes, here’s the opportunity, by proxy. It’s as good as it’s going to be for most people, who can’t afford to see pillow basalts form in the ocean.
HC: I have found that in doing this I have become more and less convinced about where this [CD-ROM] would be useful. I started off thinking, what couldn't possibly work; now I think where it would be the most useful is before or after a field trip. An introduction to what kind of thing you are going to do, or looking at a whole lot of pictures of somewhere you went and going — "ah that's where the gold in the quartz veins were" . . .

RA: That's right. I think probably that the latter would be really good. Because we don't often do post mortems on the field trip, we don't subject the students, for example to a slide show, where we say, you recall, this is what we saw. And this is this. It's not done. We assume when you've been on the trip, why would you repeat it, but in fact, that's the way you learn well. By reinforcement.

HC: With the Web stuff, do you have anything you recommend to your students, or have you found anything that is particularly useful? Do you think students are just using it as a kind of database, as a substitute for the library, or do you think there is anything they can get out of using the Web?

RA: I'm sure there are, I suppose I'm guilty of not telling people, "this is a must look". We put links in if we think they are good. So by implication, the link is there because we think it's worthwhile to look at that. I don't treat it anymore than a reference often. If you want to see more, here's a reference. And it's up to you if you look at it or not. But it's there. I think there are some fantastic things on the Web. Just amazing. You think why would anybody invest this enormous amount of time and make it available without charging for it. I don't know. There are simulations on the Web, its fantastic.
TRANSCRIPT OF INTERVIEW WITH GARY LEWIS, HEAD OF EDUCATION AT GEOSCIENCE AUSTRALIA, JULY 21, 2000.

Heather Catchpole: What resources does AGSO [Australian Geological Survey Organisation, now Geoscience Australia] have in terms of education of the public . . . I know there is the education centre . . . do you have school groups?

Gary Lewis: Our program is divided up into a number of sections; we’ll look at principally school education first. We develop teacher resources, that’s one of our programs, we’ve currently got thirty odd geoscience topics covered, they are normally resources that involve some background information and then a series of reproducible activities, they are in the format that they are photocopy-able. This is one, the science of gold, it’s got a bit of gold in the front, it’s got background notes for teachers about gold, and then there’s all these activity ideas. This is a primary one, and there are secondary ones that are similar.

HC: Can you tell us why was gold picked? Was that specifically because people recognise and like gold?

GL: Why? Because primary school teachers teach gold, as in gold rushes, as in gold in Australian history, they were told that they had to teach pieces of science and generally speaking they didn’t have science backgrounds, so we decided that one way to help them to teach their science component was to add something to something they already taught, there was a program that ran in NSW at a museum that’s now closed down called the Earth Exchange, that was principally about the
history of gold, and we had a deal with them that we would add the science component to that, so we developed something to add the science component, the museum closed down, and we decided we would just keep going, keep producing something.

HC: Have you had any feedback from that? How useful has that been found?

GL: That's very hard to say how useful it is. The only way we can measure it is through our second program, which is; we run a series of teacher training sessions based on these resources, so literally any of those thirty resources we could run a teacher training session on, although we have targeted specific resources because they have greater or stronger curriculum links than others. And we run teacher-training sessions on those and science of gold is one of those. And we have had over 2000 teachers come to sessions around Australia. That's the first way we can measure it, and the second way we can measure it is, we sell these, how many do we sell. So we can actually look at the sales figures. There's a few resources that we've developed [pause] they weren't a waste of time, but, no one buys them! When I say no one buys them . . . the market's really limited.

HC: Do you think that there is a distribution problem, or . . .

GL: No, they were things that were developed for specific curriculum, and the curriculum had changed and they are no longer relevant, therefore people won't teach them. One of them was one of the nicest things we've produced, which was a book on silicate chemistry, which was for the NSW chemistry syllabus, that has now changed, it is no longer relevant, which is really sad because it has the nicest geological story, if you are into silicate minerals.

HC: Is any of this happening on the Web as well?

GL: No, we really don't have resources that people can download on the Web, yet, but we are trialing, at the moment that people can purchase resources that they can download, literally what they
are getting is the same thing. We are trialing that at the moment, but that is a distribution mechanism, its not as if they're a Web resource.

HC: Why?

GL: Why? Why is the question, why aren't we doing Web, why aren't we doing CD-ROM's, why aren't we doing video, why aren't we doing computer games, all the things people ask . . . the reasons we don't do these things is . . . there's many reasons, the reasons are: one, we don't have the expertise ourselves in developing those materials, we don't have the expertise to develop CD-related material. Secondly, to get expertise in will cost us a lot of money. But thirdly and more importantly, from our talking to teachers, everyone in my unit who works in education has been a school teacher reasonably recently, I've been out of it the longest, from our experience schools are not using those resources as much as they are using the regulation printed resources of a textbook. And schools are still wanting to buy textbooks, rather than buying a CD to replace the textbook, because kids can go home with a textbook, but they can't go home with a CD. So its not that, it used to be that schools didn't have the laboratories with the equipment set up to run a CD, that's becoming less and less of an issue, but its probably an issue of having them but not having the teacher training, not having access to them, steering teachers away from using CD-related, computer-related resources as specific teaching tools. They may be used as examples of things, someone does an assignment, or library-based materials are being used, but they are not being used in a classroom situation for the teaching of geoscience.

