Testing Models of Collaboration among High School Science Teachers in an Electronic Environment

A Dissertation
Presented in partial fulfilment of the degree of Doctor of Education
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Declaration

I declare that this dissertation is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary institution.

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Abstract

Teacher collaboration is one of the strategies for encouraging teachers to work together to achieve their common ends. In a complex modern world, teachers rarely have time to collaborate with each other. E-mail and Internet technology encourages teacher collaboration to emerge with personal interaction. E-mail is rapid, permitting responses within the same day or even a few hours. On the network, teachers can seek advice from teachers on other campuses and around the world, and at the same time, they can build their relationship with other users. In Western Australia, an e-mail network for science curriculum leaders was established in both primary and secondary schools. In 1998, a study showed that 93 heads of science departments in government high schools were connected to this e-mail network, and more than two-thirds of them had their computers connected to the World Wide Web.

This study aims to: firstly, test Fishbough’s models of collaboration among high school science teachers in an electronic environment (e-mail and Internet); and secondly, presents a detailed science website analysis in terms of the potential of these websites to foster collaboration. The investigation is divided into two distinct studies: Study One is a survey of the teachers’ perceptions of collaboration via the Internet and Study Two is a detailed science website analysis.

Study One employed both mail questionnaire and face-to-face interview techniques as methods of data collection. The Science Teacher Collaboration via E-mail and Internet Questionnaire was developed and used to collect data on models of collaboration and interaction perspective of collaborative relationships via the Internet of science teachers at the selected schools. The information from quantitative analysis was used to compose the
interview schedule. The follow-up interview was conducted with science teachers who agreed to be interviewed at the sample schools.

Study Two adopted a content analysis technique for analysis of data collected from the two kinds of science websites, specific science websites for science teachers and science websites for general audiences from five chosen continents, Australia, Asia, Europe, America and Africa.

The study found that the Consulting model of collaboration is frequently used by science teachers and science web sites from five chosen continents.
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Chapter 1

Introduction

The Research Problem

Collaboration means working together for a common end. Many teachers are discovering that collaboration can be a powerful strategy for fostering school reform (Bauwens, Hourcade & Friend, 1989; Lewis, 1993; Lieberman, 1992; Lugg & Boyd, 1993), staff development (Barufaldi & Reinhartz, 2001), and student accomplishment (Gage, 1984; Sparks & Loucks-Horsley, 1990). Collaboration allows teachers to share ideas and reflect on their teaching; develop curriculum; share resources, expertise and the burden of responsibility; and get advice about issues of common interest (Pearson, 1999). Teachers collaborate with each other in a variety of ways. They routinely exchange information about student progress, coordinate the development of instructional plans, plan for the generalisation of skills, jointly conduct parent conferences, share decisions with regard to grades, collaboratively problem solve, and participate in cooperative professional development (Voltz, 1993). Teacher collaboration could be a circumstance for teachers’ learning as it is an interactive relationship, an adult-to-adult interactive process. Teachers can learn from such interaction, robustly supported by two different theories: constructivist theory and sociocultural theory (Barufaldi & Reinhartz, 2001).

In a complex modern society, traditional means of teacher collaboration have been questioned. Collaborative practice among teachers needs a change in the way schools do business. A collaborative school is based on norms of collegiality, the professionalisation
of teaching, a wide array of practices, and shared decision-making among all staff (Little, 1987). As the structure of the school has not changed, teachers rarely have time to collaborate with each other. When faced with a question about teaching, teachers often find their colleagues unavailable on short notice or unable to provide them with a possible solution (Little, 1990). Advice from teachers from other schools might be beneficial, but teachers from two schools rarely see and speak with each other. Sadly, the culture of schools does not offer sufficiently responsible support for teachers to work with their colleagues on both teaching and learning. Many teachers have realized that the Internet is a possible powerful tool to support such collaboration as it allows them to be inventors and modern scholars (Gallo & Horton, 1994; Pearson, 1999).

Collaboration is a process in which people work together on a practical or academic effort. Previously, a personal contact letter, or the telephone was used for collaboration. Nowadays, electronic collaboration can connect individuals via the Internet. Many tools are used for such connection, including e-mail and access to sites on the World Wide Web. The Internet allows people to communicate any time, from anywhere to anyplace. Collaborators in different rooms, buildings, countries, states, or continents can exchange information, share ideas, study together, work together, or reflect on their own practice (Pearson, 1999). Hence, the e-mail and Internet technology has the potential to encourage teachers’ collaboration in addition to personal interactions. E-mail is rapid, permitting responses within the same day or even a few hours, and it allows a freedom in writing that handwriting does not. With e-mail and Internet technology, teachers can feel and write as if they are talking directly with each other. E-mail and Internet is an alternative to face-to-face communications for thinking about a subject as it allows for an accurate and permanent record, one that can be reflected on again and again (Gallo & Horton, 1994; Pearson, 1999).
On the network, teachers can seek advice from teachers on other campuses and around the world, and, at the same time, they can build their relationship with other users. The most common purposes for which teachers use the e-mail and Internet include: to gather ideas and teaching materials, to share experiences in an ongoing way, to experiment with telecommunications, to feel less personally isolated, to experiment with project-based learning, to learn more about teaching techniques, and to inform others about their work (Jackson & Bazley, 1997).

In Western Australia, an e-mail network for science curriculum leaders was established for both primary and secondary schools. For government high schools in 1998, 93 science heads of department were connected to the e-mail network by the Education Department. More than two-thirds of them had their computers connected to the World Wide Web, and about fifty percent of these schools had access to an e-mail and Internet (Schibeci, 1998). Further, there are many reports that computer networking is promoting collaboration among science teachers (Lang, 2000). This leads to a number of questions. Will the teachers connect to the Internet? What are teachers’ roles in an electronic environment? What is required for teachers’ effective e-mail interaction? What factors contribute to science teachers’ use or lack of use of their school’s Internet communication technology? What motivates science teachers to continue using their Internet connection? What problems or barriers are there to these science teachers’ collaboration?

Consequently, this project was designed to study collaborative working models, in which high school science teachers who have direct and unrestricted access to the use of e-mail and Internet as tools for collaboration. Further, it is intended for a broad range of users from novices to those highly skilled in developing, continuing and starting their collaboration.
This study particularly investigated collaboration via the Internet among government high school science teachers, which included both heads of science department and other science teachers in Perth, Western Australia because the researcher was a high school biology teacher and used to work collaboratively with other science teachers, especially a biology teacher. We were close colleagues as we sat in the same staff room and taught the same subject. We always helped each other; for example, we shared teaching material, exchanged ideas about the laboratory, completed pre-tests and post-tests together, and took part in science activities for our science club. Consequently, the investigator was extremely interested to explore the benefits, disadvantages and barriers to collaboration among science teachers. Importantly, she really understands characteristics of science teachers and would like to use the findings from this study as a guide for further study and support in the field of science teachers’ collaboration via the Internet for their common end, including: student accomplishment; feeling less personally isolated; and, for professional development purposes (Barufaldi & Reinhartz, 2001; Gage, 1984; Jackson & Bazley, 1997; Sparks & Loucks-Horsley, 1990).

**Purpose of the Study**

Few reports about science teachers use of e-mail and Internet as a tool to support their collaboration were found from literature review. On the other hand, numerous science websites are provided on the Internet for science education. This project attempts to investigate science teachers’ collaboration via the Internet and study science websites on the Internet. Hence, this study is divided into two main purposes. Fishbough (1997) has suggested three models of collaboration: Consulting, Coaching and Teaming. Firstly, this
study aims to test these models of collaboration with science teachers who have access to e-mail and Internet as it is a learner tool, giving access to a massive resource of information and knowledge, communication and can develop collaborative works (Jackson & Bazley, 1997). Also, the first purpose intends to investigate the use of e-mail and Internet for collaboration among science teachers in government high schools in Perth, Western Australia. Secondly, this study seeks to analyse science websites, which are offered on the Internet, for their potential to encourage collaboration by using the suggested models of collaboration as a framework.

**Research Questions**

Several authors have stated that research is needed to provide a better understanding of how computer networks can facilitate users to complete their goals, and also help them to overcome the problems encountered in their endeavour to use the network to achieve their goals (Bishop, Doty, McClure & Rosenbaum, 1991). To complete this study, the A-F research questions below are posed as a guiding framework for the investigation on the first purpose of the study and the G research question is offered to examine the second purpose of this project.

The following seven research questions are proposed as a direction for this study:

A. Which of Fishbough’s models of collaboration are appropriate for analysing science teachers’ collaboration via the Internet?

B. How do science teachers perceive the potential for teachers’ collaboration via the Internet?

C. Do science teachers see a need to collaborate with other teachers via the

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Outline of Method

This study is designed to investigate the use of e-mail and Internet for collaboration among the selected sample of science teachers, and comprises two distinct, but related, studies. Study One is a survey of the teacher’s perceptions of collaboration via the Internet, and Study Two is a detailed science website analysis. The results from Study Two will be used to broaden the findings of Study One, by exploring how science teachers can work in a rich collaborative environment, and how they could use Web resources to support their collaboration.

Study One: Teachers’ Perceptions of Collaboration via the Internet

This study employed the survey approach and content analysis to test Fishbough’s models of collaboration (Fishbough, 1997) and describe the nature of science teacher collaboration using e-mail and Internet. Science teachers at twenty-four government
secondary schools were asked to respond to the ‘Science Teacher Collaboration via E-mail and Internet’ Questionnaire. This questionnaire was used to gather data on the models of collaboration and interaction perspective of collaborative relationships of science teachers at these twenty-four selected government high schools. The questionnaire was developed by using categories of teacher collaboration via e-mail and Internet, which was found in the literature review.

The semi-structured interview technique was used to follow up the study after the quantitative analysis. The interview schedule was guided by the results of the quantitative analysis of each statement from the ‘Science Teacher Collaboration via E-mail and Internet’ Questionnaire.

The teachers’ responses to the questionnaires and teachers’ comments from follow-up interviews were analysed in order to understand the models of science teachers’ collaboration, and the nature of science teacher collaboration using e-mail and Internet.

Study Two: A Detailed Science Website Analysis

Many science websites are offered on the Internet. For example, *the Science Teacher* (2003) reported that the National Science Teachers Association (NSTA) has developed a new program named “Webwatcher Field Institutes”. This program helps science educators to search and evaluate curriculum content, and use online resources in a significant way. Also, this program will research, develop and build online frame-works to hold their WebPages for use by teachers in remote locations. Thus, this project was designed to investigate the potential of these science websites in favour of science teachers’ collaboration; hence, they are designed to help science teachers with collegiality and
sustained training (NRC, 1996). Therefore, science teachers can use those science websites as a place to learn, share ideas and teaching materials, for coaching and teaming and to discuss issues with other educators.

To approach the research question G, that is, Which of Fishbough’s models of collaboration are suitable for analyzing science websites on the Internet? the investigator selected two kinds of science websites: science websites for science teachers and science websites for a general audience. The websites for this study were from five continents, Australia, Asia, Europe, America and Africa. These websites were analysed using Fishbough’s models of collaboration (Fishbough, 1997) and investigated the potential of the science websites for collaboration among science teachers.

Limitations

This project was planned to study the collaboration via the Internet of science teachers in government secondary schools, located south of the Swan River in Perth, Western Australia. Consequently, it will be possible to generalise the findings of this study to only science teachers in government secondary schools in Perth, Western Australia as they have similar characteristics (Ray, 2003). However, it will not be possible to generalise the findings of the study to all science teachers in Western Australia as science teachers in non-government schools or other institutes have significant differences from the selected sample. As in other survey studies, the reader will decide whether the findings are applicable to his/her setting. The study nevertheless contributes towards the research on collaboration via the Internet.
Significance of the study

The outcomes of the study will provide important information about science teachers’ collaboration via the Internet and how this collaboration helps them to improve their work. Further, these outcomes will also increase the understanding of the cultures of teacher collaboration and may encourage teachers to work together as colleagues in an electronic environment. In addition, the findings of the study will benefit educators and researchers who intend to use collaboration as a significant strategy for their common end.

Overview of the study

This dissertation consists of eight chapters. Chapter One is an overview of the requirement for investigating Fishbough’s models of collaboration among high school science teachers in an electronic environment. This chapter also presents the purposes of the research, research questions, an outline of the method, the limitations of the study and the significance of the study.

Chapters Two and Three present a comprehensive literature review. These chapters examine three main concerns: collaboration; the Internet; and collaboration via the Internet. Chapter Two examines various aspects of collaboration that are used as the foundation of this study. Thus, the definitions, characteristics, collaborative arrangement and process of collaboration are studied. Literature on the principles, prerequisites, requirements, benefits and disadvantages of collaboration and collaborative leadership are also reviewed. Chapter Three investigates the Internet, as it is the vital equipment for collaboration and collaboration via the Internet, which is the focus of this study. Therefore, many details
about the Internet such as definition, the background and history, operation, the Internet software, search engines, advantages and disadvantages of the Internet are reviewed. Literature on collaboration via the Internet is examined for the understanding about the Internet and education, science teachers’ collaboration via the Internet and models of collaboration via the Internet. Also, the requirement, benefits, barriers and supports for collaboration on electronic networks are investigated.

Chapter Four summarises salient features of two different theories: constructivist theory and sociocultural theory, which are perceived as a foundation of collaboration. Further, this chapter poses propositions, which are used to estimate outcomes of the study.

Chapter Five explains the research methodology used in the this study including Survey approach in educational research and methodology; Research questions, used to guide this study; Research design; Study One; Population; Preliminary questionnaire; Follow-up interview; Techniques; Data collection; Data analysis; Study Two; Population; Techniques; Content analysis; Data collection; and Data analysis.

Chapter Six offers the findings of the survey of a sample of teachers from selected schools, which are grouped into two sections. Section 1 describes demography and computers used in the sample schools. Section 2 is the analysis of Fishbough’s models of collaboration in an electronic environment, which is presented below as six research questions given on page five. Also, this chapter discusses the outcomes of the study and those propositions that are presented in Chapter Four.
Chapter Seven describes content analysis, which was adopted as a framework for analysing two kinds of science websites: specific science websites for science teachers and science websites for general audiences. Therefore, this chapter also reveals the findings of a detailed science website analysis and a summary of results testing propositions, which are used to predict the outcomes of this study.

Chapter Eight provides a summary of the dissertation and includes a detailed discussion of the analysis, results and findings presented before in this dissertation. Further, conclusions of the research and suggestions for further research are also provided in this chapter.

The next two chapters present a multidisciplinary literature review. Such a comprehensive review was believed necessary for two reasons. First, a review of general collaboration literature was conducted to understand fully the characteristics of collaboration. Second, the review explored both the Internet and collaboration via the Internet to recognize the rationale for using the Internet for collaboration, the structures that facilitate, inhibit or influence collaboration, and the supports for science teachers’ collaboration via the Internet.
Chapter 2

Review of the Literature

Introduction

Teaching involves life-long learning (NRC, 1996). Consequently, teachers should consider professional development as a continuous process for their knowledge and practices. The NRC (1996) reported that a number of teachers become active members of their professional organizations through activities such as creating contacts with local scientists; attending suitable meeting, workshops and conferences; reading and analysing professional journals and newsletters; acting as mentors for new teachers; collaborating with their colleagues; and, recognising the important relationship of professionalism to high-quality teaching and learning for their students. Also, Stevenson (1987) stated that professional development refers to the continuing development of the individual teacher, usually undertaken voluntarily. Thus the goal of professional development is to help teachers examine their beliefs in relation to their classroom practices, and to consider alternative premises and experiment with different practices. NRC (1996) offers many types of professional-development programs for science teachers such as Lectures and seminars, and Short Workshops. Specifically, the program Using Computers for Teacher Networking is provided for teachers to exchange experiences, share ideas, and request suggestions from experts and educators. The method of the program is intended to promote collaboration among teachers, and teachers and experts to reduce teacher isolation via the
Internet (NRC, 1996). Consequently, this chapter presents a literature review related to collaboration.

What is Collaboration?

The Latin roots: *com* and *laborare* recommend a plain definition of collaboration as “to work together”. Searching for a more comprehensive definition of collaboration leads to diverse possibilities, which all have something to propose depending on those specific goals, and no one view being entirely suitable on its own. As Fishbough (1997) states, “collaboration” is frequently used in professional literature but there has not been an agreement on definitions of “collaboration”. Consequently, many existing discussions about the definition of the word “collaboration” have been found to vary in both dictionaries and among authors.

Several dictionaries have stated the definitions of “collaboration” or “cooperation” in generic terms, in education, in politics and in economic. For instance, the generic term, “collaboration” has the same meaning as “cooperation” and both of them refer to planning, developing and working between or among various parties to reach the common goal or purpose (Koepp, Shafritz, & Soper, 1988). In education, collaboration generally means cooperation between school and community (Koepp, Shafritz & Soper, 1988). In politics and economics, Murray, Bradley, Craigie, and Onions, (1933) state that collaboration refers to a number of persons or communities that join together for reason of economic production or sharing for the benefit of the producers or customers.
In addition, many authors have presented varying definitions of “collaboration” depending on their studies of collaboration. For example, Drotar (2002) who has examined interdisciplinary collaboration among members of the Society for Behavioral and Developmental Pediatrics (SDBP) has noted that interdisciplinary collaboration comprises cooperative work, communication, integration of care, mutual planning, or mutual learning, which occurs across a wide range of activities such as clinical care, research, and teaching. Friend and Cook (1992) have investigated effective adult-adult interactions. They have found that collaboration, especially interpersonal collaboration, is required for such interaction. Thus, they have defined “collaboration” as a style of direct interaction, which voluntary parties use in shared decision-making when they work toward a common goal. As they noted:

> Interpersonal collaboration is a style for direct interaction between at least two coequal parties voluntarily engaged in shared decision-making as they work toward a common goal. (p. 5)

West (1990) has defined educational collaboration as cooperative planning or problem solving process including two or more team members, in which interactions throughout the process are designated by mutual respect, trust, and open communication; deliberation of each topic or problem from agreeable decision-making, pooling of personal materials and ability; and joint possession of the issue or problem being raised (p. 29).

Mostert (1998) believes that the clearest definition of collaboration will support any collaborative behavior that a collaborator chooses to undertake; thus he has described collaboration as follows. Interprofessional collaboration in schools is a style in which two or more professionals, parents and families share information, engage in decision-making and develop effective involvement for an agreed goal. He noted:
Collaboration is a style of professional interaction between and among professionals, parents and families, and where appropriate, students themselves to share information, to engage in collective decision making, and to develop effective interventions for a commonly agreed upon goal that is in the best interest of the students. (p. 16)

Also, he highlighted many significant components in his definition such as a style of professional interaction, sharing information, engaging in collective decision making, developing effective interventions, and commonly agreed upon goals which the best interests of the student. Additionally, the participants in his definition are professionals, parents and students themselves.

Pryzwansky (1977), who is an expert in the human services area, has suggested that collaboration includes joint responsibility and mutual development of interventions. Idol and West (1991) defines collaboration as an interactive relationship, an adult-to-adult interactive process. Cramer (1998) has investigated the effective collaboration between professional colleagues. She proposed the definition for the effective collaboration as professional colleagues or people who use a sequence of goal and the responsibility to improve their working relationships. She noted:

Effective collaboration consists of designing and using a sequence of goal-oriented activities that result in improved working relationships between professional colleagues. The responsibility for collaborating can either be the sole responsibility of one individual or a joint commitment of two or more. (p. 3)

Gray (1989) has developed a robust definition. In her work, collaboration is a process in which parties who perceive different features of a problem can constructively discover their differences and search for a resolution that goes further than their limited visualization of the possibility. Chrislip and Larson (1994) have provided a useful definition: collaboration is an equally beneficial association between two or more parties who work toward common goals by sharing responsibility, authority, and accountability for accomplishing outcomes.
According to Wood and Gray (1991), collaboration arises when a group or party of the same problem area engages in a collaborative process, using shared rules, norms, and structures, to decide on issues related to that problem. Welch and Sheridan (1995) have defined collaboration as a dynamic framework for attempts which endorse interdependence and parity during collaborative exchange of resources between at least two parties who contribute in a decision making activity, which is simulated by cultural and efficient factors to achieve mutual goals.

The definitions of collaboration that have been founded in the literature seem to have the same base, in which collaboration refers to working together in an encouraging and jointly advantageous relationship.

**Where Does Collaboration Take Place?**

Collaboration can occur in many places, for example, Hargreaves (1991) has suggested that collaborative relationships among teachers can occur in several places such as in the classroom, in the staff room, in the principal’s office and in the head of department’s office. Chadbourne (1991) has pointed out that collaboration can take place inside and outside school hours. Creese, Norwich and Daniels (1998) have reported that teachers can collaborate within the classroom and outside of it. Little (1982) has suggested discussions on teaching among teachers are often heard in the staff room, in hallways, in the office, in working-rooms and in unused classrooms. Petersen and Hillkirk (1992) have stated that collaboration can occur in the same company or different company. Further, Altshuler (2003) has found that different organizations such as public schools and child welfare agencies can successfully work together.
Characteristics of Collaboration

The definitions of collaboration give an indication only of the meaning of this word. Hence, many authors have described the characteristics of collaboration. For instance, Friend and Cook (1996) have suggested six principal qualities of collaboration. One, collaboration is voluntary; this means everyone accepts working together. Two, collaboration is based on parity; it means someone who collaborates must understand that all individuals’ contributions are valued equally. Three, collaboration requires a shared goal; thus participants tend to collaborate only when they share a goal. Four, collaboration embraces shared responsibility for decision-making. Five, collaboration includes shared accountability for results; it means collaborators who share decisions must also share accountability for the outcomes of the decisions. Six, shared resources are a foundation of collaboration; thus individuals in a collaborative effort should make an effort to contribute some type of resource. Also, Friend and Cook have described emergent characteristics, which grow from successful collaboration: participants’ value system, and trust and respect each other and have a sense of community.

Orelave and Sobsey (1996) have cited an idea: in working together, participants create a sense of relatedness that helps them to achieve much more than they could on their own. Bauwens and Hourcade (1995) have stated that mutual respect for each participant’s unique skills, perspectives and knowledge are the bottom line of a collaborative relationship. Mattessich and Monsey (1992) have noted that characteristics of collaboration consist of skills, attitudes and opinions of the individuals in a collaborative group, together with the culture and capacity of the organisations that form collaborative groups. Fishbough (1997) has noted that there are several foundations of sufficient collaboration such as common support and an eagerness to share information knowledge, skills, responsibilities and
resources.

Fullan and Hargreaves (1991) have described true collaborative cultures as deep, personal and enduring. They noted:

They are not formally organized or bureaucratic in nature; nor are they mounted just for specific project or events. They are not strings of one-shot deals. Cultures of collaboration are constitutive of, absolutely central to, teachers’ daily work. (p. 226)

Bird and Little (1986) have suggested that the norms of collegiality are trust, support and sharing. Wallace and Louden (1994) have reported that similarities, differences, symmetry, risk sharing, trust, emergence, humility and fair exchange are the characteristics of successful relationships among teachers. Also, Muronaga and Harada (1999) have emphasized that the heart of collaboration is trust and mutual respect.

Phillips and McCullough (1990) have explained a collaborative ethic as follows. First, members of parity who have different backgrounds, interests and skills but all of them must have similar values, belief and goals regarding the education of all students. Second, collaborators must be valued, sanctioned, and supported in the school. Hence, they must believe that pooling the intelligence and resources of all personnel is advantageous, with a various range of benefits to all. Third, the mutual relationships of partners are important and desirable. For instance, staff spirit and unity, skills in problem-solving and decision-making processes, and skill in implementing new and different instructional plans will increase while performing collaboration. Fourth, organising collaboration involves many methodical steps such as the need for cautious situational assessment and analysis, generation of choice solutions, plan and performing of a selected procedure, judgment of programs, modification of plans, and reassessment of accomplished methods.

Furthermore, Mostert (1998) has noted that to understand characteristics of collaboration and being aware of them will help participants to collaborate efficiently; hence he has stated many characteristics of collaboration such as will, indirect service delivery,
professional relationships, communal trust, collective involvement, shared goals and collective responsibility, action for problem solving, collaborative resources, confidentiality, and the student as priority.

In addition, Giangreco, Dennis, Cloninger, Edelman, and Schattman (1993) have suggested characteristics of effective groups are frequently shown through the sharing of various group responsibilities, accepted decision-making procedure, shared use of available resources, and well-developed accountability measures. Further, in their book, *Teamwork*, Petersen and Hillkirk (1992) reported that an attitude of trust, cooperation, and respect throughout the organization is the important characteristic of efficient teamwork.

**Collaborative Organisation**

There are many different types of collaborative arrangements. For example, in education, students with disabilities have been placed in a regular classroom alongside students without disabilities (Gable & Manning, 1997; Walther, Kounek, McLaughlin, & Williams, 2000) thus general, special classroom teachers, administrators, students and families are faced with the challenge of school reform. One way to meet this challenge in school reform is through teacher collaboration and shared decision-making. Gable and Manning (1997) have suggested several collaborative engagements such as all staff being involved in student removal (school-wide collaboration), second-grade teachers being matched with a reading specialist or learning disabilities resource teacher (grade-level collaboration), teachers dividing aspects of the curriculum (subject-area collaboration), and third-grade teachers being located in the same building section (multi-classroom collaboration).
Matlin and Short (1991) have reported a study group approach to support long-term, innovative changes in the teaching of reading. The study involved teachers, a principal and a researcher. Muronaga and Harada (1999), and Bishop and Larimer (1999) have suggested collaborative arrangements between librarians and classroom teachers. Further, Barufaldi and Reninhartz (2001) have reported that the Texas Regional Collaboratives for Excellence in Science Teaching Model, which is used to illustrate various components of the collaborative process, has many individuals involved such as master teachers, instructors, business partners, science and mathematics educators, scientists, mathematicians, and administrators.

The Requirements of Collaboration

Several authors have explained the needs of collaboration. For example, Rauschenbach (1996) has stated that physical education teachers can enhance their students’ learning by engaging in integrative activities with teachers of other subjects such as science. Also, he has suggested that in a science class, students could identify different classes of levers in the human body. Then, in the same week, they could explore the advantages and disadvantages of each class of lever in a physical education tumbling and apparatus unit.

Bruskewitz (1998) has reported that one school district in the USA has implemented a pilot teacher collaboration program in a school. The school hired a former special education teacher (with certification in working with students with both learning disabilities and emotional and behavioural disorders) to work cooperatively with the teachers, related services personnel, and staff who did not qualify for special education services to meet the needs of an increasing population of at-risk students who displayed significant learning or
behaviour problems. The goal of the program was to increase support for teachers in the regular education program so that they would be better able to meet the needs of the students within their classroom. The result showed that the number of schools involved had grown to 15: 12 elementary schools, 2 middle schools, and 1 high school. The plan was to increase the number of schools served each year until every school had a teacher collaborator. Briscoe and Peters (1997) explain that collaboration among elementary school science teachers across and within schools helps in changing teaching practice as the process enables the teachers to learn the course content and pedagogical knowledge from each other. Furthermore, collaboration helps them in coping with the limiting factors related with change, such as time, lack of materials or ideas. Thus, this strategy allows the teachers to discuss notions, problems and restraints.

Trent (1998) has stated in his case study the difficulties and complexities faced by a general education secondary social studies teacher who agreed to collaborate with special education teachers to serve students with disabilities in general education classrooms. The goal was to identify how collaborative relationships were established and what the benefits and problems of collaboration are. Barufaldi and Reninhartz (2001) report that collaboration is a significant strategy used for developing and implementing successful science professional development; thus, the Texas Regional Collaboratives for Excellence in Science Teaching Models was established to promote this idea.

The requirements for collaboration are needed in other areas as well. For example Duchardt, Marlow, Inman, Christensen, and Reeves, (1999) have described the collaborative effort between special education staff at Northwestern State University of Louisiana and general education (elementary education) staff, who performed co-planning and co-teaching together. They met once a week over lunch to discuss course content and service delivery in the four classes in the undergraduate elementary education. Then, the
group met again to discuss teaming arrangements. Finally, individual team members met to co-plan a lesson. The majority of public educational settings provide inclusive education for students with and without disabilities. Teachers and related educational professionals support students in achieving not only academic skills but also in developing knowledge, skills, and attitudes to become caring and considerate citizens. One of the most critical skills for these individuals who are involved in providing inclusive education is collaboration. Through collaboration, they can share ideas, develop new and better strategies, solve problems, better monitor students’ progress and effectively evaluate their outcomes. Also, Altshuler (2003) suggests that collaboration between public schools and child welfare can increase the educational success of students living in foster care.

Fagin (1992) suggests that when nurses and physicians work together in consultative relationships or teams, the costs of health and medical care can be reduced. In the business world, Tjosvold (1990) reports that personnel throughout the company need to work together to solve various problems such as an item that was not scanning properly, but the employees did not know why. They had to cope with problems resulting from the unfinished files in the computer, the non-existence of universal price codes, and operational issues. Collaborative interdependence helped employees deal with these problems and implement their company’s technological innovation successfully.

Prerequisites for Collaboration

In order to create collaborative relationships among team members, the following prerequisites are suggested. For example, Welch (1998) has studied collaboration between local schools and universities. He found that sustaining collaboration requires constant
communication about operational definitions and theoretical foundations. Further, he has suggested that to understand and practice collaboration requires understanding of the various components and dynamics within the definitive framework of collaboration. Accordingly, he has recommended three clusters of content and skills associated with collaboration for teacher education programs. The three clusters are: foundations for collaboration, skill acquisition, and skill application. These are elaborated below.

**Foundations for collaboration.** Welch (1998) asserts that teacher education programs must give a foundation for collaboration, including investigation of different theoretical formulations and definitions of collaboration. Exploring should cover a diversity of disciplinary aspects, including systems or associational theory and sociological notions. Also, the program must offer a philosophical foundation and infuse a character of collaboration.

**Skill acquisition.** A variety of skills are required for effectively working with others. Welch (1998) states that collaborators must understand the goals, objectives, and components of problem solving such as problem definition, situation analysis, brainstorming, evaluation of options, development of an action scheme, strategy accomplishment, and assessment of plan efficiency. Further, it is important that collaborators should have skills to access individuals who possess the expertise required in a given circumstance. Also, according to Zins, Curtis, and Ponti, (1988) co-workers must use good interpersonal communication and conflict management skills to assist effective work interaction.

**Skill application.** Welch (1998) explains that practitioners must have chances to utilize their newly adjusted tools by doing through role-playing in university classrooms before accomplishing work experience. Also, collaborators should have opportunities to reflect on their experiences because reflection allows preprofessionals to examine perceptions from
those practical experiences (Schon, 1987), and reflection supports practical teachers as they examine and integrate incidents with their practice because they can convert complicated theoretical formulates into actuality (Elbaz, 1988).

The Principles of Collaboration

Most investigators agree that the preconditions for effective collaboration must be democratic and inclusive, which means free from any kinds of hierarchies and have to include all parties who have a stake in the problem (London, 1995). For example, Flora, Jacqueline, Louis, Mark B., and Mark L., (1992) point out that without community sanction and extensive participation in agenda stating, the decision-making design of discussion, debate, and compromise is fairly incomprehensible.

Democratic

For Osborne and Gaebler (1992) a centralized and hierarchical organization is likely to be divided up into many layers and groups. When people begin to set apart their division that means they create their own territory. This makes communication across units and between layers complicated. Further, Petersen and Hillkirk (1992) stat many companies, which adopted teamwork as a strategy to improve their work, agree that democracy is the heart of teamwork, thus they tried to eliminate layers of management and force down authority.
There is widespread agreement that collaboration must be inclusive to be authentic. For instance, Theobald (1987) has stated that all the team leaders of a community must be effectively involved. London (1995) has pointed out that a successful collaboration must have its foundation on the commitment of principal leaders in the community such as mayors, city council members, chief executive offices, and the equivalent. According to their six collaborative case studies, Chrislip and Larson (1994) have found that the support of high-level, visible leaders brought credibility to the effort and was an essential aspect of the success of the collaborative endeavor. Further, Gray (1989) has observed that collaboration can only be meaningful if the stakeholders are interdependent. She has written:

Collaboration establishes a give and take among the stakeholders that is designed to produce solutions that none of them working independently could achieve. In this way, they all depend on each other to produce mutually beneficial solutions. (p. 11)

The Process of Collaboration

The process of collaboration is complex and comprises a number of components. Each collaborative association applies different components into its process. For example, London (1995) states that the system of collaboration usually moves through several distinct phases starting with an examination of the situation and a finding of the vital issues concerned, then moving on to a definition of the basic mission or required result, a shared vision, a plan to reach the vision and the objectives, a schedule for that plan, and finishing with the assessment of answers.
Gray (1989) suggests a three-phase process for collaboration. The first phase is the problem-setting, which is the most difficult and requires sharing definition of the problem, building a commitment to collaborate, recognizing other stakeholders whose involvement may be necessary for the success of the endeavour, accepting the legitimacy of the other parties, determining the kind of leader who knows how to bring the groups together, and the group deciding what resources are needed for the collaboration to move on. In the second phase, which she called the direction setting, there is the establishing of ground rules, setting the agenda, organising subgroups, undertaking a joint information search to establish and considering the essential facts of the issue involved, exploring the pros and cons of various alternatives, and reaching agreement and setting for a course of action. The final phase is implementation, which includes participating groups dealing with their constituencies, acquiring the support of those who will be charged with implementing the agreement, establishing structures for implementation, and monitoring the agreement and ensuring compliance.

Barufaldi and Reinhartz (2001) believe that collaboration is a mutually beneficial and well-defined relationship, which brings together two or more associations to achieve shared purposes. Thus, they have identified four essential components that have been used as a core process for collaboration in the Texas Regional Collaboratives for Excellence in Science Teaching Model: shared vision, interconnectivity, a multi-tiered process and support. These are elaborated below.

*Shared vision* is the most important characteristic in the collaborative process as it is developed from aims and objectives of the collaborators. Further, Mattessich and Monsey (1992) support this idea. They note that collaborators must have the same vision, and positively agreed on mission, objectives and strategy. The shared vision may occur at the beginning of collaboration, or partners may increase a vision during their work together.
Interconnectivity is a bond, connecting individuals within the organization.

A multi-tiered process. Collaboration within this organization is a multi-tiered process as 20 Texas Regional Collaboratives unite together to create partnerships of educators and business leaders who are committed to science education school reform. The Regional Collaboratives are partnerships among local colleges and university, education service centres, school districts, business and industry, the Texas State Aquarium and the Centennial Museum and the community.

Support. They have stressed that a sufficient financial base to sustain the operation and activities of the collaboration is the highest precedence in primarily establishing and nourishing the party.

In addition, Petersen and Hillkirk (1992) suggest three important fundamental principles for starting an effective teamwork, which can apply to the military, teachers, school administrators, and all of us in our work. Those ideas are employee involvement, participative management and worker empowerment.

Mutual Leadership

Collaboration is a process in which the whole group must be self-governing and all participants are equally represented in the making of joint decisions (London, 1995; Petersen & Hillkirk, 1992). To achieve this, the collaborative team must be lead by an effective leader who can guide and coordinate that decision-making process.

Many authors have suggested the essential qualities of collaborative leadership. Theobald (1987), for example, states traditional leadership qualities such as power, charisma, persuasiveness, and the ability to take unilateral action may be not only
inappropriate but also damaging to the process of collaboration. Thus, the effective leader must better understand networks and place linkages instead of authority structures. That is, collaboration can diminish top-down power structures and bring a new way of coordinating activities and making decisions. Chrislip and Larson (1994) suggest the collaborative leader depends on both a new vision of leadership and new skills and behaviors to help communities and organizations realize their visions, solve problems and get results. Further, this new form of leadership has been diversely defined as transformative, facilitative or servant leadership (London, 1995). Burns (1978) describes transforming leadership as a process in which more than one person unite with each other in a way that leaders and followers promote one another to higher levels of motivation and morality. Also, he says this type of leadership is the discovery of shared purpose and the interplay between motives and values.

In addition, Wellins, Byham and Wilson (1991) outline some of the critical qualities of collaborative leadership in their book, *Empowered Teams*. These qualities include the ability to learn, business planning, communication, delegation of authority and responsibility, developing organizational talent, follow-up, identification of problems, individual leadership, information monitoring, initiative, judgment, maximizing performance, motivation to empower others, operational planning, rapport building. Further, collaborative leadership builds a group that will not fall apart if something happens to the leader. Petersen and Hillkirk (1992) suggest that team leaders should give their peers an opportunity to say what they think, then include those ideas in the overall decision-making process. Team leaders should encourage co-workers to ask questions, even if they think the questions are baseless as this helps them know how the other thinks, get closer to understanding the other’s reasoning and prevent personality conflicts when people at different ends are not communicating. Thus, the team leader should push responsibility
down and promote participative peers. Further, Chrislip and Larson (1994) suggest a similar idea that a collaborative leader should be a person who possesses the role of discussion leader, puts apart all authority, expertise and position. Thus, the main leadership role is to foster discussion and reflection among the members of the team.

**Barriers to Common Collaboration**

Collaboration is rarely simple and straightforward as it moves through several distinct stages, especially when it involves several parties (London, 1995). Thus, individuals who are willing to adopt collaboration as a strategy for effort or improve work must initially be familiar with, and understand, the various barriers that may prevent their collaboration (Welch, 1998). The literature has revealed that limitations to collaboration can be linked to differences in education, culture, social status, legal jurisdiction, and language or communication style, professional elitism, sex-role stereotypes, role ambiguity, and incongruent expectations (Fagin, 1992; Prescott & Brown, 1985). Altshuler (2003) studied barriers to successful collaboration between public schools and child welfare, and found several obstacles. These included lack of trust, lack of understanding about confidential information, and lack of communication with each other. Also, Johnson, Zorn, Yung Tam, LaMontagne and Johnson (2003) studied factors that impact successful interagency collaboration, and found many aspects that prevented the achievement of the collaboration such as lack of commitment, lack of strong leadership, lack of common vision and goals, lack of trust, lack of support from upper management, lack of financial support, and resistance to change. Mostert (1998) points out many disadvantages of collaboration, such as time, commitment, resistance, differing professional views, lack of collaborative skills,
quality of decisions, lack of resources, role ambiguity and duplication of effort, levels of experience and will. Inger (1993) has stated that teacher collaboration is rare as there are substantial barriers to teacher collaboration, and the barriers are of many kinds, for example norms of privacy, subject affiliation and departmental organisation, barriers between vocational and academic teachers, status differences, department walls, and physical separation. Nias (1993) has cited that professional individualism has been an obstacle to collaboration and has been credited to the organization of schools, especially secondary schools.

In addition, Phillips and McCullough (1990) have classified the various collaborative barriers into four types. First, conceptual barriers embrace concepts that members of the schools have concerning their role and the others’ roles, for instance, teaching students with disabilities before was the job of special educators, not classroom teachers, and teachers often see parental collaboration as unimportant to the educational process. Second, pragmatic barriers are usually associated with systemic and logistic factors within the school. Idol-Maestas and Ritter (1985) note teachers, special educators, school psychologists and administrators reported lack of time as the most accepted resistance to achieve collaboration. Other pragmatic barriers comprise large caseloads, scheduling problems as well as competing and overwhelming responsibilities. Besides, McLaughlin and Yee (1988) note that schools have been described as segmented, egg-crate institutions in which teachers are isolated. Also, Mercer and Covey (1980) stat that schools are organised as bureaucracies in which a division of labor operates on rules and procedures. Thus, the basic organisation of schools may seriously deter professionals from cooperation. Attitudinal barriers are generally evident when individuals may have some beliefs or expectations about the potential outcome when involved in a new task and such impractical expectations can seriously destroy possible and significant change efforts (Welch, 1998).
Fourth, professional barriers are perhaps most pertinent to the discussion of collaboration barriers. Ware (1994) notes professionals are culturally isolated by long-established professional behaviors and beliefs. Goodlad and Field (1993) and Welch and Sheridan (1995) state a pervasive problem in accomplishing collaboration is lack of training or diversity in training among several disciplines. Welch (1998) emphasises that many novice professionals lack the essential prerequisite skills of sufficient communication and conflict management, which are necessary to be involved in working together. Also, he highlights philosophical diversity and degree of knowledge and skills in problem solving as being directly linked to ability to fully contribute in collaboration. In particular, teachers do not understand the role and ability of interrelated personnel, and so do not use them as a resource, because they were not exposed to them during in-service professional training.

