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AUTHOR Wallace, Andrew R.; Boylan, Colin R.
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ABSTRACT

This paper reports on research with a group of students in grades 3 and 4 who live on isolated grazing homesteads in the Australian desert in western New South Wales. The paper examines an alternative mode of delivery involving the application of satellite-based systems to provide a teaching-learning environment for these students. The trial of a satellite system made it possible to evaluate not only the appropriateness of the technology but also the potential for teaching and learning implied by such systems. This evaluation involved a number of key participants, including students, teachers, home supervisors, administrators, and those engaged in the preparation of the printed materials that form an essential ingredient of education for remote students. Data were collected through questionnaires, daily student records, home supervisor comments, teachers' lesson evaluations, and interviews with professional staff. Results are analyzed under two broad headings: reactions to the systems, including the nature of the learning environment and how the system might be improved; and classroom interaction analyses, including the direction of interaction and the type of interaction (e.g., social, procedural, narrative/expository, explanatory, and cognitive). Contains 17 references. (MES)

Interaction Patterns in the Extended Classroom Via Satellite Technology in the Australian Outback

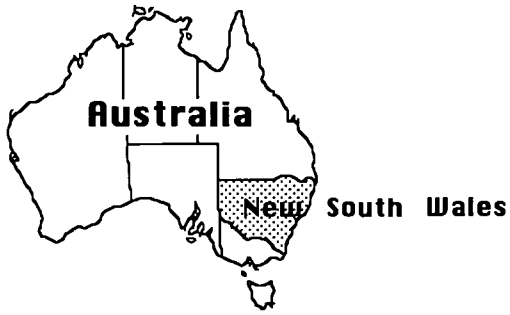
By Andrew R. Wallace & Colin R. Boylan

Interaction patterns in the extended classroom via satellite technology in the Australian outback.

Andrew R. Wallace & Colin R. Boylan
Charles Sturt University - Wagga Wagga, Australia

Introduction

For children living on large remote grazing properties in the Australian desert, access to classroom based education is limited. This paper reports on research with one group of such students, who live on isolated grazing homesteads in an area that extended for a 200 mile radius around Broken Hill, in western New South Wales. For these elementary students (Grades 3 and 4), learning is managed remotely by a distance education teacher in partnership with home supervisors, who might be a parent or a governess.



This paper examines an alternative mode of delivery, involving the application of satellite based systems to provide a teaching-learning environment for these students.

A trial of a satellite system made it possible to evaluate not only the appropriateness of the technology, but also the potential for teaching and learning implied by such systems (Boylan & Wallace, 1999). This evaluation involved a number of key participants, including students, teachers, home supervisors, administrators and those engaged in the preparation of the printed materials which form an essential ingredient of education for remote students.

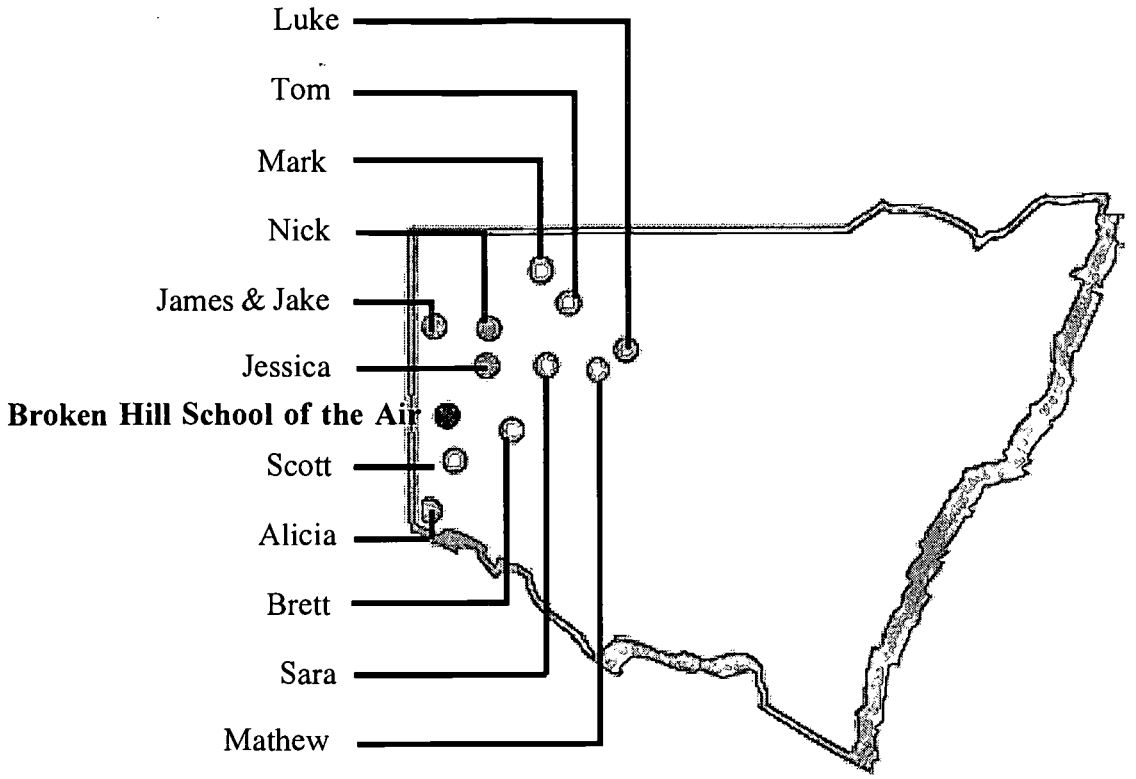
Distance Education policy in New South Wales

The provision of education to isolated and remote students is the responsibility of the New South Wales Department of Education and Training, which aims to provide equitable access to education for all students (Aquilina, 1998). Such an aim has significant implications for the provision of educational services to remote and isolated students.

The role of technology is an essential ingredient in the provision of equitable access to educational opportunities for rural and isolated students. Willis (1993) observed that in many distance education settings, the use of a technology based delivery system is typically the conduit through which information and communication flows. This use of technology by the Department of Education and Training's distance education unit has a history going back to the mid 1950s when the high frequency (HF) radio technology was first used through the *Broken Hill School of the Air*.