HC: Do you think they would be more useful in a library?

GL: As a resource, yes. There is another factor in that is to say that there are ones already on the market that have been brought out, not good, there's one called the Geology of Australia, I'm not saying its not good, its fills the niche market, its not very expensive, there's the Geological Society produced one called The Making of Australia, there's ones that have been put out by some of the
industry groups, there's one on the petroleum industry, so there are ones that already exist that answer some of those questions. And when you add up all of those reasons together, we will not be getting into CD production. However, there is a possibility that we could deliver the current resources that we've got on CD. So again it's a delivery mechanism of what we've already got rather than a mechanism that we'll look at developing down the path.

HC: How do you evaluate your resources for schoolkids?

GL: We evaluate programs in a couple of different ways. I should point out that other than the Earth Science Education Centre, which we started in October last year, all of our other programs are for school teachers not for school kids. We develop a resource which is principally designed as a resource for schoolteachers it is not a book for students.

HC: Is this again because you found a lack of a science background in teachers?

GL: Lack of geoscience background in teachers, absolutely. They don’t have it. And the only Earth Science experience they have had is probably at school from a teacher who had no Earth Science experience, so it's a big cycle and breaking the cycle, that’s the important thing for us. It's the multiplier thing. If you can get one teacher turned on, you’ve got, in primary school, thirty students a year who will be turned on to it, for their teaching career, and if you are in high-school, it could be thirty students a period turned on to it. So the multiplier effect is far, far greater than if we ran a session and turned one student on. Turned one student on, big deal! It's important to turn the student on, but, if you can put resource into multiplier effect, there’s no doubt that’s the way to go.

They’re the sorts of programs that we run; the education centre has a very high profile, because people can see it within the organisation, but in fact, it is the other programs that have the greater impact, because this while it has a couple of thousand students going through the centre, the other programs reach one and a half million students. What we do is we ask how many students would you use these materials with next year and the year after that and that’s now over 1.6 millions student
experiences; some students will be counted twice. They hit ‘em in Year 9 and they’ll hit ‘em in Year 12. Even if you take that number and you halve it, or take a quarter of that number, it is still a phenomenal number of students for the process that we go through, if that makes sense. There are three of us in fact, running, if you take Greg away, who runs the Education Centre, there are two and a half running the other program, and if you take me out because I’m literally just counting beans now, there are two people, running the program, to get to that number of people.

I suppose the lesson in science communication is that you have to know what your message is and be passionate about it. You wouldn’t be in that course if you weren’t down that route anyway.

The second thing is to find a mechanism that has a multiplier effect to get your message across. I have a problem with programs that deal with the general public, that a lot of money can be spent with little impact, because you are teaching to the great unwashed. If you find a structure like going through education, through the system as we are, then you can get maximum for your dollar. There are ways and means you have to go about that, you can’t go in with any old message, you have to go in with messages linked to the curriculum. Which makes it difficult if you are a fringe science because if you are not in the curriculum then forget it.

**HC:** There are a lot more of these fringe sciences, that I have read about anyway, that have been incorporated into high schools and colleges, and it has been partially blamed for the decline in enrolments in geology, because there are all these more practical, hand-on science course that kids can get into . . .

**GL:** That’s true, it’s probably very true for the ACT, whether its so true for the other states I’m not sure, NSW have gone this route of not having geology in the senior year and having an Earth Environmental science course, which I personally believe that that is the right way to go, and they’ve gone from 260 students doing geology for the HSC to 1500 to 2000 students are going to be sitting for this other course. It’s a remarkable change. But what you’ve done is you’ve got the people who may have done biology and not geology, who are more linked because you’ve got the word environment and you’re sucking them across, but at the same time they’re getting geology. But if you
do biology you get geology because you do about the history of the earth and evolution and that's geology-based.

HC: The great thing about geology I think is the way it incorporates absolutely everything . . .

GL: Exactly! We are developing a resource that is for NSW HSC biology, there are 14,000 students who do it, and if we can get a geological message across to those 14,000, we are actually doing better than trying to get a message across to the 1400 doing Earth Environmental science course. You’ve got to know what’s happening and then gear what you are going to do to get the maximum impact because you’re going to take the same amount of time, it is going to cost you the same amount of money whether you are getting to 1500 people or two or one and a half million, so you’ve got to work out where the best place to get your message across is.

HC: Is that a big part of your job then (working out where to get your message across)?

GL: Yep. It's not as if it is just my job to do that, we fly by the seat of our pants, we ride with it rather than drive it.

HC: Do you do much collaboration work, not only with universities and schools but with places like Questacon? Any museums?