Pugach and Johnson (1995) and Thomas, Correa and Morsink (1995) cite a similar idea that collaboration in teaching is usually explained as the sharing of expertise in providing a lecture, solving a problem, working on a project, or similar activity. Most teacher education programs do not train teachers to develop a multidisciplinary, perceptive collaboration; thus it is difficult when teachers or educators are expected to perform teamwork and collaboration, which they rarely have experience themselves.

Fullan and Hargreaves (1991) state collaboration is an automatically attractive concept and the stuff of change. But, it can also be a failed solution. They examine three forms of collaboration, which are best avoided: balkanization, comfortable collaboration and contrived collegiality.

*Balkanization* occurs in a situation in the school where teachers associate more closely with some of their colleagues than they do in a culture of individualism. As Fullan and Hargreaves (1991) describe:
A balkanized teacher culture is a culture made up of separate and sometimes competing groups, jockeying for position and supremacy like loosely connected, independent city-states. (p. 52)

Balkanization may lead to poor communication, indifference, or groups going their separate ways in a school. Ball (1987) suggests it may generate arguments and conflicts over a school’s facilities and resources.

*Comfortable collaboration* is a weak form of collaboration. This conception of collaborative cultures is restricted in the sense of not reaching or extending deep down to involvement in joint work. As Fullan and Hargreaves (1991) note:

Bounded collaboration rarely reaches deep down to the grounds, the principles or the ethics of practice. It can get stuck with the more comfortable business of advice giving, trick trading and material sharing of a more immediate, specific and technical nature. Such collaboration does not extend beyond particular units of work or subjects of study to the wider purpose and value of what is taught and how. It is collaboration, which focuses on the immediate, the short-term and the practical to the exclusion of longer-term planning concern. (pp. 55-56)

*Contrived collegiality* is a form of collaborative culture, which can be controlled or regulated by administrators. It does not arise completely by itself, and it requires managerial guidance and intervention. As Fullan and Hargreaves (1991) observe:

Contrived collegiality is characterized by a set of formal, specific, bureaucratic procedures to increase the attention being given to joint teacher planning, consultation and other forms of working together. It can be seen in initiatives such as peer coaching, mentor schemes, joint planning in specially provided rooms, site-based management, formally scheduled meetings and clear job descriptions and training programs for those in consultative roles. These sorts of initiatives are administrative contrivances designed to get collegiality going in schools. (p. 58)

In most forms of contrived collegiality, teachers’ partnerships are often imposed and they deceptively work together under the flag of collaborative cultures. Such collaborative cultures can reduce teachers’ motivation to cooperate further as true collaborative cultures need a long-term development.
In addition, in the field of medicine many authors have cited barriers to collaboration such as differences in education, culture, social status, legal jurisdiction, communication style, professional elitism, sex-role stereotypes, role ambiguity, and incongruent expectations (Fagin, 1992; Prescott & Brown, 1985; Stein, 1967).

**Advantages of Collaboration**

Professional collaboration has several different advantages over predictable education approaches (Gable & Manning, 1997). Many authors have stated those benefits. For example, Brookhart and Loadman (1990) note that the participants gain ownership of the instructional process and establish mutually satisfactory goals from the shared planning and goal setting process. This makes each party feel equally responsible for ensuring a positive outcome. Also, they state that teachers benefit from exposure to diverse philosophies, training and experience of others, which stimulate new ideas and increased communication among professionals at all levels. Lieberman (1992) has reported that collaboration allows participants to learn from one another and to establish long lasting and trusting professional relationships. Gable and Manning (1997) emphasise that collaboration significantly offers teachers a great opportunity to work together and to bring about school change. In his book, *Interprofessional Collaboration in Schools*, Mostert (1998) mentions that participants of teamwork can skill share professional competence and experience, collective responsibility, interprofessional communication and spread of resources. Drotar (2002) has suggested some potential values of the interdisciplinary collaboration such as an experience of learning from different professionals’ strengths, and benefits of sharing and mutual support.
Trent (1998) has observed that inclusive education can have many benefits from two teachers as they bring different skills to the classroom: for example, one teacher as the expert on instructional modifications and organisation, and the other as the teacher responsible for presentation of content. The general teacher learns to modify the curriculum to meet the needs of students with learning disabilities and other at-risk students. The student/teacher ratio is low and so the teacher can provide attention for the students individually, especially those with severe disabilities. Teachers are able to learn from each other such as teaching styles and learn different ways to approach instruction. Further, the teacher has the benefit of having a second person to assist with monitoring students, dealing with outbursts and inappropriate behaviors, and reading the test. Further, co-teaching provides teachers with the psychological support needed to deal with at-risk students and students with disabilities.

Rauschenbach (1996) has found many benefits by integrating physical education with other subject areas. For example, collaboration among physical education specialists, other subject area specialists and classroom teachers may gain new detail and interest in one another’s subject areas. Also, integrative activities offer benefits to different kinds of students such as students who are usually unenthusiastic about physical education might be motivated by integrative activities which allow them cognitive as well as physical success. Curtis and Curtis (1990) note that collaboration promotes an extended range and number of likely solutions. As the characteristic of solutions constructed may be superior to those of one individual thus the diversity of expertise and resources available will be greatly improved.

In addition, for Little (1987), collegial relationships among teachers help improve student achievement, behavior and attitudes. In the schools where teachers plan together to develop a unified program, students can sense program coherence and consistency of
expectations, and their improved behavior and achievement may well be a response to a better learning environment. Collaborative relationships among teachers increase teacher satisfaction and adaptability as collaboration breaks the isolation of the classroom and leads to increase a feeling of effectiveness and satisfaction. Working together, teachers have the energy, organizational skills and resources to attempt any tasks that would exhaust an individual teacher. In the schools where teachers are faced with a variety of student problems, collaboration helps teachers cope better and get more control over their daily work. Collaboration enables teachers to engage in direct commentary on the moral, intellectual and technical merit of classroom practices. Also, she cited that collegiality saves beginning teachers from the trial-and-error ordeal, as working with experienced teachers is one of the professional encounters that plausibly influence the competence and confidence of the beginning teachers, and collegiality prevents experienced teachers burning themselves out from a boring environment and stimulates enthusiasm.

Bird and Little (1985) emphasise that in the schools where teachers work as a group, they can trace both their students’ gains in achievement and the elimination of classroom behavior problems. Wilkin (1992) note that collaborative teaching can make the management of learning activities much smoother, can increase the amount of individual attention and support that students receive, and can facilitate assessment or the setting of differentiated tasks. Copeland and Jamgochian (1985) report mutual assistance would make recruits less isolated, more self-confident and more proficient. Further, Ashton and Webb (1986) suggest the main benefit of collaboration is that it can reduce teachers’ sense of powerlessness and increase their sense of efficacy.
Support for Teacher Collaboration

There are several factors which help teachers to work together in schools or outside school. For example, Little (1987) suggests six dimensions of support for teacher collaboration: endorsements and rewards, school-level organization of staff assignments and leadership, latitude for influence on matters of curriculum and instruction, time, training and assistance, and material support. These are elaborated below.

Endorsements and Rewards. Teachers work together best in schools where principals and other leaders who promote collegiality convey their belief that interdisciplinary teams can make the school better for students. Teacher collaboration is ineffective in schools where teaming is at the lower part of a principal’s list of priorities. Also, Bird and Little (1985) state school-level support for teaming requires a combination of public endorsements, material and technical support, opportunity and reward.

School-level organization of assignments and leadership. School-level organization into teams can be used to stimulate teacher collaboration, but does not guarantee it. Organization of assignments and leadership must be broadly distributed among administrators and teachers to increase the effectiveness of teamwork. Further, Lipsitz (1983) suggest the assignment of teachers to formal leadership positions is not only an accepted tradition in schools but also an effective teamwork policy.

Latitude for influence on matters of curriculum and instruction. She explains that teachers’ investment in team planning rests on the latitude they have for making decisions in areas of curriculum, materials selection, instructional grouping, classroom activity, and student assessment. Teams are more likely to form when the task is complex enough to make it probable that the team is better than one. Moreover, teachers must be involved in the development of the matters of curriculum and instruction that they are going to use.
Time. Teacher collaboration can be enhanced or destroyed by the school’s master schedule or timetable. Schools can help collaborative work by providing released time for teachers who teach the same group of students of subjects to work together on a program. Thus, the master schedule must allow teachers to be available for a block of time during the school day to perform their collaborative work.

Training and assistance. Schools must provide teamwork with task-related training and assistance to reinforce the confidence that teachers must have in collaborative work. Besides, assistance in group process helps teachers to gain particular skills required for cooperative work and develop agreements to govern their work together.

Material support. She has suggested that the quality and availability of reference texts and other materials, and human support are decisive contributors to teachers’ ability and willingness to work together successfully.

In addition, Leonard and Leonard (1999) used a survey questionnaire to study identifying leadership sources for implementing new programs and teaching practices. They found that principals were seen as important for motivation. Further, teachers considered informal collaboration to be more effective in terms of leadership provision for change than the more formal structures of planned collaboration. Leithwood and Jantzi (1990) state that a school principal may show leadership qualities related the following six proportions: articulation and sharing of a vision, fostering group goals, individual support to subordinates, intellectual stimulation, appropriate behavior modelling, and high performance expectations.
Collaborative Partnerships

Collaboration occurs in many areas of human activity and is not limited to social affairs. While the focus of this paper is on science teachers’ collaboration via the Internet, it should be noted that a great deal has been written about collaboration in several fields such as business, medicine, military and especially education.

Many authors have reported several collaborative partnerships in education such as science teacher collaboration, school/community collaboration and teacher-to-teacher collaboration.

Ingvarson and Loughran (1997) report in their study “Loose Connections: The Context of Science Teachers’ Work” that there was a weak sense of professional community among science teachers, and collegial forms of influence and accountability over teachers’ practice were weak as well. Further, the opportunities of the potential advantages of collegiality or “joint work” (Little, 1990) among science teachers were rare. Herwitz and Guerra (1996) found that the collaboration between a scientific researcher, an elementary school teacher and students demonstrated the process of becoming an active learner. They also suggest that universities can and should be more than an information source. Universities are capable of providing elementary school students and teachers with model for inquiry, discovery, and accomplishment. Briscoe and Peters (1997) investigated the teacher collaboration across and within schools to develop an understanding of how collaboration among teachers from elementary schools and university researchers facilitated the teachers as they attempted change in their practices. The collaboration effort was built into an in-service project for elementary teachers that focused on assisting teachers to implement a curriculum emphasising problem-centred learning in science. The results of the study indicate that collaboration facilitates change because it provides opportunities for teachers
to learn both content and pedagogical knowledge from one another and supports the processes of individual change in science teaching.

Smedley and Van Rooy (1996) investigated partnerships between schools and teacher education institutions to examine the ways in which one form of school/tertiary partnership was attempted. They concluded that science teacher educators have an obligation to ensure that the value of their collaboration with colleagues in schools is clearly articulated at very opportunity. Normal partnership relationships must be acknowledged as part of the basic cost of teacher education. Work on school sites is as an important part of the research of tertiary lecturers. Liaison with practicing teachers and reflection of learning is considered peripheral and incidental to the true role of tertiary staff. In addition, Koballa, Eidson, Finco-Kent, Grimes, Kight, and Sambs (1992) suggest that collaboration among science teachers in the form of peer coaching promotes teacher experimentation and risk taking. Collaboration involves both the teacher and coach sharing what each other thinks are appropriate actions and then agreeing on a plan to follow. Novice teachers usually benefit most when the coach is direct and forthcoming with suggestions for improvement.

School/Community Collaboration

School-Community partnerships are designed to foster greater collaboration between secondary schools and vital community institutions (London, 1995). For example, Winston (1995) report that staff of his science department made visits to local business, technical schools and universities to identify what educational resources were available in the community. He found incredible options such as technical support, excess equipment, or the use of the businesses’ equipment under the direction of technical mentors were available to students while they were in school and after graduation and recognised the absolute need for developing partnerships between high schools, businesses and industry,
and postsecondary educational institutions in order to make those options a reality. He also found that businesses are more likely to respond to requests for those resources. He also reported that community involvement could help students develop many skills, for example communication, problem solving, team working, and self-discipline. Further, Rowell and Guilbert (1996) state in their study “Perspectives on Science in School: Agriculturalists and Elementary Teachers in Dialogue” that community partnerships between the education, industrial and business sectors are being advocated and supported as strategies for dealing with the decontextualisation of science in classrooms. This study adopted a non-traditional approach to professional development in science for elementary teachers. The intent was to examine the conditions, which facilitate collaborative development of science literacy through discussions between a group of teachers and representatives of the agricultural sector of community. They examined the views of science and school sciences expressed by participants and considered the potential contribution of the dialogue between the teachers and agriculturalists to developing a view of science as a human activity in everyday situations and occupations.

Warren and Young (2002) investigated “Parent and School Partnership in Supporting Literacy and Numeracy”. Ninety-five parents from four elementary schools were asked to respond to a parent survey questionnaire. After those two parents, two classroom teachers and an administrator from one school were interviewed. They found the parents helped their children with literacy and numeracy at home. Further, most of that assistance was given with reading, some with writing and some with routine mathematics. The results of the survey and interview showed that parents, teachers and the administrators shared the common goal of inspiring children to learn. On the other hand, they found some barriers to forming home-school partnerships; the most critical of these barriers related to the style of communication between schools and parents as schools support unequal relationships
between families and teachers rather than support justice. Besides, schools tended to view home-school relations from a school perspective such as how parents can help the teachers in their role in school.

In addition, most researchers believe that there are many benefits from university-school collaboration such as professional development and improved education for students (Peters, 2002). Accordingly, university-school partnerships have been studied and reported. For instance, Brady (2002) reports robust support from the NSW primary principals for a great variety of partnership between school and university in the promotion of student teacher’s learning, school student’s learning, and the professional development of lecturers and schoolteachers. Also, she found contribution was concentrated on supervision and mentoring, collaborative teaching projects, shared research, professional development, joint planning, and school improvement. Further, the real meaning of the study is the remarkable enthusiasm of those principals to incorporate broad series of partnership activities, which will have vital implication for changing the nature of schooling and teacher education.

Peters (2002) accounts research for the seven university participants, who were involved in the Innovative Links Project in South Australia, project expectations as follows: providing expertise, acting as a critical friend, collaborative learning, strong link between schools and the university, and contributing to significant school change confirmed to be problematic. Both school and university participants were affected by offensive assumptions such as the personal, structural and cultural conditions.

Further, at the university she found the predominant culture of isolation, competition and the lack of structures to support communication made the university participants feel difficulty in collaborating and communicating their learning from the project with other colleagues.
**Teacher-to-Teacher Collaboration**

Cook and Smith (1993) report in their study “The Induction of Beginning Science Teachers: Some Guidelines for a Mentoring Approach” that science colleagues acting as mentors would be better placed to address the particular needs of beginning science teachers and colleagues teaching the same subjects are more appropriate agents of induction than school administrators. They found that new teachers are often expected to perform all the duties of more experienced teachers while trying to learn the rules and practices of the school; therefore, they require help frequently and on call. They also stated that the mentor should facilitate the beginning teachers’ attempts to pursue a personal approach within constraints provided by the syllabus and school philosophy and procedures. Furthermore, Bohde and Harris (1996) explain in their study “New Teacher Collaboration: First-Year Teacher Join forces for an Integrated Biology/English Unit” that teamwork between new teachers was imperative to the success of the unit. New teachers relied on each other for new ideas and support. Their ability to work together and their cohesiveness kept problems to a minimum. They also stated that the successes they encountered made them eager to plan another integrated unit.

Collaborative partnerships have been widely used in other fields such as medicine and business for jointing or improving work.

**Medicine**

Lesser (2000) describes in her study “Clinical Social Work and Family Medicine: A partnership in Community Service” that collaboration between family medicine and clinical social work showed the value of a partnership for providing a holistic approach to patient care. The team was dedicated to the concept of offering an integrated approach to patient care in a working-class community where health and mental health care would be
affordable, accessible and available in the assistance of an independent, community-based family medical practice. In the seventh year, the practice was extended to comprise a consulting psychiatrist, a nurse practitioner, a psychologist and a second social worker. Further, each of these practitioners tied the family practice to a strong biopsychosocial orientation, interdisciplinary skills, knowledge of quality assurance and reimbursement, as well as clinical practice with a wide range of patients. In addition, Phillips (2000) reports on the project, which involved collaboration between state medical societies and public health associations named “Medicine-Public Health Collaboration Tested” which involved collaboration between state medical societies and public health associations. He found many interesting results from the collaborative work, for example the collaboration devised an extensive network of professional relationships that provided project staff contact with researchers, legislators, and government officials. However, there were so many requirements among partners such as the coordination of schedules, meeting availability, and general communication that produced a slower timetable than expected. Further, some participants felt it very difficult contacting physician partners for the project, and there was a lack of follow-through at the end of tasks. There have been some reasons for continued collaboration between medicine and public health, for example cutting costs and increasingly complex world as money driven.

Business

There are several authors who have reported using collaboration as one of strategies to share or improve work in business. For example, Petersen and Hillkirk (1992) gave an example in their book, “Teamwork”, of their triumph in using teamwork to improve work in the Ford Motor Company. They noted:
If Ford’s managers had not developed a better relationship with the people inside our organization, the company would have had a difficult time competing in the 1980s. We would not have developed the best-selling Ford Taurus, an affordable, stylish vehicle for today’s middle-income family, or any of our other huge success such as the 1990 Explorer…we definitely would not have gained seven points of market share in an industry that had been so vigorously infiltrated by the Japanese. (p. 11)

They explained that the huge success of the Ford Company as the managers tried hard to foster an attitude of trust, cooperation and respect throughout their organization. Further, those managers believed in the power of teamwork and they thought human beings at all levels could work together in a positive and nurturing environment. Especially, they trusted their co-workers, which is the most important foundation of collaboration so the slogan of empowering workers and managers by pushing authority down, and how to reward team players instead of individualists was announced. In addition, they suggested the three main strategies: employee involvement, participative management and worker empowerment for building teamwork, which can be practiced by many organisations such as military or teachers and school administrators.

Development of Collaborative Practice in Education

Cook and Friend (1991) reported that the evolution of collaborative practice in education began in the mid-seventies in a form of consultation, a process through which one professional assists another in solving a problem concerning a third person. This consultative approach in education was a service delivery model to meet the demand for special education service delivery in the absence of trained special education teachers. They also note that as a consultant, a teacher is not only expected to maintain a caseload of students who are seen on a regular basis, but also to serve as a classroom consultant to other teachers working with the same students and with others who require similar
education needs. The educational consultant’s role has been elaborated in a number of sources: in text books such as ‘The Resource Teacher: A Guide to Effective Practices’ by Wiederholt, Harmmill, and Brown (1983) and ‘Effective School Consultation’ by Sugai and Tindal (1993), in handbooks such as ‘The Educational Consultant’ by Heron and Harris (1993) and ‘Special Educator’s Consultation Handbook’ by Idol (1993).

Cook and Friend (1991) characterize collaboration as different from consultation. The consulting model involves the unequal relationship of persons. In contrast, collaboration involves interaction between two or more equal parties who voluntarily share decision making in working toward a common goal. Furthermore, models of collaboration present a framework in which consultation and teaming are presented as different forms of collaboration. Hanson and Widerstrom (1992) delimit consultation as a process of giving advice, and collaboration as a different type of helping relationship involving equality of those participating.

Johnson, Pugach, and Devlin (1990) summarise the evolution of educational collaboration as a gradual movement from the prescriptive nature of consultation to the mutual parity of collaboration. They present suggestions for developing a more collaborative educational environment including sanctioning of collaborative efforts by administration, providing assistance for teachers with clerical work and other non-instructional tasks, organising meeting times for teachers to engage in mutual problem solving, providing opportunities for specialists and teachers to co-teach, developing common vocabulary and terminology in order to avoid specialised jargon, and reserving regular faculty or in-service meetings for collaboration.

Hanson and Widerstrom (1992) have stated that interagency collaboration is an essential ingredient for successful preschool special education programs, and they present recommendations for effective collaboration including commitment from decision makers,
commitment, shared ownership, and decision making among participants, adequate resources to support planning and coordination, ongoing training and technical assistance, evaluation, and family involvement.

Voltz (1993) has suggested that educators collaborate in a variety of ways. They routinely exchange information about student progress, coordinate development of instructional plans, team teach, plan for generalisation of skills, jointly conduct parent conferences, share decisions with regard to grades, collaboratively problem solve, and participate in cooperative professional development.

Idol and West (1991) define collaboration as an interactive relationship, an adult-to-adult interactive process and suggest an eight-step process for collaboration which has been termed a catalyst for change in educational collaboration including goal setting, data collection problem identification, development of alternative solution, action plan development, action plan implementation, evaluation, and redesign.

The process of collaboration as suggested by Idol and West (1991) corresponds to the components of clinical supervision formulated by Cogan (1973). Clinical supervision is developed as a promotion of continual teacher professional development in a non-threatening environment involves establishing rapport, intensive instructional planning with the teacher, planning of classroom observation with the teacher, observing in the classroom, analysing the teaching-learning process, planning the post-observation conference strategy, conferencing with the teacher, and resuming planning.

Idol and West (1991) also list thirteen principles for collaborative consultation including establishing team member relationships, respect among the team, use of situational leadership, conflict management, information sharing, active listening, non-judgmental responding, interviewing skills, common language, data gathering, willingness to receive as well as feedback, giving credit where credit is due and awareness of nonverbal messages.
Goldsberry (1984) suggests clinical supervision can lead to collaborative development and implementation of school goals, and norms of collegiality and experimentation, which can be fostered through the clinical cycle.

Fishbough (1997) proposes clinical observation as a basic collaborative tool for successful educational collaboration. The eight-step process of clinical supervision provides a foundation for clinical observation and has been condensed to a five-step process, which includes preconference, observation and data collection, data analysis, postconference, and self-reflection. In preconference, observer and observed meet to clarify needed assistance and professional interest to determine the focus of an observation and the method of data collection. In the step of observation and data collection, the observer collects requested data according to the method agreed on during the preconference. Then, observer and observed each analyse and interpret resulting data. In postconference, observer and observed meet to discuss their individual perceptions of the observation data and to determine future action based on data analysis. Finally, in the step of self-reflection, the observer evaluates his/her ability to be a facilitator of the observed’s data analysis and problem solutions.

Models of Collaboration

Fishbough (1997) states that educators should have a theoretical structure on which they can base their collaboration and proposes three models of educational collaboration: Consulting, Coaching and Teaming. According to her suggestion the three models of collaboration were adopted for this study as a framework to test models of collaboration.
among high school science teachers on e-mail and Internet. Fishbough’s models of collaboration are elaborated below.

**Consulting**

In the consulting model, an expert gives advice to a person less knowledgeable in the consultant’s field of expertise and the information flows one way from the consultant to the consultee. This has been a traditional collaborative model in special education for more than twenty years since the model is provided by Idol, Paolucci-Whitcomb and Nevin (1987). This approach is an indirect service delivery model and is defined by the inequality of those involved. One party, the consultant, has more expertise, knowledge, or experience than the other in a specific area. The other party, the consultee, relies on the expert for information and guidance to develop competence in the area of need. Sheridan, Welch, and Orme (1996) stats that consultation is a specialised problem-solving process in which one professional who has particular expertise assists another professional who needs the benefit of others. Dettmer, Dyck, and Thurston (1996) provide an example of consulting: a learning-disabilities consultant (consultant) may serve a new student (client) who has a learning disability indirectly by collaborating with the classroom teacher (consultee) who provides direct service to the student.

Furthermore, Fishbough (1997) describes examples of the consulting model in collaborative practice in education in three subcategories: mentor teacher programs, student support efforts and interagency consultation.

Mentor teacher programs refer to master teachers serving as guides for their apprentices who are novices in the teaching profession. As general and special education teachers have different, but complementary skills, they should consult with each other for skill development.
Student support efforts involve special educational consultation for general educators who include students with special educational needs in their general education classes. The role of special education teacher as consultant to general education teachers has been well documented.

Interagency consultation demonstrates interaction between and among educational and other human services organisations on behalf of individuals with disabilities.

Coaching

The second model of collaboration is coaching. Here, the key concept of a coaching model is parity. Participants in this model assist each other through the role of coach or the person being coached, and they recognize their complementary strengths and weaknesses. As the pioneers of peer coaching, Joyce and Showers (1982; 1983) used this model with teachers learning to implement different models of teaching.

Fishbough (1997) presents examples of the coaching model in collaborative practice in education being employed for three purposes: coaching for professional development, coaching for performance appraisal and coaching for problem solving.

The model coaching for professional development demonstrates professionals working in groups of two or more to coach each other toward achievement of professional development goals. An example of coaching, a means toward professional development has been described as ‘peer clinical supervision’ or ‘clinical supervision cycles’ (McFaul & Cooper, 1984). The purpose of the cycles is individual teacher development. It was found that teachers could implement the form of clinical supervision, which assumed an atmosphere of collegiality and equality. Peer coaching has also been employed as an alternative to administrative evaluation (Anastos & Ancowiz, 1987). In this project, teachers were motivated to in-depth examination of their teaching, and they felt empowered
by being involved in the process, and felt less isolation through developing trust and respect for peers.

Sparks and Bruder (1987) report professional growth was supported through peer coaching at the Ann Arbor public schools in the USA. As a result of peer coaching, teachers received frequent feedback on their teaching, increased collegiality, felt free to experiment with new teaching techniques and allayed concerns with peer observation. Costa and Kallick (1993) have summarised coaching as a critical friend relationship. In the coaching situation, the purpose of the critical friend relationship is supported. The critical friend is a trusted peer who asks clarifying questions, provides data, and offers a constructive critique. Hawkey (1995) suggests peer coaching between student teachers is also a way to develop their pedagogical skill and promote reflective practice. Similarly, in-service teachers can take advantage of the support of a peer coach without the anxiety produced by administrative evaluation.

The model coaching for performance appraisal refers to the process of peer evaluation among teachers. This process can facilitate teacher development in a more constructive process than traditional appraisal, once a year administrative observation (Fishbough, 1997).

Walen and DeRose (1993) report that teachers in an elementary school in Colorado developed a peer appraisal process as opposed to traditional supervision. They worked in appraisal pairs to observe and provide written feedback to a third teacher, provided an additional way to collaborate and discovered that as individuals they learned more from observing their peers' performance than being observed and critiqued. Bickel and Artz (1984) report team supervision was used in the School Improvement Program in Pittsburgh. Working as teams, instructional supervisors and principals coached teachers by offering them data-based instructional planning, focused attention and time, team planning and
working, general-special education collaboration and supervisor-principal collaboration. This program also allowed supervisors to be perceived as coaches rather than evaluators. As a result, team supervision promoted instructional improvement through the use of objective data and changed the supervisory role from administrative to supportive. Mandeville and Rivers (1989) report coaching was used to evaluate application of in-service teacher training in South Carolina's Program for Effective Teaching. Coaching was included in classroom observation and note taking, analysis, and pre- and post-observation conferences. As a result, teachers responded positively to the instructional training.

The model coaching for problem solving involves a peer collaboration problem-solving model (Johnson, Pugach, and Cook, 1993). The model was used to facilitate general education classroom intervention strategies for at-risk students. The initiator is the owner of a problem and seeks the facilitator to assist with finding a problem solution. Together they work through four steps of problem solving, but the initiator retains ownership by judging the potential of each suggestion and choosing the strategy to implement. This coaching model can be applied to a wide variety of situations despite being proposed as a prereferral process before formal referral to special education.

**Teaming**

The third model of collaboration is the teaming model, in which participants perform as members of an interactive team who share ownership of the purpose and outcomes of their collaborative efforts (Morsink, Thomas, and Correa, 1991). Lee (2000) has cited that teams are formal groups that have certain characteristics. They have clear goals, active and committed members and leaders; they practice to achieve their results’ and they do not let personal issues interfere with the accomplishment of their goals. Also he has stated that teaming itself will not guarantee a successful educational practice. The success of the team
will depend on each team member’s understanding of mutually shared goals and their collaborative effort for the goals.

In addition, Fishbough (1997) has grouped examples of the teaming model into three specific subcategories: teaming as co-teaching, teaming as support for professional development and teaming for problem solving.

*Teaming as Co-Teaching.* Friend and Cook (1992) describe different forms of co-teaching, which are useful for different purposes and involve more or less intensive co-planning by the co-teachers. For instance, the approach involving one person as teacher and one as observer requires little co-planning, parallel teaching which involves both instructions as teachers requires a medium amount of collaborative planning, and team teaching which involves both teachers delivering the same instruction at the same time requires a high degree of collaborative planning. Redditt (1991) reports that cooperative teaching demands commitment, flexibility and time for planning, but results in fewer at-risk students, modelling of collaboration by teachers for students and allowing teachers to view their classrooms from different perspectives.

*Teaming as Support for Professional Development.* Bickel and Artz (1984) describe team supervision for instructional improvement. The supervisory team was part of Pittsburgh's school improvement program. Members of the team, consisting of a project director, a teacher, one special supervisor and two general education supervisors interacted as individuals sharing ownership of school improvement goals. As a team, they coached school personnel toward goal achievement. Paquette (1987) states collegial support exemplifies a different purpose for teaming. Teachers in a Canadian high school developed teams to support the members' professional growth activities. As a result, participants achieved personal professional goals. Johnson and Johnson (1987) demonstrate benefits of professional cooperative efforts in their research. They state that social interdependence can
be structured competitively, individualistically or cooperatively. In a cooperative structure, peers work together to achieve outcomes benefiting each other and success is jointly determined. A meta-analysis of research demonstrated that cooperation promoted higher achievement, greater social support and higher individual self-esteem.

Krovetz and Cohick (1993) report that professional development support teams have been used instead of traditional evaluation in the Santa Cruz City Schools, California. Teachers participating in the project determined areas of professional development and the project allowed site faculty to individualise staff development efforts. As a result, teachers improved the quality of their work, built professional relationships, and developed shared professional goals.

**Teaming for Problem Solving.** West and Idol (1990), calling teaming “collaborative consultation,” defined teaming as an interactive process to generate creative solutions to mutually define problems. Team problem solving has been employed for determining pre-special education referral strategies, for individual student programming and placement decisions and for decisions addressing school-wide issues (Fishbough, 1997). Pugach and Johnson (1989) report a teaming approach may be more effective than traditional prereferral intervention, which has been in the form of consulting. Moreover, Graden (1989) has concurred that prereferral intervention should be based on collaboration employing systematic problem solving approaches. Donaldson and Christianson (1990) report that a collaborative decision making model was developed for selecting the least intrusive intervention strategy appropriate for individual students. The team determined five options and several decision points before considering continue or pullout services.

Welch, Judge, Anderson, Bray, Child, and Franke (1990) have developed the collaborative options-outcome planner (COOP) as another model of team problem solving. The COOP process involves several steps and written answers of questions before making
decisions about student programming. Forest and Pearpoint (1992) report that the McGill action planning system was employed in order to focus educational decision making on the individual. This team decision-making process includes peers and parents in special education planning and exemplifies the teaming model. The process involves asking questions of the student and other significant people in his/her life in order to plan the most supportive educational program possible. Further, this process has been used to address team goals by middle school teachers, and the team reached consensus on how to avoid barriers to teaming and fulfil the goal of their middle school programs.

Types of Collaboration

In Study Two: A Detailed Science Website Analysis, the two kinds of science websites, science website for science teachers and science website for a general audience were investigated regarding the use of the Internet for collaboration among science teachers and analysed using Fishbough’s model of collaboration and types of collaboration suggested by Little (1990). The types of collaboration are elaborated below.

Little (1990) introduces four types of collaboration. They are ‘storytelling and scanning for ideas’, aid and assistance’, ‘sharing’ and ‘joint work’. These terms constitute more than a simple inventory of activities. In her words:

They are phenomenologically discrete forms that vary from one another in the degree to which they induce mutual obligation, expose the work of each person to scrutiny of others, and call for, tolerate, or reward initiative in matters of curriculum and instruction…. The move from conditions of complete independence to thoroughgoing interdependence entails changes in the frequency and intensity of teachers’ interactions, the prospects for conflict, and probability of mutual influence. (pp. 511-512)
Storytelling and Scanning for Ideas

Little (1990) suggests that in daily classroom life, teachers occasionally search for specific ideas, solutions, or reassurances and they gain information in the quick exchange of stories. Little describes this conception of collegial relations:

One cannot examine the boundaries of teachers’ professional relations without taking account of this pervasive “ordinary reality” of sporadic and informal exchanges. A school’s staff may be described as “close,” offering large doses of camaraderie, sympathy, and moral support, but the texture of collegial relations is woven principally of social and interpersonal interests. Teachers’ autonomy rests on freedom from scrutiny and the largely unexamined right to exercise personal preference; teachers acknowledge and tolerate the individual preferences or styles of others…. In all these ways, the modal conception of collegiality is both characteristic and reinforcing of a culture of individualism, presentism, and conservatism. (p. 513)

Teachers and their colleagues learn indirectly and informally about their own and others’ practices through exchanges. When teachers are confronted with problems in their occupational practices that suppress forms of help seeking, they use stories to gain information indirectly (Little, 1990).

Aid and Assistance

Little (1990) suggests teachers as colleagues will give one another help and advice when asked. This conception is probably the most pervasive expectation among teachers that dominates studies of one-to-one interaction among peers and some studies of innovation and professional development. The limitation for this conception is that questions that colleagues ask one another are interpreted as requests for help. In her words:

Under the rubric of aid and assistance, the prevailing model for professional interaction is one that treats the matters of teaching in piecemeal fashion while resting on implied asymmetries in teachers’ status. As a basic form of collegiality, or as an outer boundary on expected interactions among teachers, learning by asking seriously limits the degree to which teachers possess what Lortie (1975) has termed a “shared technical culture”. (p. 516)
Sharing

Little (1990) suggests the routine sharing of materials and methods or the exchange of ideas and opinions among teachers is one kind of collaboration. Teachers can expose their ideas and intentions to others by making the ordinary materials of their work accessible to one another. As she wrote:

Sharing is a term that invites commonsense interpretations, appearing to promise a robust but harmonious exchange of insights and methods. In fact, however, sharing is variable in form and consequence. It may prove normatively permissive or obligatory, may engage more or fewer teachers, maybe fully reciprocal or only marginally so. Teachers may reveal much or little of their thinking or practice in the materials and ideas they share. (p. 518)

Joint Work

Little (1990) states that ‘joint work’ is the kind of collaborative work that implies stronger interdependence, shared responsibility, collective commitment, and greater readiness to participate in difficult parts of development and improvement. As Little wrote:

I reserve the term ‘joint work’ for encounters among teachers that rest on shared responsibility for the work of teaching (interdependence), collective conceptions of autonomy, support for teachers’ initiative and leadership with regard to professional practice, and group affiliations grounded in professional work…Collegiality as collaboration or as joint work anticipates truly collective action…Joint work enables teachers to engage in direct commentary on the moral, intellectual, and technical merit of classroom practices and school-level programs or policies. (pp. 519-522).

In conclusion, Little (1990) states that the first three types of collaboration: ‘storytelling and scanning for ideas’, ‘aid and assistance’ and ‘sharing’ are weak forms of collegiality since these conceptions can simply confirm the status quo. However, she describes the fourth type ‘joint work’ as the strongest form of collaboration as it is the kind of collaborative work and culture most likely to lead to significant improvement.
Summary

In order to reach the desired outcome from educational change, teachers must employ the appropriate strategy that can support their work. Teachers talking, planning and observing each other as collaboration is one way to achieve the goal. The review describes many benefits of collegiality and how it can bring about teacher development and institutional reforms. Collaboration helps teachers learn from one another as well as share and develop their experiences together. Collegiality can also enable teachers to receive and give ideas and assistance. Further, in schools where teacher collaboration is promoted, teachers can trace both students’ achievement and the diminution of problematic behaviors in classrooms.

In the contemporary world, education is becoming increasingly collaborative with the occurrence of the Internet, thus it is no surprise that educators around the world are seeking improved methods of collaboration through the medium of the Internet. They can use tools such as an e-mail, whiteboard and chat room for their collaboration. This study aims to investigate science teachers use of the Internet to support their collaboration. Hence, it is necessary to understand the use of Internet for collaboration of those educators.

Chapter 3 presents a review of collaboration via Internet of many disciplines such as business, medicine and especially education.
Chapter 3

Teachers’ Collaboration via the Internet

Introduction

This chapter provides a literature review relevant to the Internet and collaboration via the Internet.

What is the Internet?

Lane and Summerhill (1993), among others, explain that the “Internet” is an existing worldwide communications system, which links together thousands of computers around the world. Neely (1998) aptly describes the Internet as a “network of networks”. Also, she notes that the Internet is an untied collection of thousands of smaller computer networks in countries around the world, and it connects hundreds of thousands of academic, government, military and public computer systems, empowering millions of people to communicate and share information. Ebbs and Horey (1995) also indicate that the Internet is made up of millions of computers connected in many ways so they can exchange messages, files, video, sound and software. Badgett and Sandler (1993) view the Internet as a telecommunications superhighway, which picks up information from organizations, government institutions, private individuals and universities over branch roads leading into almost every corner of the planet. Lambert and Howe (1993) have stated that the Internet is a knowledge highway linking thousand of individual computer networks throughout the
world. Garfield and McDonough (1996) also explain the Internet as a gigantic ‘highway’, which links continent to continent, bridging oceans, mountains and deserts, extending to almost every city and town in nearly every country on the globe. In addition, there are millions of positions along the roads to stop such as museums, libraries, stores, concert halls, zoos, research centres and schools.

In science education, Gauger (1994) sees the Internet as a vehicle for change and a new instrument for teaching that will give teachers new techniques to encourage students, improve instruction, and increase the level of professional development and science education. Lambert & Howe (1993) explains that the Internet allows physicists access to supercomputers in distinct states, making possible for them to produce computer simulations far beyond the qualities of the computer in their office. Also, the Internet is a research tool that permits biologists to keep on top of current developments in molecular biology.

Background and History

In 1969, the United States Department of Defence designed the Internet as a military network. The military leaders were worried that strategically vital military defence computer networks, used to line up its satellites, check its fighter planes and ships and direct its rocket systems could be damaged by Russian nuclear bombs. Further, in those days, computer networks were very complicated structures. A central computer was at the top of every computer network and it organised the activities of all other computers linked to it. Thus, if one computer wanted to communicate with another computer, it would initially have to get the authorization from the central computer.
This type of network was in danger; Russian nuclear bombs could destroy the central military computer and efficiently cut off communication with all computers linked to it. The military would be sightless as it greatly depended on its network. This notion horrified military leaders; hence a number of talented computer engineers were grouped together in the Advance Research Projects Administration (ARPA) to design a new network model that could resist those strikes. The satisfying result becomes known as ARPANet, which can resist the demolition of one or more computers connected to it, whilst still permitting the remaining computers to communicate efficiently. Each computer ‘knew’ the position of every other computer linked to the network, by the use of sole addresses saved on a database. Every computer did not require permission to ‘speak’ to another computer, as they were equal. If one or more computers were inaccessible it would easily notice the problem and then prevent passing on information to the remote computers until the situation was cured. The successful network was used to link the military’s computers and a small number of selected universities.

ARPANet grew quickly, linking most universities in the United States as well as computers in England and Europe. This situation so concerned the Department of Defence that it separated its computers from the network and established MILNet, which was based on the same network model but only used by the military. Hence, ARPANet developed to link countries from around the world and became recognized as the Internet (Badgett & Sandler, 1993; Ebbs & Horey, 1995; Hofstetter, 2001; Neely, 1998).

America’s Agenda (1993) reported that the White House announced plans to use the Internet as the notional framework for the National Information Infrastructure. By building a door-to-door information network, a technological superhighway would link every home, business, laboratory, classroom and library by the year 2015. Consequently, people on seven continents are using the Internet for many purposes such as collaboration,
exploration, communication, teaching, and learning (Gauger, 1994).