The typical pattern of instruction is based on printed correspondence materials and audio tapes. Usually, these materials are supplemented with two contact sessions per week by which their teacher delivers lessons to cohorts of students using HF radio. These lessons allow the students to talk with each other and with the teacher. However there are ongoing problems with regard to the reliability of the medium, and also the lack of any visual content. The quality of radio transmission has been adversely affected by a range of factors including climatic conditions, solar activity, wildlife activity, time of day, and the vagaries of the electrical power supply. As a result, the system is unreliable and expensive to maintain, and an active search for an alternate delivery system commenced in 1997. At the same time the current telephone systems (land based and radio/microwave) provide restricted access to facilities which are fast becoming accepted as the norm in the wider community, including access for all students to the Internet and the World Wide Web. There appear to be no cost effective means to improve the telephone system to these remote properties, where current systems operate at low transmission speeds. Through an extensive analysis of the delivery options to the New South Wales Department of Education and Training, it was decided to trial the use of a satellite based delivery system to support teaching and learning for one group of the most geographically isolated elementary school students in the state, as shown in Figure 1 below.

Figure 1: Students engaged in the *NSW Outback Satellite Education Trial*



The development of satellite systems to deliver educational experiences for remote students would appear to have a number of advantages. These include:

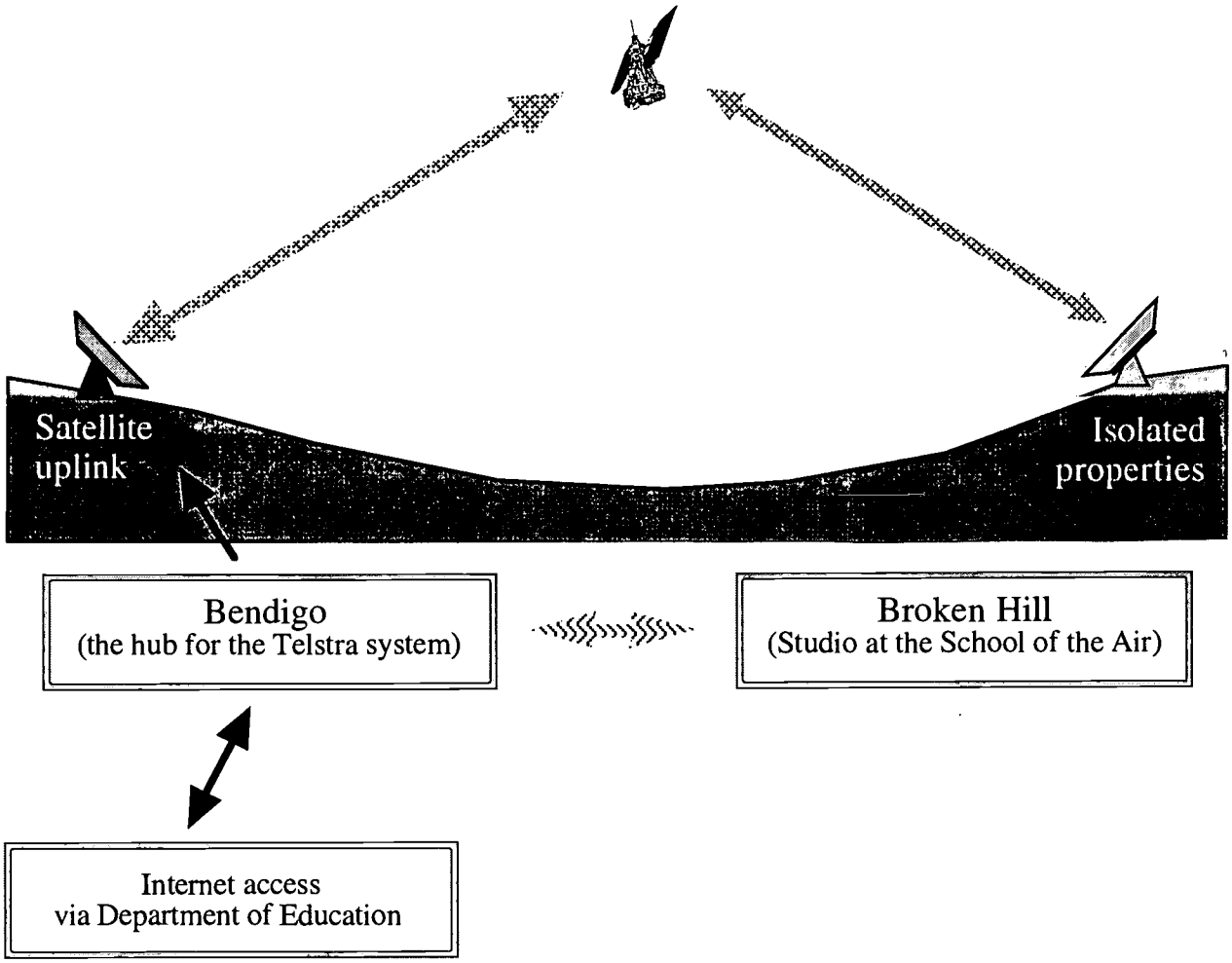
- there is no reliance upon existing inadequate telephone communications systems;
- the system offers high quality audio, video and data communications to each student site, irrespective of location or physical circumstance;
- the audio quality problems experienced with the current radio systems are overcome, while quality video and data communications are added; and,
- the costs of satellite communication are likely to fall as usage levels escalate in the next decade.

The satellite technology was essentially a computer mediated conferencing system in which one-way video, two-way voice and two-way data communications were possible between the teacher and the students. The system thus allowed students to do the following:

1. hear the teacher, and also talk to the teacher via a satellite telephone system;
2. receive high quality video signals from the *Broken Hill School of the Air*, including visuals of the teacher and other video resources (pre-recorded tape as well as other inputs using video and specialist document cameras located in the studio);
3. utilise HTML resources, including in-house pages as well as the Internet, which were available to these students for the first time; and,
4. communicate to the teacher using short text answers, email, and on-screen facilities to allow interaction with the teacher as the lesson proceeds.