GL: Yes, we have done joint work. Most of the joint work has been with someone who either has a pot of dough, because our salaries are paid for but all our other operating is literally externally funded, we have to operate on sale of products, that moneys got to come in to fund the next thing we do. Collaboration is based on OK who’s got some money to get a message across which is the same sort of message we want to get across, we’ve worked with groups like Auslig, map reading kits, remote sensing kits, etc. We’ve got some money from the mining lobby group, but its not really the game we are in, they are in promoting what they do to economists...
but collaborations with museums, we have direct collaboration with Sovereign Hill, we produced a gold history set, with Questacon and a lot of other science museums we have had little collaboration, we have spoken to people about collaborating but basically, if it doesn’t fit in with the thing they currently have in their centres, then forget it they’re not interested. But, we have run training sessions at some science centres, like the Brisbane Science Centres, and that’s been fantastic, and we’re currently helping Questacon in their Awesome Earth exhibit. We are finally getting a name for ourselves in promoting geology.

**HC:** So what’s the situation at AGSO like at the moment?

**GL:** There’s been two sets of cuts since I’ve been here, both times they’ve lost a whole lot of people, but both times we’ve moved . . . there’s been some bloodletting and people have left but they’ve refocused in the direction their going but their ahead and we are really in a new dawn now, the organisation. It’s changed its direction, I wouldn’t say dramatically, but it’s changed it focus dramatically from being a group that went out and said OK, here’s a map of Australia, we haven’t been there we haven’t been there, lets go and map those, to saying where is it we really need the information . . . the organisation looks the best that it has done since I have been here. There’s no stopping us for the next couple of years. Now what that means back here in education and promoting stuff is that we will get continued support as long as that continues and we keep track of what they do. Both times they’ve downsized, we are almost the only group within the organisation who has increased in size has been this one. So that means we have phenomenal support within the organisation. They really believe we are adding value to what they do, by letting people know about geoscience builds up the support for what the geoscience community does, not just AGSO but universities and stuff. What we do, we’re the only group in the country who is doing it basically.

**HC:** Do you think that that can then go and have benefits for increased funding?
GL: Absolutely. We are not about boosting the numbers of students who do geology at university, it
is not what I am about, it is not what this program is about. What we are trying to do is boost the
number of people in the community who have an appreciation, not necessarily an understanding, but
an appreciation of what the Earth Sciences can offer to a whole range of different debates. If they’ve
got an appreciation of that, then, you create a safety net because they’re voters to start with, right, but
beyond them being voters, they are also the bankers, the economists, the lawyers, the
environmentalists, the biologists, the doctors and that, people who in some way will influence the
decisions that are made that are geoscience based. An appreciation of what you can offer is going to
increase the chances of the science surviving, if you like.

I am not doing this to make more geologists; there are 2000 unemployed geologists, so why would
I want more people to do geology. That is a spin-off, however, that some people who would
normally say ‘I am going to be a doctor, I am going to be an economist or a dentist’, might turn
around and get turned on and say, good people, will get turned on and say I’ll go and do research in
geology, but that’s not the main reason.

HC: Do you think if people had an introduction to geology at high-school/ college level which was
different from being taught mineral names and types and things like that, do you think if they had
something which was a game something that involved them more . . .

GL: This is the biggest issue that geoscience education has had to face. It is the biggest hurdle we
have to overcome, and that is we got to get people who teach geoscience away from the concept they
have to teach classification of rocks and minerals. If we can do that, then we’ve won. Because the
majority of students have been taught . . . they get into Year 8 or Year 9 and there’s a geology unit
and the first thing they hand out is piles of minerals and say lets do rock tests and identify these
rocks and minerals, and kids get turned off by it. Geology’s not about rocks and minerals, anyone
who thinks that geology is about rocks and minerals is an idiot. Because rocks and minerals are the
smallest part to worry about, geology is about bigger systems . . . development of the planet, you
know, its about big things, things that move slowly. You start with the big picture and zoom smaller
and smaller and smaller and smaller instead of starting small and going the other way. In biology
they don’t start straight in with mitochondria . . . they go into the relevances, how does a plant work
and why is that relevant. How does your body work and why is that relevant. We need to take the
same approach with geology, how does the Earth work and why is that relevant rather than worrying
about what is the difference between barite and calcite . . . its not something that’s relevant, and it’s
about getting geology relevant, that’s the important thing. How we do that is more difficult.

I think if we can get people turned on by making it relevant, interesting and fun in the early years,
then that will be the battle won.
Table 3: A list of IMM available in Introductory Earth Science