In particular, the Internet use for collaboration among science teachers is the focus of this study.

**Accessing the Internet**

It has been called “The High-Tech highway,” “the virtual library,” and “the data super-highway.” It provides high-speed communication between 2 million computers located in 125 countries on 7 continents. It is the Internet, the international high performance communication network that serves as a global platform for daily communication and as a research mechanism for millions of users (Gauger, 1994, p 26).

The Internet is a huge source of information, but that information does not connect to a user’s gate like electricity and water. The user has to make a connection to it, usually with a modem, which plugs the user’s computer into the phone line, and software to drive the modem will be needed as well. Also, connecting into the Internet is through a registered host computer. The access is made through a workstation in a local area network (LAN).

It is useful to summarise the many types of equipment that run the Internet. For example, the modem is a tool used by a computer to send and receive data over a telephone line. The word *modem* stands for modulator/demodulator. When one makes a telephone call, the caller’s voice is sent over the telephone line as an audible tone to a receiver’s telephone, where it is reconverted from a tone to the caller’s voice. Modems do much the same thing. Thus, when a computer sends data, it is converted (modulated) into a tone, which is reconverted (demodulated) at the receiving end by the other modem. This process of modulation/demodulation allows computers to transmit data using existing telephone lines, which is an economical form of communication. When sending data via a modem, computer and modem are instructed to make a telephone call. The modem at the other end
will detect and answer the arriving call. When the modems first link, a user will possibly hear a screeching noise as the computers notify each other to set up the link as they organize to send and receive data.

Furthermore, Local Area Networks, LANs, is a set of computers linked directly together in a room or in a single building. Each computer joined to a LAN can share information and communicate with every other computer that is connected to the LAN. When two or more LANs are linked, a Wide Area Network (WAN) is created. The individual LANs that comprise the WAN are possibly located in different buildings, suburbs, states or countries. Most WANs are linked by committed telephone lines, other more complicated networks may use satellites to share or swap data between the particular LANs, which comprise the WAN. The Internet is an enormous WAN, connecting many hundreds of computer networks around the world.

Hence, a network is established and all linked computers start to talk with each other. The systems of these talks are called “protocols”, recognized as TCP/IP, Transmission Control Protocol/Internet Protocol. So, the Internet is a huge group of computers talking the same language. The language includes locations and movement such as addresses, addressing formats, systems of directions for moving things from one address to another, and so forth. It is usually referred to in the context of TCP/IP software. Every computer on a network running TCP/IP software recognises every other computer on the network, and knows precisely where on the network map they are. Thus, a computer can transmit information to another computer along the fastest way. In the case that the receiver computer is too busy to receive the information, it simply checks with the network map to find another computer that can send the information. The capability to find the best, fastest, most expedient means of sending information, and to avoid known problems, was a major advancement in computer intercommunication.
Further, new types of the TCP/IP software were developed to allow personal computers such as the PC and the Macintosh to join the network. Different types of computers can access TCP/IP networks of each other because of software programs known as “gateways”. For example, information from an IBM network is passed through a gateway program, which translates the data into a form suitable for a Macintosh computer. Therefore, a person with an IBM PC can sit at his/her terminal and send e-mail to a colleague, which can call up the message and read it on a Macintosh.

In addition, the Domain Name System (DNS) is the method by which the various separate and diverse networks linked to the Internet are mapped. Thus, the DNS is the key to understanding the Internet, and how to navigate around it. It is the computer equivalent of street signs and house numbers. It is a collection of large databases that store the names and addresses of the networks connected to the Internet. All computers on the Internet use these databases to find other Internet computers.

As indicated above, computers on the Internet communicate with each other using a protocol known as TCP/IP. IP stands for Internet Protocol; it is a numerical address that is assigned to every computer linked to the Internet. However, humans have difficulty remembering numbers, so domain names, such as myschool.edu.au, which are much easier to remember, are designed for humans. Computers prefer to communicate with each other using numerical IP addresses but they allow humans to use addresses they can easily remember, and the two names must be cross-referenced. Cross-referencing is taken care of by the Domain Names System databases. For instance, when people specify an IP address using the human domain name, the computers will first access a database, a DNS Name Server, which contains both the domain names and numerical addresses of all computers connected to the Internet. The domain names of Internet sites have a similar structure as certain conventions control the naming of computers connected to the Internet. When
people become familiar with these conventions they will be able to look at the domain name of an Internet site and tell where in the world it is and what sort of connection they have to the Internet.

Consequently, maximedia.com.au is a computer in Australia (.au), which belongs to a commercial organisation (.com) that is called Maximedia (maximedia) (Badgett & Sandler, 1993; Ebbs & Horey, 1995; Hofstetter, 2001; Neely, 1998).

Internet Software

Hofstetter (2001) notes that the Internet software creates thousands of instructions that travels over the wires, satellite links and optical fibres that make up the physical part of the Internet. He also states the Internet is a global connection as it connects of more than 72 million computers by using the Internet Protocol (IP) to communication. The Internet Protocol was developed to create a network that would carry on working even if one or more of the networks were destroyed. On the Internet, people are organised in relation to services specified by protocols that indicate how information travels across the Internet. The most popular protocols comprise electronic mail (e-mail), listserv, newsgroups, chat, videoconferencing, File Transfer Protocol (FTP), multimedia streaming, and the World Wide Web. All these instructions use the Internet Protocol to get to the right place and cause the required action. The software had different names like Gopher, World Wide Web browser, Internet Relay Chat and Veronica. Further, they are used in different ways; for example Gauger (1994) has described the three primary utilities of the Internet software including communication, research, and transfer tools.
Communication software allows Internet users to correspond via electronic mail (e-mail) or through others such as TALK, A Listserv, TELNET, USENET, and the FINGER. Internet research tools are developed by key research organizations and universities to locate information, for instance ARCHIE, WAIS, and WWW. Further, Internet file transfer tools can transmit the entire Encyclopedia Britannica coast-to-coast in 60 seconds, or about 67 million words per minute. FTP, file transfer protocol, is an Internet system that sends and receives information between computers (Gauger, 1994). However, two software tools, The World Wide Web and Electronic Mail (e-mail), can deal with most of the functions: information and communication that users need (Hofstetter, 2001). Thus, this study focuses primarily on these two software tools.

**The World Wide Web (WWW)**

Tim Berners-Lee is the primary inventor of the World Wide Web, the system of text links and multimedia capabilities that made the Internet available to heap audiences. He wrote the original Web software himself in 1990 and made it obtainable on the Internet in 1991 ([http://web.ask.com/web?q=Tim+Berners-Lee&qsrc=1&osrc=1&osrc=0](http://web.ask.com/web?q=Tim+Berners-Lee&qsrc=1&osrc=1&osrc=0)).

Many authors have explained what the WWW is. For example, Badgett and Sandler (1993) indicate that the WWW is an Internet searching tool based on indexes and text searches. Neely (1998) states the World Wide Web (the Web) is one of the main tools that will be used in the classroom environment. Because of its ease of use, the Web has caught the imagination of the mass media, technologists, educators and even big business. Hofstetter (2001) has explained that the WWW is a networked hypertext system that allows documents to be shared over the Internet. Thus, to understand the Web’s function, it is
essential to briefly know about Hypertext, which refers to text that has been linked, and which was originated by Ted Nelson (1965). Key words in hypertext, which are displayed on screen in a different color, italicized or underlined to enable them to be readily identified, are linked to other passages. By clicking on the highlighted key word with a cursor or mouse pointer, readers are taken to the related information. Hypertext links are contained in documents, and the software applications used to view them, called browsers or Web browsers. Further, Ebbs and Horey (1995) state the World Wide Web is a system of linking information together which is accessible by browser programs. A Web browser is simply an application that can interpret the links embedded in the documents and access the related documents on demand. Web documents often have links that automatically connect the reader to computers in other areas of the Internet, even on the other edge of the world.

In 1994, Netscape Communications Corporation introduced a program called Netscape Navigator which became the most popular Web browser at the time. Also, Microsoft produced a Web browser called Microsoft Internet Explorer, which ships as part of the Windows operating system. These, and other, Web browsers enable users to access almost all of the Internet’s services and resources without requiring any other software. The Web is growing in popularity; more sites are being created with the sole purpose of providing guides and directories of the information contained on Web servers around the world. How users use the Web or other Internet resources depends on the software they are running to access it.

The WWW users will notice the term “URL”, which is often used when discussing Web browsing. URL is an abbreviation for Universal Resource Locator. Every document or resource available on the Web has a URL. URLs are just a reliable, short hand method of referring to resources offered on the Internet. Web browsers understand these URLs when they command them to reclaim documents. URLs are often used in combination with one
of numerous commands, such as the http:// command. This is a contraction for hypertext transfer protocol, which the protocol is defining how information is to be sent or retrieved via the Web. By using the http:// command in conjunction with the URL, the user instructs the Web browser to expect the document to be in Web format and act accordingly. Specifying http:// in conjunction with a URL used to be mandatory. However, it is now not generally necessary to include this, as modern Web browsers can accurately determine what type of resource the user is trying to access (Ebbs & Horey, 1995; Hofstetter, 2001; Neely, 1998).

Search Engines

There is huge amount information on the Internet so Search Engines were created to help users to locate a certain piece of information a needed. Many different Search Engines are offered on the Internet such as Yahoo, Lycos, Alta Vista, Web Crawler, Excite, InfoSeek, and Google. Most Search Engines provide search and directory features, although individual Search Engines tend to emphasise one of these services. Search Engines are essential to index the contents of the hundreds and thousands of Web sites around the globe. There are two methods, Manual and Automatic, for Search Engines to indexing sites.

Manual is a method in which a creator of a new Web site submits a brief summary of the site’s contents to a number of Search Engines, including details of which category the site should be listed under such as computers, businesses or education.

Automatic is a method that most Search Engines are programmed to regularly scan the Internet and find sites that have not yet registered. Thus, when a Search Engine finds an unregistered site, it connects to that site and downloads the available information and then
scans the text for key words that it uses to index the site. In addition, to use the Web Search Engine users must decide which of the many Search Engines will be used, and then they must decide which key words will be used to locate the Information they need (Hofstetter, 2001; Neely, 1998).

**Utilisation and Advance of the Internet**

Nielsen/NetRatings (2002) report that today nearly a half billion people worldwide have Internet home access. Also, U.S. Department of Commerce (2000) reports that, in the United States, more than half of all households have a computer, and more than 80 percent of these households have access to the Internet. Adam, Bowe, and Murphy (1996) stated that the previous 10 years saw the number of computers connected to the Internet grow from 2,000 (1986) to almost 10 million (1996). Hoffman and Novak (1994) stated that the Internet was estimated to be doubling in size and volume on an annual basis, wrapping the world in a massive computer web. In 1994, it was the world’s biggest collection of interconnected computer networks and connected 50 million users across 140 countries.

The Internet can be used in many ways such as a tool for research. Few researchers used the Internet for collecting data; for example Johnson (1997) gathered detailed information about how public relations practitioners use the Web, particularly as a way to reach specific audiences, and Thomsen (1995) examined online tools for issue management. Esrock and Leichty (1998) concentrated on the Web as used within organizations. Harris (1995) and Chamberlain (1996) studied the Web as used in health communication. Also, Sundar, Narayan, Obregon, and Uppal (1998) examined the Web as an advertising medium, with researchers discovering that the Web advertisers need to do more to attract readers than
advertisers in a traditional print medium.

Furthermore, the Internet has been used in many areas such as *medicine, business,* and *education.* For example, in *medicine,* there is little opportunity for medical students to develop a physician-patient relationship, which limits their ability to improve their communication skills and become culturally sensitive to patients’ issues. Modern methods, compatible with the current educational system, are needed to increase the focus of medical training and provide opportunities for feedback on patient interaction. Opportunely, advances in communication technology offer chances to develop training models that previously were not possible. Thus, HealtheQuest (a school-based tobacco prevention program in which medical students and pediatric residents served as mentors for schoolchildren) was established. This program offers a model for providing medical students with experience in community health and a way for them to acquire feedback on physician-patient communication (Bernhardt, Dalton, Sargent and Stevens, 2000). Further, Bernhardt, Dalton, Sargent and Stevens (2000) report that the e-mail part of this program provides significant learning opportunities for student physicians in tobacco control, child development, communication skills and developing the physician-patient relationship. This model offers potential for medical students to understand pediatric populations as well.

In addition, doctors are using the Internet to develop better treatments by sending information about patients to colleagues on the other side of the world. Sutcliffe (2000) notes that an estimated 40% of doctors use the Internet regularly for e-mail, treatment information, online continuing medical education classes and collaboration with peers in discussion groups. He also suggested that pharmaceutical marketers who want to sell their products to the doctors could design an appropriate website for their pharmaceutical products, especially in the ways that influence those doctors.
Business. Consumers are buying everything from groceries to clothes and airline tickets on the Internet. Companies are using the Internet as a cost-efficient medium for communicating with suppliers and interacting with customers. For example, Rimoldi (2004) points out that the Internet is very important for design engineers as it allows them to securely transfer the essential data, and access to a lot of information, which is much easier and faster than before. Millman (1998) has reported that a survey by online travel software vendor E-Travel reveals that companies can reduce travel costs by up to 20 percent if they adopt online booking software. More than 30,000 physical travel agencies handle 80 to 85 percent of ticket sales, a percentage expected to decrease by several points as airlines begin selling tickets via the Web. American Express is teaming up with Microsoft and MCI to handle travel through its American Express Interactive (AXI) corporate reservation system, with Microsoft providing the application software and MCI contributing its Internet Solutions Center for Web hosting. AXI is a complete service that lets travelers book airline, hotel rooms and rental cars. The system displays availability, schedules and prices. It also includes airline seat charts, maps to hotels near the meeting site, information about nearby health clubs and restaurants and destination weather information. AXI’s system remembers users’ preferences and creates a profile for each user, imitating services that human travel agents might provide.

Gruman (1991) presents the results of the Second Conference on Organizational Computing, Coordination, and collaboration, held in Austin, Texas, in his article “the Beginning of Collaboration Technology” showing that the collaboration technology was focused on e-mail and bulletin board systems. He also concluded that the e-mail system can offer more collaborative practice among people in several fields, including more interaction among researchers or employees, more sharing of resources among divisions of a company or even among companies, and more effective communication among business managers.
and employees with themselves and each other.

In education, Troutner (2003) has found many websites on collaboration, cooperative learning, and project-based learning were offered for teacher-librarians and classroom teachers to work together for helping students learn. Grant and Scott (1997) have examined the way in which university researchers, scientists and industrialists use the Internet to communicate and work together. For example, the partners used File Transfer Protocol (FTP) to transfer the draft proposal, as the electronic document was easy to edit. They found the Internet reduced the barriers of this collaborative working such as geographical remoteness, lack of time in the working day, the cost of travel and difference in culture.

However, the Internet can be used in an unlawful way as reported by St George, Emmanuel, and Middleton (2004) studied drug misuse via the Internet. They found that a patient who clicked on a mouse could have whatever drug he or she wanted from online pharmacy services available 24 hours a day. Those sites are easy to use and often require little information to gain access to a wide range of prescription drugs, such as diazepam, alprazolam and temazepam.

The Internet and Education

The Internet is being used for all aspects of education, including administrative, educational, professional development, library and community building (Parker, 1994).

Administration. Parker (1994) who examined the important of the Internet and schools found that it is quite a large scope in school education for administrative applications, systems that provide everything from student record creation and maintenance, to class scheduling, food services and accounting. For the most part, these systems are accessible to
local districts or regions only and are not networked into large systems. There is much need for the ability to transfer administrative information between schools and districts. What are needed are standards for the exchange of this information across a common network, such as the Internet. Using Electronic Document Interchange (EDI), student records could be transferred across the Internet to other schools, as well as universities and community colleges. The time could be cut from weeks to seconds and estimated cost savings are considerable.

*Educational.* Students, teachers and educators can use the Internet to support their study and work. For example, Jarvis, Hargreaves and Comber (1997) report their study of the effect of collaboration via e-mail links on the quality of 10-11 year old students’ science investigative skills in six primary rural schools. In this research, students were taught to use a variety of computer tools such as electronic communication and a data processing package. The students in each school were asked to collect and identify moths from two habitats in their locality and then transfer information, via e-mail, to other schools. The results show that students demonstrated a variety of science skills and used the e-mail facilities with varying degrees of success. The vast majority of science skills demonstrated by the students were observation and recording. Most students were very positive about the use of computers and considered that e-mail was a valuable way for collaboration in studying science. Gilmer (1997) investigated the using of the Internet to teach physical science in elementary schools in Miami, Florida. The website called Connecting Communities of Learners (CCL) was designed for teachers to communicate with an individual student, small groups of students, or the whole class, and for students to write to both the teachers and other students via e-mail. Teachers were asked to deliver an e-mail message about favorite action experiments in physical science that they developed collaboratively during class time, and students had to post critical reviews of elementary
school teachers’ accounts of action research, and to engage in dialogue with each other on field experiences in physical science in elementary school classrooms. The results show that the Internet is a powerful way to enhance the learning of students. Students learned to know science at a deeper level as the e-mail program provided them with a chance to organize their thoughts, post them on the web, read the ideas of each other and have dialogue with both teachers and other students.

Further, Jackson and Bazley (1997) suggest that science educators can use the Internet in three potential ways. First, they can access information and knowledge. The Internet has the broadest and most updated library of scientific information such as on-line journals, the resources of universities, scientific research associations, and focus groups or individuals. Besides, a variety of search engines help them to search for everything of scientific interest. Those are *Alta Vista, Google, Lycos, Webcrawler, and Yahoo*. Second, the Web is a powerful tool for educators to communicate with each other or other people across the world without regarding cultures or age groups. E-mail is used for the communication that takes various forms such as discussion groups, newsgroups, web-based forums, informal chat environments and CUSeeMe videoconferencing. Third, science educators can develop collaborative projects on the Internet as networking offers a gigantic capacity to work with people who have the same interest and objectives all over the world.

Also, Jackson and Bazley (1997) recommended many science educational practices via the Internet. For example, research tools: *Internet for learning* site ([http://www.rmplc.co.uk](http://www.rmplc.co.uk)) is a good place to find and share information within the educational world and *Schools On-Line* ([http://www.shu.ac.uk/schools/sci/sol/contents.htm](http://www.shu.ac.uk/schools/sci/sol/contents.htm)) is good at library links, on-line projects and a question-and-answer area. In Australia they also suggested many educational websites such as Australia’s *Mag-Net* ([http://mag-net.educ.monash.edu.au/](http://mag-net.educ.monash.edu.au/)) that is regarded as promoting a variety of projects. In addition, one of the most common uses of the Internet in
education is for instructional purposes. There are lots of distance learning projects being conducted, ranging from electronic pen pals to collaborative or comparison studies. One such project involved students from different countries comparing prices, packaging and contents of various products, integrating math, social studies, language and geography.

Professional development. Many teachers are using the Internet for professional development. For instance, Gallo and Horton (1994) found that after teachers became more experienced and confident using the Internet they began to explore ways they could implement it in their classrooms. For example, a teacher provided students with access to network news so his students could post questions on research topics. Moreover, teachers discovered many ways to use their Internet connection such as getting into the Federal Information Exchange, obtaining some information on minority schools, and checking the news all the time. Gallo and Horton also found teachers used the Internet as a motivational tool, a builder of self-esteem and a way to help students to create resumes for themselves.

Other than collaborating with colleagues and developing joint projects, teachers can also engage in dialogues with field experts. Using the Internet, teachers can connect to NASA and send questions to space experts, including space shuttle astronauts. Another project provided by the Educational Resources Information Centre (ERIC), a US national information system, provides an Internet-based question-answering service for teachers, library media specialists and administrators who have questions about K-12 education, learning, teaching, information technology and educational administration. Anyone involved with K-12 education can send an e-mail message to AskERIC and receive an answer within 48 working hours. Teachers can also download useful information, guides and images for use in the classroom. Many are taking advantage of online Associated Press (AP) and Reuters newsfeeds, the daily CNN (Cable News Network) Newsroom curriculum guide, NASA space images and regularly updated weather reports; all of these are easily
accessible and available on the Internet.

Library. Broholm and Aust (1994) studied the communication patterns of teachers who were early users of UNITE, a regional-area-network electronic mail system designed to encourage curricular collaboration and sharing of resources. The e-mail program, which is used in this study, was part of the Unified Network for Informatics in Teacher Education (UNITE) system developed at the Kansas University Instructional Technology Center. The results of the study show that the largest group of electronic mail users was the science teachers. However, the most avid users of the e-mail system were the librarians as most computers are located in libraries. They corresponded on the system with more individuals than non-librarians, and especially they sent more messages than other teachers.

Community building. Johnson (2000) points out that there are many advantages in providing community access to school resources. Some school and network projects are encouraging parents to become involved and have offered access via dialup accounts to school systems. Homework assignment archives, schedules, calendars, lunch menus, etc. are just some of the things that can be made publicly available. Additionally, teachers are more accessible via electronic mail for parent or teacher conferences. While community access is not as well–defined or made known yet, it is a crucial part of the educational and community-building use of the Internet. Several schools are experimenting with providing low-cost accounts to parents and members of the surrounding community to provide access to local school information and the Internet. Also, Johnson (2000) states that genuine, regular, and real-time collaboration with parents can make a positive difference in a child’s learning experience. Thus, teacher created Web pages available on the Internet can simplify communication and planning efforts.
Electronic Mail (e-mail)

Electronic mail was developed so that people can communicate when they cannot contact in person. People no longer wait for traditional postal mail delivery as it is very slow, and has became known as *snail mail* (Hofstetter, 2001). On the Internet, both the sender and the receiver can exchange many messages with each other in a single day. E-mail is the most popular, and probably the most productive, resource available to Internet users. E-mail is mail sent over a network, which can be a local area network (LAN) where all the users are in the same building and using the same computer system. Further it can be a network of non-related computer systems that crosses the globe. E-mail generally takes only seconds to find its way across the network to the mailbox of the recipient, regardless of whether this is across the room or across the globe. The ability to send electronic messages almost instantly to other users anywhere has made the world a much smaller place, enabling millions of people to share information and participate in discussions on an unprecedented level (Ebbs & Horey, 1995; Hofstetter, 2001; Neely, 1998). Gruman (1991) reports the results of the Second Conference on Organizational Computing, Coordination, and Collaboration, held in Austin, Texas, in his article, *the Beginning of Collaboration Technology*. The collaboration technology focused on e-mail and bulletin board systems. He concluded that the e-mail system can offer more collaborative practice among people in several fields, including more interaction among researchers or employees, more sharing of resources among divisions of a company or even among companies, and more effective communication among business managers and employees with themselves and each other.
Utilisation and Advance of E-Mail

The use of e-mail has been the subject of communication research for about two decades. Many studies noted the technological capability of e-mail. For example, Althaus (1997) dealt with e-mail use within organizations. Kiesler, Siegel, and McGuire (1984) looked at the social and psychological implications of communicating with e-mail versus more traditional methods of communication. They found that people using e-mail appeared to be less inhibited than those communicating face-to-face. Sproull and Kiesler (1991) concluded that e-mail not only changes how people work together but also can influence the structure of an association. Phillips and Eisenberg (1993) point out that e-mail can be used to achieve strategic goals within an association setting. Schaefermeyer and Sewell (1998) found that e-mail was replacing other types of communication, including telephone, letters, and face-to-face communication. Many authors report that e-mail and Internet is used as tools for collaboration. O'Dowd (2003) reported that Spanish and English second Year University students used e-mail and the Internet as tools for their collaboration by exchanging e-mail with each other for one year. They found e-mail helped them to develop learners’ intercultural communicative competence. Furthermore, Liaw (2003) described results of a cross-cultural e-mail project, which was offered for a group of English-as-a-Foreign-Language teachers in Taiwan to work together with bilingual/English-as-a-Second-Language pre-service teachers in the United States. The partners exchanged significant information on the areas of interpersonal, sociocultural, pedagogical, and language learning subjects.

Hunter and Allen (1992) report e-mail is broadly used, with users ranging from major businesses to academic societies. For instance, Russell, Bebell, O'Dwyer, and O'Connor (2003) explained that experienced teachers used e-mail to deliver instruction and for
student activities. Dorman (1998) notes that teachers use e-mail to improve classroom teaching. Bunting and Russell (1998) state that health care researchers use e-mail to synthesize data and Schmitz and Fulk (1991) found petrochemical organizations use e-mail to do research. Ey (1995) notes that the Electronic Messaging Association, a group funded by corporate e-mail users, estimates that the largest two thousand U.S. corporations have five million employees who share 6.1 billion e-mail messages each year. Crowther and Goldhaber (2001) report that Rogen International, which studied the effectiveness of e-mail and face-to-face communication in the workplace in the USA, found that e-mail use has grown by more than 600 percent in six years.

In addition, Dimmick, Kline, and Stafford (2000) found that nearly half of their respondents reported using the telephone less frequently since they began using e-mail. Thus, e-mail was noted to be superior in fitting into people’s work schedules and allowing them to communicate readily across different time zones. In contrast, the phone provided greater sociability for respondents. These researchers concluded that telephone and e-mail both have broad niches that are not in direct competition with each other and are not substitutes for one another. Flaherty, Pearce, and Rubin (1998) have similarly concluded that e-mail is a functionally specialized serving as a unique communication channel that enhances but does not duplicate other communication methods. Tumminello and Carlshamre (1996) state reliable, efficient alternatives to individuals working on projects in a central location are becoming a reality. If individuals are able to work together without being in the same physical location, businesses can make more efficient use of their human resources. They studied two individuals in the computer industry: Par Carlshamre, a systems analyst from Sweden and Joanna Tumminello, a technical communicator from the U.S who collaborated over the Internet for one year by using e-mail to send their work back and forth throughout their project.
Further, Grant and Scott (1997) note that an everyday use of e-mail in a company or university is to announce conferences, schedule meetings, arrange appointments between employees and managers and distribute committee meeting. Thus, e-mail is a medium for sharing hypotheses, results, preparing draft documents and for discussing project issues. The uses of e-mail are never-ending, as it has become an essential instrument in most collaborative work and definitely in everyday academic time. Peat and Fernandez (2000) state that the major advantage of the Internet might be considered to be the interactive communication capabilities afforded by virtual access, virtually anywhere and virtually anytime. According to their study, Broholm and Aust (1994) found that teachers used the e-mail system both for work-related discussions and social purposes.

Russel and Cohen (1997) report their investigation into the use by reflective colleagues who use e-mail as a means for improving university instruction. These two researchers are university academics living in different countries; one is living in Oregon, U.S.A., another in Queensland, Australia. They captured their e-mail communications during a ten-week teaching course. One academic contemplated her struggle to teach a new subject and another academic responded to the introspections. The role of e-mail in the process of journalising together was non-hierarchical and the term “reflective colleague” was used to explain the mirror-like role provided: supportive affirmation, belief clarifications, alternative perspectives, and future and global projections. The results show that both colleagues found value in exploring together the teaching of a new course. One colleague stated that benefits to her were: being heard, feeling support when things were difficult, getting new ideas and alternative viewpoints, and transforming the experience to one focusing on her own learning. Benefits to the other party were strengthening her own understandings of data she had previously collected as well as applying strategies discussed to her own teaching.
Klemm and Snell (1994) report Networked computers can be an effective medium for teaching interactive groups of students and it can be done through e-mail. This model is often used where students and teachers are geographically separated or have conflicting schedules. Teaching through networking provides several advantages, by allowing a greater concentration on student-centred learning. Students are more empowered to participate, and information is stored electronically and is easily retrievable. Using the e-mail model, teachers send out assignments via e-mail, and students e-mail back their assignments. Messages can be made public if desired. Students’ computer work assures the oft-stated goals of “writing through the curriculum” and of active, student-centred learning. Time is not wasted on roll call, waiting for late attendees, or on verbal and social disruptions in class. Students have more time to do research and to clarify their thinking before responding to teachers’ questions. Shy students cannot hide, but rather are empowered to participate. Information is stored in written form, organized and electronically retrievable. Student accountability is promoted. Additional advantages accumulate when teaching via computer networks employs cooperative learning methods. Student-to-student interactions engage more fully than do student-to-teacher interactions alone. Students must hone their communication and social skills for organizing, summarizing, elaborating, explaining and defending their knowledge to each other. Students may also be inspired by the labors and insights of peers.

Currently, institutional-supported e-mail is the fastest and cheapest way to send data between schools in different parts of the world. Moreover, international sharing of information in global science issues through collaborative school projects is a perfect way to practice the science skills and processes that should be learned and transferred to daily life. In a world filled with distrust and misunderstanding, this method of sharing information may also promote bicultural understanding (Robinson, 1994). Thus, computers
are opening new realms in science, education and entertainment through complex simulations that are closer and closer to reality. One way to help fulfil the educational priorities of the United States is to assure that all students have the opportunity to access and share information, whether they are in wealthy cosmopolitan urban centres or in isolated rural schools. Making databases available to all schools would be one way of providing this opportunity.

Many authors have reported that e-mail is currently being used in education around the world. For example, higher education in the U.S.A, the primary use of e-mail is in collaborative research or in accessing and sharing information by and between faculties. E-mail may also be used to submit articles for journal review, to keep in touch with professional associations and access databases. In physics, proof papers that have been accepted for publication will soon be available on e-mail before they are actually published in journals. Rowe (1993) indicates that teachers are also more likely to communicate more openly when sharing teaching ideas by e-mail than they are in person. Lenk (1988) notes that a number of K-12 classrooms are using e-mail to exchange information with other classrooms in U.S. schools. E-mail can offer a database, promote better collaboration and communication between classrooms and promote an interdisciplinary approach to science teaching. One of the better-known and most widespread interdisciplinary networks for grades 4-6 is the National Geographic Kids Network. As of 1990, it was estimated to have over 10,000 users collecting and sharing data on such topics as acid rain, land use, weather, health, and water pollution. Many secondary teachers are also making use of e-mail as an instructional strategy, but they seem to focus more on the international arena. Ely (1992) mentions that telecommunications is said to be the link that is connecting education to the world, and a number of projects are in progress that are based at least in part on e-mail.
Morgan and Sheets (1992) explain that e-mail is also being used to teach courses in the American Department of Defence schools that are short of teachers in areas such as physics and higher-level math. Assignments are given and sent by e-mail over 11 time zones without the benefit of fiber optics video transmission and satellite downlinks. Feedback on assignments as well as new information to help students do assignments are all transmitted through Internet without the expense of long-distance phone calls. Another international network, Computer Pals Across the World (CPAW), now several years old, involves over 10 schools including those in the U.S., Canada, the United Kingdom, Germany, Australia, and Sweden. Recently the schools shared information from science projects on the water content of snow as well as other climatic conditions in various parts of the world. The original goals of the program fit within the rubric of global education and a global approach to living. Emphasis is on environmental awareness, active citizenship and multicultural education.

However, e-mail is not being used to its full potential in K-12 education. For example, Robinson (1994) states there are at least three reasons why e-mail is not being used more in K-12 education. First, administrators and teachers often think the cost is too high. Second, there is lack of teacher awareness as older teachers are often not aware of the potential for improving instruction through the use of e-mail. Even when they are informed, they may need some in-service training to overcome the barrier and pressure of what they perceive as a complicated technology. They may need release time and financial support to travel to a university or other institution to receive the training. Third, there is a lack of awareness of many college professors of the instructional benefits of the technology. If pre-service courses do not promote its value and require pre-service teachers to learn how to use it in their teaching methods classes, it is certainly less likely that the technology will soon become widespread in the schools.
The study reported here focuses on science teachers using e-mail/Internet as a tool for their collaboration.

E-mail and Science

E-mail was used early and frequently in the scientific community (Aborn, 1988). For instance, Lievrouw and Carley (1990) point out that NASA appears with the word *telescience* to explain how scientists living in different geographic areas used e-mail to communicate and collaborate with each other. Walsh, Kucker, Maloney, and Gabbay (2000) report that now e-mail is widely used in American science. Also, Cochran (1997) found that journalists depend on e-mail to keep in touch with their offices and to communicate with resources that are thousand of miles away.

E-mail and Science Education

It is only in the last few years that the U.S. government has supported networks to the degree that universities and federal agencies can make them available to schools without charge. The reason for this support is directly related to the perceived decline of science, technology, engineering and math education in the United States. It is also related to making education more equitable to students in small rural schools and inner cities where course offering, especially in upper-level science and math, are often limited (Monk & Haller, 1993). In support of giving schools more educational opportunities, a major national science goal is the establishment of national electronic networks that link all American schools with other sites where learning occurs (By the Year 2000: First in the World,
Science and technology are considered so important in the United States that federal money has been supplied to support two key areas in education: first, pre-service and in-service training for teachers of science and mathematics and second, the development of better curriculum and instruction to teach science and mathematics (Robinson, 1994).

Dyrli (1995) points out that as the Internet is connected to numerous networks, thus e-mail can reach resources and individuals around the world. Importantly, it brings enormous knowledge to support classroom curriculum. For example, students who studying science units for Grade 3-8 can send experimental results to a central database, and the entire data are returned to each class for interpretation. Moreover, the project facilitator of the Acid Rain unit for Grades 5-6 can quickly use e-mail to communicate with participants, students and teachers.

E-mail is being used in science education around the world. Science and mathematics are nationally recognized as critical areas; more materials and financial support are available to improve teacher education in mathematics and science than in other subjects. Partly as a result of this increased support, there are a number of science and mathematics e-mail networks that have been set up by states, universities and school districts throughout the United States and other parts of the world (Robinson, 1994). Further, Schwartz (1990) stats science teachers have fallen behind industry and the military in the use of educational technology for instruction. Teachers are not familiar enough with emerging educational technologies to recognize their value in instruction, and when they do recognize their value they do not have the time or opportunity to learn how to use the new technologies.

Berenfeld (1993) notes that a recent international project involves schools in Russia that share information with schools in the U.S. by using e-mail. Holman (1993) reports that in Europe, over 200 secondary schools in more than 10 countries now use facsimile to exchange data in the science project entitled “Science Across Europe”. These schools are
hoping to get e-mail access so that information from every school will be available to every other school on the network. Recently, the project has been expanded to schools in Southeast Asia where it is called “Science Across Asia”. A few U.S. schools from Ohio will be joining the project this year, and it may soon become a world science curriculum endeavor called “Science Across the World”.

Thus, a large number of Internet applications have developed, all through e-mail, including the following: Discussion groups, Online projects, Teacher-to-teacher collaboration, Student-to-student conversations and Key pals.

**Collaboration via the Internet**

Many authors are discovering that telecommunications is a potentially powerful tool to support collaboration or teamwork and thus it is being used by many parties. For example, Hogue (2003), a high school English teacher, stated that she has been a member of the NCTE-Talk listserv for more than three years. On the list, she asked questions about everything she did in her classroom, listened to, and engaged in discussion about pedagogy. This contact helped her to understand some key words such as constructivism, Web-based instruction and hypertext. More importantly, online colleagues inspired her to learn and grow as she successfully created Cyber English class (http://www.sheboyganfalls.k12.wi.us/cyberenglish9/index.htm). Now, it is an online English class model for many teachers to use. Also, Hogue confirmed that the Internet provides an opportunity for natural dialogue among people who share common interests and goals, even though they may never meet.
Bernstein (2000) sees the Internet as a wonderful tool for lawyers to work together as it is low-cost and increases computer skills. Lawyers and others can post messages and engage in online discussion in areas devoted to selected topics on the World Wide Web. Messages and files are preserved on the Internet-permanently, if required. Lawyers can hold group discussions that extend over time, checking into the group from their homes, offices or anywhere else via the Internet. When lawyers new to the discussion log on, all previous discussion is available for their immediate examination. There are three ways that lawyers can use the Internet for their collaboration. First, e-mail is almost universally used by lawyers, who also commonly attach documents to e-mail messages. Second, groups of lawyers use list serves to send e-mail to each other via a store-and-forward mailing list with just a few clicks of the mouse. Lawyers may find list serves do not provide and preserve focused information. Third, forums that are also online discussion groups in which participants with common interests can exchange messages. Unlike list servers, this technology allows messages to be posted directly on the Web, not transmitted by e-mail to individuals on the list. Bernstein suggested that forums is the best tool for lawyers to use as they can focus on the matters they are concerned about and not get bombarded with everything being discussed on a list serve. However, he reckoned that lawyers trying to save time and money might find a combination of basic e-mail, list serve and forums of value.

The present study focused on science teachers’ collaboration via e-mail and Internet. The next part of the literature review analyses the ways in which teachers can use e-mail and Internet for their collaboration.
Teachers’ Collaboration via E-mail and Internet

I’m the only science teacher in my school. I feel isolated as I’ve no one to talk to about teaching science and no one to exchange ideas with, especially I’m not a science specialist so I’d like to share my successes and failures with other science teachers (the Science Plus Teachers Network (http://www.chebucto.ns.ca/Education/SPTN/page3.html).)

This is a time when educators are facing many difficult tasks. They are being asked to change the way they teach, to adapt curriculum to meet new curriculum standards, to change assessment practices and to integrate technology into their teaching and learning.

Some educators are finding that collaboration among teachers around issues raised by these challenges can be a powerful means to help them observe and progress their classroom practice. They know that such collaboration is important, because it allows them to reflect on their teaching, develop curriculum, share resources and get advice about issues of common interest.

According to Dyrli (1995), most of the traffic on the Internet is still electronic mail, and e-mail is a main reason for having the Internet. E-mail is an exceptionally valuable communication tool for teachers, as evidenced by a cooperative school science project. Those project used e-mail to let teachers shared information and experimental results among schools via a central database. Further, as several Internet applications have developed such as Discussion groups, Online projects and Teacher-to-teacher collaboration; thus teachers began joining those Internet applications themselves. Consequently, teachers make wider their online activities by connecting with other schools around the world, using e-mail to request documents and finding relevant information. When the teachers are confident about using the e-mail, they propose new projects to discussion groups. For example, one teacher used e-mail to connect with a school in Japan for a unit on Asia.
Models of Collaboration


Consulting

The consulting model is an indirect service delivery model and is defined by the inequality of those involved. One party, the consultant, has more expertise, knowledge or experience than the others in the specific area. The other party, the consultee, is less knowledgeable in the consultant’s field of expertise. Walbert (1997) proposes that teachers seek advice from experts such as teachers on other campuses or professors and graduate students from around the world on an Internet network when faced with a question about their teaching. In his account, he reported that for his first query on the Internet about what to do on the first day of a discussion section, he received suggestions from dozens of experts from around the world.

Many science websites are presented in this model of collaboration. For example, Larkin (1999) suggests two websites: First, is the 6 Billion Human Beings (http://www.popexpo.net/eMain.html) website, which is an interactive website that serves as a mystery for a full-scale exhibition on the world’s population at the Musee de l’Homme in Paris. Visits are easily personalized-enter their age and discover how many people were on earth when they were born, and how many of their peers are alive today. Second, is the Cool Science (http://www.hhmi.org/coolscience) website, which is from the Howard Hughes Medical Institute which uses animation, sound, quizzes and other techniques to encourage elementary schoolchildren to explore science. The online activities such as making an airborne junk detector, building a model of a butterfly emerging from a cocoon and
identifying the parts of plants were adapted from similar practical activities at five US museums. The objective is to make science fun, practical and realistic with parents encouraged to join in. Also, Larkin (2000) illustrates how the website of the American Society of Tropical Medicine and Hygiene offers a searchable and downloadable abstract book with some 700 abstracts, complete with author contact information, from its upcoming annual meeting. Topics include emerging and re-emerging infectious diseases, travel precautions for pregnant or immunosuppressed individuals, DNA vaccines, pathogenesis of malaria and mucosal immunity. Also of interest: an international directory of travel clinics and links to related websites. Further, Fox & Lancaster (1994) note that the database federation would enable scientists to search multiple, independent databases on the Internet simultaneously. The Federation would require a common query language such as Structured Query Language, which most commercial databases employ. They also reported that Community databases open to all members of a scientific discipline offer the greatest potential for scientific exploitation of the Net. For example, the genome community has databased via the Net for roughly a decade. A community database is an open collaboration. Via Internet, a scientific community at-large both queries and contributes. The accepted structure is client-server. Through the client, the scientist constructs the unique view of the collective data that best address his research question. The community database is the most highly developed form of scientific sharing.