The system under which the *Satellite Trial* at Broken Hill took place is illustrated by Figure 2. The studio was set up at Broken Hill and broadcast lessons to the students via the *Telstra* facility at Bendigo in northern Victoria. The signal from Bendigo was then transmitted via the satellite to each of the participating properties as well as the window sites (used by the professional staff and evaluators to observe the lessons)

Figure 2: Simplified schema of the system used for the *Satellite Trial*



At the heart of the system is a simple broadcast studio, including video equipment and a management and control system. From the studio the signal is immediately digitised, compressed and transmitted directly by a transmitter to the satellite, and from there to a satellite dish receiver at the student's home. The home dish is connected by cable and associated hardware directly to a personal computer, which uses specially developed software to present all of the information on screen. Both the visual information (video) produced at the studio and the study materials (in HTML) are presented directly on the computer screen. The students use standard off-the-shelf computer peripherals, including a keyboard, mouse, and telephone to participate in interactive class sessions.

The use of HTML is a significant advancement. The use of a satellite for distribution enables the use of multicast technology over the Internet. Multicasting enables an Internet server in the studio to transmit the study materials simultaneously to any number of remote locations. Importantly, materials stored in HTML are available asynchronously, so that students can revisit lesson materials both before and after the lesson. Access to the World Wide Web during and after the lesson through the satellite also makes available resources which are taken for granted in urban schools, but which will not be available to these students for some years to come.

In short, satellite technology is arguably the best available means for delivering the three different means of communicating and conveying information (video, audio, and data) to remote properties. Visual information of this quality requires either fibre-optic cables or satellite, and clearly the former is not an option for these students. The system will however run over any IP (Internet Protocol) network which supports IP multicast.

The technology mediated learning environment

The satellite system used for the trial was developed in Israel by *Gilat* (Ziv-Tal, 1998). The system was developed in conjunction with the Open University in Israel and was based around proprietary hardware and software, which was used to create and broadcast lessons using satellite systems. It has been developed using the proprietary name *LearnNet*, and has been operationalised in Australia by *Telstra* as *SkyConnect Tutor.*

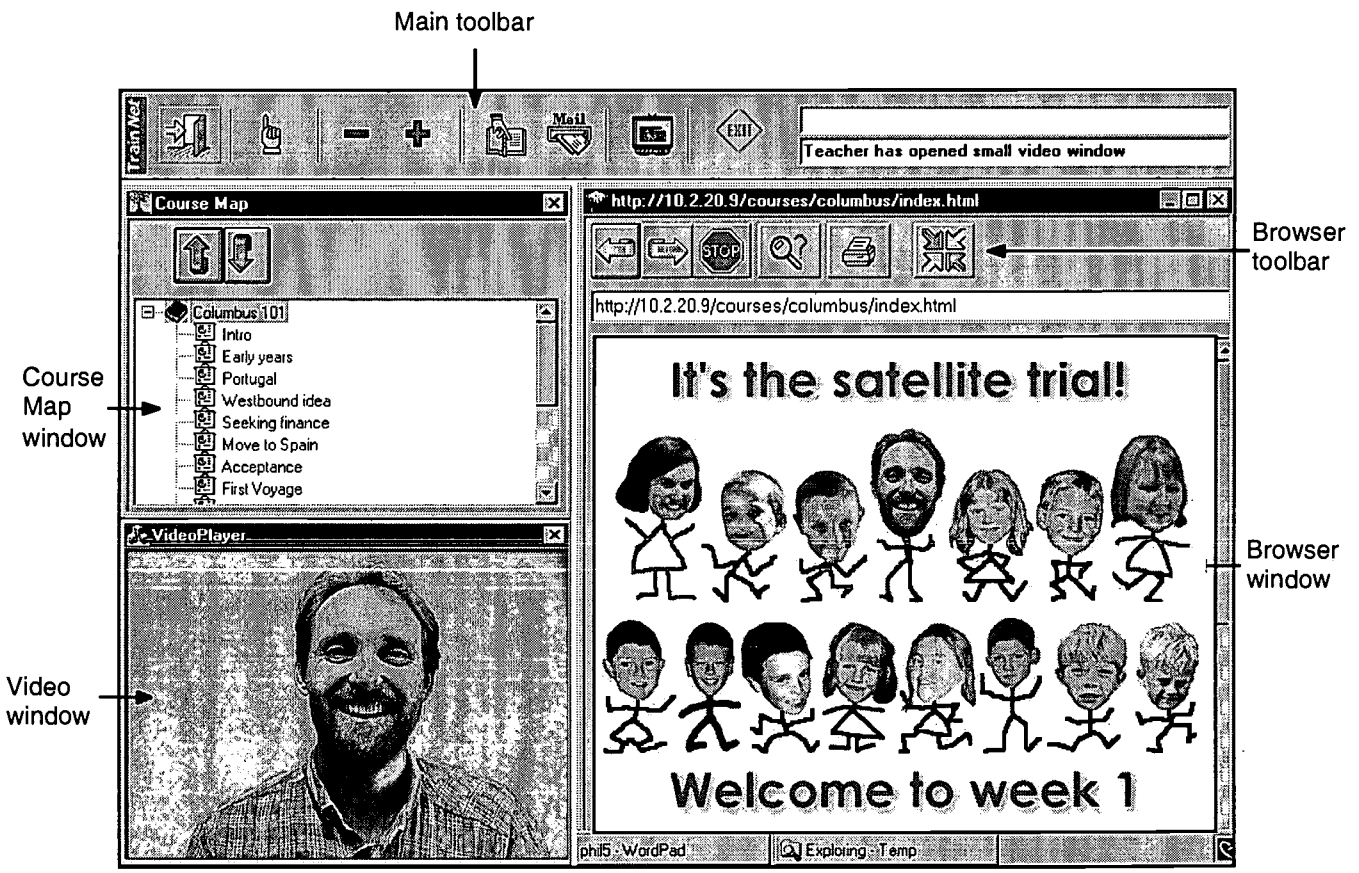
The student screen is illustrated in Figure 3, and basically consists of three parts, these being:

1. The main tool bar, which provided access to the main feature of the system (e.g. to email, the video screen, and to other means of communication with the teacher);

2. The video window, which could be varied in size by the student or teacher; displaying pre-recorded video, or images from cameras in the studio (i.e. of the teacher, or of other materials which could be presented on the document camera), and,

3. The HTML components, which included the Course Map (which allowed the students to gain access to materials developed within the satellite lessons), and the Browser window (which provided access to the World Wide Web).