<table>
<thead>
<tr>
<th>WHO</th>
<th>WHAT</th>
<th>COMMENTS</th>
</tr>
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<tbody>
<tr>
<td>United States Geological Survey</td>
<td>Website: <a href="http://info.er.usgs.gov/networ">http://info.er.usgs.gov/networ</a> k/science/eart/earth.html</td>
<td>Index of Earth Science Websites. One of several sites available with a comprehensive list of links to Earth Science websites, including the websites of geological survey organisations of countries around the world.</td>
</tr>
<tr>
<td>Non-profit Organisation of Earth Scientists and Teachers</td>
<td>Website: <a href="http://rockdetective.org/">http://rockdetective.org/</a></td>
<td>Catalogue of educational Earth Science 'mystery' kits. Aimed at pre-college age students, these hardcopy kits are exercises in role-play and field work.</td>
</tr>
<tr>
<td>Computer-Oriented Geological Society</td>
<td>Website: <a href="http://w.csn.net/~tbrez/cogs/">http://w.csn.net/~tbrez/cogs/</a></td>
<td>Provides links to databases, computer software catalogues and websites, and gives trouble-shooting advice on using these programs. Encourages the use of computer-based products in Earth Science by providing the</td>
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<tr>
<td>Organisation</td>
<td>Website:</td>
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<tr>
<td>Australian Government Survey</td>
<td><a href="http://www.agso.gov.au/education/">http://www.agso.gov.au/education/</a></td>
<td>Information about AGSO and links to teacher resources. Contains quizzes and a glossary of geological terms. The secondary school teacher resources advertised include hardcopy kits on plate tectonics, volcanoes, earthquakes, landslides, climate change, remote sensing and silicate chemistry.</td>
</tr>
<tr>
<td>Uniserve, managed by University of Sydney</td>
<td><a href="http://science.uniserve.edu.au/">http://science.uniserve.edu.au/</a></td>
<td>Teaching resource that provides links to useful sites in Earth Science. The linked sites encourage teachers to incorporate use of the Web into class, and have information available for student for research purposes.</td>
</tr>
<tr>
<td>Adam Mickiewicz University, Poland</td>
<td><a href="http://hum.amu.edu.pl/~sgp/gw.htm">http://hum.amu.edu.pl/~sgp/gw.htm</a></td>
<td>Equivalent to a textbook with links, with a linear presentation. Also includes papers from a creationist viewpoint.</td>
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<tr>
<td>ANU,</td>
<td></td>
<td>Like many universities, ANU</td>
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<tr>
<td>Course</td>
<td>Website</td>
<td>Description</td>
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<tr>
<td>Geology Labs Online</td>
<td><a href="http://vcourseware4.calstatela.edu/VirtualEarthquake/VQuakeIntro.html">http://vcourseware4.calstatela.edu/VirtualEarthquake/VQuakeIntro.html</a></td>
<td>Interactive programs with built-in earthquake analysis and rock dating technology. 'Virtual Earthquake' gets the user to calculate the epicentre of an earthquake.</td>
</tr>
</tbody>
</table>
earthquake and 'Virtual Dating' calculates the absolute age of a rock. Upon completion of the activities the user receives a certificate of completion. One of the few interactive opportunities in Earth Science available on the Web.

| University of Tasmania Library | **Website:** [http://sirocco.geol.utas.edu.au/geol/library.html](http://sirocco.geol.utas.edu.au/geol/library.html) | Online library service provides a database of minerals and rocks (search fee involved). Many other online search services exist. |
| Edwards, Bryon & Sowerbutts (1996). | **Courseware:** A reference and text-style module with links | Slightly more involved than just lecture notes on the Web, this kind of interactive courseware is designed to complement existing teaching strategies. |
| Steel (1995). | **Courseware:** Authoring package | Steel is one of many educators using authoring packages such as 'Director' to produce multimedia presentations tailored to specific lecture courses. |
| Boger & | **Courseware:** Use of | The interactivity in the |
Boger (1994). | Computers for assisting labs and checking answers. | Program developed by Boger and Boger is enhanced by use of 'what’s the point' buttons. Allows for immediate feedback to students.

Hounslow (1996). | **Courseware:** An index-style identification aid with no graphics for the higher-level student. | List of minerals and their properties; used as a tool for identification.

Clarke, Hubble & Dunkley (2000). | **CD-ROM:** A set of tutorials on the teaching of mineral optics. | An extensive library of Quicktime movies of petrographic slides show birefringence properties, changes in relief etc., as you turn a slide around in this 'virtual microscope'. A large amount of memory is required. Each movie is between three and four megabytes, so a fast computer is required.