Coaching

The key concept of this model is parity. Participants in this model assist each other through the role of coach or the person being coached, and they recognise their complementary strengths and weaknesses.
Many authors have reported coaching collaborative practice on the Internet. For instance, Russel and Cohen (1997) investigated the ‘reflective colleague’ to improve university instruction by using e-mail as a means of communication. Both academics worked in different campuses and captured their communication during a ten-week teaching course. One academic contemplated her struggle to teach a new subject and another academic responded to the introspections. As a result, both academics found value in the reflective colleague via e-mail during the teaching of a new course. One academic felt supported when things were difficult as she could get new ideas and alternative viewpoints by e-mail from her colleague in a very short period of time. The reflective colleague also helped the other academic strengthen her own understandings of the data she had previously collected as well as applying strategies discussed to her own teaching.

Further, Mather (2000) reports the successful work of the Learning Communities Technology Group at Boston College in the U. S. A. This centre is convinced that achieving the new math and science standards requires a shift in the way teachers teach, and more importantly, in the way they receive professional development to influence that teaching. The Learning Communities Technology Group at Boston College has launched the project called MSTelementoring (Math-Science Telementoring), an innovative online professional development model that incorporates an intensive on-site summer institute; follow-up workshops and year-long online peer mentoring. A unique feature is the fact that it supplements threaded discussions with a Web-based exchange and a collaborative environment known as Mentor Centre. Mentor Centre participants work in virtual teams of four or five, building relationships and facilitating the development of an online learning community. Participants submit and reply to one another’s responses to guided reflective activities. The project has found that participants balance each other’s expertise. The mentor Centre is good for structured exchanges, whereas the threaded discussion supports
their individual issues around practice, classroom management, social concerns and administrative dealings. It allows teachers to address daily problems such as how to get help with an inclusion student or how to facilitate student discussion. Adding an online component to professional development allows teachers to participate over an extended period of time and to intimately connect their learning to what is going on in their classrooms. This has proven particularly important for teachers isolated in rural districts and for those with limited resources from inner-city schools. The MSTelementoring project forms linkages across schools and districts through the region and serves as a replicable model across any state.

Teaming

In the teaming model, participants perform as members of an interactive team who share ownership of the purpose and outcomes of their collaborative efforts. For example, Gilmer (1997) investigated the use of the internet network to teach physical science in elementary schools. A website was designed for teachers to communicate with each other and students. Teachers were asked to deliver an e-mail message to students and other teachers about favorite action experiments in physical science that they developed collaboratively during class time. The results of this project show that the Internet network is a powerful means for teachers to support each other while they were teaching a course. The e-mail program provides teachers with a chance to organise their thoughts about their teaching, post them on the Web, read the ideas of other teachers, and have dialogue with each other.
The Possibility for Teachers’ Collaboration via the Internet

DiMauro and Gal (1994) state that many teachers are discovering telecommunications is a potentially powerful tool to support their collaboration as it allows them to be creative thinkers, problem solvers, risk takers and innovators. Collaborating electronically can take many different forms. Some of the more common activities include Discussion groups, Data collection and Organization activities, Sharing documents, Synchronous communication activities, as well as Teachers participating in online courses.

Becker and Riel (2001) in their study of more than 4,000 teachers nationwide, determined that teachers who value professional collaboration with other teachers outside their school are more likely to have their students engage in collaborative activities and to use computers in exemplary ways in their instructional practice. Additionally, their findings showed that teachers who are engaged in professional collaboration also tend to use computers in very effective ways. Those teachers who use computers with students are not limited to only gaining computer competence, but also to involvement in cognitively challenging tasks where computers are tools used to achieve greater outcomes of students communicating, thinking, producing and presenting their ideas.

Further, research has shown that networks can create encouraging conditions for collaboration via the Internet. For example, Gallo and Horton (1994) note that Internet technology has the potential to promote teacher collaboration as well as personal interaction, as on the network teachers can seek advice from teachers on other campuses around the world and, at the same time, they can build their relationship with other users. Riel (1998) states that teachers who have access to resources such as databases and computer libraries, can communicate with other professionals via e-mail and published discourse, as well as review a record of dialogue. Tsui and Ki (1996) report on a study on
the characteristics of the interactions in the computer network for ESL teachers in Hong Kong secondary schools. The computer network was set up to enhance the professional development of in-service ESL teachers by the Department of Curriculum Studies of the University of Hong Kong. The results of the study show that there were signs of collaborative network among teachers. There was a significant increase in the frequency of teachers responding to fellow teachers. There was also a significant increase in teachers sharing views in a variety area, including the sharing of materials, comments on teaching ideas and information about language. The results of the study also indicate that computer proficiency and technical accessibility of the network are not the only factors in building a collaborative electronic community of professionals, sociopsychological factors like users’ perception of the nature of the network, their perceptions of their relationship with other users on the network, and their perceptions of themselves and their role on the network are equally important factors.

The Requirement for Teachers’ Collaboration via the Internet

Several authors have reported the contexts that encourage teachers to collaborate via the Internet. For example, Gallo and Horton (1994) state that the most common purposes for which teachers use the Internet technology include gathering ideas and teaching materials, sharing experiences in an ongoing way, experimenting with telecommunications, feeling less professionally isolated, experimenting with project-based learning, learning more about teaching techniques and informing others about their works. They also found teachers use e-mail to check their e-mail both from front office and outside school and because of the
quick and huge correspondence they can participate with no effort whatever and with extremely little time.

For science teachers, Robinson (1994) investigated the use of electronic mail as an effective instructional strategy for improving science teaching in American schools. In his article “Improving Science Teaching with E-mail”, he reported that the use of e-mail is a teaching and learning strategy that offers the prospect for improving science teaching as well as making upper-division science courses available to schools in remote areas and motivating more students in the upper grades to continue taking science classes. The availability of e-mail in a rural school or other underserved areas can help science instruction by giving students greater access to information. Further, Spitzer and Wedding (1995) examined the use of an electronic community for professional development. LabNet, an on-line community of over 1000 U.S. primary and secondary science and mathematics teachers, is focused on the challenges and opportunities of improving science and mathematics teaching. The results also show that 80% of the LabNet community report that their participation in the network has influenced their professional development and teaching. Thus, the most common purposes for which members use the network include gathering ideas and teaching materials, sharing knowledge, feeling less proficiently isolated, learning more about teaching science or mathematics and showing others about their effort. These results indicate that electronic communities can provide fertile ground for ongoing learning and professional growth.
The Frequent Use of Electronic Mail in Teachers’ Collaboration

Teachers will use the Internet more if they feel familiar with it and it is easy to access. Once teachers meet with some point of success such as receiving a personal e-mail reply to a network news posting, discovering a database of interest, successfully accessing resources from it and becoming more comfortable with the language of the Internet, their fears and anxieties diminish and they then will start using the Internet more frequently. Besides, obtaining rapid feedback on curricula issues and other topics of professional interest and keeping current on subject matter, pedagogy and technical trends are also important reasons for teachers greater use of the Internet (Gallo & Horton, 1994). Further, Honey and Henriquez (1993), and Gallo and Horton (1994) note that there is information overload on the Internet or the Internet is a sea of information, but after teachers discovered the wealth of information available to them, they became excited about the Internet and could not resist using it more.

On the other hand, many teachers revealed nervousness at becoming actively involved in electronic discussing groups because they feared criticism from their Internet peers and were unwilling to risk worldwide embarrassment. Hence, they are satisfied to be passive observers without engaging in any direct dialogue. A teacher understands the rudiments of the system and is capable of making limited use of it (Honey & Henriquez, 1993).

Barriers to Teachers’ Collaboration via the Internet

There is not a question that use of the Internet is increasing in traditional classes with live data from distant lands and cultural exchange between students or teachers.
Unfortunately, there are quite a few barriers preventing teachers and schools from making the connection; some barriers are described below.

*Internetworking Expertise.* Lai, Trewern and Pratt (2002) stated that secondary schools in New Zealand lack of internetworking technical expertise and vision. It is hard enough for anyone these days to make head or tail of the bewildering number of choices, and so it is understandable that schools are having problems figuring out which way to go. There is concern that committing to one distance-learning solution will prohibit upgrading to future technologies. There is also confusion over how to establish a wide area connection. It is going to take a while for schools to fully understand how the convergence of the broadcast, telephone and computer industries is going to play out and who the players will be. In the USA, both telephone and cable companies are promising connections and reduced rates in the hope of capturing the K-12 educational market. In their investigation of teachers use of the Internet, Gallo and Horton (1994) have found three major technical problems: the school’s local area network (LAN) was not sufficiently robust to support an Internet connection, the teachers’ computers had a major deficiency as the computers needed at least eight megabytes of random access memory (RAM), and teachers lacked technical support (Parker, 1994).

*Existing Network Infrastructure.* Parker (1994) studied the Internet in schools found a significant percentage of schools do not have local area networks in the computer labs. Therefore access to the Internet for the time being is limited to stand-alone machines with modems. Unfortunately, because of the current practice of most states in the USA permitting phone companies to charge business rates for telephones in schools, there are very few phone lines in the classrooms. It is necessary to educate the state public utility commissions (PUCs) about the benefits of access to the Internet via a phone in the
classroom; indeed, there have already been several success stories in some states where regulation was introduced to lower cost for phone lines in schools.

But it is important to educate the school and district technology planners on the importance of scaling their networking solutions effectively. One phone line in a computer lab is a great start to demonstrate the benefits of the Internet. However, the computer/phone line/modem model does not scale well as the cost of adding phone lines and modems increases significantly but the bandwidth and increased access to resources do not. Dialup access is an easier solution to understand and implement initially, but ultimately harder for the end-user to learn and more expensive to scale. Schools need to be educated on the internetworking model that is, connecting networks to networks. Building a good local area network foundation is crucial (Parker, 1994).

In addition to a scalable local area network, schools will need to address the issue of administrating mail accounts, newsfeeds, local information servers and other network related configuration duties. A server that makes these tasks considerably easier and integrates educational software in a distributed networked environment is the Copernicus system, developed by Bolt, Beranek and Newman in Cambridge, Massachusetts (Parker, 1994).

_Funding._ Dvorak (1996) notes that schools adopted computer technology early but have not kept pace with it, partly because more and more money is wasted on overheads and administration instead of being put into teaching. Student performance has declined even as educational budgets have increased. Many teachers have been hoping for a technological revolution in how people teach and learn, but this change has not come about, and there are still no research results conclusively proving that students benefit from computers in the classroom. The Internet may change this situation, especially if the much-maligned ‘network computer’ is embraced by educational institutions. Emerging trends in school
computing include collaboration, experimentation with computer based teaching, long-distance learning and heavy use of e-mail. Network computers are ideal for all these developments and cost much less than PCs, but even 500 U S dollar machines are beyond the budgets of many school districts.

*Information Age Projects.* Parker (1994) noted that using the Internet in the classroom is inspiring teachers to abandon the obsolete, incorrect textbooks, and alternatively suggest students to explore the Internet for existing issues, examples and data. The Internet has a way to go before it can dependably serve as the only digital lab or classroom, but there are a lot of valuable projects happening right now where students are convinced to use their creativity and common sense. The problem is teachers require a good instruction to use and apply this technology to instruction.

*Poor web design.* Maddux (1999) has reported that this problem makes the Web frustrating and confusing to use as it is cluttered with thousands of pages that contain nothing but the words under construction. Further, the Webmaster intends to quickly get a page up and running on the Web, thus it contains spelling and punctuation errors and erroneous factual material. Also, the Web may be functional and appealing when viewed with one browser, but may not work or may be ineffective when viewed with another browser. Besides, some common design mistakes such as pages contain no link back to the home page; especially no author identification and no contact person make it difficult to communicate with.

Many barriers to teachers’ collaboration via the Internet have been identified.

*Time.* Gallo and Horton (1994) report that teachers commented that time is a major concern as teachers have their regular teaching loads and they also were involved in extra-curricular activities such as the school planning committee or preparing science research students for the Science Fair so it was difficult for teachers to find sufficiently large blocks
of uninterrupted time at school for them to use the Internet. Tinker (1993) observed that many teachers do not have time for “mining” the Internet and that the issue of free resources is important of the days in which free software accompanied microcomputers. Schrum (1995) investigated the using of Internet for professional development in a teacher education program. This research was accomplished through a case study of an intense graduate seminar, Educational Telecommunications and Distance Learning. A course was offered in an intensive, 5-week format, in which students met twice a week for 5 hours each session. In the course, the inservice educators learned to interact with colleagues and the professor through electronic mail to clarify assignments, discuss readings and facilitate group projects. The results show that these inservice educators were enthusiastic about introducing telecommunications to their colleagues and wanted to provide new skills to their students. Although they were frustrated by obstacles when they returned to school including lack of time, access to equipment and resources for implementation, most have continued using telecommunications.

*Comprehension.* Gallo and Horton (1994) investigated the barriers to a group of high school teachers when they elected to use the Internet. They found that teachers lacked a basic understanding of how to use their computers and lacked the vocabulary of an experienced computer user. Also, teachers commented on the problem they were having interacting with the Internet because they simply did not understand the language.

*Commitment.* Lelong and Fearnley-Sander (1999) suggest one important feature of collaboration. They state that partners must have a commitment or the same degree of enthusiasm for a job project. Without that, it is unlikely any electronic mail project will be very successful.
Advantages to Teachers’ Collaboration in an Electronic Environment

Many authors have found the benefits to teachers’ collaboration via the Internet as described. Networking activities encourage and facilitate both cooperative learning activities and teachers’ change from being providers of information to being coaches. Besides, the Internet encourages teachers to use more cooperative education techniques and get a different structure in their classrooms (Gallo & Horton, 1994).

According to Deal (1998), network-based collaborative work also becomes the model for productive student collaboration. Network-based communication encourages a high degree of individualisation, which can lead to users’ feeling a sense of control over their learning experiences. These feelings of control may be a significant factor in participants’ continued use of computer networks for collaborative learning (Mclissac & Gunawardena, 1996). Teachers’ roles as collaborative learners on a new medium also give them a new appreciation for the learning process (Serim, 1996).

Teacher access to electronic wide area networks has encouraged a number of benefits for the medium’s professional development potential. Many authors have claimed those advantages. For example, the Internet can change teachers’ self-esteem. One teacher reported that before he was afraid of embarrassing himself, afraid of sounding dumb to post something. When he posted his first message, he felt self-pride and found some personal satisfaction from the Internet. The more teachers use the Internet, the more they are learning how to use it and how to apply these applications (Gallo & Horton, 1994).

Hawkes (1999) notes that network-based communication can help teachers to improve knowledge in three areas: knowledge of educational policy, knowledge of subject area and knowledge of professional community. Knowledge of educational policy facilitates teachers in being able to influence both up and down the educational system. Curriculum
policy that teachers know can be applied to the classroom practice and can wield influence at the local, state and national levels. Network-based communications helps teacher to refresh collegiality by engaging peers in subject matter at new and deeper levels. Also, learning more about the content area serves to expand a teacher’s perception about what students are capable of doing and how current curricular delivery can be enhanced. Further, knowledge of professional community aids teachers in building a web of shared classroom experiences that increases teachers’ confidence and helps them critically analyse their own work and ideas. This knowledge allows teachers to increase collegiality and collaboration among teachers.

Leadership skills can be boosted by collaboration via the Internet. For example, Dryli and Kinnaman (1995) point out that a network increases the number of opportunities available to build leadership skills through mentoring, moderating and organisational activities. Also, they note that in broad network discourse, participants’ identities are often masked, leaving readers to judge the merit of an assertion, experience or position on the basis of its content alone.

As a consequence, computer networks work to tear down cultural biases that are automatically at work when the person’s race, religion, gender or ethnicity is known. Honey (1995) emphasises the ability that networks have to mask social identity also enables teachers to analyse their own practice without being self-conscious.

Collaboration via the Internet reduces teacher isolation (Branstad, 1996; Yap, 1997). For Bennett (1998), participation facilitates increase collegiality and collaboration among teachers. Hawkes, Good and Van Es (1998) state that collaboration is not only suggested to occur among teachers, but between teachers and other professionals, researchers and experts outside the school community.
In addition, collaboration via the Internet is convenient and quick. For instance, Lang (2000) notes that e-mail is used for direct interpersonal exchange or mediated exchange. Zelingher (1995) suggests that electronic mail is by far the most widely used and most basic service available on the Internet. It is convenient, inexpensive, reliable and fast. Tumminello and Carlshamre (1996) used e-mail for collaboration for one year and found that it was quicker and easier to edit the questions if they sent them in text files attached to e-mail messages.

On several occasions, they exchanged multiple messages within a matter of minutes. Especially, sending e-mail during work hours is lower cost than using a telephone call overseas. Besides, using e-mail, they could work at their own convenience and deliver drafts complete with explanation and the material was then waiting for the recipient when he or she arrived at work the next day.

Many advantages of electronic communication have been further stated. For instance, Dyrli and Kinnaman (1995) suggest many benefits of the network such as resource sharing, resource management, research and development, remote access, global access and collaboration. Thus, in their perception, the WWW breaks down the walls of time and geographic location and gives every individual the ability to be a continuing and lifelong learner. Peat and Fernandez (2000) state that the major advantage of the Internet might be considered to be the interactive communication capabilities afforded by virtual access, virtually anywhere and virtually anytime.

Sproull and Kiesler (1991) note that network messages which do not include the sender’s or receiver’s professional title can be sent and received by anyone who has an Internet account and are transmitted directly to a personal computer fostering collaborative conditions through a reduction in hierarchical difference.
Gal (1992) points out that telecommunications also help overcome geographical distances and form sustained affiliations between teachers and offer a memory of the discourse, making it public to all participants and forming a reference that can be revisited.

Support for Teachers’ Collaboration via the Internet

Teachers’ collaboration via the Internet needs many supports as indicated below.

**Time.** Reduce before or after school duties and allow teachers to experiment with changes in pedagogy and changes in curricula, as well as seek alternative methods of assessment using the Internet (Gallo & Horton, 1994).

**Accessibility.** Facilitate before or after school usage by providing teachers with access to the school outside normal school hours, provide reasonable Internet access to all teachers (Gallo & Horton, 1994).

**Computer.** Ensure that teachers’ Internet workstations are configured with sufficient memory, disk space and processor speed to accommodate the system overhead that will be introduced from the Internet protocols and application softwares (Gallo & Horton, 1994). Dyrli and Kinnaman (1995) point out that interconnecting the great variety of PCs that exist in most schools, and certainly across schools, requires highly advanced and complex hardware and software. It is far more complicated than connecting computers and peripherals with a piece of cabling.

**Funding.** Seek funding to install and maintain Internet connections at their schools and provide teachers with adequate support mechanisms, provide teachers with the autonomy to seek alternative teaching methods that incorporate Internet resources into their classes (Gallo & Horton, 1994).
**Internet training.** Teachers require occurrence Internet training, which emphasises both the language of the Internet and using their computers. They can follow user manuals and any other appropriate given documentation related to their computers (Gallo & Horton, 1994).

**Technical support.** Perform a thorough network analysis prior to connecting the school LAN to the Internet to detect existing or potential problem areas, and resolve any problems uncovered from the analysis before an Internet connection is made. Employ a full-time manager for both the local network and the Internet connection (Gallo & Horton, 1994). Dyrli and Kinnaman (1995) suggest that using network teachers will still need technical support specialists and network administrators for the foreseeable future, but conceptually there are only a few things that the average teacher needs to know to understand the basics of personal computer networking.

**Home Internet.** Most teachers need home Internet access (Gallo & Horton, 1994).

**Workshops.** To help teachers change perceptions of themselves as a result of using the Internet, workshops or in-service activities that would assist teachers in making a transition from lecturer to facilitator could be provided (Gallo & Horton, 1994).

**Websites**

Many websites are specially created for science teachers to use to support their work and e-mail, a Listserv or its equivalent might be created. A term from the Internet, Listservs are server computers in a network that distribute information to a list of “subscribers”. An e-
mail message is sent to a Listserv’s address, and then a computer duplicates the message and delivers it to everyone who subscribes. Most Listservs focus on a specific topic of interest; by subscribing people add themselves to the list of receivers. E-mail has two notable advantages for teaching.

One is the existence of several effective mail-handle systems, particularly for LANs. Secondly, since a university network typically has linkage to the Internet, a huge variety of databases and teaching resources is accessible to teachers and students from the same environment. For example, LabNetwork is the first national telecommunications network designed for science teachers. It is a dynamic medium for building and sustaining a community of practice for teachers who are geographically distant. Once on-line, teachers can communicate through the LabNetwork with other on-line science teachers across the nation.

DiMauro and Gal (1994) examined a group of teacher leaders using network exchange to reflect upon their involvement with peer leadership and teacher-teacher support. They found that reflective messages about professional practice rarely happen on networks and do not naturally occur in the practice of teaching. The network area that was accessible to all LabNet teachers was used mainly for “shop talk”, to seek resources and technical assistance, as well as for some teaching activities.
Summary

The literature review gives an insight into issues that are related to the study. The following summary brings together the main features and relates them to the purposes of the project. In order to reach the desired outcome from global communication that causes educational change, teachers must employ the appropriate strategy that can help them. Teachers talking, planning and observing each other as collaboration is one way to achieve the goal.

The review describes many benefits of collegiality and how it can bring about teacher development and institutional reforms. Collaboration via e-mail and Internet can help teachers learn from one another and share and develop their experiences together. Collegiality can also enable teachers to receive and give ideas and assistance. Further, in schools where teacher collaboration is promoted, teachers can trace both students’ achievement and the diminution of problematic behaviors in classrooms.

This literature review shows that many authors believe that professional interaction is a vital function for educational outcomes and development. Thus, collaboration is selected to be one of the strategies for teachers’ and schools’ development.

However, when considering use of collaboration, there are still questions about the models of collaboration that science teachers use as a framework to support their collaborative practice. They see a need to collaborate with each other, they face the problems or benefits and they want to continue or cease their collaborative practice via the Internet.
Chapter 4

Theoretical Model and Propositions

Introduction

This chapter proposes a research model based on our understanding of adult learners and constructivist and sociocultural theory, which are used to inform science teachers’ collaboration. Various propositions based on previous research evidence are also constructed and presented.

The advocacy literature described in Chapters Two and Three was useful for exploring collaboration via the Internet as the framework for studying science teachers’ collaborative practice. It described the perspective for using collaborative practice and the Internet for collaboration as a framework for improvement and increased teaching effectiveness.

However, this body of literature does not adequately direct the psychological issues involved in science teachers’ collaborative practice. Research on how collaborators think, act and function, situated as they are in a social, cultural and institutional context, is also relevant to develop a better understanding of the subjects and suggests a number of the propositions. Sociocultural studies of mind and cognition have found there is an interdependent relationship between higher mental functioning, shared knowledge and social and cultural processes generated as a result of collaboration in the organisational context. Collaborators pay more attention to the tools, language, interactions and culture of collaboration so that they can have more scope to fully understand how collaboration shape their shared knowledge; how culture is used as a socialisation mechanism and how tools for
collaboration are used to constrain or develop higher mental functioning, creativity and self-direction. Idol and West (1991) define collaboration as an interactive relationship, an adult-to-adult interactive process. Therefore, it is necessary to find other theories that are believed it is the foundation of collaboration.

The Theory Supports Teachers’ Collaboration

The roots of collaboration are found in natural social skills developed by children through play. When this lesson is learned in childhood, we learn that together, we can accomplish more than we can usually accomplish alone.

Zone of Proximal Development (ZPD), as it is called by Vygotsky (1978), is defined as the distance between the understanding a student would reach working independently and the depth of understanding able to be gained with expert guidance. If libraries are learning-based, then it makes sense that the roles for the library media specialist would encompass both confrontation and support.

The theoretical base supporting teachers’ collaboration comes from two different theories: Constructivist theory, which is based on Piagetian views and Sociocultural theory, which is based on Vygotskian views (Hatano, 1993). Combined together, both theories support a professional collaboration for science teachers. Sociocultural theory is sensitive to teachers and who they are, how they learn, and what role theory plays in the teaching and learning process (Howe & Stubbs, 1996).

Constructivist theory recognizes teachers as active agents in the construction of their knowledge. The sociocultural theory legitimises teachers’ work with colleagues in ways that provide a forum for problem solving and dialogue. In such dialogue, the language
serves to mediate ideas as teachers work their way through scientific misunderstanding and misconceptions. In a competency-based professional model, teachers are empowered and independently come up with their own reasonable explanations derived from discussion and opportunities for personal and professional reflection. In this rich environment, teachers do not expect others to provide the answers to their questions or to resolve their problems; what they expect is to have a sounding board for testing ideas and possible solutions. Also, Resnick (1989) notes, from a constructivist point of view, that meaning is constructed in a flexible way by negotiation and collaboration with others to show multiple perspectives.

Wallen (1974) points out that the hypothesis stating is a basic prediction that is done regarding the possible outcome of this study. The study is divided into two studies, thus the propositions are presented according to two studies.

Study One: Teachers’ Perceptions of Collaboration via the Internet

The propositions that are used to predict the outcomes of Study One are presented in the context of the six research questions, which guided the study.

Research questions A: Which of Fishbough’s models of collaboration are appropriate for analysing science teachers’ collaboration via the Internet?

Proposition 1: Science teachers use the Internet for their collaboration.

Proposition 2: Science teachers use the Consulting model of collaboration as a framework for their collaborative practice.
Proposition 3: Science teachers use the *Coaching* model of collaboration as a framework for their collaborative practice.

Proposition 4: Science teachers use the *Teaming* model of collaboration as a framework for their collaborative practice.

Research question B: *How do science teachers perceive the potential for teachers’ collaboration via the Internet?*

To visualize the potential of science teachers’ collaboration in an electronic environment, the following propositions were raised to guide the study.

Proposition 5: Many factors influence science teachers use of e-mail and Internet for collaboration with other science teachers.

Proposition 6: Many benefits exist for science teachers as regards using e-mail and Internet to support their collaboration.

Proposition 7: The e-mail and Internet changes the way(s) in which science teachers collaborate with each other.

Research question C: *Do science teachers see a need to collaborate with other teachers via the Internet?*

Proposition 8: Science teachers require collaborating with other teachers in electric networks.
Proposition 9: Science teachers want to continue using the Internet for their collaboration.

Proposition 10: Science teachers need support for their collaboration.

Research question D: *In what contexts do science teachers collaborate with each other on the Internet?*

Proposition 11: There are many contexts in which science teachers collaborate with each other on electronic networks.

Research question E: *Why do some science teachers collaborate more in an electronic network? Why do some science teachers collaborate less?*

Proposition 12: Science teachers frequently collaborate with other teachers on electric networks.

Research question F: *What are barriers to teachers’ collaboration via the Internet?*

Proposition 13: There exist many barriers to teachers’ collaboration via the Internet.
Study Two: A Detailed Science Website Analysis

The propositions used to predict the outcomes of Study Two are presented in the context of two kinds of science websites, specific science websites for science teachers and general science websites for interested parties from five chosen continents (Australia, Asia, Europe, America, and Africa).

In the first group, specific science websites for science teachers, two particular websites, specific science websites for science teachers in Western Australia and specific science websites from five selected continents are investigated. Science teachers in Western Australia can use many websites to collaborate with other science teachers around the world. However, three particular websites, the Science Teachers’ Association of Western Australia website (STAWA), the list server for West Australian Science Educators (Catalist) and the Teachers Survival Kit website (TSK) were specifically studied. The propositions for guiding the investigation of those three websites are offered:

**Proposition 1:** The STAWA’s website is provided as *Consulting* model of collaboration.

**Proposition 2:** The STAWA’s website is provided as *Coaching* model of collaboration.

**Proposition 3:** The STAWA’s website is provided as *Teaming* model of collaboration.

**Proposition 4:** Science teachers subscribe to the Science Educators List server-Catalist.

**Proposition 5:** The Science Educators List server-Catalist is provided as *Consulting* model of collaboration.

**Proposition 6:** The Science Educators List server-Catalist is provided as *Coaching* model of collaboration.

**Proposition 7:** The Science Educators List server-Catalist is provided as *Teaming* model of collaboration.
**Proposition 8:** The Teachers Survival Kit website (TSK) is provided as *Consulting* model of collaboration.

**Proposition 9:** The Teachers Survival Kit website (TSK) is provided as *Coaching* model of collaboration.

**Proposition 10:** The Teachers Survival Kit website (TSK) is provided as *Teaming* model of collaboration.

Specific science websites for science teachers from five chosen continents (Australia, Asia, Europe, America, and Africa) are examined. The propositions for guiding the study are presented:

**Proposition 11:** Specific science websites for science teachers are provided as *Consulting* model of collaboration.

**Proposition 12:** Specific science websites for science teachers are provided as *Coaching* model of collaboration.

**Proposition 13:** Specific science websites for science teachers are provided as *Teaming* model of collaboration.

General science websites for interested parties from five selected continents (Australia, Asia, Europe, America, and Africa) are investigated. The propositions for guiding the study are offered:
**Proposition 14:** General science websites for interested parties are provided as *Consulting* model of collaboration.

**Proposition 15:** General science websites for interested parties are provided as *Coaching* model of collaboration.

**Proposition 16:** General science websites for interested parties are provided as *Teaming* model of collaboration.

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**Summary**

The literature review and propositions highlight the need to develop insight into the dynamics of science teachers’ collaboration via the e-mail and Internet in Perth, Western Australia. It suggests a better understanding is needed of the foundation for science teachers’ collaboration via the Internet. Thus, the seven research questions that identify the purpose and process for the research project were posed in the previous chapter.

The present study addressed all these questions. Its major aim was to develop insight into the models of collaboration of science teachers in their collaboration via the Internet and investigate the use of e-mail and Internet for their collaboration. The following chapter outlines the methodology used to address these questions and the form of quantitative and qualitative research method, content analysis and other perspective employed in the study.
Chapter 5

Research Methodology

Introduction

This chapter presents a discussion of the research methods used in this study. The chapter consists of three sections. The first section deals with the survey approach in educational research and methodology and content analysis. The second section presents the research questions for this study. The third section deals with the research designs for the two distinct, but related, studies. Study One is a survey of teachers’ perceptions of collaboration via the Internet and Study Two is a detailed science website analysis. For both studies, relevant data, such as the population and sample, techniques, instruments, data collection and data analysis are summarised.

Survey Approach in Educational Research and Methodology

Surveys are one of the most popular research methods in education as they can be used for a broad variety of purposes: many doctoral dissertations use surveys, departments of education use surveys to decide levels of knowledge and to determine needs in order to plan programs, schools use surveys to estimate aspects of the curriculum or administrative procedures, governmental agencies use surveys to form public policy, university schools of education use surveys to evaluate their courses and programs. Surveys are preferred because if they are conducted correctly, the information collected from a small sample can be generalised to a large population. Thus, it is necessary to employ correct sampling
procedures and carefully design the data collection techniques in order to produce reliable and valid survey research (McMillan & Schumacher, 1989).

Definitions of survey research

Many definitions of survey research have been suggested. Good (1963) defines the term ‘survey’ to mean the gathering of evidence relating to current conditions. Cohen and Manion (1980) describe survey research as the most frequently used descriptive method in education. Normally, surveys are used to gather data at a particular point in time. They have been used to describe the nature of existing conditions or to identify standards against which present conditions can be compared, or to determine the relationships that exist between particular events. Fowler (1984) focuses on the following characteristics of surveys. The aim of the survey is to produce statistics: that is quantitative or numerical descriptions of aspects of the study population. The principal way of collecting information is by asking people questions; their answers establish the data to be analysed. Ordinarily, information is collected from a small part of the population only: that is, a sample, rather than from all members of the population.

Wadsworth (1984) suggests that a survey involves the idea of inspecting or investigating, from some vantage point, an entire terrain. McNeill (1985) has proposed a social survey is a method of acquiring large amounts of data, usually in a statistical form, from a large number of people in a relatively short time. It has been the most broadly used method of social research for many years. Jaeger (1988) has stated that the purpose of survey research is to describe specifics of a large group of persons or objects or institutions. McMillan and Schumacher (1989) have emphasised surveys are used to learn about people’s attitudes, beliefs, values, demographic facts, behaviors, habits, desires, ideas and other types of information. In addition, they have also noted that survey research is
constantly used in business, politics, government, sociology, public health, psychology and education because accurate information can be achieved for enormous numbers of people with a small sample.

Burns (1990) points out several characteristics of survey research. It requires a sample of respondents to answer a number of standard questions under equivalent conditions. For example, a researcher may administer the questionnaire by mailing the respondents a form for self-completion, or by telephone. In addition, the respondents represent a defined population. If less than 100 percent of the defined population is sampled, then a sample survey has been conducted. A 100 percent survey is a census; the results of the sample survey can be generalised to the defined population, and the use of standard questions performs comparisons of individuals.

Pyke and Agnew (1991) cite survey research as a vehicle for researchers to ride into the world of values, attitudes, beliefs preferences, aspirations, stereotypes, past experiences and future plans as well as into the worlds of lies, false hopes, exaggerations and distorted recall and self-delusions.

Wiersma (1991) suggests that survey research is possibly the most broadly used research form in educational research. It encompasses a wide variety of research studies. He cited one of the most comprehensive national surveys in education in the U.S.A, the annual Gallup Poll of the Public’s Attitudes Toward the Public School (Elam & Gallup, 1989). Furthermore, surveys are used to measure attitudes, opinions or achievements. Studies may be local, regional, national or even international. One of the more extensive and continuing surveys is the National Assessment of Educational Progress (NAEP), a survey that measures the achievement of America’s youth and young adults. He has also indicated that surveys are used to answer research questions of “What is?”

Alreck and Settle (1995) have stated that surveys are frequently conducted because they
are the sole way to get the information wanted. Survey research may be an easier, quicker, less expensive and more accurate way to get the required information than other approaches. Surveys can be planned to achieve the gathering of broad types of information on many different topics. They have also listed eight basic topics often used in surveys: attitudes, images, decisions, needs, behavior, lifestyle, affiliations and demographics. These eight basic topics are not completely independent of one another: some may overlap and some issues do not fit entirely into one category.

It is clear, then, that the surveys are used in business, politics, government, sociology, public health, psychology and education to gather data at a particular point in time, to describe the nature of existing conditions, to determine the relationship that exist between particular events, to learn people’s attitudes, images, decisions, needs, behavior, lifestyle, affiliations, and demographics. Further, the required information of surveys can be obtained for a large of population with a small sample by mailing the questionnaires to or interviewing the sample.

*The methodology of survey research*

The two popular dominant types of surveys are *longitudinal* and *cross-sectional*. The length of time during which the researcher collects data separates them from each other. If data are collected only on a sample, a survey is recognized as *cross-sectional*. If data are collected on the sample repeatedly over a period of time, the survey is recognized as *longitudinal* (Wiersma, 1991).

Surveys are generally used with samples; nevertheless, they can be used with the whole population (Wiersma, 1991). They can be used as large-scale or small-scale or department or sole researcher studies (Cohen & Manion, 1980). Whether the survey is large-scale or small-scale and accomplished by department or sole researcher, the data collection involves
one or more of the following techniques: structured or semi-structured interviews, self-completion or postal questionnaire, standardised tests, attainment, performance and attitude scales (Cohen & Manion, 1980). To produce good surveys, three methodological areas, sampling, designing questions and interview have to be carefully planned (Fowler, 1984).

**Survey sampling**

The early stage in the sampling process is defining the target population. The designated population is the group of things about which the researcher is interested in obtaining information and drawing conclusions (Tuckman, 1978). Once the target population has been identified, the next step, selecting a sample from the population to be respondents, is a key factor. Several concepts of sampling have been suggested. Alreck and Settle (1995) state sampling is easily understood. It simply means taking part of some population to represent the whole population. Fowler (1984) mentions a good sampling strategy is finding a way to give all population members the same chance of being sampled. Burns (1990) points out that the major task in sampling is to select a sample from the target population by an appropriate technique that ensures the sample is representative of the population and as far as possible not biased in any way. Warwick and Lininger (1975) emphasise sampling is the method of selecting a particular sample in the well-defined population to represent the whole. The population can be generalised from the sample data. Borg and Gall (1989) have defined sampling as a means of selecting a given number of subjects from a defined population so as to be representative of that population.

The main reason for sampling is economy; to survey every individual in a population using lists is ordinarily much too expensive in terms of time, money and personnel. There is no need to survey every individual. Only a small fraction of the entire population can represent the whole group with enough accuracy (Alreck & Settle, 1985; Borg & Gall,
In addition, Moser and Kalton (1971) suggest some similar ideas such as sampling saves money as it is surely cheaper to collect answers from 400 individuals than from the entire population of 3,000. Sampling saves labour because a smaller staff is needed both for fieldwork and for tabulating and processing the data. They also point out that sample coverage generally permits a higher overall level of accuracy than a full enumeration because the smaller numbers allow the field personnel to check and test for correctness at all stages.


Also, they explain that if the surveys are small-scale surveys, it is useful to use non-probability samples because they are not difficult to set up; importantly, they are not expensive. In addition, researchers may not want to generalise their findings or they may be more concerned with describing the specific situation than generalising the results. Several kinds of non-probability sampling are suggested, such as: Convenience Sampling, Quota Sampling, Purposive Sampling, Dimensional Sampling, and Snowball Sampling. The Purposive Sampling technique was chosen as the appropriate technique for this study.

Sample size

Many experts suggest guidelines for the minimum number of individuals to produce statistically reliable results. Some of those experts suggest a minimum number of samples; for example, Harrison (1979) recommends that most studies use samples of thirty subjects or more but acknowledges that twenty subjects per group might serve as a bare minimum. In addition, there are experts who do not suggest the minimum number of individuals.
Cates (1985), for example, suggests that, as a general rule, researchers should use the largest sample they can afford and obtain. Thus, both of which are used as the foundation for producing sample size of this study.

Methods of data-collection

The three principal methods of data collection used in survey research are personal interviewing, telephone interviewing and mail questionnaire (Alreck & Settle, 1995; Cates, 1985; Cohen & Manion, 1980; McMillan & Schumacher, 1989; Wiersma, 1991). In questionnaires, there is a series of questions that can be either self-administered, administered by mail or asked by interviewers. Closed items, open-ended items and scale items are three kinds of items generally used in the construction of questionnaires (Burns, 1990). McMillan and Schumacher (1989) suggest that the most widely used scale items are Likert scales and Semantic Differential scales. Many authors (for example, Burns, 1990; Cates, 1985; Moser & Kalton, 1971; Oppenheim, 1966) suggest several advantages of the questionnaire. It is cheap because it does not require a trained staff of field workers; it requires the cost of the planning, pilot work, printing, sampling, addressing, mailing and providing stamped, self-addressed envelopes for the completed questionnaire. If the questionnaire is well prepared, it can offer a reliably consistent presentation of items. It can cover a much larger sample at a modest increase in cost and the sampling is more accurate because an envelope can be addressed to a particular individual. The processing and analysis are usually also simple and cheap.

Furthermore, the disadvantages are stated. Cates (1985) points out that the respondents must be able and willing to read it. It is difficult to write good questionnaire items. Burns (1990) notes that all questionnaires are not returned, so the potential of biased sampling exists as non-respondents may differ significantly from respondents, especially if the
investigator is unable to learn the reason for non-responses. The method is unsuitable when exploration is desirable. There is no respondent's motivation for answering the questionnaire. In addition, some researchers (Burns, 1990; Cates, 1985; Oppenheim, 1966) state the greatest disadvantage of mail questionnaires is that they always produce low response rates.

The interview is unique as it involves the collection of data through direct verbal interaction between individuals. Cohen and Manion (1980) suggest that it may be used for three purposes. First, it may be used to gather data on the research objectives. They mentioned Tuckman's (1972, p. 196) assertion, “By providing access to what is inside a person's head”, [it] makes it possible to measure what a person knows (knowledge or information), what a person likes or dislikes (values and preferences), and what a person thinks (attitudes and beliefs). Second, it may be used to test hypotheses or as an explanatory device to help identify variables and relationships. Third, it may be used in conjunction with other methods in a research undertaking. They cite Kerlinger (1970): it may be used to follow-up unexpected results, to validate other methods, or to delve deeper into the motivations of respondents and their reasons for responding as they do. Furthermore, others (Cohen & Manion, 1980; McMillan & Schumacher, 1989) suggest that there are four kinds of interview that may be used as research tools: the structured interview; the unstructured interview; the non-directive interview; and the focused interview.