Figure 3: The student screen



The research literature

The literature on the use of learning with technology has grown exponentially in recent years, though the major area of concern involves the use of computers in traditional classrooms. The impact of technology upon distance education has also grown through the past decade. Barker (1991) succinctly analysed the educational advantages and disadvantages of a range of telecommunicated distance education technologies, including satellite based delivery systems for teaching and learning. He identified a comprehensive set of advantages and disadvantages for such systems, which are listed below.

Advantages

i) Students can see their teacher.

ii) Real time video images are presented.

iii) Student - teacher interactions are possible.

iv) The satellite signal can cover a large geographical area.

Disadvantages

i) The teacher cannot see the students.

ii) Little student - student interaction.

iii) Audio 'echo' can be a problem when students talk.

iv) Often programs are centrally controlled with little local input.

v) Some receival satellite dishes are weather sensitive, while Ku band reception may be affected intermittently by 'sun outages'.

vi) Large class sizes are not normally possible.

vii) The cost of establishment, and on going annual fees are high (Barker, 1991, pp. 5-6).

The *Satellite Trial* in New South Wales is not the first in the use of satellite based technologies within Australia. An interactive satellite television trial (OLTC, 1994) was conducted by the Victorian Ministry of School Education during 1992 and 1993. This program used a one way video, with a phone / fax return to the television studio, to deliver lessons around the state. This particular trial sought to provide better access to professional development for teachers, and to explore the strengths and weaknesses of the technology. In the resultant report, OLTC (1994) claimed that the educational benefits of the interactive satellite television system for teacher professional development were:

i) no costly and time wasting travel;

ii) no filtering of information by numerous consultants and colleagues;

iii) quality of access to inservice programs;

iv) better use of scarce resources; and,

v) maximised participation by cutting out quotas and lessening the time release necessary for teachers to attend programs (OLTC, 1994, p.2).

Oliver and Grant (1995) examined the use of interactive broadcast television in distance learning courses delivered through the Western Australian Golden West Network. They discussed the nature of real-time interactions that occurred between the presenter and the viewers. They concluded that the inclusion of an interactive element in the teaching program created the opportunity for the significant enhancement of the learning environment, depending upon the nature of the interaction sought by the presenter. When

specific questions were asked, then a high level of interaction occurred within the class, while a low level of interaction occurred when more general questions were asked by the presenter.

Yet the use of the technology is problematic. Oliver and McLoughlin (1997a, p. 11) observed that interactivity has 'become both the identifying feature, and the holy grail of emerging trends in the design and provision of distance education and open learning programs.' These authors note that in the distance education setting, interactivity is often defined 'as any learning material or learning environment that provides the learner with more than a passive learning environment' (p.11). In their research on interactivity in live interactive television, the authors found that the most common form of communication was expository in nature and the form of interaction was influenced by the nature of the content in a course. The authors concluded that despite the limitations inherent in live interactive television, 'interactions that focus on instructional applications can serve a very useful purpose' (p. 22).

Studies by Oliver and Grant (1995), and Oliver and McLoughlin (1997a, 1997b) looked at levels of interaction in a variety of class settings and modes of delivery where the technology clearly impacts upon the nature of the interaction. It was not surprising that these studies reported lower overall levels of interaction and that the majority of these interactions were teacher initiated. Clearly the limitations inherent in the technology are central to the adoption of teacher centred pedagogies.

Classroom interaction within this environment is limited by the technology and the enormous distances between students and teachers. The technology thus mediates communication, provides the infrastructure for this virtual classroom, but makes analysis based on normal classroom interaction problematic. Thus the theoretical frameworks for interaction analyses that have been developed for computer mediated conferencing (CMC) were identified as the most appropriate for the present study, based upon the early work of Moore (1989), who suggested that interactions within CMC might be analysed through three modes of interaction, these being learner - teacher; learner - content; and finally learner - learner. This framework was applied by Henri and Parer (1993) and by Oliver and McLoughlin (1997b), who demonstrated that their framework was appropriate for analysis within the environment created by similar technologies, especially audiographics and interactive live television. The work of Oliver and McLoughlin (1997b) extended the theoretical framework developed by Moore (1989), and Henri and Parer (1993) in ways that made it applicable to educational settings involving elementary aged children. This framework of analysis was adopted for use in the present study.

The importance of providing for classroom interactions in distance education settings has been identified as a major pedagogical concern (McHenry and Bozik, 1995). It was recommended by Kruh and Murphy (1990) that 'it is essential that the distant educator purposefully designs this essential ingredient into the instructional program' (p.6). Yet, McHenry and Bozik (1995, p. 362) stated that 'it remains to be seen whether the results of research from traditional classroom research hold true for the distance classroom.'. In their research on interactive, live television lessons delivered to four remote sites with high school students, McHenry and Bozik (1995) found that all interactions were teacher initiated and no interactions between students across the different sites occurred. However, such observations vary with the subject area involved, as found by Oliver and McLoughlin (1997b) who looked at patterns of interaction with a Year 6/7 Japanese language class using audiographic technologies, and found that the teacher initiated only 80.8% of the interactions, while the remainder were student initiated.

In the literature on classroom interaction research using face to face elementary classrooms, Susskind (1969) reported that, on average, 86 interactions occurred in a one hour lesson, of which 84 (97.67%) were initiated by the teacher, leaving 2 (2.33%) which were student initiated. Finally, Dillon (1988) provided further confirmatory observations, when he stated that 'no one is known to have gone into a sample of classrooms and to have found a lot of student [initiated] questions' (p. 105).

In a synthesis of the research on teacher initiated interactions, Gall (1984, 40) noted that most analyses of classroom interactions focused on teacher generated questions, many using a simple two tier classification system including 'factual questions and higher cognitive questions'. Gall extended this system of analysis to include a third category involving procedural questions, and reported that 'about 60 percent of teachers' questions require students to recall facts; 20 percent require students to think; and 20 percent are procedural' (p.42).