Wolters, Shaffer, | **CD-ROM:** 'Visualisation of Milankovitch Climate-' | Educational tool that allows visualisation of processes that
<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
<th>Description</th>
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<tr>
<td>Cerveny &amp; Barnhill (1996).</td>
<td>Change Theory'</td>
<td>normally operate over thousands of years to be relayed quickly. It is intended for university-level use.</td>
</tr>
<tr>
<td>Bursik, Hodge, &amp; Sheridan (1994)</td>
<td><strong>CD-ROM</strong>: ‘Volcano!’</td>
<td>A role-playing educational tool. In addition to being vulcanologists, students can also be terrorised villagers.</td>
</tr>
<tr>
<td>Location</td>
<td>CD-ROM:</td>
<td>Description</td>
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<tr>
<td>Renshaw &amp; Taylor (2000)</td>
<td>Supplement to a textbook.</td>
<td>Electronic textbook enhanced with electronic flashcards and containing basic interactivity such as a quiz of multiple-choice questions.</td>
</tr>
<tr>
<td>Maryland Earth Science</td>
<td>'The Maryland Earth Science CD-ROM'.</td>
<td>A database of Maryland Earth Science and Environmental data. Enables the user to zoom in on a region of Maryland for geological, topographical and earthquake occurrence data.</td>
</tr>
<tr>
<td>Discovery Online</td>
<td>'Beyond Planet Earth'.</td>
<td>An interactive guide to the solar system. Contains over 50 minutes of video and a gallery of images to explore planet by planet.</td>
</tr>
<tr>
<td>Astronomical Society of the Pacific</td>
<td>'Earth Quest'.</td>
<td>Piece together tectonic plates; see time spans of millions of years speeded up into minutes. Most exercises are interactive. For ages 8 and up, requires 2 CD drives.</td>
</tr>
<tr>
<td>United States Geological</td>
<td>Database of magnetic data.</td>
<td>Knowledge base of geological survey information.</td>
</tr>
<tr>
<td>Survey</td>
<td>CD-ROM:</td>
<td>Contains video and audio clips, interactive games as well as geological and biological information on the museum.</td>
</tr>
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<tr>
<td>Mammoth Site Museum bookstore</td>
<td>'Ice Age Adventures: A Mammoth Mystery'.</td>
<td></td>
</tr>
<tr>
<td>Australia on CD: An Australian Federal Government Initiative</td>
<td>CD-ROM, 'Mission: Australia'.</td>
<td>Interactive multimedia with environmental content directed at general public. User can explore various environments and solve problems faced by these areas.</td>
</tr>
<tr>
<td>Australia on CD: An Australian Federal Government Initiative</td>
<td>CD-ROM, 'Ingenious'.</td>
<td>An award winning role-playing game taking the user around Australia exploring various science professions and involving role-playing in those professions to solve scientific mysteries.</td>
</tr>
</tbody>
</table>
Appendix D

GEOQUEST STRUCTURE MAP
Appendix E

SYNOPSIS OF DEVELOPED SCREENS

GeoQuest has four quests the user can participate in, in different fields of introductory geology, as detailed in Chapter 3. The area developed was the 'Gold!' section, a virtual field trip that deals with mineral identification and the process of field trips.

Screen 1: The opening sequence

GeoQuest opens to the strains of The Raiders March to set the theme of exploration and mystery. The use of sounds is designed to give clues to the geological nature of the program, as was the orange/brown graphics design. Four buttons appear, if developed these would lead to the other quests, 'Ancient seas', 'Extraterrestrial' and 'Earthquake!'. There is the option to quit, and to turn off the music for in-classroom use.

Screen 2: The virtual laboratory

The Gold quest begins in a virtual laboratory. The lab was designed to maintain the same graphical feel as the opening screen, while being recognizable as a lab to high school students. Given the intended audience, I felt it was important to have a
design that used bright colours and was not overly simplistic in appearance. The tools that appear on the bench top are: a microscope, a magnifying glass, a set of scales and beaker, a streak plate and the Mohs Hardness test, a field bag and a mission sheet. On the wall behind the bench there is a poster containing mineral identification information and a geological map. To the far right of the screen is the door that leads to the site areas.

The Mission Sheet

Clearly labelled “Mission”, the mission sheet provides information on the input required to complete the quest, as well as some background information on gold formation. The theme from “Mission Impossible” is used to add interest and is popular and familiar to 12-16 years olds (from the movies).

The Field Bag

In the beginning of the quest, the field bag contains an empty field guide. The icon is visible initially to give a clue to the nature of the quest. Access to the field bag is available also from the site area and any of the tool screens. This is where the 'samples' are 'stored' for testing. The identifying characteristics of the gold sample must be completed in the field guide for the quest to be finished.

The Map
The geological map is of the virtual field trip area. Access to the map is available from the lab and the site area. It serves the function of allowing the user a reference to the rock types present. It also provides a clue to the nature of the program and provides familiarity with the geological map as necessary part of a field excursion.

**The Door**

The door leads to the field area (Screen 4), providing a realistic mechanism for moving out of the laboratory.

**The Laboratory Tools**

The tools for mineral identification, except for the Mohs Hardness Test, are all on pop-up screens, designed brown and cream in keeping with the graphical design, but with vivid pictures to add interest and provide an idea of what the operation of the tool looks like. X-marked 'close' boxes can close the screens; there is also a help button to provide the user with additional information on how to use the tools in the virtual and real scenarios.

*Calculating specific gravity*
Clicking on the scales and beaker image directs the user to a pop-up screen where they learn what specific gravity is and can calculate the specific gravity of a mineral sample. The equation for calculating specific gravity is shown, and is calculated by the computer, based on the input by the user of the weight of the mineral over the weight of the equivalent volume of water. This shows the user what is involved in the calculation of specific gravity, further discussion of the principles involved is meant for the classroom.

*Microscope and magnifying glass*

The pop-up screens of the microscope and magnifying glass aid in the determination of colour, they might in an extended version of the program be used for determining more advanced identification properties, such as cleavage, relief, texture, lustre and birefringence, however I believed that it was more important to give an overall feel for mineral identification without going over every aspect involved. The purpose of GeoQuest is not to provide a comprehensive coverage of introductory geology, but to give the user a sense for some of the activities undertaken by a geologist.