The advantages of the individual interview are many. For example, Cates (1985) states that the interviewer could tailor to the person being interviewed and utilize both verbal and nonverbal cues in determining the responses. Borg and Gall (1989) suggest that the well-trained interviewer can make full use of the responses of the subject to alter the interview situation. It does not provide immediate feedback; the interview permits investigators to follow-up leads and obtains more data and greater clarity. They also state that some
negative aspects of the self or negative feelings toward others are difficult to reveal in other methods and will only reveal in an interview situation if interviewees have been made to feel comfortable. Many authors have suggested the disadvantages of the personal interview: for example, Cates (1985) mentions that data gathered through personal interviews may be unreliable or unsuitable because of differences in questions or methods employed by the interviewer or because of differing levels of intelligence and capability among interviewers. Cohen and Manion (1980) emphasize that personal interviews would be both expensive and time-consuming. Telephone interviews have been used in survey research in recent years and, when appropriate, they can be used effectively. According to Cates (1985), the telephone interview requires little time to complete and enables the researcher to reach large numbers of subjects easily. Wiersma (1991) found respondents could be sampled from a greater accessible population because the researcher does not have to travel to individual respondents. He also found there is little likelihood of data being faked by the interviewee. Thus, telephone interviews are certainly worth considering as an alternative to face-to-face interviews because of the saving in effort, time and costs. Cates (1985) also lists disadvantages: it might employ either geographically biased samples or small national samples because researchers often use samples drawn from a limited geographic area or use small national samples in telephone interviews. The reasons for these: the long-distance telephone call is expensive and selecting only those who have telephones as a sample leads to a biased sample.

**Combined methods**

Currently, most social research and educational research has used more than one method of collecting data because those kinds of research have more than one phase to analyse data, and the secondary phase of analysing data may be the main method of research
(Stacey, 1969). The various methods that can be used in collecting data have their advantages and disadvantages, so responses need to be checked by more wide ranging surveys; for example, questionnaire techniques can be used to encounter high sample coverage, but they always produce low response rates and some questions in the questionnaire are not answered. In the case of personal interview (either face-to-face or telephone), it is widely accepted: high response rates and in-depth answers (Shipman, 1981).

Thus, there may be advantages to response rates or other problems in surveys from a combination of different methods of data collection in one research in order to use the strengths in each method to complete weakness in each method. Further, it is not only to improve response rates through the use of a combination of methods but also it is possible that respondents may respond differently to different methods. It may be essential to show some pieces of research, which have used a variety of methods in one research. For instance, Bossard and Boll (1956) found that in their study of the large family system it was helpful to use the personal document and the personal interview. In the first instance they wrote to their respondents and asked them to write an account of their experiences as members of large families. Some personal documents are long, others brief. If it were possible the same respondents were interviewed. They also emphasised that in these cases one method supported the other; for example, some brief documents were greatly extended by face-to-face discussion. In others, the document was more revealing than the interview. Hilton’s (1967) study of the hospitalisation of young children also combines two sociological techniques. The first was a diary record by the observer particularly stressing interaction. The second was a method of observation of the frequency of interaction controlled by a predetermined schedule and time sampling. The two methods complement each other, the first having a quality of depth and the second of precision, which the other
lacks. Suntisukwongchote (1995) found that it was fruitful to use mail questionnaires and personal interviews to study science teachers’ collaboration in two government secondary schools. The two methods support each other. The general nature of science teachers’ collaboration was obtained by mail questionnaire and the results were used to construct the interview schedules for the missing data. The last step of collecting data, face-to-face interview was used to gain the missing data and the in-depth information needed.

Further, some researchers (Donald, 1960; Eckland, 1965; Levine & Gordon, 1958; Suchman & McCandless, 1940) have used telephone interviews to supplement the mail questionnaire. Other (Kegeles, Clinton, & John, 1969; Sudman, 1976; Schmiedeskamp, 1962; Sharp, 1955) have used various combinations of mail, telephone and personal interview methods to accomplish the goal of high response rates. Consequently, this study used two principal methods of data collection: personal interviewing and mail questionnaire as methods to collect data.

*The Advantages of survey research*

Surveys are used frequently today because they offer so many advantages to those seeking information. Alreck and Settle (1995) suggest surveys can be designed to measure things as simple as respondents’ physical or demographic characteristics or as complex as their attitudes, preferences or lifestyle patterns. They may cover only one small aspect of the respondents' mentality or situation or they may include dozens or even hundreds of questions about almost every aspect of the respondents' lives. Surveys can be designed to capture the respondents' personal history, their present life circumstances, their intentions and expectations for the future or the entire scope of the time spectrum. Survey data can be collected by personal interview, telephone interview or direct mail. Respondents can be reached in their homes, at work, while shopping or even during their recreation. They can
be presented with a response task that requires only a few seconds or one that takes an hour or more. The most important advantage of survey research is it can be customised to fit both the needs and the budgets of people seeking information. Survey research uses sampling; information about an extremely large population can be obtained from a relatively small sample of people. Rarely do surveys sample more than about a thousand people, even when the results are to be generalised to many millions.

Burns (1990) suggests that the strengths of the survey method include the following: it is often the only way to obtain information about a subject’s past life; it is one of the few techniques accessible to provide information on beliefs, attitudes and motives; it can be used on all normal human populations except young children; it is an efficient way of collecting data in large amounts at low cost in a short period of time and structured surveys are amenable to statistical analysis. Pyke and Agnew (1991) have stated that survey is a popular research method because of its flexibility and deceptively simple technology.

The limitations of survey research

Survey research methods have some disadvantages and limitations. Alreck and Settle (1995) suggest that the most serious limitation is that it is hard or unrealizable to measure causality using survey research. Respondents will not answer some questions because the information is so private that they are too ashamed or threatened to give the information, and information may be obtained only with considerable expertise, effort and resourcefulness. Surveys often generate information that is worth various times more than the cost of the project. But surveys take time, cost money and require well-directed effort. Survey research is demanding in one detail: it requires completing, planning and cautious implementation at essentially every step in the process.

Good (1963) provides several limitations of survey research. First, surveys cannot obtain
the information that the respondents do not know. Second, information that is not important
to the respondents cannot be achieved in a faithful way. This makes surveys untrustworthy.
Third, a demand for hidden information should be avoided, as should questioning that
appears to check upon the honesty of the respondent. The success of surveys will be
endangered if questions are asked about income from gambling, or about bank notes hidden
in mattresses or locked in safety deposit boxes, or about tax returns already filed. Fourth,
information about activities shared by a very small proportion of the population cannot be
obtained in a reliable way in cross-section survey. Fifth, data that can be accomplished only
with very great sampling error does not establish suitable topics of sample survey. Sixth,
information obtained from a single survey is less secure than direction data reclaimed from
two or more consecutive surveys made by the same methods. Seventh, surveys cannot be
intended to provide exact quantitative forecasts of things to come.

The investigator now turns to the specific research questions which are the basis of the
dissertation.

**Research Questions**

Literature review, Chapter 2 and Chapter 3, exposed some knowledge and understanding
of collaboration both in general and via the Internet. The review found there was little
observed evidence about science teachers use the Internet for their collaboration. Besides,
the literature do not provide enough details to determine if the Internet is used to facilitate
and develop collaborative work it would be relevant to the science teachers’ collaboration
via the Internet situation. Would the Internet foster science teachers’ collaboration via the
Internet? The literature too, was limited in determining what are the benefits and
disadvantages of using the Internet as tool for collaboration. Finally, the literature review
proved inconclusive in determining what the models, factors, characteristics and possibility of collaboration among science teachers via the Internet.

This study major aim was to develop insight into science teachers’ collaboration via the Internet and study science websites that were provided on the Internet. Therefore, in order to investigated all those situations. The following research questions were offered to frame the study.

There are seven research questions for the overall investigation reported in this dissertation.

A. Which of Fishbough’s models of collaboration are appropriate for analysing science teachers’ collaboration in an electronic environment?

B. How do science teachers perceive the potential for collaboration among teachers via the Internet?

C. Do science teachers see a need to collaborate with other teachers via the Internet?

D. In what contexts do science teachers collaborate with each other on the Internet?

E. Why do some science teachers collaborate more in an electronic network? Why do some science teachers collaborate less?

F. What are barriers to science teachers’ collaboration via the Internet?

G. Which of Fishbough’s models of collaboration are suitable for analyzing science websites?

**Research Design**

This investigation is divided into two distinct studies: Study One is a survey of the teachers’ perceptions of collaboration via the Internet and Study Two is a detailed science website analysis.
Study One: Teachers’ Perceptions of Collaboration via the Internet

This study employed a survey approach to analyse the collaboration in an electronic environment of a sample of science teachers at government secondary schools in the metropolitan area of Perth, Western Australia. This area comprises six school districts: Cannington, Fremantle, Joondalup, Peel, Perth and Swan. The survey used both quantitative and qualitative techniques to examine the ways in which science teachers at these schools use the Internet, especially e-mail and the World Wide Web as potential tools for collaboration. In addition, the investigation sought data on how these science teachers collaborated via the Internet with science teachers in the same school, other schools in Australia and other schools in other countries. The purpose of Study One was to test models of collaboration via the Internet based on Fishbough’s models of collaboration and to investigate the use of the Internet in collaboration among those science teachers.

Population

The population comprised government high schools within the following school districts in the metropolitan area of Perth, Western Australia: Cannington, Fremantle, Joondalup, Peel, Perth and Swan.

Preliminary questionnaire

The sample size followed the general rule that the researchers always use the largest sample that they can afford and obtain (Cates, 1985). The sample was selected by using purposive sampling technique because this method allowed the researcher to design a sample that was satisfactory to her needed (Ray, 2003).

Therefore, the two school districts, Cannington and Fremantle, which are located in the
metropolitan area south of the Swan River of Perth, Western Australia were purposively selected as being appropriate for this survey. Specifically, by focusing on these two school districts, the investigator can study the collaboration process via Internet at a great depth and they are convenient for collecting data as well. A further reason for the selection of the two school districts was the fact that comparative data from a number of schools of all school districts were not required for this study. The twelve secondary schools that are found in the Cantaloupe school district and the twelve secondary schools that are found in the Farmhouse school district are listed in Table 1. The school names are fictitious.

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<tr>
<th>School district</th>
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<td>Cannington</td>
<td>Aroma Senior High School</td>
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<td>Belamont Senior High School</td>
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<td>Carrington Senior High School</td>
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<td>Kenaty Street Senior High School</td>
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<tr>
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<td>Kewdala Senior High School</td>
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<td>Madungtion Senior High School</td>
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<td>Rolston Senior High School</td>
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<td>Thorndie Senior High School</td>
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<td>Fremantle</td>
<td>Apple Senior High School</td>
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<td></td>
<td>Hamadryad Senior High School</td>
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<td>John Senior High School</td>
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<td>Kwinyaya Senior High School</td>
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<td>Lavender Senior High School</td>
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<td>Lychee Senior High School</td>
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<td>Nostoc Senior High School</td>
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<td>Rosemary Senior High School</td>
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<td></td>
<td>Soursop Free Senior High School</td>
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<tr>
<td></td>
<td>Willow Senior High School</td>
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</tbody>
</table>

Thus, twenty-four government secondary schools in two school districts: Cannington and Fremantle, which were purposively selected as the sample of government secondary schools within the following school districts in the metropolitan area of Perth, Western Australia: Cannington, Fremantle, Joondalup, Peel, Perth and Swan. Such a sampling technique is used when certain selected cases are studied without necessarily wishing to
generalise to all other cases. The most important reason for choosing these schools is that the heads of science department of the twenty-four high schools indicated to the investigator that they were interested in collaboration via Internet and they agreed to allow the investigator to approach their staff to assist with the study.

**Follow-up interview**

Survey packages were sent to twenty-four science departments of the sample schools in two school districts: Cannington and Fremantle. Of those contacted, sixteen schools returned the completed questionnaires; in some cases, more than one science teacher in the school completed the questionnaire. Of the twenty-four sample schools, sixteen responded, a response rate of 67%, which is an acceptable rate. According to Ray (2003) a return rate of 50% should be considered acceptable. The names of contributing schools and number of returned questionnaires from each school are given in Table 2. In fact, thirty-one individual teachers in all responded.

<table>
<thead>
<tr>
<th>School district</th>
<th>Schools</th>
<th>Returned questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannington</td>
<td>Aroma Senior High School</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Celery Ann Senior High School</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Coconut Senior High School</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Gorilla Senior High School</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Kelpie Senior High School,</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Thorndie Senior High School</td>
<td>1</td>
</tr>
<tr>
<td>Fremantle</td>
<td>Apple Senior High School</td>
<td>3</td>
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<td></td>
<td>Hamadryad Senior High School</td>
<td>2</td>
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<tr>
<td></td>
<td>Lavender Senior High School</td>
<td>3</td>
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<tr>
<td></td>
<td>Lettuce Senior High School</td>
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<td></td>
<td>Lychee Senior High School</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Melon Senior High School</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Nostoc Senior High School</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Rosemary Senior High School</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Soursop Free Senior High School</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Willow Senior High School</td>
<td>2</td>
</tr>
</tbody>
</table>

Total 31 schools
Science teachers’ participation

Twenty-four heads of science department of the sample schools were invited to participate in this study. Sixteen heads of science department allowed the researcher to interview them: two heads of science department indicated they collaborated via the Internet and fourteen heads of science department pointed out they did not collaborate via the Internet. Eight heads of science department did not want to participate in the interviews as they lacked of time and for personal reasons. The names of the sixteen schools whose heads of science department agreed to participate in the study are shown in Table 3.

Table 3

<table>
<thead>
<tr>
<th>Collaborate</th>
<th>Not collaborate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma Senior High School</td>
<td>Apple Senior High School</td>
</tr>
<tr>
<td>Melon Senior High School</td>
<td>Celery Ann Senior High School</td>
</tr>
<tr>
<td></td>
<td>Coconut Senior High School</td>
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<tr>
<td></td>
<td>Gorilla Senior High School</td>
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<td></td>
<td>Hamadryad Senior High School</td>
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<td></td>
<td>Kelpie Senior High School</td>
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<td>Lavender Senior High</td>
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<td>Lettuce Senior High School</td>
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<td>Nostoc Senior High School</td>
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<td>Rosemary Senior High School</td>
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<td>Soursop Free Senior High School</td>
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<td></td>
<td>Willow Senior High School</td>
</tr>
</tbody>
</table>

Five science teachers allowed the researcher to interview them: two science teachers who stated in the questionnaire that they collaborate via the Internet and three science teachers who indicated in the questionnaire that they do not use the Internet for collaboration. The names of these science teachers and schools are shown in Table 4.

Table 4.

<table>
<thead>
<tr>
<th>Collaborative status</th>
<th>Names</th>
<th>Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborate</td>
<td>Dave</td>
<td>Rosemary Senior High School</td>
</tr>
<tr>
<td></td>
<td>Ricky</td>
<td>Kelpie Senior High School</td>
</tr>
<tr>
<td>Not collaborate</td>
<td>Johnny</td>
<td>Kelpie Senior High School</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>Rosemary Senior High School</td>
</tr>
<tr>
<td></td>
<td>Sandy</td>
<td>Lychee Senior high school</td>
</tr>
</tbody>
</table>

Therefore, twenty-one science teachers: sixteen heads of science department and five
science teachers were purposively selected to participate in the follow-up interview in which their collaborative status was discussed in a great depth.

**Techniques**

In the process of data collection for the survey study, the researcher used both quantitative techniques (questionnaire) and qualitative techniques (semi-structured interview). The techniques used in the survey study may vary and may include both quantitative and qualitative approaches (McMillan & Schumacher, 1989). Both questionnaires and interviews can be used as a way of getting data about a person by asking him or her rather than by watching the person behave or by sampling a bit of behavior. Further, questionnaires and interviews can also be used to discover what experiences have taken place and what is occurring at the present and this information can be transformed into numbers or quantitative data by using the attitude scaling or rating scale techniques or by counting the number of respondents (Tuckman, 1972).

Ary, Jacobs and Razavich (1972) state the structured or unstructured interview is a simple way to ask questions. They also state that one of the most important aspects of interviewing is that it is flexible and the rapport established with the subjects provides for a cooperative atmosphere in which truthful information can be obtained. Cohen and Manion (1992) focused on the idea that the interview allows the interviewer to find out what is inside a person's head and to measure the knowledge a person has. It also gives details of a person's values and preferences.

In this study, mail questionnaire and face-to-face interview techniques were used together as a combined method of data collection. They were purposely used to balance strengths and weaknesses of each.
The mail questionnaire was used to obtain altogether existing characteristics of science teachers’ collaboration via e-mail and Internet at the sample schools. After analysing the data from the mail questionnaire, those results were used to compose the interview schedule for obtaining the missing information. The main strength of face-to-face interview is that the investigator can rigorously obtain the missing information and in-depth details needed. Hence, this study used this worthwhile quality of the interview to complete the weaknesses of the mail questionnaire. Importantly, the investigator was satisfied with the data from the mail questionnaire and these data were sufficient to be used to compose the interview schedule, which was used to gain the needed data for testing research questions and propositions (Stacey, 1969).

The **Science Teacher Collaboration via E-mail and Internet Questionnaire**, which is attached as Appendix 1 was used to gather data on models of collaboration and interaction perspective of collaborative relationships of science teachers at the twenty-four selected government high schools. The questionnaire was modified from the Collaborative Science Teacher Questionnaire (CSTQ), which was developed using categories of teacher collaboration used by Little (1982). The CSTQ was used to study science teacher collaboration in two secondary schools as a project submitted in partial fulfillment of the requirements for the degree of Master of Science at Curtin University of Technology in Perth, Western Australia. Then, categories of teacher collaboration via e-mail and Internet, which were found from the literature review, were used to construct the items in sub-scales of each model of collaboration in the Science Teacher Collaboration via E-mail and Internet Questionnaire. Also, the questionnaire was validated prior to the study by obtaining feedback from the Chair of the Science Teacher Association of Western Australia (STAWA) Electronic Communication Committee. The questionnaire is composed of four parts.
Part A, The teachers' use of electronic communication, is composed of two kinds of question. Firstly, Question One and Two are multiple-choice questions in which science teachers can choose from the answers that were given. Secondly, Question Three and Four are open-ended questions, which science teachers can use to describe the experiences about their collaboration via e-mail and Internet.

Part B, The teachers’ perceptions of electronic networks in teachers’ collaboration, is a 22-statement scale about teachers’ perception of teachers’ collaboration via the Internet. Each of the statements is accompanied by a 5-point scale: ‘Strongly disagree’, ‘Disagree’, ‘Neither agree or disagree’, ‘Agree’ and ‘Strongly agree’.

Part C, Collaboration via e-mail and Internet, is a 15-statement scale about science teachers use of e-mail and Internet to collaborate with other science teachers. Each of the statements is accompanied by a 5-point scale: ‘Almost never’, ‘Seldom’, ‘Sometimes’, ‘Often’ and ‘Very often’.

Part D, Background, sought demographic background about the respondents. In addition, the last two questions asked respondents if they wanted a summary of a summary of the result and their permission to interview them. If the respondents had some comments they could write in the space that was provided under the heading ‘Additional Comments’.

The semi-structured interview technique was used to follow up the study after the quantitative analysis. The interview schedule was guided by the results of the quantitative analysis of each statement from the Science Teacher Collaboration via E-mail and Internet Questionnaire. During the interviews, science teachers were asked to express their thoughts and experiences about the reasons for the trends in the quantitative data.

The interview schedule (Appendix 5) was developed to answer the research questions by using categories of science teachers’ collaboration via e-mail and Internet, which was found from the quantitative analysis. The interview schedule is composed of two sections. Section
One is used to answer the research question A given on page five. This section has two questions for science teachers who collaborate via the Internet and one question for science teachers who do not collaborate via the Internet. Section Two addresses the six research questions B, C, D, E, F and G given on page five. This section has seven questions for science teachers who collaborate via the Internet and five questions for science teachers who do not collaborate via the Internet.

Data Collection

The information of the government secondary schools and schools districts in the metropolitan area of Perth, Western Australia and the government secondary schools and school districts located south of the Swan River of Perth, Western Australia was provided by the Corporate Information Management of the Education Department of Western Australia. The document gave details for each school in the school districts such as names of the school districts and schools, telephone numbers of school districts and schools and the postal addresses of the school districts and schools.

The numbers of science teachers in two school districts at south of the Swan River of Perth, Western Australia were obtained from direct contact with the school receptionist of each school. Telephone calls were made with twenty-four heads of science department of the selected schools requesting their cooperation in distributing survey packages to their staff. On 2 September 1999, after obtaining their cooperation, the survey packages were posted to the heads of science department of the selected schools of the two school districts: Cannington and Fremantle.

Each survey package consists of a questionnaire, a researcher’s covering letter, a consent form and a return envelope. The copies of the researcher’s covering letter and the
consent form are attached as Appendix 2 and Appendix 3. The questionnaires and consent forms were required to be returned to the researcher in two weeks after science teachers received the survey package. After two weeks, twenty completed questionnaires were returned to the researcher. Follow-up was made by posting a gentle remind letter to the head of science department of each school. The copy of this letter is attached as Appendix 4. Eleven additional questionnaires were returned to the researcher. Thus, the completed questionnaires from 16 cooperating schools were analysed. Therefore, on 6 March 2000 to 24 March 2000 the follow-up interviews were conducted with sixteen heads of science department and five science teachers. The interviews were held in the science staff room of each school. A tape-recorder was used to record the whole of research-respondent exchanges (Hitchcock & Hughes, 1989). The investigator could see the location that the computers were placed in the science staff room and asked the permission to take photographs.

**Data Analysis**

The *quantitative* data were collected from the four parts of the *Science Teacher Collaboration via E-mail and Internet Questionnaire*.

Part A: The teachers’ use of electronic communication. In Question One and Two science teachers were asked to indicate their computer experiences. Question Three and Four are open-ended questions. In Question Three, science teachers were asked to specify the advantages of using e-mail and Internet to support their collaboration. In Question Four, science teachers were asked to explain the way(s) in which they change collaboration when e-mail and Internet were used as implements for collaboration.

Part B: The teachers’ perceptions of electronic networks in teachers’ collaboration.
Science teachers were asked to respond to 22 statements to assess their perception of teachers collaboration via Internet on a 5-point scale from 1 = ‘strongly disagree’ to 5 = ‘strongly agree’. Means of science teachers’ ratings on each statement were converted to a percentage.

In Part C: Collaboration via e-mail and Internet. Science teachers were asked to respond to 15-statements to testify their use of e-mail/Internet to collaborate with other science teachers on a 5-point scale from 1 = ‘almost never’ to 5 = ‘very often’. Means of science teachers’ ratings on each statement were transformed to a percentage.

In Part D: Background. Science teachers were asked to indicate their personal details about computer usage. In addition, the last two questions in this part asked science teachers if they wanted the summary of the result and whether they would be willing to be interviewed if further information were needed. On ‘Additional Comments’, if science teachers had some comments they could write in this part of the questionnaire.

The qualitative data were collected from Question Three and Four of Part A of the questionnaire and the follow-up interviews. Question Three and Four are open-ended questions. In Question Three, science teachers were asked to indicate the benefits of using e-mail and Internet to support their collaboration. In Question Four of Part A of the questionnaire science teachers were asked to state the way(s) in which they change collaboration when e-mail and Internet were used as tools for collaboration.

In the follow-up interviews, science teachers were asked to respond to the questions from the interview schedule, which is attached as Appendix 5. The answers were recorded on a tape-recorder during the interviews and were transcribed by the researcher. The quantitative and qualitative data were combined to describe the collaboration via e-mail and Internet of science teachers at each school.
Study two: A Detailed Science Website Analysis

To address the research question G, that is, *Which of Fishbough’s models of collaboration are suitable for analysing science websites on the Internet?* the investigator selected two kinds of science websites: science websites for science teachers and science websites for a general audience. The websites were from five continents, Australia, Asia, Europe, America and Africa, for this study. These websites were analysed using the selected models of collaboration and investigated the possibility of the Internet for collaboration among science teachers.

Population

The sample was selected by using a purposive sampling technique (Cates, 1985 and Ray, 2003). Thus, the five continents, Australia, Asia, Europe, America and Africa were purposively selected. The main reason for focusing on the two kinds science websites in the five selected continents is that the investigator believes that there are a large number of science websites, which include specific science websites for science teachers and general science websites for interested people and those science websites are used for joint work or collaboration.

Techniques

Three different groups of data were gathered in this study. First, in Western Australia, there are three particular websites available for science teachers to use for their collaboration: the Science Teachers’ Association of Western Australia (STAWA) website, the list server for Western Australian Science Educators (Catalist) and the Teachers Survival Kit (TSK) website. To collect data about these three websites, the address of each
website and electronic mail (e-mail) were used as tools to collect data. Further, for the list server, Catalist, a collection of Catalist network messages was compiled, beginning with the first semester of year 1999 and finishing at the end of the first semester of year 2001.

Second, many search engines were used to identify the two kinds of science websites. Specific science websites for science teachers as well general science websites for interested parties in the five chosen continents, Australia, Asia, Europe, America and Africa were compiled. A Murdoch librarian, who was a tutor while the investigator attended the Murdoch University Library training in 1998, suggested search engines such as HotBot, Excite, Alta Vista, LookSmart, WebCrawler, Google and Lycos as useful search engines for this study. Thus, these search engines were most frequently used to identify the two kinds of science websites in the five continents.

In addition, many keywords were used in conjunction with the selected search engines to identify the two kinds of science websites in the five selected continents. To illustrate, in order to find the specific and general science websites for Australia, the relevant keywords were:

- Australian science websites.
- Australian science websites for science teachers.
- Australian biology or chemistry or physics websites
- Australian biology or chemistry or physics lesson plan

Third, the investigator sent electronic mail (e-mail) to the websites identified around the world for more information was needed. The investigator’s e-mail address was supplied for this study and the investigator’s computer was operated for sending e-mail to the investigated websites around the world as well.
Content Analysis

What is content analysis? Berelson (1971) notes that content analysis is a research technique for the objective, systematic and quantitative description of the manifest content of communication. Kerlinger (1973) observed that content analysis is a method for observing and measuring the content of communication. Kerlinger describes this conception of content analysis:

Instead of observing people’s behavior directly, or asking them to respond to scales, or interviewing them, the investigator takes the communications that people have produced and asks questions of the communication (p. 525).

Stempel (1981) describes content analysis as a formal system for doing something that we all do informally rather frequently, drawing conclusions from observations of contents.

Content analysis has been used as a research technique to study many forms of communication such as textbooks, high school compositions, novels, newspapers, magazine advertisements and political speeds (Gall & Borg, 1963). Therefore, this research technique was employed as a method to analyse the Internet network messages that science teachers have accomplished when they communicate among themselves and the objective or subject matter of selected current science websites from the five chosen continents.

Data Collection

Content analysis (Berelson, 1952; Kerlinger, 1973) was used as the research technique for the analysis of data from the two kinds of science websites. It is an excellent research technique for ordering, observing and measuring the content of communication without observing, asking or interviewing people. The investigator can take and examine the content of communication that people have formed when they communicate among themselves. This allowed the investigator to obtain and investigate the Internet network
messages from the list server and missions or goals of each investigated website without the need to interview people. Therefore, the Internet network messages from the list server and missions or goals of each studied website were the important considerations in choosing the two kinds of science websites. Data were initially collected in Western Australia, then in the five chosen continents, Australia, Asia, Europe, America and Africa.

Collecting data in Western Australia.

There were two different processes for collecting data from the three websites: the Science Teachers’ Association of Western Australia (STAWA) website, the list server for Western Australian Science Educators (Catalist) and the Teachers Survival Kit (TSK) website in Western Australia. First, the investigator’s e-mail address was used to subscribe to the Catalist list server. The Catalist website was successfully subscribed to in the first semester of year 1999. In the period of data collection, e-mails from Catalist were checked every day. Thus, all Catalist network messages, which were sent and replied to by Western Australian science educators during the period of data collection were printed and summarised. The summarised Catalist network messages are attached as Appendix 8. Further, the investigator e-mailed the chair of Electronic Communications Committee of STAWA to request information about this website such as the number of subscribers and its objectives. The Electronic Communications Committee Annual Report of August 2001 was provided in response to this request. This annual report is attached as Appendix 7. Second, data were collected from the STAWA and the TSK websites, the addresses of these two websites: http://www.stawa.asn.au/ and http://tsk.stawa.asn.au were used to obtain the information needed. The analysis of these two websites is presented in Chapter 6.
Collecting data in Australia, Asia, Europe, America and Africa.

Many search engines, Hotbot, Excite, Alta Vista, LookSmart, WebCrawler, Google and Lycos, were used to obtain the two kinds of science websites: specific science websites for science teachers and science websites for general audiences in the five chosen continents.

Both kinds of science websites from the five selected continents were accessed and their objectives and subject matter, which were the significant factors in deciding the two kinds of science websites, were summarised. The analysis is offered in Chapter 6.

Data Analysis

Three different processes were used to analyse data for Study Two. First, content analysis was used as a method to analyse the Internet network messages that science teachers have communicated among themselves and the objective or subject matter of selected current science websites from the five chosen continents. Second, to investigate the research question G: Which of Fishbough’s models of collaboration are suitable for analysing science websites on the Internet? the objectives and subject matter of the two kinds of science websites, specific science websites for science teachers and general science websites for interested people in the five chosen continents were analysed into the three models of collaboration. The three models are: Consulting, Coaching and Teaming. The selected models of collaboration are specifically used as a method to analyse models of collaboration. The analysis is presented in chapter 6.
On the other hand, when science teachers use the Internet for their collaboration a more delicate detailed analysis is needed. Thus, the types of collaboration are more classified. The four types of collaboration, which have been proposed by Little (1990) are: *Storytelling and Scanning for Idea, Aid and Assistance, Sharing and Joint work.*

Hence, the notion of the four types of collaboration was employed as a system to analyse the types of science teachers’ collaboration with each other via the Internet. So, to analyse the use of the Internet for collaboration among science teachers, science teachers’ Catalyst network messages were analysed into the four types of collaboration: *Storytelling and Scanning for Idea, Aid and Assistance, Sharing and Joint work.*

Then, the results were analysed according to Fishbough’s models of collaboration: *Consulting, Coaching and Teaming.* The analysis is also presented in Chapter 6.

**Summary**

This chapter provided full detail of the two distinct, but related studies. Study One is a survey of teachers’ perceptions of collaboration via the Internet. This study provided the survey research approach, research design, procedures used to collect and analyse data as well as, characteristics of the sample used in the study. Study Two is a detailed science websites analysis. This study described population, techniques, content analysis and methods used to collect and analyse data.
Chapter 6

Results of Study One

Introduction

This chapter presents the findings of the survey of a sample of teachers from the twenty-four selected schools. The results from mail questionnaires and face-to-face interviews are combined together. The findings of the current collaborative status in an electronic environment are also shown. The findings from each school are grouped into three sections. Section One describes demography and computers used in the sample schools. Section Two is the analysis of Fishbough's models of collaboration in an electronic environment, which is presented below as six research questions (A-F) given in Chapter One. Section Three is the analysis of current collaborative status in an electronic environment, analysed in terms of the models of collaboration: Consulting, Coaching and Teaming.

Section 1: Demography and Computers used in the participating Schools

Demography

The following statistics provide a general picture of teachers who participated in the study.

Number of science teachers: There were forty-six science teachers who participated in the study: thirty-one science teachers who responded to the questionnaire and fifteen heads of science department who agree to be interviewed.

Gender: There were more male (78%) than female (22%) participants.
Age: 9% were under 30, 26% were between 30-40, 43% were between 40-50 and 22% were over 50.

Professional qualification: 43% were B.Sc., 22% were other Bachelor’s Degree, 18% were Post Graduate Diploma, 13% were Master’s Degree and 4% were Ph.D.

Strongest science teaching qualification: 39% were Biology, 28% were Physics, 22% were Chemistry, 9% were General Science and 2% were Environmental Science.


Experience in teaching: 11% had 5 years of teaching, 9% had 6 to 10 years of teaching, 20% had 11 to 15 years of teaching, 20% had 16 to 20 years of teaching and 40% had more than 21 years of teaching.

Type(s) of support during collaboration via the Internet: Most science teachers (65%) have not received any type(s) of support during their collaboration via the Internet. Of the remainder, 4% received support from administrators, 2% received support from the head of department, 13% received support from colleague(s) and 16% received support from STAWA.

Collaboration among science teachers in the past 12 months: 48% of participants reported that they collaborated with science teachers in the same school, 22% reported that they collaborated with science teachers in other schools in Australia, and 30% reported that they do not collaborate with other teachers.

Subscribed to the Science Teachers Listserver-Catalist: Only 6% of participants have subscribed to the Teachers Listserver-Catalist.

Recently, visited STAWA’s website: The result showed that 16% of participants reported visiting STAWA’s website at least once.
Computers used in the participated Schools

The following descriptions provide a general picture of computers and the Internet that were used in the sample schools. These details were gained from the fifteen heads of science department who agree to be interviewed.

Aroma Senior High School

There were three computers rooms, each of which had twenty-five computers, which were used either for computing classes or teachers could book them for class lessons. There were twelve computers and ten laptop computers in the library, which could be used by students for research lessons and teachers could book in for their students’ use. Each classroom in all areas had at least one computer available for students. There were ten computers in the music area and they were used as tools for the music teachers in particular for composition and the music programs. There was at least one computer in the technology and design area and it was used as a CAD computer, which had a drafting program. There was no limitation on teachers to use computers in school hours or after school hours.

E-mail and Internet. A mini lab area in the science department had six computers. One of them was dedicated to the Air Watch-monitoring program but it could also be used for research. In this school all computers were networked. Teachers could access the Internet from all classrooms. Staff rooms had at least one computer, which was linked to the network. Most teachers had an e-mail address.

Apple Senior High School

There were three science offices: two of them had two computers in each and the third office had one computer. There were two rooms in between laboratories, which had about
eight computers in each for students’ use. A few of the physics laboratories had a computer in each room. Teachers could use computers at school without limitation.

_E-mail and Internet._ All computers in the physics laboratory were networked. Students had to use password to access Internet. Every teacher had an e-mail address.

**Celery Ann Senior High School**

There was one computer per classroom in the main block and four computers in two administration areas.

_E-mail and Internet._ Computers in the whole school were networked, which covered a fairly large proportion of the school (called the curriculum network). Staff had the facility to have an e-mail address.

**Coconut Senior High School**

There were about twenty computers in the library, sixteen computers in the first computer room, twenty-five computers in the second computer room, and seventeen computers in the third computer room. There was no limitation for teachers and students using the computers at school.

_E-mail and Internet._ Computers in the whole school were networked and it was very easy to access Internet as it was a fast system. It occasionally went down or slowed down when the server was ‘full’. The science office had its own server and e-mail account.

**Gorilla Senior High School**

At that time, there were only two laptop computers and a standard computer, which was probably mainly for staff use or occasionally teachers would take it into classrooms. Therefore, teachers had not used computers to any great degree in the classrooms. There
was no limitation on using computers in this school. The business department had had computers for long time. The students in other parts of the school could come and use those computers as groups and they could use a small number of computers in the library as well. In the science department has one computer plus a laptop.

_E-mail and Internet._ At that time, if teachers wanted to use Internet they had to take students to the library or the business area. The science department had only a science e-mail address; teachers did not have individual e-mail addresses.

**Hamadryad Senior High School**

There was at least one computer in each department. In the science office, there were four computers: one was for the technician to use for stock and another one in laboratory, which were connected to the Air Watch program on Channel Seven a commercial television station.

_E-mail and Internet._ All computers were connected to a network inside of the school. Both of the computers in the science office were connected to the Internet but it was not easy to access the Internet if the computers in the laboratories, the library or in the classrooms were being used.

**Kelpie Senior High School**

There were one hundred computers in this school. There was one old computer in the science office, which was available for staff all day.

_E-mail and Internet._ At that time, the school could not use e-mail or Internet as things were changing and they would get a new system later. All teachers had an e-mail address.
**Lavender Senior High School**

There were more than one hundred computers in this school. One room had about twenty computers. In science office had two computers plus a laptop for science teachers to use. In the library, there were about six computers, which students could use, and another six computers for library use. There were computers in other offices as well. Teachers could use computers as much as they wished.

*E-mail and Internet.* All computers in this school were connected to the network. Thus, teachers could change students’ record and so on. There was a school’s e-mail address and teachers could have personal e-mail address if they wanted. There was an e-mail address for the science department.

**Lettuce Senior High School**

There were many computers in this school. For example, in the science department, there were two computers and two laptops. There were two computer laboratories, which had more than twenty computers in each; they were accessible when they were not being used for computer lessons. In the staff room, there were four computers. Further, teachers could use the computers in the library area as well.

*E-mail and Internet.* All teachers had e-mail addresses and all computers in this school were connected to the network; however, the network had an inferior quality cable, which was about two generations out of date and if it got damp users lost connection.

**Lychee Senior High School**

There would have been approximately four hundred computers in this school. Computers had been extensively used for administrative purposes, teacher learning...
purposes and interactive learning software. They were easy to access and frequently used. Whenever teachers had time they certainly used computers as a teaching and learning tool.

*E-mail and Internet.* This school used e-mail and Internet extensively. E-mail had been using to communicate both in and out the school. Further, teachers used the Internet to look at or change students’ records. Every teacher had a password and that password changed every month.

**Melon Senior High School**

There were two computers in the science staff room. This school had two computer laboratories, which contained twenty computers in each. The library had a computer as well. This school was working toward one computer per five students, a goal for every government high school in Western Australia.

*E-mail and Internet.* Teachers could access the Internet as the school was networked and students could access the Internet as well. The computer in the staff room could access the Internet and it was a fast system.

**Nostoc Lake Senior Campus**

There were two computers in the science office, both of which had access to the Internet. The computer laboratory had sixteen computers but they did not have access to the Internet at that stage; these computers were used for science software learning purposes.

*E-mail and Internet.* Two computers in the science office were connected to the Internet. This school was waiting for the network to be extended; when it was finished the school would connect as many computers as possible to the Internet. In fact, every single employee of the department had their own e-mail address, which could communicate with anyone in the whole department, but no one was doing that at the time of the interview.
**Rosemary Senior High School**

There were two or three rooms full of computers and every office had one or two computers. In the science department, there were three computers for seventeen science staff. The school had just purchased some notebook computers that year. There were eight of those computers in the laboratory for students and some of the staff to use but there were not any printers connected up to those computers. Teachers could use computers with no limitations. This school was working towards getting one room with some power points in there so teachers could use the notebook computers in that room.

*E-mail and Internet.* If teachers wanted to use a network they would have to book into the computer room that was usually not available because other classes were timetabled to be in there. But there were notebook computers; teachers could book up to eight of these for computer based lab work. In the science office, there were three computers but only two of them were connected to the Internet. It was easy to access to the Internet and every teacher had an e-mail address at school.

**Soursop Free Senior High School**

In the science department, there were three online computers for six science staff.

*E-mail and Internet.* At that time, the networking around the school was not finished. It would be done when the school had some more money. In this school, there was a list of e-mail addresses of the sixty teachers, and thirty teachers had a personal e-mail address that could be contacted directly. Teachers in this school had not used the Internet much for the classroom. They mainly used the computer for setting tests and students used it for research.
Willow Senior High School

In this school, there were about two hundred and fifty computers. There were four computers in the science department: three computers in the staff room and one was outside the room for students to use. In the library, there were twenty to twenty-five computers with Internet access and word processing for students to use. Students could use the computers by themselves at lunchtime. There were five computer laboratories, which were available for anyone to use, but a booking system controlled their use. There were another fifteen or sixteen computers in the social studies room and another twenty computers in the English room.