Methods of inquiry

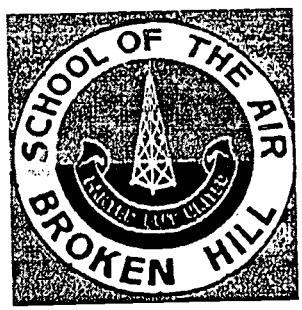
A number of instruments were used to collect data on the nature of the teaching and learning taking place, and of the interactions which were taking place within the virtual classroom. The instruments included Likert type scales and open-ended questions to provided a mix of qualitative and quantitative data, involving the students and the other partners engaged in the program. The principal instruments were:

1. Questionnaires, administered to all participants at the beginning and end of the program;
2. Daily records kept by all students to record the ways in which the technology was used, and reactions to the lessons;
3. Home supervisor comments on the nature of the engagements engendered between the students, teachers and the lesson content. These involved daily comments, together with weekly summaries of the teaching and learning which was taking place at each remote site;
4. Lesson evaluations conducted by independent groups of distance education teachers at the remote "window" sites, who then prepared summary reports on the lessons for the weekly professional development sessions; and,
5. Interviews were conducted with the professional staff engaged in the program (curriculum support officers, teachers, technical support staff, and administrators) as well as with the students and home supervisors. Group discussions were also used to provide a means by which the data collected could be extended and verified within each of these groups.

However, the analysis of the data was carried out with the following constraints in mind:

- The sample was small, consisting of only 12 students, and 11 families;
- Data were only collected over a five week period, which is too short a period to generate adequate data on the extent to which educational outcomes were achieved; and,
- The professional staff involved in the *Trial* were also small in number (n=30), and developed their expertise with the technology as the *Trial* proceeded.

Both the size of the group and the short time frame constrain the extent to which generalisations can be made about the findings presented. The study did however point to the issues which should be considered in the development of policy concerned with addressing educational opportunities for remote and isolated students across the state, and to the nature of the classroom interaction promoted by this computer mediated learning environment. This analysis thus involved the use of descriptive statistics, together with qualitative techniques based around grounded theory principles. These are further explained in the results section of the paper.



Results

This section considers the results of the analysis of the satellite lessons under two broad headings, dealing initially with the teaching/learning environment created by the system, and then the nature of the interactions which were observed during the *Trial*.

1. Reactions to the system

The analysis began by establishing broad parameters, by examining participant responses to two broad questions that were posed to the professional staff and home supervisors about the essential features of a good distance education. The responses to each question were remarkably similar for the groups.

The first of the broad questions asked respondents *What are the essential features of good distance education?* The largest number (29 responses or 42.7% of the sample) spoke about the learning process, using phrases such as *being able to get teaching concepts across in a better more positive manner; accessing high quality and appropriate learning materials; creating a fun learning environment, and being engaged in hands on learning*; and using *explicitly communicated outcomes.* The next largest group (22 responses or 32.4% of the sample) identified good interaction as an essential feature. This group of comments included responses such as *good distance education requires a high and constant level of communication;* or it requires *rapport and interaction between the three parties involved;* or *good contact with class teacher - verbal and visual.* It would appear that there was indeed a sense that the technology provided an environment which supported teaching and learning, and effective classroom interaction.

The second general question extended these issues further as it asked *What are the essential features of a successful satellite lesson?* A majority of the respondents returned to the learning process as the most important feature (59 responses or 57.1% of the sample). Their responses included: *There needs to be regular and varied methods employed to cater for different learning styles;* and there need to be *opportunities for independent learning and discovery after the lesson.* Further, the students need to have *learnt something, or enjoyed the lesson.* This might be achieved through *good visual stimulus or examples of expected work.* The next group (25 responses - 25.5% of the sample) were concerned with the need for good interaction in a lesson. Examples of written comments here included: *there needs to be opportunities for interactivity between students, between teacher and students; all children being involved in lessons;* and *the child needs to have some input through talking, the Hands-Up button or the Yes / No.* It is thus significant that the quality of the interaction taking place was of prime concern, and that students be engaged in quality interactions with each other, and with the teacher through the learning materials presented.

Home supervisors and the professional staff were asked at the conclusion of the *Trial* if the form of delivery promoted a positive learning environment. The results of Likert scale items for these participants are presented in the pie graph below. A total of 95% of the respondents believed that a positive student-teacher learning environment was promoted by the use of the system.

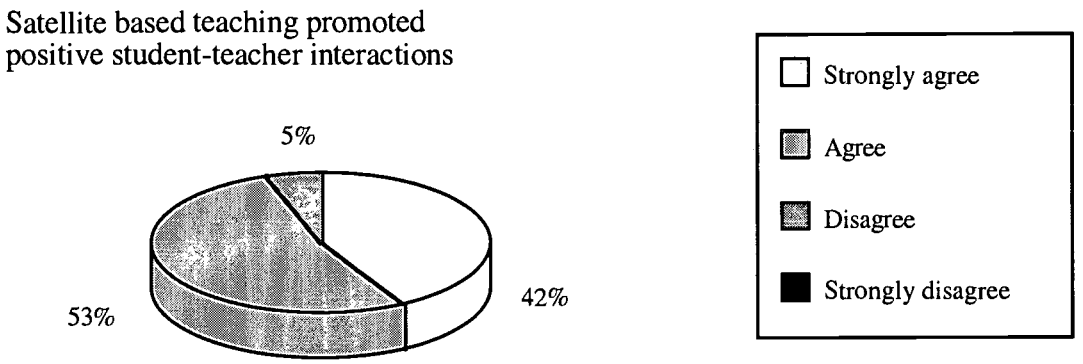


Figure 4: Positive student-teacher interactions

The nature of the learning environment was investigated as part of the final questionnaire. Respondents were asked to reflect upon the extent to which *the satellite technology created a learning environment that was more open and comfortable than was previously possible.* Responses were divided on the issue, as a number of respondents felt that the radio lessons were also successful in promoting such a learning environment. The variation in responses is illustrated by the pie graph below.

While the majority of respondents did find the learning environment which was made possible was open and comfortable, a significant minority were not convinced that the technology was better than that which was available through radio technologies.