The magnifying glass simply provides a zooming function to allow a closer look at mineral samples. The microscope contains a library of thin section images of the mineral samples that can be collected from the site, and some information about the particular features of the petrographic microscope.
The streak plate

This contains a representation of a square ceramic plate, which a mineral sample is scratched across to determine streak colour. Clicking the sample than dragging the cursor over the area in the box creates a scratching sound and an animation of a line of colour going across the plate.

The Minerals Poster

The minerals poster provides the necessary information for final identification of the sample. The user is able to check identification characteristics of all the minerals in the program, view an image of the mineral, and obtain information about how the mineral may form.

The Quit Button

Enables the user to quit the program from the laboratory screen.

Screen 3: The Mohs Hardness Test

The Mohs Hardness Test moves the program to a new screen where pictures of the minerals of hardesses one to ten is shown in a representation of a box. After choosing which sample to test in their field guide, the user can “test” for the
hardness of their mineral sample by clicking on each of the images; the words "SOFTER" or "HARDER" appears above the image. The user then concludes that the mineral's hardness lies between the values of the minerals that listed "HARDER" then "SOFTER" subsequently, and records this number in the field guide. Closing the screen with the 'X' box on the top left returns to Screen 2.

**Screen 4: The field area**

Going out the door from the virtual laboratory brings the user to the field area. Initially the larger area on the right side of the screen features an aerial photograph of the site area. The top left part of the screen features a smaller version of this photograph and the bottom left of the screen features a large icon of the field guide. Also present along the bottom of the screen are buttons leading back to the lab, a map button, which allows the geological map to pop-up, and a quit button to enable the user to quit the program from the site area.

**The Top Left Aerial Photo**

This large icon allows the user to return the half screen at the right to the aerial photograph at any time while navigating through the field area.

**The Field Bag Icon**
This leads to a pop-up version of the field bag so that details of at which site samples were obtained from can be recorded, and to provide a visual of a sample being collected.

**The Large Aerial Photograph**

There are three invisible buttons embedded in the aerial photograph, relating to different land types as identified by the geological map: the granite hills, the alluvial plain, and the basalt hills. Clicking on an area of the aerial photographs 'presses' these invisible buttons leading the user to one of the three areas.

**The granite hills**

Clicking on the left hand side of the aerial photograph changes the half screen to an image of a hilly granite outcrop. This is the 'site area' the user has chosen to 'visit'. Text comes up giving some information about the area, and informing the user to click on the area to obtain a hand specimen. An animation of a geological pick shows the hand specimens being taken. This then leads to a screen featuring an image of a hand specimen, and an animation of four minerals coming out of the hand specimen, to indicate that these are the mineral specimens available. To 'collect' these mineral samples, the user clicks on the sample and an animation shows the sample moving to the field bag.
The other site areas, 'basalt hills' and 'alluvial plains' operate in a similar manner to the 'granite hills' area. The 'alluvial plains' area had the screens of texts removed as the focus group considered that the user should move directly to the rock area without an interim screen with a large amount of text.

After visiting the site area and obtaining samples, various properties such as colour, hardness, streak and specific gravity can be tested back in the virtual laboratory, and the information recorded in the field guide. The field guide is 'handed in' for the program to be complete.

What Wasn't Developed

The three other sections of GeoQuest; 'Earthquake!', 'Extraterrestrial' and 'Ancient seas' were not developed.

Aspects of the 'Gold!' section not developed include the boxes that would show minerals present in the field bag, and in the pop-up tool boxes. This was beyond the scope of the software used to make the program. The functions of the tools in the pop-up tool boxes were not developed, nor the function of 'writing' in the field guide.
The function to 'hand in' the field guide was not developed. Further evaluation could provide ideas on how feedback could be provided at this stage of the program.

At the currently developed stage, users can go out to the sites and collect samples, and explore the range of functions in the 'lab' but not utilise the tools and complete the quest.
FOCUS GROUP CONSENT FORM, INFORMATION SHEET
AND SURVEY QUESTIONS

Consent form

The following survey is to be used as part of a study on the development and implementation of interactive multimedia technologies in introductory Earth Science education. As part of this study an interactive multimedia program is developed for use in Australian high schools. You are invited to take part in testing the program and a subsequent focus group discussing the usefulness of the program.

Heather Catchpole

Email: heather.catchpole@helix.csiro.au

Ph: (w) 62766017 (h) 62627511

130 Duffy St, Ainslie, ACT, 2602

Participation in the focus group is voluntary. Participants can withdraw at any stage. Data will be stored in a locked cabinet throughout the duration of the project. None of the names of the participants will be recorded with the data or for any
other purpose. The consent form will be separated immediately from the questionnaire so that identification is not possible.

I agree to take part in this survey and that my comments may be used anonymously for the purposes of publication in a sub-thesis.