E-mail and Internet. This school had a new connection to the Internet, which was a lot faster than the previous year. Every teacher and every student had to have a password for the Internet. The school did not have limitations for using Internet at that time.

During the interview, the investigator was allowed to take photographs of computers in the science offices and libraries as shown below in Figure 1 and 2.

Figure 1: A sample photograph of computer in the science office of a participated school.
Summary

There were forty-six science teachers who participated in the study and most of them were male (78%). The majority of them had the highest qualification of the B.Sc. (43%), with the strongest science qualification in Biology (39%), and had teaching experience of more than 21 years. Most of these science teachers (48%) collaborated with other science teachers in the same school. Only 6% of participants had subscribed to Catalist and 16% only had recently visited STAWA’s website.

Computers in the sample schools were mostly located in the library, the computer laboratory, classroom and staff rooms of each subject area. Mainly, computers were for student use. Every school had Internet access for both students and teachers.
Section 2: Analysis of Fishbough's models of collaboration in an electronic environment.

Six research questions guided the investigation, outlined below. The models of collaboration in an electronic environment were assessed using the Science Teacher Collaboration via E-mail and Internet Questionnaire and a follow-up interview. The questionnaire is composed of four parts. Part A, Teachers’ use of electronic communication, has four questions. Questions One and Two are closed items; in both questions, science teachers are asked to indicate time(s) and place(s) that they use computers for collaboration in an electronic environment. Questions Three and Four are open-ended questions; in these two questions, science teachers are asked to describe the benefits and experiences in using e-mail and Internet for collaboration. This part of the questionnaire is used to answer the five of the research questions for this study.

Part B, Teachers’ perceptions of electronic networks in teachers’ collaboration, contains 22 items in the form of a statement scale. Science teachers are asked to respond to these statements on a 5-point scale from 1 = ‘strongly disagree’, 2 = ‘disagree’, 3 = ‘neither agree or disagree’, 4 = ‘agree’ to 5 = ‘strongly agree’. This part of the questionnaire is also used to answer the five of the research questions for this study.

Part C, Collaboration via e-mail and Internet, contains 15 items in the form of a statements scale. Science teachers are asked to respond to these statements on a 5-point scale, from 1 = ‘almost never’, 2 = ‘seldom’, 3 = ‘sometimes’, 4 = ‘often’ to 5 = ‘very often’. This part of questionnaire is used to answer the first research question for this study.

Part D, Background, science teachers are asked to indicate some background information by responding to nine questions. At the end of the questionnaire, teachers are invited to provide names and addresses of those teachers who might be interested in the
results of this study. Those teachers’ names and addresses are also used to contact them in case further information is needed. In addition, teachers can state their comments on the ‘additional comment’ section provided.

After the questionnaires were analysed, those results were used to construct the interview schedule (see Appendix 5). The interview schedule is composed of two sections. Section One is used to answer the research question A: Which of Fishbough’s models of collaboration are appropriate for analysing science teachers’ collaboration via the Internet? This section has two questions; the first question is used to identify science teachers who collaborate or do not collaborate via the Internet and the second question follows up science teachers who do collaborate via the Internet. Teachers are asked to describe all the computers used in their schools and to explain their roles in using the Internet for their collaboration. Section Two addresses the five research questions given of this study. There are eight questions for science teachers who collaborate via the Internet and six questions for science teachers who do not collaborate via the Internet. Science teachers who collaborate via the Internet are asked to describe the motivation, benefits, and barriers in using the Internet for their collaboration, and science teachers who do not collaborate via the Internet are asked to explain why they do not use the Internet for their collaboration.

To collect further information about science teachers’ collaboration via e-mail and Internet, a follow-up interview was conducted with fifteen heads of science department who agreed to be interviewed and five science teachers who completed the questionnaire and also agreed to be interviewed. Nine heads of science department did not want to participate in a follow-up interview because they lacked of time.
Research question A: Which of Fishbough's models of collaboration are appropriate for analysing science teachers' collaboration via the Internet?

The Consulting model of collaboration.

Five statements in the questionnaire were used to examine the way(s) in which science teachers’ collaboration via the Internet related to this model of collaboration. The five statements related to this model are given in Table 5, together with the results of the quantitative analysis of science teachers' responses.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I give advice to other teachers on how to teach a science topic.</td>
<td>77 3 6 10 3</td>
</tr>
<tr>
<td>2. I seek advice from other teachers and experts when faced with problems about how to teach a science topic.</td>
<td>77 10 6 3 3</td>
</tr>
<tr>
<td>3. I help novice science teachers plan their teaching activities.</td>
<td>71 6 13 6 3</td>
</tr>
<tr>
<td>4. I learn more about teaching techniques in science from other teachers and experts.</td>
<td>52 6 29 6 6</td>
</tr>
<tr>
<td>5. I ask experienced teachers how to teach a difficult science topic.</td>
<td>71 10 10 3 6</td>
</tr>
</tbody>
</table>

Note: AN = almost never, SD = seldom, S = sometimes, O = often and VO = very often

Table 5 shows that most science teachers in the sample almost never give advice to other teachers on how to teach a science topic or seek advice from other teachers and experts when faced with problems about how to teach a science topic or help novice science teachers plan their teaching activities. In addition, they almost never learn more about teaching techniques in science from other teachers and experts or ask experienced teachers how to teach a difficult science topic.

Comments from the interviews with heads of department and science teachers supported these results of the Consulting model of collaboration.
To begin with, heads of department emphasized that few science teachers used e-mail and Internet for collaboration. For example, heads of department noted that those science teachers used the Internet to share information, join professional lists and access some websites to get information. Sample quotes include:

- There is a science teacher association, which teachers can contact.
- I can actually join professional lists and can share information.
- Three science teachers do use computers to get information from the Internet but they do not contact other teachers.
- I do not use it as such and I do not collaborate in that way.

Heads of science department further emphasized that most science teachers rarely used the Internet to contact other teachers or ask other teachers questions. They also noted that they had never seen collaboration on the Internet. Sample quotes include:

- We would probably just check e-mails to see what have been sent to us.
- Science staff and I do not contact other teachers in other countries.
- I never use a computer for collaboration. I have never worked with other science teachers in other school and I have never seen collaboration on the Internet.

However, science teachers emphasized that few of them used the Internet to collaborate with other teachers. For example, one science teacher stated that he did use the Internet to give advice, share information and get work from his colleagues:

I give advice, swap strategies, work sheet and so on with science teachers in another schools. Besides, I work on exam papers and I want different questions or choice questions so my colleagues help me a lot and sometimes I get work sheets from them.

Another science teacher also emphasized that she used the Internet superficially. She used it to look around, not to find particular information:

The Internet, I just look at what there is and I suppose, I use that less because I am not trying to solve the particular problem…I am just looking at what is there…If I use it to solve the particular problem maybe I might find it is more useful.

The results indicate that science teachers at the sample schools rarely used the Consulting model of collaboration to collaborate with other teachers. Proposition 2
Science teachers use the Consulting model of collaboration as a framework for their collaborative practice) was not supported.

The Coaching model of collaboration.

Five statements in the questionnaire were used to investigate the characteristics of science teachers’ collaboration via the Internet related to this model of collaboration. The five statements related to this model are presented in Table 6, together with the results of the quantitative analysis of science teachers' responses.

Table 6
Coaching model of collaboration: science teachers’ rating. (N=31)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. I work jointly with other teachers to implement models of teaching.</td>
<td>AN 68  SD 6  S 10  O 13  VO 6</td>
</tr>
<tr>
<td>7. I assist other science teachers to develop their teaching techniques and materials of a new topic.</td>
<td>AN 71  SD 3  S 10  O 10  VO 6</td>
</tr>
<tr>
<td>8. I receive frequent feedback on my own teaching from other science teachers.</td>
<td>AN 71  SD 16  S 13  O 0  VO 0</td>
</tr>
<tr>
<td>9. I have a trusted peer, who asks clarifying questions, provides data and offers constructive critique.</td>
<td>AN 71  SD 13  S 6  O 6  VO 3</td>
</tr>
<tr>
<td>10. I seek assistance from other teachers find problem solutions for at risk students.</td>
<td>AN 68  SD 10  S 16  O 6  VO 0</td>
</tr>
</tbody>
</table>

Note: AN = almost never, SD = seldom, S = sometimes, O = often and VO = very often

Table 6 shows that most science teachers almost never work jointly with other teachers to implement new models of teaching or assist other science teachers to develop their teaching techniques and materials for a new topic or receive frequent feedback on their own teaching from other science teachers. Besides, they also almost never have a trusted peer, who asks clarifying questions, provides data and offers constructive critique or seek assistance from other teachers to find problem solutions for at risk students.

Comments from the interviews with heads of department and science teachers supported these results of the Coaching model of collaboration. To begin with, heads of science
department stated that science teachers rarely used e-mail and Internet to contact other teachers. For example, heads of department pointed out that they seldom used the Internet, as it was a new mode of collaboration and that they had to learn to use it properly:

- I have never contacted with other teachers in other schools or outside Australia.
- Collaborate via the Internet…we have not reached that stage yet.
- I do not think any teacher is going to use e-mail or the Internet for collaboration in this school.

Then, science teachers stated that most of them rarely used the Internet to contact other people. For example, one science teacher cited that once he used it he did not get good responses. Sample quotes include:

I tried to do an honors thesis and I contacted a lot of people via the Internet because I thought I can collect a lot of data quickly but I did not get one positive response.

Accordingly, he emphasized that he would like to learn how to use the Internet efficiently. A sample quote was: So I would say that I have to learn to know how to use it effectively.

The results indicated that science teachers at the sample schools very seldom used the Coaching model of collaboration to collaborate with other teachers. Proposition 3 (Science teachers use the Coaching model of collaboration as a framework for their collaborative practice) was not supported.

The Teaming model of collaboration.

Five statements in the questionnaire were used to analyse the performance of science teachers’ collaboration via the Internet related to this model of collaboration. The five statements related to this model are presented in Table 7, together with the results of the quantitative analysis of science teachers' responses.
Table 7
Teaming model of collaboration: science teachers’ rating. (N=31)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. I am involved in a team for instructional improvement.</td>
<td>71 3 6 16 3</td>
</tr>
<tr>
<td>12. I share ownership of programs for professional development with other teachers.</td>
<td>71 6 3 13 6</td>
</tr>
<tr>
<td>13. I develop teams with other teachers to support members’ professional growth activities.</td>
<td>71 10 6 6 6</td>
</tr>
<tr>
<td>14. I participate in a team problem solving approach to design special strategies for individual students.</td>
<td>74 13 6 0 6</td>
</tr>
<tr>
<td>15. I share my experiences with other teachers and we support each other while teaching the same topic.</td>
<td>65 0 13 10 13</td>
</tr>
</tbody>
</table>

Note: AN = almost never, SD = seldom, S = sometimes, O = often and VO = very often.

Table 7 shows that most science teachers are almost never involved in a team for instructional improvement or share ownership of programs for professional development with other teachers or develop teams with other teachers to support members’ professional growth activities. Moreover, they almost never participate in a team problem solving approach to design special strategies for individual students or share their experiences with other teachers and support each other while teaching the same topic.

Comments from the interviews with heads of department and science teachers confirmed these results of the Teaming model of collaboration.

To begin with, heads of department pointed out that science teachers rarely used e-mail and Internet to work with other teachers. For example, one head of department stated that she and her colleagues had experiences of collaboration with a Swedish teacher, which occurred with sharing but only for a short period of time as that website had gone:

Bobby and I had some contacts with people in Sweden a couple of years ago. It was a project that the Swedish were running about genetics. It sort of started and went for a little while and then disappeared.

On the other hand, heads of science department emphasized that they sometimes used the Internet to collaborate with other teachers but not very much; mainly they used it to
check e-mails and share information between colleagues within the school. Sample quotes include:

- I use Internet as a tool for collaboration and I use e-mail to contact with other head of department but not very much.
- Now, I check my e-mail every morning because my school notices and my daily notice, which come from administration, are on e-mail.
- They use the Internet to communicate or inform between science teachers within the school.

Then, science teachers emphasized that few of them used the Internet to contact other teachers. For example, one science teacher stated that he used the Internet to do research with his colleagues in a university:

I use Internet to collaborate in education. I collaborate with my colleagues at Curtin University. I use Internet to get information about studies that are relevant to the research.

The results revealed that science teachers at the sample schools very seldom used the Teaming model of collaboration to collaborate with other teachers. Proposition 4 (Science teachers use Teaming model of collaboration as a framework for their collaborative practice) was not supported.

Accordingly, Proposition 1 (Science teachers use the Internet for their collaboration) was not supported.

**Research question B:** How do science teachers perceive the potential for teachers’ collaboration via the Internet?

*Teachers' use of electronic communication.* To investigate the potential of science teachers’ collaboration in an electronic environment, two closed questions and two open-ended questions were employed. To begin with, science teachers responded to the two closed questions, which asked them to account for themselves as users of information
technology or educational computing. These results are presented in Table 8. In addition, salient parts from the interviews with heads of department and science teachers are also presented to give more information and confirm these results.

### Table 8.

<table>
<thead>
<tr>
<th>Status</th>
<th>Responses (%)</th>
<th>Status</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ability of using the Internet</td>
<td></td>
<td>The place of using computers</td>
<td></td>
</tr>
<tr>
<td>extremely competent with technology.</td>
<td>16</td>
<td>school computers</td>
<td>10</td>
</tr>
<tr>
<td>comfortable with technology.</td>
<td>55</td>
<td>home computers</td>
<td>19</td>
</tr>
<tr>
<td>just a beginner.</td>
<td>29</td>
<td>both home and school computers</td>
<td>35</td>
</tr>
<tr>
<td>Habit of using the Internet</td>
<td></td>
<td>The time of most often using the Internet</td>
<td></td>
</tr>
<tr>
<td>classified themselves as regular e-mail</td>
<td>58</td>
<td>before or after school</td>
<td>10</td>
</tr>
<tr>
<td>or the Internet users</td>
<td></td>
<td>when they are free from their classes at school</td>
<td>13</td>
</tr>
<tr>
<td>did not classify themselves as regular e-mail or the Internet users.</td>
<td>42</td>
<td>when they are at home</td>
<td>45</td>
</tr>
<tr>
<td>The frequency of using computers</td>
<td></td>
<td>The accessibility of using computers</td>
<td></td>
</tr>
<tr>
<td>daily.</td>
<td>32</td>
<td>At work</td>
<td>42</td>
</tr>
<tr>
<td>weekly.</td>
<td>26</td>
<td>They have adequate access to a computer</td>
<td></td>
</tr>
<tr>
<td>monthly.</td>
<td>3</td>
<td>They have adequate access to the Internet</td>
<td>39</td>
</tr>
<tr>
<td>The duration of normally using the Internet per day</td>
<td></td>
<td>They have their own personal e-mail address</td>
<td>32</td>
</tr>
<tr>
<td>less than one hour</td>
<td>48</td>
<td>At home</td>
<td>52</td>
</tr>
<tr>
<td>one or two hours.</td>
<td>10</td>
<td>Science teachers have a computer.</td>
<td>42</td>
</tr>
<tr>
<td>more than two hours</td>
<td>3</td>
<td>Science teachers have the Internet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Science teachers have personal e-mail address.</td>
<td></td>
</tr>
</tbody>
</table>

With respect to the *ability* of science teachers to use computers, most science teachers in the sample regarded themselves as comfortable with technology but some of them were just beginners. In comments from the interviews, heads of department commented on the range of ability of science teachers using computers in their schools. For example, heads of department stated that most science teachers were confident with computers but few of them were beginners. Sample quotes include:

- In this stage, I say teachers have had brief experiences with computing and in collaboration with other teachers in other schools.
• Most teachers now have got a very basic knowledge: being able to switch computer on and work the way through and just do some word processing.
• Most teachers can work on a computer but some cannot.

Further, science teachers explained that most of them could use computers and surf the Internet but few of them could not do. Sample quotes comprise:

• I use e-mail every day and I do not have any problem.
• I am a person who surfs Internet a lot.
• The computing skills in my department, one teacher would have none. Another woman is very good; she does as much as she need on computer.

With respect to the habit of using the Internet, most science teachers in the sample schools classified themselves as regular e-mail or Internet users. In Comments from the interviews, heads of department mentioned the typical e-mail and Internet users on their staff. For instance, heads of department pointed out that some science teachers used computers regularly but some did not. Sample quotes include:

• We have a couple of staff in this year that are very competent in technology.
• Using computers: some teachers do but some do not.
• I do not think some of my staff knows how to get on the Internet anyway.
• There would be about ten of seventeen science teachers who actually use computer regularly at school.

In addition, science teachers explained that most of them used computers regularly: Sample quotes include:

• I use e-mail every day; it is wonderful and I do not have any problem.
• I would say each week I will spend at least two or three hours on Internet.

With respect to the frequency of using computers, science teachers reported that most of them used computers daily and the rest of them used it weekly or monthly. In comments from the interviews, heads of department explained the regularity of using e-mail and Internet among their staff. To illustrate, heads of department stated that most science teachers used computers daily. Sample quotes regarding this issue:
• Most teachers have an e-mail address. I have one and I use it. I check my e-mail constantly and it is a really good way of keeping up with everything.
• Now, I check my e-mail every morning because my school notices and my daily notice are on e-mail so I have to read them every morning.

Furthermore, science teachers explained that they used computers daily or weekly.

Sample quotes contain:

• I use e-mail every day.
• I would say each week I will spend at least two or three hours on Internet.

With respect to the *place* of using computers, science teachers reported that most of them used both home and school computers. In comments from the interviews, heads of department cited that most science teachers used computers both home and school computers. Sample quotes comprise:

• I use a Macintosh at home so it is very hard to learn a completely new system.
• Most staff uses the computer at school but some are better than others are.
• I do not use school computers. I always use my computer at home.

Besides, science teachers noted that most of them used the Internet at home. Sample quotes include:

• I always use home computer because access at school is difficult.
• I use computer at home because I do not have a lot of time at school.

With respect to the *time* of using the Internet, science teachers reported that most of them often used the Internet when they were at home. In comments from the interviews, heads of department explained that science teachers could use school computers any time if they were not being used, but some science teachers preferred to use their home computer. Samples quotes include:

• Teachers can use computers as much as they can during school hours.
• I have used the Internet at home for five years. It is OK.
• If teachers want to check e-mail, they have to get to school early in the morning and start to use computer or they can use at recess time or lunchtime.
In addition, science teachers pointed out that they used computers at home as they did not have time at school and access to computers at school was difficult. Sample quotes include:

- I have a lot of time at home so I use the computer at home.
- I always use home computer because access at the school is difficult…The school does not have enough computers.

With respect to the duration of normally using the Internet per day, science teachers reported that most of them normally used the Internet less than one hour per day. They rarely used the computers for more than one or two hours. In comments from the interviews science teachers explained their duration of using e-mail and Internet. To illustrate, science teachers emphasized that they used the Internet more than two hours. Sample quotes include:

- I am a person who surfs the Internet a lot. I would say each week I will spend at least two or three hours on the Internet
- No one in my family uses Internet from 5 p.m. and 8 p.m. in the evening so I write e-mail and send it at 8 p.m. in the evening.

With respect to the accessibility of using computers, science teachers reported the accessibility of using computers both at work and at home. At work, most of them had adequate access to a computer and they had their own personal e-mail address. In comments from the interviews, heads of department explained the accessibility of using e-mail and Internet of their staff at work. For instance, they stated that science teachers had adequate access to computers and some of them had an e-mail address at work. Sample quotes comprise:

- Every teacher has an e-mail address but I do not think every teacher uses it.
- The computers are very easy to access Internet and it is very fast system.
- I have an e-mail address and most of the staff has their e-mail address.
Further, one science teacher explained that he used e-mail at school to contact colleagues: The other thing that I would do at school is just e-mail information to my colleagues.

At home, science teachers reported that most of them had a computer and some of them had the Internet and personal e-mail address. In comments from the interviews, heads of department commented that most science teachers had computers and e-mail address at home but few of them did not have the Internet at home. Sample quotes include:

- I have my own laptop, private property.
- I would say probably the majority of teachers in the science department have got their own computer at home.
- I do not have access Internet at home and I do not think any of my science staff has access at home.

Moreover, science teachers explained that they had a computer at home and preferred to use it at home as they did not have time at school. Sample quotes comprise:

- I can go home and use my Internet that is available all a time.
- I always use computer at home because I do not have time at school.

Then, science teachers responded to two open-ended questions, which asked them to note on advantages and the changing way(s) of using e-mail and Internet to support their collaboration. Firstly, several advantages of using e-mail and Internet for collaboration were reported as follows.

- E-mail and Internet is quick and cooperatively transfers information.
- Rapid response is possible… e-mail and Internet can be accessed anywhere.
- It is a cheap, efficient and convenient collaborative tool.
- Information between colleagues occurs quickly and efficiently.

Comments from the interviews with heads of department and science teachers supported the results of this open-ended question. To illustrate, one head of department pointed out that the Internet was a convenient tool for collaboration and the best resource for information:
I think it is a good way of sharing information and getting information from the websites.

In addition, science teachers emphasized that there were several advantages of the Internet. For example, they stated that they could get or send materials and exchange new ideas from the Internet. Sample quotes include:

- I can get an idea from other science teachers without paying money.
- I am writing papers when I have finished I will send drafts by e-mail.
- I do access some websites particularly concerned with evolution selection. A number of websites is very good for the subject that I am teaching.

On the other hand, comments from the interviews with heads of department and science teachers explained some disadvantages of using the Internet. For example, head heads of department pointed out that there were two types of computers, and it was difficult for them to be familiar with both types, connecting to the Internet was a time consuming activity. Sample quotes include:

- I use a Macintosh at home so it is very hard if I have to learn a completely new system.
- Doing all the connecting up and go through the entire site is a very time consuming exercise.

Science teachers also pointed to various disadvantages of using the Internet for collaboration. To illustrate, they stated that the Internet was big and hard to find a specific topic and it consisted of a lot of ‘stuff’. Especially, users did not know which websites had gone out-of-date, and if they wanted to send something it had to be an electronic document. Sample quotes include:

- Internet is so big, so how do I find who is doing the research.
- I gave them three sites to research music instrument. One of those sites did not work. It has gone out-of-date since the Internet sites were researched.
- If I want to send something to someone else, I have to turn it into an electronic document and that takes time.

The results pointed out that there were many benefits to science teachers at the sample schools using e-mail and Internet for their collaboration. Proposition 6 (Many benefits exist
Then, science teachers reported the changing way(s) of their collaboration when the Internet was used as a tool for collaboration into the open-ended question. Sample quotes include:

- E-mail and Internet helps me to collaborate faster and less paper work.
- E-mail and Internet is the new mode for communication.
- E-mail and Internet makes collaboration much easier; encourages, ease of use and speed.

In comments from the interviews with heads of department and science teachers supported the results. Explanations of heads of department upheld these results. For instance, they pointed out that they felt it was more convenient to contact people and exchange information. Samples quotes include:

- I find it is possibly a little more convenient than other ways of contacting people and getting that kind of exchange.
- It is just so convenient too and much better than writing letters.

Furthermore, science teachers explained the changing way(s) of collaboration when the Internet was used for collaboration. For instance, they mentioned that it was a rapid and cheap way to contact people. One teacher commented:

It is a lot of quicker. I get the responses in a very short period of time so I really like the Internet as it is very, very convenient than writing letter or telephone call and it is cheaper.

These findings indicated that science teachers in the sample found several ways in which collaboration was changed when they used e-mail and Internet. Proposition 7 (The e-mail and Internet changes the way(s) in which science teachers collaborate with each other) was supported.
Eight statements in the questionnaire were also adopted to investigate science teachers' perceptions of the potential of teachers' collaboration via the Internet. The eight statements are presented in Table 9, together with the results of the quantitative analysis of science teachers' responses.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
<th>(N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.  I gather ideas about teaching techniques on a science topic from teachers around the world on the Internet.</td>
<td>52</td>
<td>19 10 13 6</td>
</tr>
<tr>
<td>2.  I get support by interacting with other teachers on the Internet.</td>
<td>77</td>
<td>3 3 10 3</td>
</tr>
<tr>
<td>3.  I share my teaching experiences, ideas, project result, student problems with other teachers on the Internet.</td>
<td>77</td>
<td>13 3 6 0</td>
</tr>
<tr>
<td>4.  I conduct a science project for my students with other teachers on the Internet.</td>
<td>81</td>
<td>10 3 3 3</td>
</tr>
<tr>
<td>5.  I discuss teaching material with other teachers on the Internet.</td>
<td>84</td>
<td>0 6 10 0</td>
</tr>
<tr>
<td>20. The Internet allows me to communicate with other teachers around the world.</td>
<td>29</td>
<td>6 23 23 19</td>
</tr>
<tr>
<td>21. I can contact other teachers on the Web without thinking about communication skills and different cultures.</td>
<td>68</td>
<td>13 32 10 6</td>
</tr>
<tr>
<td>22. The Internet allows me to help beginning teachers with teaching materials.</td>
<td>39</td>
<td>13 39 3 6</td>
</tr>
</tbody>
</table>

Note: SD = strongly disagree, D = disagree, N = neither agree or disagree, A = agree and SA = strongly agree

Table 9 indicates that most science teachers strongly disagree that they gather ideas about teaching techniques on a science topic from teachers around the world on the Internet, get support by interacting with other teachers on the Internet, share their teaching experiences, ideas, project result, student problems with other teachers on the Internet, or conduct a science project for their students with other teachers on the Internet.

Furthermore, they correspondingly strongly disagree that they discuss teaching material with other teachers on the Internet, that the Internet allows them to communicate with other teachers around the world, that they can contact other teachers on the Web without thinking
about communication skills and different cultures and that the Internet allows them to help beginning teachers with teaching materials.

In comments from the interviews, heads of department stated that science teachers had limited understanding of electronic networks in teachers’ collaboration for many reasons.

First, heads of department explained why most science teachers had negative ideas about using the Internet for collaboration. To illustrate, they pointed out that science teachers rarely used computers or did not use it. Sample quotes include:

- They will not use it if they do not know how to use it.
- Using e-mail and Internet at the moment it is not particularly convenient because teachers have not taken to computers totally yet.
- Some teachers may need some training: how to use e-mail facility itself.
- …teachers are very limited in access to computers at this stage.

Second, heads of department explained that science teachers did not take up the idea of collaboration in an electronic environment. Particularly, they were not confident about using the Internet as a tool for collaboration and most of them wanted to keep good ideas to themselves. Sample quotes include:

- There will be someone who resists any teamwork or collaboration, I suspect.
- They do not object to it but they have not done that yet.
- Sharing ideas on Internet, I do not think a lot of people in the environment of the Education Department have set up because they do not encourage that.

Third, heads of department pointed out that most science teachers have been using another mode of collaboration for a long time and they are accustomed to doing that. For instance, they mentioned that tools for collaboration are not only is e-mail but also are phone and fax and they prefer to use phone or fax as it is an easier way. Sample quotes as follows:

- The collaboration is not particular to e-mail. The big thing is teachers do not use e-mail…they use phone and fax.
- If I want something from other school just ring up the school I do not to know the person talk to…The phone is the best place to start.
- I do not go to the Internet or e-mail. It is easier to use the phone or fax.
Fourth, most heads of department had diverse ideas about e-mail and Internet. To illustrate, they cited that the Internet was used for getting information, it was not for communication. Further, they also stated that e-mail was limited for collaboration. For example, they wanted to use it for communication they had to get people’s name but for fax or phone this was not necessary. Sample quotes include:

- E-mail rather than Internet for collaboration. I can not imagine Internet in general as being used as a collaborative tool.
- Using e-mail I have to get the name and after that I can get the e-mail.
- E-mail is limited as far as I can see in what you can actually communicate to people unless you can attach very large attachments to it.

Fifth, heads of department explained that most science teachers were not very clear about benefits of using the Internet for collaboration and they had not seen the Internet was used in this way, so most of them needed time to be familiar with it. Sample quotes contain:

- E-mail is very powerful tool but I have to get the purpose to using it.
- Teachers do not know the pros and cons of having an e-mail and collaboration through the network and so on.
- For collaboration via e-mail and Internet, I can not really see it being used in that way.

Sixth, one head of department explained that science teachers had limited knowledge about the capacity of the Internet because the school did not have the Internet yet:

I think when we get the networking system up that will become more suitable and more obvious in classroom use. Then the teachers will have to be aware of and become more aware of it capacity and so on.

Then, science teachers explained their perceptions of electronic networks in teachers' collaboration. Most science teachers were negative about collaboration via the Internet because of many reasons.

First, science teachers were not willing to agree to collaboration via the Internet. For instance, they did not accept the idea that teaching teachers could use the Internet more and they also believed that Internet was valuable used for solving only a specific problem.
Sample quotes include:

- I believe it is too hard for teaching teachers to use Internet a lot.
- The Internet, I just look at what there is and I suppose, I use that less because I am not trying to solve a particular problem.

Second, science teachers had been using another manner of collaboration for a long time and they were accustomed to it. For example, they cited that they jotted a new idea down on a paper or copied a work sheet for colleagues and sometimes shared an idea by talking to members. Sample quotes include:

- The six of us pretty much exchange ideas…if I do a lesson and it is really good, I just mention it or just jot down a few ideas on a piece of paper and put it on everyone desk and if it is a work sheet, I just give everyone a copy.
- Collaboration with science teachers here, I get verbally from them or by telephone with teachers in other schools.

Third, one science teacher had negative ideas about the Internet. To illustrate, she cited that using the Internet was a time consuming activity:

I think, the huge volume of stuff just puts me off because to sit down to find something just takes me two or three hours quite literally.

Fourth, science teachers did not think it was convenient to use computers at school. For example, one science teacher explained that most computers at the school always broke down and no one was bothered to repair them and especially she had to use passwords to access those computers:

The computer down there has never worked especially the Internet but nobody can fix it. The other problem is passwords; I do not know where my passwords are so now I cannot get my password.

The results indicated that most science teachers had negative perceptions of the potential of science teachers’ collaboration in an electronic environment. They had negative perceptions because they found that there were many factors such as ability, habit, frequency, place, time, duration, accessibility, advantages, and disadvantages manipulated science teachers at the sample school regarding the use of e-mail/Internet for working with
other science teachers. Thus, Proposition 5 (Many factors influence science teachers use of e-mail and Internet for collaboration with other science teachers) was supported.

**Research question C.** Do science teachers see a need to collaborate with other teachers via the Internet?

Five statements in the questionnaire were used to examine science teachers' requirement to collaborate with other teachers in electric networks. The five statements are given in Table 10, together with the results of the quantitative analysis of science teachers’ responses.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. I can work on the Internet when it is convenient for me.</td>
<td>23 10 16 26 26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I can post requests to other science teachers on the Internet.</td>
<td>23 10 26 16 26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. The web is very useful for receiving information and making professional contacts.</td>
<td>19 19 26 13 19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Communicating with other teachers on the Web is cheap, reliable and uninterrupted.</td>
<td>16 10 39 16 19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. I can complete my joint work with other science teachers on the Internet without a face-to-face meeting.</td>
<td>39 16 32 3 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: SD = strongly disagree, D = disagree, N = neither agree or disagree, A = agree and SA = strongly agree.

Table 10 indicates that most science teachers in the sample schools agree or strongly agree to work on the Internet when it is convenient for them. They neither agree or disagree or strongly agree to post requests to other science teachers on the Internet. They neither agree or disagree about the Web being very useful for receiving information and making professional contact and communicating with other teachers on the Web is cheap, reliable...
and uninterrupted. However, they strongly disagree to completing their joint work with other science teachers on the Internet without a face-to-face meeting.

Comments from the interviews with heads of department and science teachers confirmed the results in Table 10. To begin with, heads of department noted that most science teachers would like to work with other teachers on the Internet even if they were not confident of the capacity of the Internet for collaboration. Further, heads of department also stated that to support their collaboration several things were required.

First, one head of department pointed out that science teachers would like to collaborate with other teachers on the Internet as it could help them to perceive knowledge in the modern world. Especially, they could develop computing skills and their professional career:

I guess it is just a way to keep up to date with things that are going on without me having to go somewhere else to find it out. I guess in terms of all teachers using Internet. It is the time for teachers to use it, to play with it, to find what there is and the opportunity for them to go along to professional development and to find out those obvious things.

Second, heads of department indicated that science teachers would like to collaborate with other teachers via the Internet but they needed to construct objectives of the collaboration before starting it. Sample quotes include:

- It could be useful but it depends on what is direction of the Internet: certainly e-mail rather than Internet for collaboration.
- If I am going to collaborate I need a purpose or group purpose without that I will not do it.
- It would depend on the requirements and what is involved.

Third, heads of department mentioned that science teachers would like to collaborate with other teachers via the Internet if there were benefits from their collaboration. Sample quotes include:

- My staff and I probably like to collaborate via the Internet in the future if there are things that are of value to the science teachers here.
• I am not against collaborating but I will do it if I can get some benefit.
• Sure, certainly if it is beneficial.

Fourth, heads of department indicated that science teachers would like to collaborate with other teachers via the Internet, as they wanted to share ideas or problems or exchange information. Further, they wanted to make clear issues regarding the curriculum among schools. Sample quotes include:

• We would like to exchange information, share problems and concerns.
• We try to reduce the gap between the intended curriculum and the delivered curriculum by bringing the two closer together by creative collaborative work.

Fifth, one head of department stated that he would like to collaborate with other teachers via the Internet but he needed to indicate the length of time for his collaboration:

I collaborate with parents and other science teachers as well but not on a regular basis. There are people whom I have contacted to get courses for senior science but once I have collaborated it comes to an end. I do not need to continue at length.

Sixth, heads of department explained that science teachers were going to collaborate with other teachers via the Internet but they needed to gain confidence about computing skills before starting their collaboration. Sample quotes include:

• I need a professional development program, which says if I want to do something that this is what I need help me to be able to use e-mail or Internet
• Once teachers become confident in the use of computer and confident in the benefits by the use of it they will be widespread use.

Seventh, heads of department pointed that they would like to collaborate with other teachers via the Internet if those links had good and clear directions, objectives and outcomes or had new methods. Sample quotes include:

• If I want to use it I want to know that has somebody got an idea about this concept, about this objective or outcome and it needs to be clearly document.
• If there is someone who had already worked out good websites that I could get on to well that will be great. If someone comes up with great ideas we would like to collaborate.
Eighth, heads of department pointed out that they would like to collaborate with other teachers via the Internet if they had time. Sample quotes include:

- I would do but time is a very important issue at the moment.
- It is just a question of time. I would not say no and I would not want to say yes because I find I do not get time to do it.

Ninth, heads of department had positive perceptions about collaboration and agreed to take part in this activity. To illustrate, they pointed out that they used to perform collaboration and could imagine the way it was set up. Further, they would like to be involved in the computing world. Sample quotes include:

- I would do, I used to do before all this revolution stuff came out. There used to be a newsletter that went around…I can see how it has been set up and we should be doing it more.
- I suppose my staff and I all say yes. I do not think there is any question.

On the other hand, a few heads of department did not support collaborating via the Internet. For example they stated that they did not see a need to collaborate via the Internet because they had enough aid from the school. Sample quoted as follows:

- I do not see that it is going to be a great deal of use. I do not think that there is going to be a lot of things that I can collaborate on.
- I have not seen a need to do it really. I have not found a need to do it because I have found all the support I need within the school and it seems to be enough.

Science teachers explained the requirement to collaborate with other people in an electronic environment. Most science teachers would like to take part in this activity but they think it would be very difficult, as many things to support their collaboration were required.

One science teacher stated that he agreed to collaborate via the Internet: I enjoy collaborating and I will be very happy to be involved in everything. Other science teachers stated that they would like to collaborate via the Internet because it was convenient, cheap
and free and they could get and share new ideas from using this technology. Sample quotes include:

- I use Internet because I can get rapid responses and it is highly convenient, cheap and free. I think I get enough new ideas from Internet.
- Using resources from around the world it will be good to share information and get resources from other teachers.

Third, science teachers cited that they would like to be involved in collaboration if they could do sufficient experiments and find someone who was interested in the same area. Sample quotes include:

- I can see it will be great. It will be very useful if I can do large experiments.
- I can not find anyone who is interested in doing the same area as me.
- I will not stop doing this. I just need other science teachers who are interested in what I am doing to collaborate with.

Fourth, one science teacher cited that he wanted to have good indexes telling him the things that schools were interested in before starting his collaboration: I need guidelines about the particular things that each school is interested in.

Fifth, one science teacher pointed out that he wanted to have good supplies for his collaboration: I need good equipment to do it.

Sixth, one science teacher pointed out that if he wanted to find a specific thing out of curiosity then he wanted to use the Internet: If I am interested in a particular sort of thing then I might want to use the Internet.

Finally, a few science teachers mentioned that collaboration was very difficult to establish because teaching teachers did not have time, and most schools did not have technicians for the Internet; for example:
I have not got time or expertise to produce my own website so how it is going to happen as far as day-to-day teaching is concerned is very difficult.

The results showed that most science teachers wanted to collaborate with other science teachers on the Internet as several benefits of using this technology will be experienced.

Hence, Proposition 8 (*Science teachers require collaborating with other teachers in electronic networks*) and Proposition 9 (*Science teachers want to continue using the Internet for their collaboration*) were supported.

On the other hand, science teachers were not ready to use this technology for collaboration yet. They needed to prepare themselves by improving their computing skills and predetermine the aim and direction of their collaboration.

Further, science teachers thought it was very complex to form collaboration via the Internet because teachers did not have time and each school did not have technician support for this activity. Accordingly, Proposition 10 (*Science teachers need support for their collaboration*) was supported.

**Research question D:** *In what contexts do science teachers collaborate with each other on E-mail and Internet?*

Four statements in the questionnaire were used to investigate the contexts in which science teachers collaborate with each other in electronic networks. The four statements are presented in Table 11, together with the results of the quantitative analysis of science teachers’ responses.
Table 11
Science teachers rating on a 5-point scale of statements to investigate the contexts in which science teachers collaborate with each other on the Internet. (N=31)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. I develop curriculum and teaching materials cooperatively with other teachers on the web.</td>
<td>SD 13  D 74  N 6  A 3  SA 3</td>
</tr>
<tr>
<td>10. I can use the web to announce conference, schedule meeting and arrange appointments with other teachers.</td>
<td>SD 10  D 77  N 10  A 0  SA 3</td>
</tr>
<tr>
<td>11. The Internet encourages me to express my thoughts to other teachers.</td>
<td>SD 10  D 81  N 0  A 6  SA 3</td>
</tr>
<tr>
<td>12. I help other teachers with ideas about teaching difficult science topics on the Internet.</td>
<td>SD 10  D 77  N 3  A 3  SA 3</td>
</tr>
</tbody>
</table>

Note: SD = strongly disagree, D = disagree, N = neither agree or disagree, A = agree and SA = strongly agree

Table 11 indicates that most science teachers strongly disagree that they develop curriculum and teaching materials with other teachers on the Web and use the Web to announce conferences, schedule meetings and arrange appointments with other teachers. In addition, they also strongly disagree that the Internet encourages them to express their thoughts to other teachers and they can help other teachers with ideas about teaching difficult science topics on the Internet.

Comments from the interviews with heads of department and science teachers supported the results in Table 11.

Initially, heads of department explained that they did not use e-mail and Internet to improve curriculum or teaching materials or to announce conferences or meetings with other teachers because they rarely used the Internet and used it in other ways. To illustrate, they pointed out that the Internet was used to join professional lists and to get or to share information with colleagues. In addition, the Internet was also used to access some websites. Samples quotes include:
• I can join professional lists and can share information with other people. It is actually an extremely convenient way of getting information and sorting it….I can use the Internet to access Curriculum Council Materials and EDWA.
• We share test papers and a bit of information but not very much. I use the Internet as a tool for collaboration but not very much.

Some science teachers explained that they had never expressed their thoughts to other teachers or helped other teachers on the Internet because they used it in other ways. For example, one science teacher stated that the Internet was used to exchange ideas, to give advice, to get work sheets from colleagues or to find suitable materials for lessons:

I give advice, swap strategies and work sheets with science teachers in other schools. I work on exam papers and I want different questions or different choices in questions so my colleagues help me a lot and sometimes I get work sheets from them. I prepare things and find suitable materials then pass information.