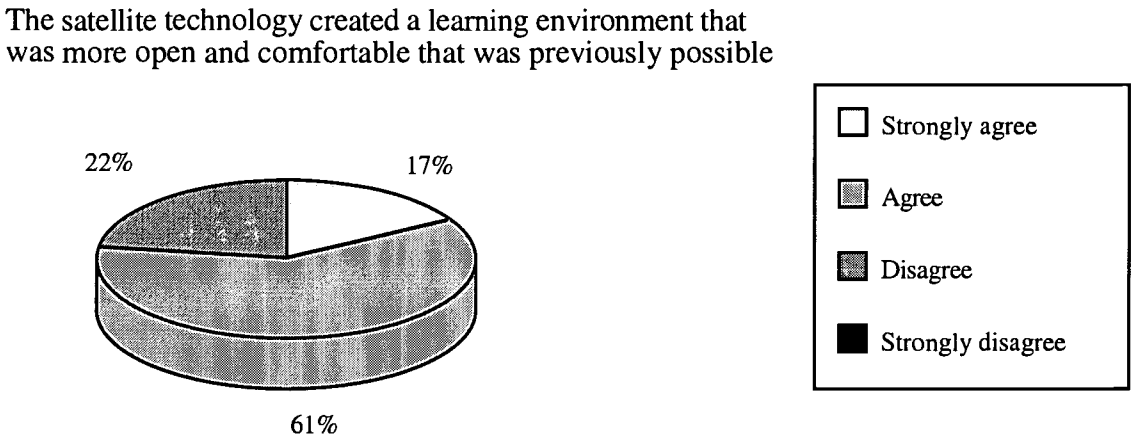


Figure 5: The satellite learning environment

The nature of the learning environment

The nature of the learning environment was further explored in greater depth. During the latter part of the trial a detailed analysis of the use of the teaching and learning tools found within the software system was conducted on each lessons. The teaching and learning tools monitored were:

i) the telephone system;

ii) the HTML screens;

iii) the Document Camera;

iv) the *Hands-Up* communication button;

v) the *Plus / Minus* communication button; and,

vi) the multiple choice facility.

The results are reported in Table 1. The analyses present the average usage frequency for each teaching and learning tool, and the range of usage within the lessons taught during this period, and the following usage patterns were observed:

i) over half of the students participated in individual teacher dialogue via the satellite telephone during each of the lesson (7 students from 11 homesteads);

ii) about 8 *different* HTML screens were used per lesson;

iii) the Document Camera was used regularly during each lesson (5 times per lesson); and,

iv) the *Hands-Up* and *Plus/Minus* buttons were used frequently.

Table 1: *SkyConnect™ Tutor* interaction tools

Specific learning tools	Average (per Lesson)	Range per Lesson Low	High
Student telephone contact	7	4	19
Length of telephone contact	1 min. 44 sec.	5 sec.	4 min. 45 sec.
Different HTML screens used	7.4	4	14
Use of Document Camera	5.1	3	9
The *Hands-Up* button			
• Teacher initiated	7.9	4.0	13.0
• Student initiated	0.8	0.2	1.6
• Responses per student	6.6	2.2	8.9
The *Plus / Minus* button	3.8	1	12
The Multiple Choice function	0.9	0	5

Clarificatory comments related to the teaching and learning tools contained within the *Gilat* system include:

- The pattern of usage for *HTML screens* in lessons typically involved the inclusion of:

  i) HTML pages prepared specifically for the lesson, normally by specialist curriculum support personnel in Sydney;

  ii) Internet web sites that had been down-loaded onto the student screen during the lesson; and,

  iii) student work from emails and *Hands-up* typed responses, which were captured and displayed by the teacher on the screen as HTML pages.

- The use of the Document Camera varied considerably within and between lessons, being used for story analyses and comprehension, as well as for the display of 3D objects and student work.

- The *Hands-Up* tool was used by the teacher for three main purposes, these being:

  i) requesting student comments and suggestions on lesson content;

  ii) engaging students in developing understandings of the lesson content; and,

  iii) assessing student understanding of lesson content.

This is exemplified in the following comments taken from the *Lizard Log* lessons:

Tell me the meaning of diurnal. Press Hands-Up and answer a question now.

What can you tell me about what the Contents page tells us? Press Hands-Up and type in your response.

- The *Plus / Minus* button, by contrast, was used for basic class management and monitoring purposes. The following lesson extracts characterise the use of the *Plus / Minus* button:

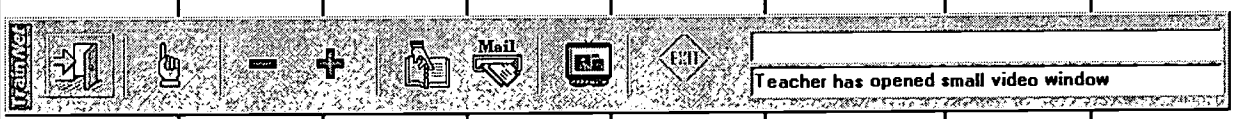
  If you're still working on your answer and need more time, press PLUS please.

  A Narrative is factual or non-fiction. Is that true or false. Is it PLUS or MINUS?

Patterns of usage changed over time. Table 2 below provides a summary of patterns of usage as reported in the *Daily Diaries*. These indicate usage patterns and problems based on daily reported data.

Table 2: *Daily Diary* data on the uses of the system in the lessons (presented as a percentage of total responses for each week)

	I used the *Plus/Minus button*	I used the *Hands-Up* button	I used email today	I spoke to the teacher today	I had no problems hearing other students	I liked the lesson today	I found the system easy to use today
Week 2	100.0	100.0	24.0	40.0	80.0	100.0	98.0
Week 3	97.7	100.0	41.9	51.2	88.4	95.3	97.7
Week 4	96.4	100.0	20.0	56.4	98.2	100.0	100.0
Week 5	82.5	100.0	40.4	57.9	100.0	100.0	98.2
Week 6	80.4	100.0	21.6	62.7	98.0	98.0	96.1
Week 2 - 6	91.0	100.0	29.3	53.9	93.4	98.8	98.0



The following trends were evident from an examination of Table 2.