Yes          No

Signature ______________________________________

Date __________

Human Ethics Committee contact:

Sylvia Deutsch

Email: Sylvia.Deutsch@anu.edu.au, phone: 6125-2900
The following survey is to be used as part of a study on the development and implementation of interactive multimedia technologies in Introductory Earth Science education. As part of this study an interactive multimedia program is developed for use in introductory Earth Science Education. You are invited to take part in testing the program and a subsequent focus group discussing the usefulness of the program.

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Sylvia Deutsch
Email: Sylvia.Deutsch@anu.edu.au, phone: 6125-2900
GeoQuest Teacher Focus Group Questions

• What do you use computers for in class?

• What (if any) kind of programs similar to the program shown (GeoQuest) have you used?

• Do you think the content of the program is relevant to introductory Earth Science?

• Do you think the content is relevant to students of the intended age group (12-16)?

• In what ways do you think the program GeoQuest could be improved?

• Would you use GeoQuest as a teaching tool?

• Was it fun?
GEOQUEST TEACHER FOCUS GROUP TRANSCRIPT

Four high school science teachers present represented as A, B, C, D.

A: This [GeoQuest] is the sort of thing where you go through the theoretical side of things where they’re actually looking at their mineral specimens doing their tests, identifying what rock is what, ok, granite and basalt, sedimentary and metamorphic, that sort of thing, once they’ve got that sort of thing they’d go onto something that was a little larger structure, like, what’s a structure, folds, faults, that sort of thing, ... little bit of geological map sort of work, ok, show that ok here’s an ordinary map that people see, a street directory for example, then you go to something it might be a topographic map, and then you go to a specialized map like a geology map. So that will distinguish – that’ll make things a bit clearer for the kids, once you go into that sort of thing, then you would apply ‘what does a geologist do’, what does a geoscientist do and that’s where this thing [GeoQuest] would come in.

I would see it [GeoQuest] as an advantage because it actually brings together everything as far as a career opportunity is concerned. It also relates to the real-life situation, of what an actual exploration geologist does. That’s where I would see it, that’s where it would fit, towards the end of a course, where you could put the . . .

B: apply . . .

A: Yeah, apply it in the real life.

B: It’s [GeoQuest] a very stimulating environment, because in schools it’s not realistic to go out to alluvial plains to gather samples.
C: We can’t get much of that anyway, around here you not allowed to go out places and gather samples. “Please do not destroy our only geological specimen of this in the area!”

A: The interesting thing is that they’ve got compasses but they rarely ever use them. Course, there’s obviously not rocks where you could measure strike and dip. Having said that, one of the exercises we do is to set up clipboards, with a rock type on it, and you’d set them up in the field in an area where you’d get practice measuring strike and dip, you’d have a position, and the kids would plot it on the map and discover it’s an actual fold or something. That was a very simple thing. It takes a bit of time to set up, that’s the only sort of practical fieldwork that we do in the school environment. And even that would take a double lesson to do a very simple experiment.

Heather Catchpole: Is lack of equipment a problem?

A: Oh, it’s not so much equipment, if you look around there’s plenty of bits and pieces, stereoscopes...(list of equipment). The problem is trying to apply all that sort of thing.

B: To make it a meaningful task rather than a set of unrelated experiences.

A: Yep. For those who are not experienced in geoscience that [GeoQuest] would be ideal – to see what a geoscience professional does, why they use this equipment, and you might be able to come up with an idea of how they actually use a compass. I mean in the classroom for example, strike and dip, you can use an inclined board to explain strike and dip, but then it’s dependent on your personal experience if you go and do that.

HC: Do you think this is something you could use after a field trip or before a field trip?

D: yeah.

B: the trouble is if we were to do a field trip in a high school environment is would be quite artificial, there is a limit to the things that we could do.
A: The problem with the field trip that I see, apart from the usual sort of logistical problems, is, the amount of information and the type of information that the kids would really receive – what I mean by that, if you’re in a classroom and you’ve taught them how to use a compass, where out in the field they can actually measure some strikes and dip on a rock face, that’d be a bit of a buzz. Or you go to an area to a geological cutting to look at some structures, the problem is there is so much in geology, so many individual things you couldn’t possible put them all in one field trip.

C: You’d need a week-long excursion to south-east NSW, and visit site after site after site.

A: So what they do in that particular aspect is not actually look at the geology itself, but how geoscience affects the environment, digging up mines, that sort of thing. The end result rather than getting into the nitty gritty.

B: Software such as this is a good way of giving kids a similar experience, to the way in which a geologist would work out in the field without taking them out in the field. This is something that they could hand in for assessment.

C: having a photocopyable sheet with that [GeoQuest] would be really good.

HC: Do you use computers in class?

A: We’ve certainly got computers in high school, but I think the application of computers is really up to the individual teachers. Particularly in science, but also across the board, you know we’ve got computers in labs, and we take students up there to do particular, computer-oriented practicals, in the class themselves it’s up to the teacher.

B: The type of classwork we do on computers is logging, database stuff, also tutorials such as the chemistry ones, Light and Sound...
C: Or 'Power Point'.

B: We also have some science software that is stored on the networked computers we’ve recently bought, in genetics, some information on genetics, simulations, we’ve got some tutorial-type software.