Another science teacher mentioned that he used the Internet for education research. He did not use it for teaching purposes:

I use the Internet to collaborate in education. In fact, my main use of Internet would be collaborating through my education research. I collaborate with my colleagues at Curtin University. I use Internet to get information about research studies. I do not really use Internet much for teaching purposes in school.

These results show that science teachers in the sample schools rarely use the Internet and they use it to exchange ideas with colleagues, join professional lists and find the appropriate materials for teaching purposes and research.

Consequently, Proposition 11 (There are many contexts that science teachers collaborate with each other on electronic networks) was supported.
Research question E: Why do some science teachers collaborate more in an electronic network? Why do some science teachers collaborate less?

Three statements in the questionnaire were used to examine the extent to which science teachers collaborate with other teachers in electric networks. The three statements are given in Table 12, together with the results of the quantitative analysis of science teachers’ responses.

Table 12
The extent to which science teachers collaborate with other teachers in electronic networks: science teachers’ rating. (N=31)

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. I find it is difficult to explain my understanding of a science topic on the Internet.</td>
<td>52</td>
<td>10</td>
<td>23</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>16. I often use the Web for collaborating with other science teachers.</td>
<td>68</td>
<td>16</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>18. I can contact other science teachers quickly on the Web.</td>
<td>39</td>
<td>19</td>
<td>16</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: 1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree and 5 = strongly agree

Table 12 indicates that most science teachers strongly disagree that they find it is difficult to explain their understanding of a science topic on the Internet and they often use the Web for collaborating with other science teachers. Further, they also strongly disagree that they can contact other science teachers quickly on the Web.

Comments from the interviews with heads of department and science teachers supported the results in Table 12.

To begin with, heads of department emphasized that most science teachers felt comfortable expressing their thoughts about science themes on the Internet but they were not confident that they could contact other science teachers quickly on the Internet as they
rarely use the Internet. Further, heads of department pointed out that there were several issues that make science teachers rarely collaborate via the Internet.

One head of department mentioned that time is a crucial factor for science teachers' collaboration on electronic networks:

All teachers have limited time, which is the limiting factor for using a computer. When people need to get things done, they tend to do what they are familiar with and if they do not have time to get familiar then they do not use it.

Another head of department pointed out that the workability of websites was another problem for their collaboration because most websites were always out of date and there are not web-managers or teachers to update those websites:

We have a school website and so does the science department, which probably is not up to date. We do not have a web-manager that has time to update those sort of things that is the other thing that demanded teachers' time…would be great to have that but at this stage of time there is nobody has time to put all those stuffs up to date.

A third head of department pointed out that the levels of expertise and interest in using the Internet of science teachers was the problem as well:

Checking e-mail, not every teacher does that because there are various levels of expertise and interest among them. Some teachers do not want to know about it but others are right in there.

Finally, heads of department emphasized that the curriculum might be the last reason, at that time, which course science teachers rarely collaborated on the Internet. Sample quotes include:

- The curriculum does not encourage telecommunication because we teach kids for tertiary entrance exams.
- …variations in the freedom of syllabuses and what is going on in one school does not tie up or lap perfectly with what is going on in another school so I see less usage there.

Science teachers pointed out that most of them could express their thoughts on the Internet but they were not positive about contacting other science teachers quickly on the Internet because they rarely used the Internet for many reasons.
Firstly, most science teachers pointed out that time was the huge issue that prevents them from contacting other science teachers via the Internet. Sample quotes include:

- The big factor is time. I just do not have time.
- I think it really fits into the same category whether on communicate with Lettuce, just down the road, or whether I communicate with some school in WA. It takes the same time so just the time factor. In fact, no one has time.

Secondly, science teachers stated that there were not enough computers for teachers to use so they needed more computers. Sample quotes include:

- I want some more facilities, which become available for the staff to use it.
- The school does not have enough computers.

Third, one science teacher mentioned that he used to contact with other schools via Internet but he did not get a response so this reason discouraged him from continuing his collaboration:

I did try to collaborate via Internet but I did not get positive responses this is the main problem that stopped me from doing that.

Fourth, one science teacher revealed that Internet was an alternative to a book and he preferred a book to the Internet:

I found computers in some ways it is a very powerful tool but in other ways it is a substitute for a book. I can quite often be more efficient using a book.

Finally, one science teacher stated that computers at the school were not fast and access to the Internet was a time consuming activity:

The server sometimes is not fast enough at the school and access to computers is difficult.

The results indicate that most science teachers in the sample minimally collaborate via the Internet because time and equipment was the main issues that prevented them from greater collaboration. Therefore, Proposition 12 (Science teachers frequently collaborate with other teachers on electric networks) was not supported.
Research question F: What are barriers to science teachers' collaboration via the Internet?

Two statements in the questionnaire were used to examine the barriers to science teachers’ collaboration with other teachers in electronic networks. The two statements are given in the Table 13, together with the results of the quantitative analysis of science teachers' responses.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel uncomfortable using the school’s computers in collaborating with other teachers.</td>
<td>39 10 19 16 16</td>
</tr>
<tr>
<td>I feel reluctant to contribute to the Web as other science teachers can read my contribution.</td>
<td>58 16 19 0 6</td>
</tr>
</tbody>
</table>

Note: 1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree and 5 = strongly agree

Table 13 shows that most science teachers strongly disagree that they feel uncomfortable using the schools computers in collaborating with other teachers and they feel reluctant to contribute to the Web as other science teachers can read their contribution.

Comments from the interviews with heads of department and science teachers supported the results in Table 13.

To begin with, heads of science department pointed out that most science teachers were comfortable using the school’s computers to collaborate with other teachers and they were also willing to contribute to the Web. Accordingly, using the school’s computer and the contribution to the web were not barriers to science teachers’ collaboration. Heads of department pointed out that there were other issues that were barriers to science teachers’ collaboration on the Internet such as the following.
First, time was the huge factor for science teachers’ collaboration via the Internet. To illustrate, heads of department pointed out that most science teachers did not have time to use the Internet to make contact with other science teachers because most time was spent in the classrooms. Sample quotes include:

- Time is the big problem. I do not have time to do that.
- All science staff here are very keen about using e-mail and Internet for their own benefit…but they just sheer frustration of not have enough time for that.
- In terms of putting something in the Internet, time is the factor.
- The support that is most in need is time, which is the thing I least have.

Second, school lines can cause the problem to science teachers’ collaboration via the Internet as well. For example, heads of department stated that if school lines were being used in the library or laboratories, it was very difficult for teachers to connect the Internet. Further, some schools’ lines were out of date or had limited time or there were not enough lines for teachers to use. Sample quotes include:

- Computers here are international servers…sites cannot be accessed because of limited time.
- Both of computers in science office are connected to Internet. It is not easy to access the Internet because the computers in the laboratories are being used.
- The whole network has inferior cable…about two generations out of date.

Third, the number and the operation of computers were also problems for science teachers’ collaboration in electronic networks. For instance, heads of department explained that there were not enough computers for science teachers to use individually. Besides, the different operation of computers some science teachers felt it difficult to practice using two kinds of computers at the same time. Sample quotes include:

- I could use e-mail to contact with other department…but it is IBM computer that I am not familiar with its technology. I use Macintosh at home so it is very hard if I have to relearn completely a new system.
- There is one old computer in the science office at the moment and every science teacher can use it.
Fourth, computing skills was another important problem for science teachers’ collaboration in an electronic environment. To illustrate, heads of department pointed out that most science teachers were competent in using computers but few of them still needed learning, training and practicing using the Internet. Sample quotes include:

- We have not reached that stage yet. I think it will be around the corner at the moment…People are slowly coming to learn, learn the various things.
- The use of Internet is really dependent on whether the teachers have the skills. Most teachers can work on computers but some can not and I am one of those persons.

Fifth, the curriculum can prevent science teachers from collaborating via the Internet as well. For example, one head of department pointed out that he could not give students an extra activity as he must keep every class on the same activity at the same:

The curriculum is very rigid. I cannot use it to go outside, especially in a big school like this where I want all the classes to do the same thing.

Sixth, one head of department explained that science teachers could not use e-mail and Internet as the school was putting a new system of the Internet instead of the old one:

At the moment, all the whole school cannot use e-mail or Internet because it is changing and we will get a new system to put in. We used to use e-mail and Internet but we just have stopped using it for two months. We will have Internet a new system from next week.

Seventh, the benefits from collaboration are the other issue that science teachers are concerned about. For example, heads of department explained that most science teachers were not confident about the benefits of collaborating on the Internet. Sample quotes comprise:

- I am not quite sure what it is going to benefit on connection so that will be the reason.
- Teachers do not know the pros and cons of having an e-mail and collaboration through the network and so on. Teachers certainly do not have enough experiences to understand that.

Eighth, heads of department explained that most science teachers were not familiar with the Internet, as it was a new mode of communication technology so that it would take a
little while for science teachers to get accustomed to it. Sample quotes include:

- We are happy with it. It is a matter of getting used to it.
- It is OK having a message but teachers have to clear their mailbox and a lot of them do not bother to do that. Teachers are not used to doing it. I think it will take a while for a lot of teachers to start using e-mail.

Ninth, heads of department explained why they could not contact other teachers via the Internet. To illustrate, they pointed out that they did not know the other science teachers’ e-mail addresses so if they knew they could communicate with them. Sample quotes include:

- The other thing is teachers do not know other teachers’ e-mail addresses and who have e-mail and have not that facility: it is very limited.
- The problem is I do not know their e-mail address so if I know their e-mail address I can use it.

Science teachers explained that using the school computers and the contribution to the Web were not an obstacle to their collaboration. Further, they stated that there were other issues that presented difficulties to science teachers’ collaboration on the Internet.

First, time is the big problem to science teachers’ collaboration on the Internet. To illustrate, science teachers pointed out that most of them did not have time to sit and put things into the Internet or to contact other science teachers because most time was used to finish their everyday duties. Sample quotes include:

- Most teachers are just in a hurry to get to everyday work. I do not have time
- I think, it starts to get the same problem is time.
- I do not find any barriers to my collaboration, just time.
- The most important thing that I need is time to continue my collaboration.

Second, the web-manager or technical support is another problem to science teachers’ collaboration on the Internet. For instance, science teachers pointed out that they needed technical support to maintain computers for the whole school or to help them to produce the science website. Sample quotes include:

- I have not got time or expertise to produce my own website so how is it going to happen?
• There is no technical support to run the computers in the whole school. There are a lot of problems with the computers.

Third, computing skills are the obstacle to science teachers’ collaboration via the Internet as well. To illustrate, science teachers cited that most of them were familiar with the computers but a few of them needed training and practice in computing skills. Sample quotes contain:

• I would like to have a training in website construction or training in works web search.
• The computing skills in my department, six science teachers OK, one teacher would have actually none.

Fourth, science teachers explained that it was very difficult to find other people who were interested in the same subject as them because the Internet was so huge. Sample quotes include:

• The Internet is so big so how do I find who’s doing the research, what they are interested in…I would guess a lot of people have the same feeling like me that Internet is hard, huge and it is limited.
• I just need other science teachers who are interested in what I am doing to collaboration with.

Fifth, the objective of collaboration is the barrier to science teachers to work with other teachers via the Internet as well. For instance, one science teacher cited that he needed to have the direction of collaboration but he could not find it. Moreover, if he had the right direction he could be involved in collaboration:

If someone gives me the right direction, I think I will get involved in collaboration but now I have not found the right direction

Sixth, the workability of the Internet can also be the trouble to science teachers using the Internet. To illustrate, one science teacher pointed out that access to computers at the school is difficult because the server is not fast enough:

The server sometimes is not fast enough at the school and access to computers is difficult sometimes.
Seventh, the other important obstacle to science teachers’ collaboration is passwords. For example, one science teacher mentioned that she needed a password to use the Internet but she had not seen it since the holidays:

In theory I can use the Internet in the science department. The password department has got one and I have one but now it has disappeared since the holidays. So I have not been able to get on to the Internet without using password.

The results indicate that there are several barriers to science teachers’ collaboration on the Internet; among these are: time which most science teachers pointed out is a huge problem for them; and the quality and numbers of computers.

Accordingly, Proposition 13 (There exist many barriers to teachers’ collaboration via the Internet) was supported.

Summary

The results indicate that science teachers in the sample schools rarely collaborate with other teachers in an electronic environment.

Most of them have negative opinions on the potential of science teachers’ collaboration in an electronic environment. The few science teachers who use the Internet, exchange ideas with colleagues, join professional lists and find the appropriate materials for teaching purposes and research. Most science teachers seldom use the Internet because of several barriers to science teachers’ collaboration on the Internet such as time and the quality and number of computers.

The summarised results of supported and not supported propositions that were used to predict the outcomes of research question A-F will be presented together with the results of the propositions of the research question G in Chapter 7.
Chapter 7

Results of Study Two

Introduction

The purpose of this chapter is to provide an analysis of two kinds of science websites, specific science websites for science teachers and science websites for a general audience. Both categories of websites are relevant to Research Question G: Which of Fishbough’s models of collaboration are suitable for analysing science websites on the Internet? Also, specific focus of the analysis is the potential uses of the Internet for collaboration among science teachers.

Fishbough’s models of collaboration applied to an electronic environment.

Websites

Two kinds of science websites, specific science websites for science teachers and science websites for interested parties from five chosen continents (Australia, Asia, Europe, America, and Africa) were analysed according to Fishbough’s models of collaboration: Consulting, Coaching and Teaming.
Framework for the analysis

The data were analysed using three complementary methods. First, Fishbough’s models of collaboration were used as a broad system to investigate the models of collaboration evident in the two kinds of science websites, specific science websites for science teachers and science websites for interested parties from five chosen continents. Second, the types of collaboration proposed by Little (1990) were employed as a more fine-grained system to examine how science teachers use the Internet for their collaboration. Finally, content analysis was used to analyse Internet network messages that science teachers have communicated among them and the objectives or subjects of selected current science websites from five chosen continents.

Australia

Initially, specific science websites for science teachers in Australia were located and analysed. In Western Australia, there are many websites that science teachers can use to collaborate or to jointly work with other science teachers in Australia or other countries. To illustrate, the three particular websites for science teachers in Western Australia, managed by the Electronic Communications Committee of the Science Teachers’ Association of Western Australia (STAWA), which could be used for their collaboration are:

- The Science Teachers’ Association of Western Australia website (STAWA),
- The list server for West Australian Science Educators (Catalist) and
- The Teachers Survival Kit website (TSK).

Each of these three sites will be analysed in turn.
The STAWA website (http://www.stawa.asn.au/)

The goals and objectives of the STAWA website are concerned with representation, equitable access, professional development, teacher support, strengthening membership base, and enhancing communication. To further these goals, STAWA members are offered many professional activities such as a professional development program and a STAWA mentors’ program. For the professional development program, many activities are offered such as Earth and Beyond: Astronomy in the Classroom (4-7).

The investigator e-mailed (10/12/01) the Executive Officer of the STAWA, asking about the number of subscribers to the STAWA website. He has indicated that people do not subscribe to the STAWA website, as it is public and openly accessible and he has also said that the STAWA website has about 1,000 visitors per month.

Model of collaboration

The STAWA website functions as an “expert” which gives advice to science teachers in Western Australia. Thus, the appropriate model of collaboration for this website is identified as the Consulting model. Thus, Proposition 1 (The STAWA’s website is provided as Consulting model of collaboration) was supported, but Proposition 2 (The STAWA’s website is provided as Coaching model of collaboration) and Proposition 3 (The STAWA’s website is provided as Teaming model of collaboration) were not supported.

Analysis of the STAWA website supports the views expressed in the interviews with heads of science department and science teachers of the sample schools in the period of investigation, details of which were given in Chapter 5.

Initially, heads of science department explained that they knew about the STAWA website as they are all members of the Science Teachers’ Association of Western Australia.
(STAWA), and some of them have visited this website. They reported that there have been some very good professional development activities from the STAWA website. Sample quotes from those interviewed include:

- There has been some very good professional development being done.
- We tap into the STAWA website and try to get information on the professional development programs and the in-service programs.
- I do use professional development from time to time.
- Other teachers and I have visited the STAWA website. It is informative.

However, a number of heads of science department stated that they had never visited the STAWA website nor have their staff. However, they would not mind visiting it if there are good things such as mentor programs or lesson plans for new teachers. Sample quotes from those interviewed include:

- For the STAWA website I have never been there, it is only the recent months the STAWA website has a plan for new teachers. That is the one I would not mind visiting.
- I know the STAWA website but I have not accessed it yet and I do not think my staff has.

Science teachers in the interviews characterised the STAWA website as interesting. Some of them visited it but not frequently as, at the time, they believed that there was anything essential on it. Sample comments include the following:

- I have visited STAWA but not regularly. I have not used it a great deal.
- I remember STAWA and I am interested in what are they doing but at the moment it does not seems to be something that is necessary.

On the other hand, two science teachers in the interviews confirmed they have never used the STAWA website.

**Summary**

Some science teachers use the STAWA website to support their collaboration. Thus, the appropriate model of collaboration for science teachers who use this website is identified as
the *Consulting* model. Further, the finding that two science teachers have never used this website is an extremely important result as it clearly supports the results of the questionnaire presented in Chapter 6, which revealed few science teachers in the sample use the Internet for their collaboration.

**Catalist- List server**

Catalist, the list server for Western Australian Science Educators, serves to function as the prime communication and interaction medium for science educators in Western Australia. The annual report of the Chair of Electronic Communications Committee (August 2001) noted that the number of subscribers to Catalist developed slowly in 1999, but in 2001 exceeded 240 subscribers. It also noted that the standard of professional interaction is a highlight of Catalist. This annual report is attached as Appendix 7. Further, the Information of STAWA reported that the number of subscriber to the Catalist-list server in 2002 was 888 subscribers and in 2003 was 373189 subscribers (10/12/2003). The report shows that this mailing list is growing. To identify the appropriate model of science teachers’ collaboration via this website and to examine the use of the Internet for collaboration of science teachers, a collection of Catalist's network messages was compiled, beginning with the first semester of 1999 and finishing at the end of the first semester of 2001. These messages were completely analysed.

As previously described, two methods of analysis were used to analyse these network messages for collaboration: *Storytelling and Scanning for Idea, Aid and Assistance, Sharing* and *Joint work* (Little, 1990) and Fishbough’s three models of collaboration: *Consulting, Coaching and Teaming.*
Catalist’s network messages were classified into type of collaboration. Catalist’s network messages from the first semester of 1990 to the first semester of 2001 were summarised and the results are given in Appendix 8.

**Science teacher use of Catalist for collaboration**

This study particularly investigated science teachers’ collaboration via the Internet. Thus, only science teachers’ network messages were extracted from the data in Appendix 8 and are attached as Appendix 9.

**Science teachers’ participation**

The results of classifying science teachers’ Catalist network messages into types of collaboration and the number of science teachers who used the Catalist website in the period of this study are also presented in Table 14.

<table>
<thead>
<tr>
<th>Year</th>
<th>Semester</th>
<th>Number of science teachers</th>
<th>Total messages</th>
<th>Science teachers’ messages (%)</th>
<th>Type of collaboration</th>
<th>Unclassified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Storytelling (%)</td>
<td>Aid (%)</td>
</tr>
<tr>
<td>1990</td>
<td>1</td>
<td>89</td>
<td>61</td>
<td>13</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>2000</td>
<td>1</td>
<td>20</td>
<td>12</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>2000</td>
<td>2</td>
<td>19</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2001</td>
<td>1</td>
<td>31</td>
<td>19</td>
<td>-</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>52</td>
<td>159</td>
<td>100</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 14 shows 52 science teachers used Catalist to collaborate with other science teachers in the data collection period. Thus, this result indicates that there is a small fraction of science teachers who used Catalist as a tool for collaboration.
Science teachers’ collaboration via Catalist

Table 14 shows most Catalist network messages are science teachers’ messages (63%). These network messages were classified as types of collaboration as follows: 20%, Storytelling and Scanning for Idea; 47%, Aid and Assistance; 20%, Sharing; 4%, Joint work; and 9%, unclassified messages. The results of the classification of science teachers’ electronic messages into types of collaboration show that science teachers who use Catalist to collaborate with other science teachers most frequently use it to ask about difficult or new science topics (47%) and quickly scan ideas from colleagues (20%). In addition science teachers use Catalist to discuss teaching experiences or share or exchange ideas (20%) more than to do joint work (4%).

Models of collaboration

To identify the appropriate model of collaboration of Catalist, science teachers’ Catalist network messages in Appendix 8, which were classified in terms of type of collaboration, were used to indicate models of collaboration: Consulting, Coaching and Teaming. These results are presented in Table 15.

<table>
<thead>
<tr>
<th>Type of collaboration</th>
<th>Science teachers’ messages</th>
<th>Total messages</th>
<th>Models of collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Consult (%): Coach (%)</td>
</tr>
<tr>
<td>Storytelling and Scanning for idea</td>
<td>20</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Aid and Assistance</td>
<td>47</td>
<td>47</td>
<td>-</td>
</tr>
<tr>
<td>Sharing</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Joint work</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unclassified</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>159</td>
<td>67</td>
</tr>
</tbody>
</table>

Table 15 shows science teachers’ network messages can be classified into three models
of collaboration in this way: 67% Consulting, 0% Coaching and 24% Teaming.

The results indicate science teachers use Catalist to collaborate with other science teachers, and the model of collaboration most frequently found is the Consulting model. Accordingly, Proposition 5 (The Science Educators List server-Catalist is provided as Consulting model of collaboration) and Proposition 7 (The Science Educators List server-Catalist is provided as Teaming model of collaboration) were supported, but Proposition 6 (The Science Educators List server-Catalist is provided as Coaching model of collaboration) was not supported.

Summary

Science teachers who used Catalist to collaborate with other science teachers, and models of collaboration most frequently found are the Consulting model (67%) then the Teaming model (24%). Science teachers did not use the Coaching model in the period investigated.

A small fraction of science teachers in Western Australia used Catlist in the period of study to support their work. These results are consistent with the results obtained from the interviews with heads of science department and science teachers of the selected schools. Relevant comments from the interviews are presented below.

To begin with, heads of science departments explained that most science teachers do not use the Catalist-list server. Sample quotes for those interviewed include:

- For Catalist it does not ring a bell and I do not think my staff knows.
- I do not know about Catalist. There has been no sort of printed information come to the school about this.
- No I have not visited Catalist. I may have heard about it but I have not heard about teachers asking about a problem on the Internet.
On the other hand, some heads of science department noted that some science teachers used Catalist. Those users found it was a useful website and they suggested that participants could follow from end to end of all discussions for the best understanding of those debates. Sample quotes include:

- I have visited Catalist, but I have not used it as much as my staff has.
- Some of my staff have responded to Catalist. They found it is useful if you follow through all the arguments. It makes senses if you are very precise.

Two science teachers in the interviews explained that they had never seen Catalist. However, those who used this list server found that most mail was junk mail and was not relevant to them. Sample quotes from those interviews include:

- No I have never seen it.
- Catalist…I get a lot of stuff through that but it is probably junk stuff. My e-mail most through Catalist and they are not relevant to me. I have been with Catalist a couple of months. I think there is too much posted to it and I also think a lot of people have the same ideas as me; there is too much stuff there.

Summary

The results show that 52 science teachers in Western Australia used Catalist to collaborate with other science teachers in the period of study. Those science teachers often used it to ask about difficult or new science topics more than to discuss teaching experiences or to share or to exchange ideas. Consequently, these science teachers used the Consulting model most frequently as a model of collaboration via the Catalist list server more than the Teaming model. Proposition 4 (Science teachers subscribed to the Science Educators List server-Catalist) was supported.
The Teachers’ Survival Kit website (http://stawa.asn.au/tsk/)

A few science teachers had the excellent idea that science teachers in Western Australia could use the Internet as a place to share resources or experiences with colleagues and they also recommended that experienced science teachers could help other science teachers who were in need because of isolation, inexperience, unfamiliarity or have responsibility for many lesson plans. Consequently, the project named The Teachers Survival Kit (TSK) was developed for the Science Teachers’ Association of Western Australia by the chair of STAWA’s Electronic Communications Committee. For security, only memberships can access this website. Subsequently, many volunteers have helped to collect resources for various subject areas.

The investigator received the Communications Committee Annual Report August 2001 (Date: 9/8/2001), which reported that collecting teaching materials to put in this website is the priority. Further, the TSK is developing, as the number of contributed files in 2001 was over 120 resources, and is being prized as a model of the best educational practice. For instance, a quote from the report is given below.

- The collection of teaching resources to be placed on this site has continued to be a priority. Last year we have doubled the number of files available to over 120 resources available for download.
- This site continued to develop and is being hailed as an example of best practice in education circles. (STAWA, 2001, p 1)

The investigator e-mailed (10/12/01) the Executive Officer of the STAWA website, who is responsible for all information of the three websites: the Science Teachers' Association of Western Australia website (STAWA), the list server for West Australian Science Educators (Catalist) and the Teachers Survival Kit website (TSK). She asked him about the numbers of subscribers to the TSK website. He explained that there were 400 subscribers to this
website and the public access section receive about 30 visitors per day (11/12/01). This information shows this website is developing.

Model of collaboration

The Teachers’ Survival Kit website’s principal function is collecting teaching resources to place on this site for science teachers who need those materials to download. Thus, the appropriate model of collaboration of this website is classified as the Consulting model. Proposition 8 (The Teachers Survival Kit website (TSK) is provided as Consulting model of collaboration) was supported, but Proposition 9 (The Teachers Survival Kit website (TSK) is provided as Coaching model of collaboration) and Proposition 10 (The Teachers Survival Kit website (TSK) is provided as Teaming model of collaboration) were not supported.

Summary

Science teachers in Western Australia use the TSK website as a place to share resources or expertise. In particular, some science teachers use this website to liberate them from overwhelming preparation tasks or urgent needs, as they can download many contributed activities or lesson plans from this website. The appropriate model of collaboration for this website is the Consulting model.

Analysis of specified Science websites

The method of analysis of the three websites discussed above was also used to analyse the two kinds of science websites: specific science websites for science teachers and
science websites for general audiences (from five selected continents: Australia, Asia, Europe, America and Africa).

Procedure

The investigator selected 50 science websites (10 science websites from each of the five chosen continents) as representative science websites from around the globe. The 10 science websites from each continent included five specific science websites for science teachers and five science websites for general audiences. The results of the analysis of these 50 websites are shown in Table 16. Further, a summary of each selected current science website from the two kinds of websites of the five continents is included as Appendix 10.

Selecting current science websites

There are enormous numbers of websites of each type. Hence, three steps were used to collect data. First, eight search engines: HotBot, Excite, Alta Vista, LookSmart WebCrawler, Google, Yahoo and Lycos were used to identify the two kinds of science websites from the five continents. Second, many keywords were used with the selected search engines for identifying the science websites. To illustrate, in order to find out both the specific and general science websites in Europe, the relevant keywords used were:

- Science websites for science teachers in Europe
- European science websites
- Biology or Chemistry or Physics websites in Europe
- Environment or Space or Earth Science websites in Europe
Third, a purposive sampling technique and missions or goals of each website were used as core principle to select the 50 science websites: 25 specific science websites for science teachers and 25 science websites for general audiences from the five continents.

Consequently, the 50 science websites (10 science websites from each continent) were selected as the sample for detailed analysis in this study.

**Analysis of preferred science websites**

According to the above principles, the 50 science websites were chosen and analysed using Fishbough’s models of collaboration. The result of the analysis of the science websites are presented in Table 16.

<table>
<thead>
<tr>
<th>Continents</th>
<th>No</th>
<th>Website</th>
<th>Models of collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Consult</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ing (%)</td>
</tr>
</tbody>
</table>

1. **25 specific science websites for science teachers**

**Australia**

1. STAWA  
   http://www.stawa.asn.au/  
   x - -

2. Catalyst (listserv)  
   http://stawa.asn.au/tsk/  
   x - x

3. The teachers Survival Kit website  
   http://stawa.asn.au/tsk/  
   x - x

4. Biotechnology Online  
   x - -

5. Science Teachers' Pot of Gold  
   x - -

**Asia**

1. HK Association for Science and Mathematics Education Ltd  
   http://www.hkasme.org/  
   x - x

2. Science Teachers’ Association of Singapore  
   x - x

3. Asia-Europe Classroom (AEC)  
   http://www.aec.asia.org/index_static.html  
   x x x

4. Science Teachers  
   x - -
<table>
<thead>
<tr>
<th>Country</th>
<th>Website</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asia-Pacific</strong></td>
<td>Asian-Pacific Forum on Science of Learning and Teaching&lt;br&gt;<a href="http://www.ied.edu.hk/apfstlt/">http://www.ied.edu.hk/apfstlt/</a></td>
<td>x</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td>Association for Science Education&lt;br&gt;<a href="http://www.ase.org.uk/">http://www.ase.org.uk/</a></td>
<td>x</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>SCIcentre&lt;br&gt;<a href="http://www.le.ac.uk/se/centres/sci/about.html">http://www.le.ac.uk/se/centres/sci/about.html</a></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Physics on Stage&lt;br&gt;<a href="http://www.estec.esa.nl/outreach/pos/">http://www.estec.esa.nl/outreach/pos/</a></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>The European Network of Science Communication Teachers&lt;br&gt;<a href="http://www.ucl.ac.uk/sts/enscot/">http://www.ucl.ac.uk/sts/enscot/</a></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>The European Schools Project&lt;br&gt;<a href="http://www.esp.uva.nl/">http://www.esp.uva.nl/</a></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>America</strong></td>
<td>National Science Teachers Association&lt;br&gt;<a href="http://www.nsta.org/">http://www.nsta.org/</a></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Educational Resources for Physics Teachers&lt;br&gt;<a href="http://www.ba.infn.it/www/didattica.html">http://www.ba.infn.it/www/didattica.html</a></td>
<td>x</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>The Puerto Rico Collaborative for Excellence in Teacher Preparation (PR-CETP)&lt;br&gt;<a href="http://cetp.crci.upr.pr/cetpweb/">http://cetp.crci.upr.pr/cetpweb/</a></td>
<td>x</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Atlantic Science Curriculum Project (ASCP) and theSciencePlusTeachersNetwork&lt;br&gt;<a href="http://www.chebucto.ns.ca/Education/SPTN/index.html">http://www.chebucto.ns.ca/Education/SPTN/index.html</a></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
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<td>Prime Minister's Awards for Teaching Excellence&lt;br&gt;<a href="http://www.schoolnet.ca/pma/home-e.html">http://www.schoolnet.ca/pma/home-e.html</a></td>
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<td><strong>Africa</strong></td>
<td>Western Cape Primary Science Programme (PSP)&lt;br&gt;<a href="http://www.psp.org.za/">http://www.psp.org.za/</a></td>
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<td></td>
<td>National Professional Teachers' Organization of South Africa, NAPTOSA&lt;br&gt;<a href="http://www.naptosa.org.za/index.html">http://www.naptosa.org.za/index.html</a></td>
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<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>Science Education Centre, Soweto&lt;br&gt;<a href="http://www.sec.org.za/">http://www.sec.org.za/</a></td>
<td>x</td>
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<td>-</td>
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<td></td>
<td>The Teacher&lt;br&gt;<a href="http://www.teacher.co.za/about.html">http://www.teacher.co.za/about.html</a></td>
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<td></td>
<td>Chemistry Clinic&lt;br&gt;<a href="http://www.chem.wits.ac.za/ChemClinic/clinic_full.shtml">http://www.chem.wits.ac.za/ChemClinic/clinic_full.shtml</a></td>
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<td>-</td>
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<tr>
<td><strong>Australia</strong></td>
<td>The Community Biodiversity Network (EBN)&lt;br&gt;<a href="http://www.cbn.org.au/member/cbn/">http://www.cbn.org.au/member/cbn/</a></td>
<td>x</td>
<td>x</td>
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<td></td>
<td>ABC Online&lt;br&gt;<a href="http://www.abc.net.au/">http://www.abc.net.au/</a></td>
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<td>Australian Academy of Science&lt;br&gt;<a href="http://www.science.org.au/">http://www.science.org.au/</a></td>
<td>x</td>
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2. 25 science websites for general audiences
<table>
<thead>
<tr>
<th>Region</th>
<th>Website</th>
<th>Country</th>
<th>URL</th>
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<tr>
<td>Asia</td>
<td>Chinese Biodiversity Information System (CBIS)</td>
<td>China</td>
<td><a href="http://cbis.brim.ac.cn/cbise/index.html">http://cbis.brim.ac.cn/cbise/index.html</a></td>
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<tr>
<td>Asia</td>
<td>Russian Space Science Internet (RSSI)</td>
<td>Russia</td>
<td><a href="http://www.rssi.ru/rssi_hp.html">http://www.rssi.ru/rssi_hp.html</a></td>
</tr>
<tr>
<td>Asia</td>
<td>National Center for Genetic Engineering and Biotechnology, Thailand</td>
<td>Thailand</td>
<td><a href="http://www.biotec.or.th/">http://www.biotec.or.th/</a></td>
</tr>
<tr>
<td>Asia</td>
<td>The Fossil Evidence for Human Evolution in China</td>
<td>China</td>
<td><a href="http://www.chineseprehistory.org//index.htm">http://www.chineseprehistory.org//index.htm</a></td>
</tr>
<tr>
<td>Asia</td>
<td>Friends of the Earth (Hong Kong)</td>
<td>Hong Kong</td>
<td><a href="http://www.foe.org.hk/welcome/geten.asp">http://www.foe.org.hk/welcome/geten.asp</a></td>
</tr>
<tr>
<td>Europe</td>
<td>European Science Foundation</td>
<td></td>
<td><a href="http://www.esf.org/">http://www.esf.org/</a></td>
</tr>
<tr>
<td>Europe</td>
<td>European Cooperation in the Field of Scientific and Technical Research (COST)</td>
<td></td>
<td><a href="http://cost.cordis.lu/src/home.cfm">http://cost.cordis.lu/src/home.cfm</a></td>
</tr>
<tr>
<td>Europe</td>
<td>European Science Education Research Association</td>
<td></td>
<td><a href="http://www.summerschool.dk/esera/home.html">http://www.summerschool.dk/esera/home.html</a></td>
</tr>
<tr>
<td>Europe</td>
<td>European Thematic Network in Biology (ETNB)</td>
<td></td>
<td><a href="http://www.yub.ac.be/gst/eurobio/">http://www.yub.ac.be/gst/eurobio/</a></td>
</tr>
<tr>
<td>Europe</td>
<td>BIOLOG-Europe</td>
<td></td>
<td><a href="http://www.biolog-europe.de/index.html">http://www.biolog-europe.de/index.html</a></td>
</tr>
<tr>
<td>America</td>
<td>Science Canada</td>
<td></td>
<td><a href="http://www.mts.net/~dforbes/ScienceCanada.html">http://www.mts.net/~dforbes/ScienceCanada.html</a></td>
</tr>
<tr>
<td>America</td>
<td>Endangered Jamaican Manatees</td>
<td>Jamaica</td>
<td><a href="http://jamaicanmanatee.freeservers.com">http://jamaicanmanatee.freeservers.com</a></td>
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<td>America</td>
<td>ThinkQuest</td>
<td></td>
<td><a href="http://www.thinkquest.org/">http://www.thinkquest.org/</a></td>
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<tr>
<td>America</td>
<td>National Aeronautics and Space Administration (NASA)</td>
<td></td>
<td><a href="http://www.nasa.gov/">http://www.nasa.gov/</a></td>
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<td>Africa</td>
<td>National Botanical Institute SA</td>
<td></td>
<td><a href="http://www.nbi.ac.za/homepage.htm">http://www.nbi.ac.za/homepage.htm</a></td>
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<tr>
<td>Africa</td>
<td>Science in Africa</td>
<td></td>
<td><a href="http://www.scienceinafrica.co.za/">http://www.scienceinafrica.co.za/</a></td>
</tr>
<tr>
<td>Africa</td>
<td>South Africa Expo for Young Scientists</td>
<td></td>
<td><a href="http://www.exposcience.co.za/">http://www.exposcience.co.za/</a></td>
</tr>
<tr>
<td>Africa</td>
<td>South African National Antarctic Program (SANAP)</td>
<td></td>
<td><a href="http://home.intekom.com/sanap/">http://home.intekom.com/sanap/</a></td>
</tr>
</tbody>
</table>

Total 25 (100) 12 (48) 13 (52)
Analysis of specific science website for science teachers

Table 16 summarises the results of the quantitative analysis of the 25 specific science websites for science teachers: 100% Consulting, 28% Coaching and 60% Teaming. Proposition 11 (Specific science websites for science teachers are provided as Consulting model of collaboration), Proposition 12 (Specific science websites for science teachers are provided as Coaching model of collaboration), and Proposition 13 (Specific science websites for science teachers are provided as Teaming model of collaboration) were supported.

Analysis of science website for general audiences

Table 16 also summarises the results of the quantitative analysis of the 25 science websites for general audiences: 100% Consulting, 48% Coaching and 52% Teaming. Proposition 14 (General science websites for interested parties are provided as Consulting model of collaboration), Proposition 15 (General science websites for interested parties are provided as Coaching model of collaboration), and Proposition 16 (General science websites for interested parties are provided as Teaming model of collaboration) were supported.

Model of collaboration

Consequently, the Consulting model is the most frequently found in both kinds of science websites, and the Teaming model is more frequently found than the Coaching model in both kinds of science websites.

The Potential for Collaboration

Both science websites are greatly encouraging for collaboration. For example, the
STAWA website, specific science website for science teachers, has written its principal aim as teacher support, strengthening membership base and enhancing communication. To fulfill its goals, STAWA members are offered many professional activities such as a professional development program, a STAWA mentors’ program; importantly the STAWA website provided Catalist-list server to encourage communication among its members.

Further, most science websites for general audiences encourage visitors to collaborate with them by providing a place for feedback, comments or contact detail.

Summary of Results: Testing Propositions of the Two Studies

Many propositions used for expected outcomes of this study were developed within the outline found from previous research in a variety of disciplines including models of collaboration, collaboration via the Internet, benefits and disadvantages of collaboration via the Internet, the attitude of science teachers toward collaboration using the Internet and the existing science websites. The set of propositions put toward in Chapter 4 was used as a basis for testing Fishbough’s models of science teachers’ collaboration and teachers’ perception of collaboration on the Internet. Also, many propositions were used as a foundation for testing Fishbough’s models of collaboration of the two existing science websites: specific science websites for science teachers and science websites for general audiences.

A summary of the results from the testing methods of these propositions is presented in the context of seven research questions see page five which guided this study. The results are given in Table 17.
<table>
<thead>
<tr>
<th>Research Question</th>
<th>Proposition</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>1: Science teachers use the Internet for their collaboration.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>2: Science teachers use <em>Consulting</em> model of collaboration as a framework for their collaborative practice.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>3: Science teachers use <em>Coaching</em> model of collaboration as a framework for their collaborative practice.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>4: Science teachers use <em>Teaming</em> model of collaboration as a framework for their collaborative practice.</td>
<td>Not supported</td>
</tr>
<tr>
<td>B.</td>
<td>5: Many factors influence science teachers’ use of e-mail and Internet for collaboration with other science teachers.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>6: Many benefits exist for science teachers as regards using e-mail and Internet to support their collaboration.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>7: The e-mail and Internet changes the way(s) in which science teachers collaborate with each other.</td>
<td>Supported</td>
</tr>
<tr>
<td>C.</td>
<td>8: Science teachers require collaborating with other teachers in electric networks.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>9: Science teachers want to continue using the Internet for their collaboration.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>10: Science teachers need support for their collaboration.</td>
<td>Supported</td>
</tr>
<tr>
<td>D.</td>
<td>11: There are many contexts that science teachers collaborate with each other on electronic networks.</td>
<td>Supported</td>
</tr>
<tr>
<td>E.</td>
<td>12: Science teachers frequently collaborate with other teachers on electric networks.</td>
<td>Not supported</td>
</tr>
<tr>
<td>F.</td>
<td>13: There exist many barriers to teachers’ collaboration via the Internet.</td>
<td>Supported</td>
</tr>
<tr>
<td>G.</td>
<td>1: The STAWA’s website is provided as <em>Consulting</em> model of collaboration.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>2: The STAWA’s website is provided as <em>Coaching</em> model of collaboration.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>3: The STAWA’s website is provided as <em>Teaming</em> model of collaboration.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>4: Science teachers subscribe to the Science Educators List server-Catalist.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>5: The Science Educators List server-Catalist is provided as <em>Consulting</em> model of collaboration.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>6: The Science Educators List server-Catalist is provided as <em>Coaching</em> model of collaboration.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>7: The Science Educators List server-Catalist is provided as <em>Teaming</em> model of collaboration.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>8: The Teachers Survival Kit website (TSK) is provided as <em>Consulting</em> model of collaboration.</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>9: The Teachers Survival Kit website (TSK) is provided as <em>Coaching</em> model of collaboration.</td>
<td>Not supported</td>
</tr>
<tr>
<td></td>
<td>10: The Teachers Survival Kit website (TSK) is provided as <em>Teaming</em> model of collaboration.</td>
<td>Not supported</td>
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</table>
as *Teaming* model of collaboration.
11: Specific science websites for science teachers are provided as *Consulting* model of collaboration.