- The *Hands-Up* button was used by all students in every lesson as the major means to communicate with the teacher;
- Usage of the *Plus/Minus* button declined throughout the period of the *Trial*. These buttons were largely used for procedural matters as indicated by the clarificatory comments above, and declined as the *Trial* proceeded, and as the lessons became more student centred;
- Email usage tended to vary over the passage of the *Trial*. The evaluators are however a little sceptical of data on email, as it is possible that there is some confusion concerning the use of the typed response option included within the *Hands-Up* button, and the separate email facility provided within the lesson environment (see Figure 3);
- A significant finding was that the number of students who spoke over the telephone system to the teacher rose as the weeks passed. This has probably occurred as the teacher became more aware of strategies which might be used to enhance student participation in the lesson. Thus the opportunities for students to speak rose from an average of twice per week per student at the beginning to three times per week per student at the completion of the *Trial*; and,
- After the initial week, students became comfortable with the use of the system, and satisfaction levels remained high.

From the student perspective, as indicated in the final questionnaire, the four most frequently identified features of the system that they enjoyed were:

i) the visual aspects of the system by being alike to watch their teacher on the video screen;

ii) the opportunity to talk to their teacher during a lesson via the telephone;

iii) the chance to see the work submitted by the other members of the class (eg. typed answers, drawings and home made video); and,

iv) access to the Internet .

How might the system be improved?

The final questionnaire administered to the professional staff participating in the *Satellite Trial* sought their recommendations on additional features which might be included within the system to enhance teaching and learning for elementary students, placing them in priority order using a three point scale (Essential, Important and Useful). Their responses are reported in Table 3 below.

Table 3: Additional teaching and learning features required in *SkyConnect™ Tutor*

Feature	Frequency (N)	*Essential*	*Important*	*Useful*
• Audio conferencing	12	9	3	0
• Electronic white board	10	5	4	1
• Email facility	4	2	2	0
• Two way visuals	3	0	0	3
• Better quality document camera	2	1	1	0
• Mobility for video camera	2	0	1	1
• Instant dial up	2	1	1	0

From this table, the two most frequently mentioned additional system requirements, which were also given the highest priority order of 'Essential', were the need for an audio conferencing facility to permit the teacher to talk to multiple students simultaneously as well as allowing students to talk directly to each other during a lesson, and the inclusion of an electronic whiteboard so that the teacher and students can engage in a range of typed text and graphical interactions during a lesson. These comments were supported by other distance education teachers interviewed at the Window sites.

2. Classroom interaction analyses

For a three-week period during the *Satellite Trial*, the researchers analysed the interactions that occurred during daily lessons (30 minutes to 60 minutes in duration, with an average of 45 minutes).

The analysis involved data taken from observations made at the researcher's window site, from video tapes of the lessons, from direct lesson observations made at the studio in Broken Hill, and finally from direct lesson observations made during visits to homesteads.

Drawing on Henri and Parer (1993) expansion of Moore's (1989) ideas, a theoretical framework was further refined by Oliver and McLoughlin (1997b) that was specifically designed for application in Computer Mediated Conferencing (CMC) environments. This framework was employed in this study. This interaction framework consisted of two dimensions, these being:

a) the direction of interaction; and,

b) the type of interaction that occurred during a lesson.

a) The direction of interaction

This dimension focused on the originator and recipient of the interaction. This was done to explore the extent to which the lessons were teacher or student centred. This focus reflected the observations in the literature that student centred activities have proved difficult when using computer mediated facilities (eg. Barker, 1991), even though *Gilat* contends that the system is constructivist, and thus by implication, student centred. Table 4 reports both on the overall direction of interactions during the lessons for the originator and recipient of each interaction.

Table 4: Direction of lesson interactions

Direction of interaction	Total number of interactions	Percentage of total interactions	Average interactions in each lesson
Total Teacher initiated	**1459**	**92.3**	**112.3**
Teacher -> class	785	49.7	60.5
-> student	674	42.6	51.8
Total Student initiated	**122**	**7.7**	**9.3**
Student -> teacher	98	6.2	7.5
-> student	6	0.4	0.5
-> class	17	1.1	1.3
Total	**1581**	**100**	**121.6**

From Table 4, the following generalisations can be made:

Overall direction of interactions:

i) there was considerable interaction occurring within each lesson;

ii) most of the interactions that occur were initiated by the teacher (92.3%); and,

iii) few student initiated interactions were recorded (7.7%).

Recipients of the lesson interactions:

i) approximately half of all lesson interactions involved the teacher initiating whole class interactions (49.7%);

ii) about 2 in 5 of the teacher initiated interactions were directed to individual students (42.6%); and,

iii) only 7.7% of the interactions originated from the students. Most of these concerned student interaction with the teacher (6.2%) rather than with the class (1.1%) or an individual class member (0.4%).

It would thus seem that the majority of the interactions documented in these lessons were teacher centred. These interactions were not just a reflection of the nature of the communication possible with the technology, but also of the impression held by the teacher that he should direct and be in control of the lessons, due mainly to his perceptions of the expectations of the large external audience viewing these classes from the Window sites across the state.

Comparisons with interaction research based on face to face elementary classrooms were favourable. As indicated in the review of the literature, Susskind (1969) reported that 97.67 percent of face to face elementary classroom interactions were teacher initiated (compared to 92.3%) while only 2.33 percent were student initiated (compared with 7.7%).

b) The type of interaction

The second dimension used for lesson analyses on the nature of interactions within the virtual classroom concerned with the intellectual context of these interactions. This dimension focused the substantive content of the dialogue that occurred between the teacher and the student(s). There were five categories of lesson interactions used to examine the quality of the interactions occurring (Oliver & McLoughlin, 1997b). These categories were:

i) social interactions;

ii) procedural interactions;

iii) narrative or expository interactions;

iv) explanatory interactions; and,

v) cognitive interactions.