C: The biggest restriction I see is that computers in science aren’t related. I would like to do a prac. where kids could put their data into a computer as they go, to do the whole thing right there and then, rather than have to book in [to a computer lab], make sure that it’s a time soon after the prac., take them all up there, you have to do that individual, small, little task, it wastes the whole time! And you come back, and it’s two, instead of one lesson.

[Rather than it being] This is IT and this is Science. When it’s really all connected. In the real world, there should be a computer on every kid’s bench. Then they could put the data in and it’s there and it’s great. And the 486’s they’ve got for the data logging ... they’re no good for anything else. Way it is now, it’s just annoying. You can do a lot of stuff, but it’s just time-consuming and inconvenient.

HC: The Light and Sound modules you were talking about is this more along the lines of this sort of thing [GeoQuest]?

B: No. It’s an explanation of the basic concept and a couple of questions afterword.

C: The Evolution one, the moths – that’s an interactive one and that’s absolutely brilliant. You’re actually playing predator and picking the moths off. The kid’s loved it. Wonderful stuff, and they’re likely to take the population graphs out and see the change with time.

But they’re [IMM] very hard to get. I had a look at a $250 CD, and I thought, for $250, it should be really good. And it was nothing more than a tutorial on evolution. And they gave a lot of information, and you clicked through, and there were nice pictures, but you can get them in a book, and then they set a whole bunch of questions that you click the right answer to, and I
thought, well this isn’t $250 worth. And I sent it back! Why can’t they do something more interactive like this [GeoQuest]. This [GeoQuest] is the sort of thing that the kids will respond really well to.

A: They certainly will, but they’ll need guidance. I:’s not an easy thing to run around. That’s why I say the introductory sort of lecture on the process of how an exploration geologist goes; with guidance they’ll soon get the hang of it.

C: And a lot of the instructions seem to be about this much [wide distance] reading. Now I know a lot of my year eights will baulk at that. They just click everywhere and find where they want to go. I mean a lot of them wont read at all. Some of them just wont. They’re used to games that are self-explanatory. And they just click. They just click until they find where they want to go. So that would one suggestion that I have is less instructions on the screen.

A: If it could be made as an information thing, you know, ‘what is streak’ or something like that, you could have a quick thing, if you’re going to do streak tests, [example text] ”dragging a mineral on a porcelain plate looking at the colour” . . .

HC: So rather than having the detailed information, you could click to go to that information...

A: yeah.

C: Yeah.

A: If you wanted to get further information, you know, certain minerals have certain colour streaks, white streaks or whatever...

C: It also would be great to set up in a network type situation, where kids could actually compete with one another to get the gold first, the kids love that. That really motivates them.
HC: What do you think about the content? Do you think that’s relevant to kids 12-16?

A: It’s relevant from the viewpoint that they have to do it anyway. The relevance of this [GeoQuest] is that there is actual application to it, it is part of a geologists repertoire. Rather than this is something, we have to learn it.

C: I had the same problem when I got the kids to cut out the human chromosomes and to do a carrier type. They had to cut them out and actually line them up, to see the number of chromosomes and the type and they said [name] this is busy work. And I said, no, this is what geneticists do, and they [students] couldn’t relate. They couldn’t believe anyone would sit down and do this, "but this is BORING". Well gee, welcome to life.

A: they loved the cutting, but putting it together – o1!

C: They don’t know what reality is. They’ve got this really fake idea from TV. They [students] like it to be ‘yes or no, positive or negative’ not a shade in between. This [GeoQuest] would bring out ‘well maybe it’s grey, maybe it’s green [the streak] it’s hard to tell’, and they’d have to look at a couple of different possibilities.

B: There’s a whole other level of thinking, trying to pull all the results together, to come up with a solution to the problem.

HC: You’ve mentioned a couple of ways the program could be improved, is there anything else you’d like to say about that?

A: The one thing I would suggest, is that is you went through an introductory lecture, there’s going to be a lot of overheads or a lot of writing, I reckon if you had a menu down the side with the steps, this is what you should do. OK? So the steps go from one to two, to three, to four, rather than them just wandering around. A geologists knows what he’s doing, kids wont.
C: A lot of programs do have it on the first page, so we have a room here, then you do that, that’s the extent of the program, that kind of thing, I get lost in these.

A: Sort of highlighting where they’re at with the steps, number three, that’s where they’re at, at the moment.

B: Like a flow chart.

C: It would be also good to have a set of handouts that directly relate to that [GeoQuest] so that you can say "this is what you will see".

D: Yeah, that’d be a good idea.

C: This is what this will mean, and you can talk about it, directly as they would see it on the screen.

HC: Would you think that you could use this as a teaching tool, and did you find it fun?

A: As a geologist, I would.

D: yep.

A: Because, you know, I’ve already got the background information on it, so I now know what to do. I guess it now becomes a case of trying to express it to the kids in a way that they could understand.

B: For me it would help me collate what seems to be a series of unrelated experiences to something meaningful.

D: How it applies, and what it means to test streak and hardness...
A: It brings it all together . . .

D: . . . by a real-life situation.