Each of these headings is briefly explored below, to establish the nature of these elements of interactions.

i) Social interactions

This category examined teacher - student talk that served to establish and develop rapport within the class. Examples of responses that conform to this category included; *Good morning everyone, you might like to send me a hello to let me know you're here. Hello [student name], how are you today? That was excellent reading[student name].*

ii) Procedural interactions

Teacher - student dialogue involving information exchange on lesson requirements and procedural instructions. In particular, operational procedures concerning communication facilities of the system were included in this category. Examples of dialogue classified as procedural interactions included: *The boys in the class are to choose the top paragraph and the girls in the class are to take the bottom paragraph. Scroll down to Verse 1 of the Goanna song. Press Plus if you're reading the chapter now. Use Hands-Up to tell me some describing words for the shell.*

iii) Narrative and expository interactions

This category dealt with two aspects of interaction, first, the general 'teacher talk' associated with introducing new concepts, skills or ideas into the discussion, and second, the student or, in a few cases, the teacher, demonstrating knowledge or skill in response to direct request, normally from the teacher. Examples of interactions classified as narrative / expository interactions included: *You have to decide yourself ... about which words you think we can leave out to make the text a bit easier, simpler - that's what we're trying to do. Tell me one thing about the Goanna from the story. We are going to look for some describing words or adjectives to describe the Blue Tongue Lizard. Who can tell me what kind of an animal a turtle is?*

iv) Explanatory interactions

This category focused on the teacher seeking student responses to explain knowledge and develop content during a lesson. Examples of explanatory interactions derived from the teaching unit included: *Would you end the story there or would you have another complication and resolution to the story? Those little beads of water on the grass are called 'DEW'. What is the difference between a reptile and an amphibian? Why don't we copy information from an information source word for word, [Student name]? Can you explain a bit more what 'put it in your own words' means, [Student name]?*

v) Cognitive interactions

This category dealt with interactions in which the teacher provided constructive feedback to a student's response causing the student and the class to reflect and to consider an alternate perspective/reality. Examples of cognitive interactions included. *Why would a Lace Monitor lay its eggs in a termite's nest? Why do you think it matters to have wild animals living on earth? Do you think the baby crocodile is related to the big crocodile?*

The lessons were analysed using the five categories discussed as a framework The results of the lesson analyses are reported in Table 5.

Table 5: The types of lesson interactions

Direction of interaction	Total number of interactions	Percentage of total interactions	Average interactions in each lesson
Social	296	18.7	22. 8
Procedural	513	32.5	39.5
Narrative / Expository	617	39.0	47.5
Explanatory	132	8.3	10.2
Cognitive	23	1.5	1.8
Total	**1581**	**100.0**	-

From Table 5, the following conclusions about the type of lesson interactions can be made:

i) narrative and expository interactions were the single largest type of interaction (39.0%);

ii) approximately one-third of all interactions were procedural interactions, dealing with routine class management issues (eg. the use of appropriate data communication buttons within the system), and organisational matters (eg. the assignment of lesson follow up work) (32.5%); and,

iii) about one in six lesson interactions were social interactions (eg. greetings at the beginning of the lesson, or a farewell at the end of a lesson) (18.7%).

It thus appears that the lessons were very teacher centred, with narrative and expository dominating over cognitive interactions. These findings would seem to support the evidence provided in the literature (eg. Barker, 1991; McHenry and Bozik, 1995; Education Department of Western Australia, 1998). Further, our findings revealed a low level of student initiated interactions that are generally supported in the literature (eg Dillon, 1988; McHenry & Bozik, 1995; Oliver McLoughlin, 1997b; Susskind, 1969).

Conclusion

The study sought to examine the nature of the interactions which occur in lessons delivered via satellite. The following statements encapsulate the key findings:

1. There was a high level of satisfaction with the system by teachers, students and the home supervisors. This satisfaction reflected the ease of use of the system, higher levels of reliability, and the enriched learning environment that the system created;

2. The technology mediated learning environment was an effective medium for communication, though there remained concerns about the extent to which it promoted student centred learning. A number of changes and improvements in the system's features were thus recommended that would enhance student engagement within the virtual classroom and which would create more opportunities for the teacher and the students to engage in meaningful interactions; and,

3. Satellite lessons, on average, contained more interactions than the reported face to face lessons. Procedural interactions accounted for a larger portion of the satellite lesson interactions than was the case for face to face lessons, while factual interactions (represented by narrative/expository interactions) and higher order thinking interactions (represented by explanatory plus cognitive interactions) were lower in the satellite lessons than in the face to face lessons.

It thus seems that the satellite system, and others like it, provide the opportunity for students to work within a learning environment which fosters and supports interactions between the key participants. The virtual classroom appears to transcend distance and isolation, offering students the kind of educational environment which has never been available in the past. It is a technology that bridges distance to provide educational experiences which are exciting and rewarding for all participants.

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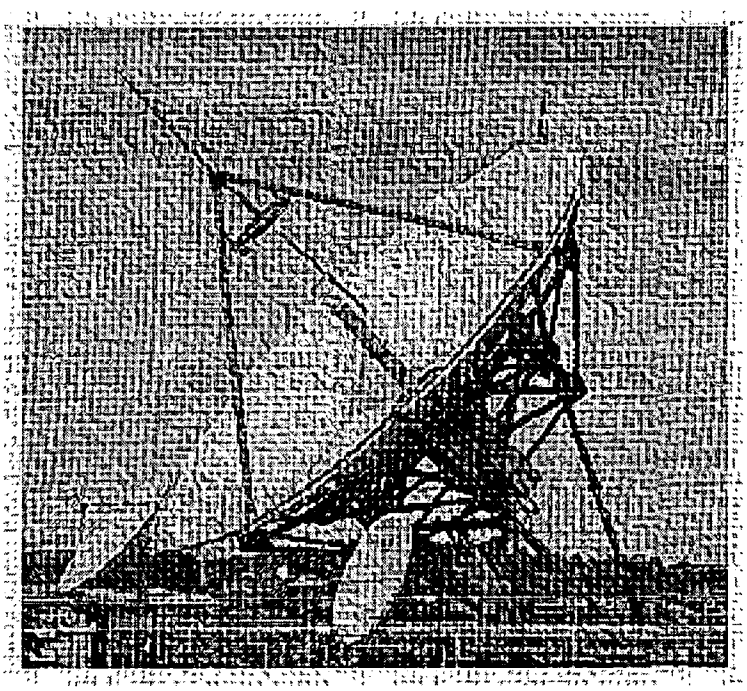

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