12: Specific science websites for science teachers are provided as *Coaching* model of collaboration.

13: Specific science websites for science teachers are provided as *Teaming* model of collaboration.

14: General science websites for interested parties are provided as *Consulting* model of collaboration.

15: General science websites for interested parties are provided as *Coaching* model of collaboration.

16: General science websites for interested parties are provided as *Teaming* model of collaboration.

*Support* was found as follows: many factors influence science teachers use of e-mail and Internet for collaboration with other science teachers, many benefits exist for science teachers as regards using e-mail and Internet to support their collaboration, the e-mail and Internet changes the way(s) in which science teachers collaborate with each other, science teachers require collaborating with other teachers in electronic networks, science teachers want to continue using the Internet for their collaboration, science teachers need support for their collaboration, and there exist many barriers to teachers’ collaboration via the Internet.

In addition, analysing two kinds of science websites, *support* was found as follows; the STAWA website, the Science Educators List server-Catalist and the TSK website are offered as *Consulting* model of collaboration; and the two kinds of science websites are provided as *Consulting*, *Coaching* and *Teaming* models of collaboration.

Discussion of the results reported above, and their implications for collaborative practice via the Internet together with suggestion for further study is presented in the final chapter of this dissertation.
Summary

This chapter presents an analysis of two kinds of science websites: specific science websites for science teachers and science websites for general audiences from five chosen continents: Australia, Asia, Europe, America and Africa using Fishbough’s models of collaboration: Consulting, Coaching and Teaming as a framework. A purposive sampling, content analysis technique, eight search engines and many keywords were used to decide the two kinds of science websites. Accordingly, the results shows the Consulting model is the most frequently found in both kinds of science websites, and the Teaming model is more frequently found than the Coaching model in both kinds of science websites. Besides, both science websites highly encourage audiences’ collaboration.

The results gained from propositions testing research question A-G which guided the study. Support was found as follows: many factors influence science teachers’ collaboration via the internet, many benefits exist for science teachers using e-mail and Internet to support their collaboration, the Internet changes the way(s) in which science teachers collaborate with each other, science teachers require collaborating with other teachers via the Internet, science teachers want to continue using the Internet for their collaboration, science teachers need support for their collaboration, and there exist many barriers to teachers’ collaboration via the Internet. Further, analysing two kinds of science websites supported was found for the STAWA website, the Science Educators List server-Catalist and the TSK website are offered as Consulting model of collaboration. Also, the two kinds of science websites are provided as Consulting, Coaching and Teaming model of collaboration were supported.
Chapter 8

Summary, Discussion and Conclusion

The study was designed to investigate the use of e-mail and Internet for collaboration among a sample of science teachers in government high schools in Perth, Western Australia. This investigation comprised two studies. Study One is a survey of the teachers’ perceptions of collaboration via the Internet, and Study Two is a detailed science website analysis. The results were analysed using Fishbough’s models of collaboration (Fishbough, 1997).

Study One: Teachers’ Perceptions of Collaboration via the Internet

This study tested Fishbough’s models of collaboration and described the nature of science teacher collaboration using e-mail and Internet of the three models of collaboration, Consulting, Coaching and Teaming. It was clear from the study that science teachers at the sample schools rarely used the Consulting model of collaboration to collaborate with other teachers via the Internet. Further, those science teachers very seldom used the Coaching and Teaming model to collaborate with other teachers via the Internet.

It was also evident from the study that most science teachers at the sample schools had negative perceptions of the potential of collaboration in an electronic environment.

The study found that science teachers wanted to collaborate with other science teachers on the Internet as it had several benefits; however, they were not ready to use this technology for collaboration at the time of the investigation. They believe that they needed
to prepare themselves with computing skills and predetermine the aim and direction of their collaboration. Further, science teachers thought it was complicated to collaborate via the Internet because they did not have time and none of the schools had a technician to support this activity.

It was also clear from the study that some science teachers in the sample schools did use the Internet to exchange ideas with colleagues, join professional lists and find the appropriate materials for teaching purposes and research. However, there were several perceived barriers to science teachers’ collaboration on the Internet such as time, which most science teachers pointed out was a huge problem for them. Also, the quality and numbers of computers were the problem for science teachers as well.

Supporting the Consulting model of collaboration the study found that most science teachers at the sample schools reported that they never gave advice to other teachers on how to teach a science topic or sought advice from other teachers and experts when faced with problems about how to teach a science topic or helped novice science teachers plan their teaching activities, and almost never learned more about teaching techniques in science from other teachers and experts or asked experienced teachers how to teach a difficult science topic. Further, science teachers’ comments from the interviews revealed that few of them use e-mail and Internet to work with other people, join professional lists, access websites to get information, give advice, share information and get work from colleagues. Thus, science teachers rarely used the Consulting model of collaboration for working with other teachers via the Internet.

Supporting the Coaching model of collaboration the study found that science teachers at the sample schools related that they almost never worked jointly with other teachers to implement new models of teaching or assisted other science teachers to develop their teaching techniques and materials of a new topic or received frequent feedback on their
own teaching from other science teachers, and almost never had a trusted peer, who asks clarifying questions, provides data and offers constructive critique or sought assistance from other teachers to find problem solutions for at risk students. Further, science teachers’ comments from the interviews showed that science teachers very seldom used the Internet, as it was a new mode of collaboration and they wanted to learn how to use the Internet efficiently.

In support of the Teaming model of collaboration, the study revealed that science teachers at the sample schools stated that they were almost never involved in a team for instructional improvement or shared ownership of programs for professional development with other teachers or developed teams with other teachers to support members' professional growth activities, and almost never participated in a team problem solving approach to design special strategies for individual students or shared their experiences with other teachers and support each other while teaching the same topic. Further, science teachers’ comments from the interviews explained that they rarely used e-mail and Internet to work with other teachers. There was only one science teacher who used the Internet to work with a colleague in a university. Most of them used it to check e-mails and exchange information between colleagues within the school.

Hence, science teachers at the sample schools rarely collaborated with other teacher via the Internet. This finding was in agreement with many authors who studied collaboration from past until the period of studying. For example, Grimmett and Erickson (1988) found that many teachers remain professionally isolated from their peers, from sources of innovation, from opportunities for reflection on practice and from resources for teaching and professional development. Nias (1993) pointed out that professional individualism has been an obstacle to collaboration and has been credited to the organisation of schools, especially secondary schools. Also, Inger (1993) stated that teacher collaboration is rare
because there are substantial barriers; such as, norms of privacy, subject affiliation and department organisation, and barriers between vocational and academic teachers. Welch (1998) emphasised that many novice professional lack the essential prerequisite skills of sufficient communication and conflict management, which are very important for being involve in collaborative work. Altshuler (2003) found several obstacles for collaboration between public schools and child welfare such as lack of trust, lack of understanding about confidential information, and lack of communication with each other. Also, Zorn, Yung Tam, LaMontagne and Johnson (2003) reported some factors that impact interagency collaboration; for example, lack of commitment, lack of strong leadership, lack of common vision and goals, lack of trust, lack of support from upper management, lack of financial support, and resistance to change. Consequently, science teachers at the sample schools rarely used the Internet to support their collaboration as there were quite a few obstacles preventing them; these finding were in agreement with many authors. For example, Dvorak (1996) noted that funding is a problem as many schools arrange more money on overhead and administration. Maddux (1999) reported that poor web design makes teachers frustrated and confused as it is cluttered with thousands of pages that contain nothing but the words under construction. Further, Lai, Trewern and Pratt (2002) stated that secondary schools in New Zealand lack of Internetworking technical support and vision.

However, Yap (1997) and Spitzer & Wedding (1995) found that with careful attention to technical and social design, network-based communication could provide a fruitful basis for science teachers’ collaboration. Also, Tsui and Ki (1996) report a study on the characteristics of the interactions in the computer network for ESL teachers in Hong Kong secondary schools. The computer network was set up to enhance the professional development of in-service ESL teachers by the Department of Curriculum Studies of the
University of Hong Kong. The results of the study show that there were signs of a collaborative network among teachers. There was a significant increase in the frequency of teachers responding to fellow teachers. There was also a significant increase in teachers sharing views in a variety of areas, including the sharing of materials, comments on teaching ideas and information about language. The results of the study also indicate that computer proficiency and technical accessibility of networks are not the only factors. In building a collaborative electronic community of professionals, sociopsychological factors such as users’ perception of the nature of the network, their perceptions of their relationship with other users on the network, and their perceptions of themselves and their role on the network are equally important factors.

The present study also examined the use of e-mail and Internet for collaboration among science teachers at the selected schools. Most science teachers at the sample schools had negative perceptions of the potential for science teachers’ collaboration in an electronic environment. However, those same science teachers were also willing to collaborate with other science teachers on the Internet as the new way of collaboration and reap the several benefits, which would be experienced. Unfortunately, they were not likely to use this technology for collaboration yet. They needed to prepare themselves with regard to computing skills, aims, direction, time and technician support for the activity.

The study also found that science teachers at the sample schools expressed their ideas about the potential of teachers’ collaboration via the Internet as the following: science teachers disagree that they gather ideas about teaching techniques on a science topic from teachers around the world on the Internet, get support by interacting with other teachers on the Internet, share their teaching experiences, ideas, project results, student problems with other teachers on the Internet or conduct a science project for their students with other teachers on the Internet. They strongly disagree that they discuss teaching material with
other teachers on the Internet, that the Internet allows them to communicate with other teachers around the world, that they can contact other teachers on the Web without thinking about communication skills and different cultures and that the Internet allows them to help beginning teachers with teaching materials.

Further, science teachers’ comments from the interviews confirmed many reasons that made them have negative understanding of electronic networks in teachers’ collaboration. First, they rarely used computers. Second, they were not confident about using the Internet as a tool for collaboration and most of them wanted to keep good ideas to themselves. Third, most science teachers had been using other modes of collaboration such as phone, fax, jotting a new idea down on a paper, copying a work sheet for colleagues and sharing an idea by talking to members at length, so they were accustomed to doing that. Fourth, most science teachers had diverse ideas about e-mail and Internet such as: the Internet was used for getting information, it was not for communication, e-mail was limited for collaboration, especially if they had to get people’s names for communication. Fifth, most science teachers were not very clear on benefits of using the Internet for collaboration and they had not seen the Internet used in this way; they needed time to be familiar with it. Sixth, science teachers had limited knowledge about the capacity of the Internet because the school did not have the Internet yet. Seventh, science teachers were not willing to agree to collaboration via the Internet as they believed that the Internet was best used for solving only a specific problem. Eighth, science teachers cited that using the Internet was a time consuming activity. Ninth, science teachers did not find using computers at school convenient as most computers at the school were always broken and no one bothered to repair them, especially as they had to use passwords to access those computers.

Consequently, science teachers had negative perceptions on the potential of science teachers’ collaboration in an electronic environment because of they rarely used computers,
they were not confident about capacity and benefits of using the Internet for collaboration and especially, they had limited knowledge about the Internet.

These findings were in agreement with many authors. For example, Minkel (2001) has found that many teachers are still reluctant to use the Internet and e-mail as part of their own day-to-day classroom-management work. Minkel stated that many public librarians have offered an “assignment-alert” page on their websites for teachers to let them know about upcoming assignments as they will prepare materials for students, but they have never received responses from teachers. Simon (1992), who studied the use of computer conferencing as a component of a teachers’ training program for collaborative learning, found that low participation rate of teachers in computer conferencing was because of teachers’ dislike for the medium as being very cold and teachers’ finding that it is difficult to imagine the person to whom they were addressing their messages.

In the ability to use computers, most science teachers considered themselves comfortable with technology with only some of them beginners. Science teachers classified themselves as regular e-mail or the Internet users. Most science teachers used computers daily and the rest of them used them weekly or monthly. They used both home and school computers. Most science teachers used the Internet when they were at home as they did not have time at schools, and accessing computers at school was difficult. Science teachers normally used the Internet less than one hour per day. Science teachers accessed computers both at work and at home. At work, most of them had adequate access to a computer and they had their own personal e-mail address. At home, most of them had a computer and some of them had the Internet and personal e-mail address. Few science teachers did not have the Internet at home.

These findings were in agreement with many reports. For instance, Topp & Grandgenett (1996) reported that the respondents identified characteristics related to the Internet
situation in their schools. Few Internet-connected computers were available at school. This made teachers use the Internet much more at home than at school and electronic mail was currently the most frequently used application, with over 70% of the respondents using e-mail more than twice per week. Gallo & Horton (1994) investigated the effect direct and unrestricted access to the Internet had on a group of high school teachers. They found that some of the participants lacked a basic understanding of how to use the computer and also lacked the vocabulary of an experienced Macintosh user. Honey & Henriquez (1993) reported that participants conducted much of their telecommunication-related activities from their home and on their own time.

Further, this present study found many advantages when science teachers at the sample schools used e-mail and Internet to support their collaboration. For example, e-mail and Internet was quick and cooperatively transferred of information, rapid response was possible and e-mail and Internet could access anywhere in the world quickly, it was a cheap, efficient and convenient collaborative tool, the Internet had more resources available to use, and information exchange between colleagues occurred quickly and efficiently. Additionally, science teachers commented in the interviews that the Internet was a convenient tool for collaboration and the best resource for information. They could get or send materials quickly and exchanged new ideas on the Internet.

These findings were in agreement with several authors. For example, Liaw (2003) reported the results of a cross-cultural e-mail project that the partners exchanged significant information on the areas of interpersonal, sociocultural, pedagogical, and language-learning subjects. Russell, O’Dwyer and O’Connor (2003) found that experienced teachers use e-mail to deliver instruction and for student activities. Lang (2000) notes that e-mail is used for direct interpersonal exchange or mediated exchange. Peat and Fernandez (2000) state that the major advantage of the Internet might be consider being the interactive
communication capabilities afforded by virtual access, virtually anywhere and virtually anytime. Hawkes (1999) notes that network-based communication can help teachers to improve knowledge in three areas: knowledge of educational policy, knowledge of subject area and knowledge of professional community. Yap (1997) found that the Rural Telecomputing Initiative project helped rural teachers to connect with math and science reform communities and use the ideas and resources available through the Internet to become more effective in the classroom. Parker (1994) states many benefits of the Internet in education such as student records can be rapidly transferred across the Internet between schools; teachers can share ideas with or ask questions of others in their discipline or download resources for use in the classroom; teachers can log onto the Internet and share with their friends across the world; teachers can also engage in dialogues with experts or coordinate projects with classrooms in other countries.

It was found from this study that the changing way(s) of collaboration occurred when science teachers at the sample schools used the Internet for collaboration. For example, e-mail and Internet helped them to collaborate faster and with less paper work; e-mail and Internet was the new mode for communication; the ease with which collaboration could occur was very attractive; e-mail and Internet made collaboration much easier; it encouraged collaboration through consensus, ease of use and speed. Additionally, science teachers noted from the interviews that they felt it more convenient to contact people and exchanged information; especially it was a rapid and cheap way to contact people.

These findings were in agreement with Becker and Riel (2001), their findings showed that teachers who are engaged in professional collaboration also tend to use computers in very effective ways and they can gain outcomes from communication, thinking, producing and presenting their ideas. Riel (1998) states that teachers, who have access to resources such as databases and computer libraries, can communicate with other professional via e-
mail and published discourse. Yap (1997) found that telecomputing reduced teachers’ sense of isolation and increased their collaboration with colleagues and experts. Resources acquired via the Internet at least had a moderate impact on their teaching; most teachers change teaching techniques as a result of acquiring Internet resources. Teachers became more comfortable with being learning facilitators rather than information distributor. Also, Topp & Grandgenett (1996) note that the Internet seems to provide a chance to truly break down the walls of individual classroom and make it possible for teachers to share resources and ideas quickly and easily over long distances.

From the study, science teachers at the sample schools stated that regarding the requirement to collaborate via the Internet, that they agreed to work on the Internet when it was convenient for them. However, they disagreed that they can post requests to other science teachers on the Internet, and that the Web is very useful for receiving information, making professional contact or communicating with other teachers on the Web is cheap, reliable and uninterrupted. Also, they disagree to complete their joint work with other science teachers on the Internet without a face-to-face meeting.

Further, science teachers’ comments from the interviews emphasised the need to collaborate via the Internet even if they were not confident of the capacity of the Internet for collaboration; for example: it can help them to perceive knowledge in the modern world; they can develop computing skills and their professional career; there were benefits from their collaboration; they want to share ideas or problems or exchange information; they want to make clear about curriculum among schools; they want to be involved in the computing world, because it is convenient, cheap and free and they can do experiments and find someone who is interested in the same area.
In addition, science teachers wanted to collaborate via the Internet but many things were required such as they needed to construct objectives of the collaboration before starting it; they needed to indicate the length of time for their collaboration; they needed to gain confidence about computing skills; they wanted to know if those links have good and clear directions, objectives and outcomes or have new methods; they needed time and technicians to support their collaboration.

These findings were in agreement with several authors’ reports. For instance, Hugue (2003) states that online colleagues inspired her to learn and grow as she successfully created Cyber English class and now it is an online English class model for many teachers to use. DiMauro & Gal (1994) report that science teachers communicate with each other via the Internet, they discuss how to promote science project in the classroom and provide encouragement to other teachers. Gallo & Horton (1994) point out that teachers need to use the Internet as it can increase teachers’ self-esteem and improve their attitudes toward computers and education. Further, Handler (1991) notes that teachers in a small district need to collaborate via the Internet as they have a lack of others to share ideas and concerns.

This study investigated the contexts in which science teachers collaborate with each other in electronic networks. Science teachers at the sample schools reported that they strongly disagree to developing curriculum and teaching materials with other teachers on the Web, using the Web to announce conferences, schedule meetings or arrange appointments with other teachers. Also, they strongly disagree that the Internet encourages them to express their thoughts to other teachers and they can help other teachers with ideas about teaching difficult science topics on the Internet. Furthermore, science teachers’ comments from the interviews emphasized the following findings: they did not use e-mail and Internet to improve curriculum or teaching materials or to announce conferences or
meetings with other teachers because they rarely use the Internet; they had never expressed their thoughts to other teachers or helped other teachers on the Internet; they used the Internet to exchange ideas with colleagues, join professional lists and find the appropriate materials for teaching purposes and research.

These findings were in accord with many reports. For example, Hugue (2003) reports that she uses the Internet as a place to ask questions about everything she did in the classroom, listened to, and engaged in discussion about pedagogy. Knowles (1996) found that English teachers use the Internet to discuss issues with others in the profession, while Tsui & Ki (1996) found that teachers use the Internet to share materials, comments, and information.

To the extent to which science teachers collaborate with other teachers in electric networks, this study found that most science teachers strongly disagree that they find it is difficult to explain their understanding of a science topic on the Internet and they often use the Web for collaborating with other science teachers. Also, they disagree that they can contact other science teachers quickly on the Web. Further, science teachers’ comments from the interviews confirmed the findings that most science teachers felt comfortable expressing their thoughts about science themes on the Internet but they were not confident that they could contact other science teachers quickly on the Internet as they rarely used the Internet.

Further, this study found that there were several issues that made science teachers at the sample schools rarely collaborate via the Internet including time, which was the main factor for science teachers' lack of collaboration on electronic networks; the workability; most websites were always out of date; there were not any web-managers or teachers to update schools’ websites; the levels of expertise and interest in using the Internet of science
teachers were also problems; there were not enough computers for teachers to use; contacted other schools via Internet but did not get response; computers at the school are not fast; access Internet was a time consuming activity and the curriculum course science teachers superficially collaborate on the Internet.

These findings were in agreement with several reports. For example, Spitzer & Wedding (1995) found that teachers need to connect colleagues but there are no Internet applications for supporting teacher conversations with functionality, ease of access, privacy, or user-friendliness. Besides, the vast majority of the school’s computers are still older computers and have slow modems that simply will not work with high-bandwidth application.

Science teachers pointed out various disadvantages of using the Internet for collaboration. To illustrate, they stated that the Internet is big and hard to find a specific topic and it consist of a lot of ‘stuff’. Especially, users do not know which websites have gone out-of-date and if they want to send something that “thing” has to be an electronic document.

From the study, science teachers at the sample schools described their ideas about the problems that prevent them from collaboration via the Internet as the following: science teachers strongly disagree that they feel uncomfortable using the schools computers in collaborating with other teachers and they feel reluctant to contribute to the Web as other science teachers can read their contribution. Science teachers are comfortable about using the school’s computers to collaborate with other teachers and they are also willing to contribute to the Web. Accordingly, using the school’s computer and the contribution to the web are not the barriers to science teachers’ collaboration.

Further, science teachers’ comments from the interviews pointed out that there are many other issues that are barriers to their collaboration on the Internet such as: time which is the main factor, school lines, the number and the operation of computers, computing skills, the
curriculum, the benefits from collaboration, e-mail addresses, or technical support, the
objective of collaboration, the workability of the Internet at the school, passwords and
number of computer at school. Accordingly, there are many barriers to science teachers’
collaboration on the Internet.

These findings were in agreement with many studies. For example, Lelong and
Fearnley-Sander (1999) suggest that partners must have a robust commitment for a job
project. Gallo & Horton (1994) found many barriers to teachers’ collaboration via the
Internet such as time; the school’s local area network (LAN) was not sufficiently robust to
support an Internet connection, school’s computers lack of sufficient memory for the
Internet connection, as well as lack of technical support. Also, Gallo & Horton (1994)
reported that teachers lacked a basic understanding of how to use their computer and lacked
the vocabulary of an experience computer user.

**Study Two: A Detailed Science Website Analysis**

This study sought to determine whether websites encourage collaboration among science
teachers and models of collaboration of science websites that were provided on the Internet.
Two kinds of websites were analysed: specific science websites for science teachers and
science websites for general audiences from five selected continents Australia, Asia,
Europe, America and Africa. These two kinds of science websites were analysed using
three complementary methods: Fishbough’s models of collaboration (Fishbough, 1997),
types of collaboration (Little (1990) and content analysis (Berelson, 1952; Gall & Borg,
In Western Australia, three particular websites; the Science Teachers’ Association of Western Australia (STAWA), the list server for West Australian Science Educators (Catalist) and the Teachers Survival Kit (TSK) were investigated. It was found from the study that specific websites for science teachers encouraged science teachers’ collaboration by providing mailing lists, which allow science teachers to communicate with each other. For example, in the Catalist-list server of the STAWA website, science teachers can subscribe to this e-mail list and can communicate with other science teachers. These findings were in agreement with Merlino (2000), who reports that a weather site, associated with Project Atmosphere Australia On-line (http://schools.ash.org.au/paa) highly encourages collaboration. Its audiences, students or teachers, who want to participate on line, must join the mailing lists, which allow those audiences to communicate with each other. This site not only encourages its audiences to communicate with each other but also encourages them to publish their work on the web.

Also, from the study found that science teachers in Western Australia often used Catalist to ask about difficult or new science topics more than to discuss teaching experiences or to share or to exchange ideas. This finding was in agreement with DiMauro and Gal (1994) who studied a group of teacher leaders using network exchange to reflect their involvement with peer leadership and teacher-teacher support. They found that reflective messages about professional practice and teaching rarely happen on networks. The network area that was reachable to all LabNet teachers was used mainly for “shop talk”, to seek resources and technical assistance, and for some teaching activities as well.

Further, the Teachers’ Survival Kit website major function is collecting teaching materials to place on website for science teachers who need those resources to download. It was evident from the study that science teachers in Western Australia use the TSK website
as a place to share resource and expertise. This finding was in agreement with Broholm and Aust (1994) who studied the communication patterns of teachers. They found that the largest group of electronic mail users were the science teachers.

Specific science websites for science teachers

25 specific science websites for science teachers (5 science websites from each of the five selected continents) were examined. In the study found that most specific science websites for science teachers also enhance collaboration of their audiences by offering a place for “feedback, comments or contact detail” on the website. Particularly, science teachers can use those websites for classroom practice.

Science websites for general audiences

25 science websites for general parties (5 science websites from each of the five chosen continents) were investigated. It was evident from the study that most science websites for interested parties too, encourage their audiences’ collaboration by offering “contact detail” on the website.

Models of collaboration

Three particular websites for science teachers in Western Australia, the Science Teachers’ Association of Western Australia (STAWA), the list server for West Australian Science Educators (Catalist) and the Teachers Survival Kit (TSK), and 50 science websites (25 specific science websites for science teachers and 25 science websites for general audiences) were analysed using Fishbough’s models of collaboration. The study revealed that the specific science websites for science teachers the Consulting model of collaboration was the most frequently used, and the Teaming model of collaboration was
more frequently used than the Coaching model of collaboration. Similarly, science websites for general audiences, the study most frequently found the Consulting model of collaboration, and more frequently found the Teaming model of collaboration than the Coaching model of collaboration.

The results of Study Two revealed that science teachers were working in a very rich collaborative environment; importantly, science teachers could use various science websites and mailing lists to support their collaboration.

**Conclusion**

The study sought to investigate the use of e-mail and Internet in collaboration among science teachers in a sample of government high schools in Perth, Western Australia and study science websites on the Internet. The crucial issues and their implications for further study are indicated as follows.

First, norms of isolation (Little, 1990) or individualism (Fullan & Hargreaves, 1991) do persist in spite of the evidence for all three Fishbough’s models of collaboration. To increase collaboration among teachers will be a long term goal for all schools. Principals and school-level leaders need to continue their effort to support collaborative activities among teachers by employing six dimensions of support for collaboration as Little (1987) suggests. These dimensions are ‘Endorsement and Rewards’, ‘School-Level Organisation of Assignments and Leadership’, ‘Latitude Given to Teachers for Influence on Matters of Curriculum and Instruction’, ‘Time’, ‘Training and Assistance’ and ‘Material Support’. Researchers need to continue their efforts to study the conditions supporting collaborative cultures in school in order to help chart school improvement for both teachers and students. Further, Leonard and Leonard (1999) suggest that the principals are important person for
motivation, and informal collaboration is more effective in term of leadership provision for change than formal structure of planned collaboration. Also, Leithwood and Jantzi (1990) state that a school principal may demonstrate six proportions of leadership: articulation and sharing of a vision, fostering group goals, individual support to subordinates, intellectual stimulation, appropriate behavior modeling, and high performance expectations.

Second, the findings from Study One suggest that most science teachers at the sample schools rarely used the Internet as a tool for their collaboration, only a few of them used the Internet to share ideas, joint professional lists, give information and find material for teaching. Further, most science teachers had negative ideas about collaboration via the Internet as there were many barriers to their collaboration such as time, which is the main problem for them, and equipment. However, science teachers need to collaborate with peers via the Internet as many benefits: student accomplishment (Gage, 1984; Spitzer & Wedding, 1995), feeling less personally isolated (Drotar, 2002; Bennett, 1998), and professional development will be experienced (Barufaldi & Reinhartz, 2001; Hawkes, 1999), but they need much support such as time, good equipment, technical support and websites.

Third, the findings from Study Two suggest that there are a large number of both kinds of science websites offered and most of those science websites were presented in the Consulting model of collaboration. Teachers generally do not have time to find a particular needed website or find, from the large number of websites, the website that shows three models of collaboration. Consequently, websites that demonstrate the three models of collaboration need to be offered for teachers to study and use it as model for their own collaboration. Also, high-quality equipment need to be provided for teachers as it will encourage teachers to use Internet to support their collaboration.
Thus, this proposition needs to be tested beyond the sample schools that participated in this study, as well as ascertaining whether the situation has changed since this study were conducted.

Finally, it would be worthwhile knowing more about culture, benefits and disadvantages of collaboration via the Internet among teachers. This study investigated teachers and their collaboration. Further questions remain as follows:

1. Are teachers more likely to collaborate via the Internet within particular subject areas or with regard to some sets of teachers’ tasks?
2. Do science teachers in non government schools collaborate via the Internet?
3. What kind of websites do teachers need to support their collaborative practice?
4. How can the Internet be put to work in the classroom?
5. How can the Internet be use effectively for collaboration?
6. How can teachers be encouraged to collaborate via the Internet?

Continued research is necessary, and alternative approaches which involve participant observation in schools and teachers as action researchers might prove to be fruitful (Little, 1990).
References


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**Appendices**

**Appendix 1**

Science Teacher Collaboration via E-mail and Internet Questionnaire
PART A: TEACHERS’ USE OF ELECTRONIC COMMUNICATION

In questions 1-2, please cross [x] the response, which best fits you.

1. How do you see yourself as a user of information technology / educational computing?
   [ ] extremely competent with technology
   [ ] comfortable with technology
   [ ] just a beginner

2. Would you classify yourself as a regular e-mail and Internet user?
   [ ] Yes  [ ] No
   If yes, please answer 2.1-2.6 below

2.1 How often do you use this technology?
   [ ] Daily  [ ] Weekly  [ ] Monthly

2.2 Which computer do you use?
   [ ] School computer
   [ ] Home computer
   [ ] Both home and school computers

2.3 What time do you most often use e-mail and Internet?
   [ ] Before / after school
   [ ] When you are free from your classes at school
   [ ] When you are at home

2.4 For how long do you normally use e-mail and Internet per day?
   [ ] Less than 1 hour
   [ ] 1-2 hours
   [ ] More than 2 hours

2.5 At Work
   [ ] I have adequate access to a computer
   [ ] I have adequate access to the Internet
   [ ] I have my own personal e-mail address

2.6 At Home
[ ] I have a computer
[ ] I have Internet
[ ] I have personal e-mail address

If you use E-mail and Internet for collaboration with other science teachers, please answer question 3 and 4 below.

3. What are the benefits, for you, of using E-mail and Internet to support your collaboration?

4. How does using E-mail and Internet change the way(s) in which you collaborate?

PART B: TEACHERS’ PERCEPTIONS OF ELECTRONIC NETWORKS IN TEACHERS’ COLLABORATION

Please rate your level of agreement or disagreement with case statements below. Draw a circle around your response 1, 2, 3, 4 or 5.

<table>
<thead>
<tr>
<th>Circle</th>
<th>1. if you strongly disagree with the statement.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. if you disagree with the statement.</td>
</tr>
<tr>
<td></td>
<td>3. if you neither agree or disagree with the statement.</td>
</tr>
<tr>
<td></td>
<td>4. if you agree with the statement.</td>
</tr>
<tr>
<td></td>
<td>5. if you strongly agree with the statement.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statement</th>
<th>strongly disagree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>disagree</td>
<td>agree</td>
</tr>
<tr>
<td></td>
<td>I gather ideas about teaching techniques on a science topic from teachers around the world on the Internet.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I get support by interacting with other teachers on the Internet.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I share my teaching experiences, ideas, project results, and student problems with other teachers on the Internet.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I conduct a science project with other teachers on the Internet.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I discuss science teaching material with other teachers on the Internet.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I can work on the Internet when it is convenient to me.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I can post requests to other science teachers on the Internet.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The Web is very useful for receiving information and making professional contacts.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I develop curriculum and teaching material cooperatively with other teachers on the Web.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I use the Web to announce conferences, schedule meeting and arrange appointments with other teachers.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>The Internet encourages me to express my thoughts to other teachers.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I help other teachers with ideas about teaching difficult science topics on the Internet.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>I feel uncomfortable using the school’s computers in collaborating with other teachers.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>I find it is difficult to explain my understanding of a science topic on the Internet.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>I feel reluctant to contribute to the Web.</td>
<td></td>
</tr>
</tbody>
</table>
as other science teachers can read my contribution.  

16. I often use the Web for collaborating with other science teachers.  

17. Communicating with other teachers on the Web is cheap, reliable and uninterrupted.  

18. I can contact other science teachers quickly on the Web.  

19. I can complete my joint work with other science teachers on the Internet without a face-to-face meeting.  

20. The Internet allows me to communicate with other teachers around the world.  

21. I can contact other teachers on the Web without thinking about communication skills and different cultures.  

22. The Internet allows me to help beginning teachers with teaching materials.  

### PART C: COLLABORATION VIA E-MAIL/INTERNET

Please indicate how frequently the statements apply to you when you use E-mail and Internet to collaborate with other science teachers.

Draw a circle around your response 1, 2, 3, 4 or 5.

<table>
<thead>
<tr>
<th>Circle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>if the practice takes place Almost Never</td>
</tr>
<tr>
<td>2.</td>
<td>if the practice takes place Seldom</td>
</tr>
<tr>
<td>3.</td>
<td>if the practice takes place Sometimes</td>
</tr>
<tr>
<td>Statement</td>
<td>1</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>1. I give advice to other teachers on how to teach a science topic.</td>
<td>1</td>
</tr>
<tr>
<td>2. I seek advice from other teachers and experts when faced with problems about how to teach a science topic.</td>
<td>1</td>
</tr>
<tr>
<td>3. I help novice science teachers plan their teaching activities.</td>
<td>1</td>
</tr>
<tr>
<td>4. I learn more about teaching techniques in science from other teachers and experts.</td>
<td>1</td>
</tr>
<tr>
<td>5. I ask experienced teachers how to teach a difficult science topic.</td>
<td>1</td>
</tr>
<tr>
<td>6. I work jointly with other teachers to implement new models of teaching.</td>
<td>1</td>
</tr>
<tr>
<td>7. I assist other science teachers to develop their teaching techniques and materials of a new topic.</td>
<td>1</td>
</tr>
<tr>
<td>8. I receive frequent feedback on my own teaching from other science teachers</td>
<td>1</td>
</tr>
<tr>
<td>9. I have a trusted peer who asks clarifying questions, provides data, and offers constructive critique.</td>
<td>1</td>
</tr>
<tr>
<td>10. I seek assistance from other</td>
<td></td>
</tr>
</tbody>
</table>
teachers to find problem solution for at-risk students.  
11. I am involved in a team for instructional improvement.  
12. I share ownership of programs for professional development with other teachers.  
13. I develop teams with other teachers to support members’ professional growth activities.  
15. I share my experiences with other teachers and we support each other while teaching the same topic.

**PART D: BACKGROUND**

Please cross [x] the response which best fits you.

1. Are you male or female?
   - Male [ ]
   - Female [ ]

2. How old are you?
   - under 30 [ ]
   - between 30-40 [ ]
   - between 40-50 [ ]
   - over 50 [ ]

3. What is the highest qualification that you hold?
   - B.Sc., Dip Ed [ ]
   - Bachelor’s Degree [ ]
   - Post Graduate Diploma [ ]
Master’s Degree [ ]
Ph.D. [ ]
Other; please specify: ________________________________

Year of graduation of highest qualification 19___________

4. How many years have you been teaching science _______ years.

5. What is your strongest science in your teaching qualification?
   General science [ ]
   Physics [ ]
   Chemistry [ ]
   Biology [ ]
   Environmental science [ ]
   Other science; please give details: _________________________________

6. What type(s) of support have you received during your collaboration via E-mail and Internet?
   None [ ]
   From administrators [ ]
   From head of department [ ]
   From colleague(s) [ ]
   Other; please state: ___________________________________________

7. With who have you collaborated in a past 12 months?
   science teacher in the same school [ ]
   science teacher in other schools in Australia [ ]
   science teacher in other countries [ ]
   if other; please state: _________________________________

8. Are you subscribed to the Science Educators List server-Catalist?
   yes [ ] no [ ]

9. Have you visited STAWA’s web site www.stawa.asn.au recently?
   yes [ ] no [ ]
   Would you like a summary of the result of this survey?
   yes [ ] no [ ]

256
If yes, please provide full name and postal address.
Name: ____________________________________________________
Address: __________________________________________________
Would you be willing to be interviewed if further information needed?
yes [ ] no [ ]
If yes, please give your name and school.
Name ____________________________ School _______________________

Additional Comments:

Appendix 2

Covering letter

Murdoch University
Science Teacher Collaboration via E-mail and Internet

Questionnaire

This questionnaire is part of an investigation into the use of electronic technology as a means of collaboration among science teachers in government high schools in Perth, Western Australia. The data will be use to test models of collaboration and elucidate the use of the Internet in collaboration with teachers who use E-mail and Internet.

This questionnaire consists of questions about your background, your experiences and perceptions of electronic communication, and your collaborative practices via E-mail and Internet.

The information contained in this questionnaire will be treated confidentially. Questionnaire data have been analysed names will be destroyed.

If you would like a preliminary analysis of the results, please indicate at the end of the questionnaire.

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE. YOUR ASSISTANCE AND COOPERATION IS HIGHLY VALUED.

Punipa Suntisukwongchote
Australian Institute of Education
Murdoch University
Murdoch, WA 6150
Phone: (08) 9360 6633
E-mail: suntisvk@central.murdoch.edu.au

Appendix 3

Consent form
Appendix 4

Follow-up letter
Appendix 5

Follow-up interview schedule
A. *Which of Fishbough’s models of collaboration are appropriate for analysing science teachers’ collaboration via the Internet?*

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>No Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe all the computers used in your school</td>
<td>1. Describe all the computers used in your school</td>
</tr>
<tr>
<td>- Location</td>
<td>- Location</td>
</tr>
<tr>
<td>- Number</td>
<td>- Number</td>
</tr>
<tr>
<td>- How to access</td>
<td>- How to access</td>
</tr>
<tr>
<td>- Limitation</td>
<td>- Limitation</td>
</tr>
<tr>
<td>- E-mail and Internet</td>
<td>- E-mail and Internet</td>
</tr>
</tbody>
</table>

[The photo of the computers will be taken.]

2. Explain your roles in using the Internet for your collaboration.

B. *How do science teachers perceive the potential for teachers’ collaboration via the Internet?*

C. *Do science teachers see a need to collaborate with other teachers via the Internet?*

D. *In what contexts do science teachers collaborate with each other on E-mail and Internet?*

E. *Why do some science teachers collaborate more in an electronic network? Why do some science teachers collaborate less?*

F. *What are barriers to science teachers’ collaboration via the Internet?*

G. *Which of Fishbough’s models of collaboration are suitable for analysing science websites on the Internet?*

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>No Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What motivates you to use the Internet for your collaboration?</td>
<td>1. Describe your attitude about using the Internet for collaboration</td>
</tr>
</tbody>
</table>
2. In what contexts and who do you collaborate via the Internet?

3. Have you received any new teaching ideas or new information from using the Internet for your collaboration?

2. Why don’t you collaborate via the Internet? What are the problems?

3. Describe the barriers that make you collaborate less via the Internet.

3. Do you want to collaborate? if yes, What support services do you need?

4. Do you want to continue using the Internet to seek your educational or professional goals? if yes, What support services do you need?

- basic network services (Trentin, 1999)
- access to information
- collaboration skill via the Internet

4. The others that you would like to be mentioned.

The interview will take about 30 minutes

Appendix 6

The transcribed follow-up interview with heads of science department of two sample schools and five science teachers.
Aroma Senior High School (Head of science department)

Interviewer: Describe all the computers used in your school (location, number, accessibility, limitation and e-mail and Internet).

Head of department: We have three dedicated computer rooms, each of which has twenty-five or more computers. They are used on a regular basis either for computing classes or teachers can book them for class lessons. I think there are twelve computers in the library, which can be used by students for research lessons and teachers can book in for their students use. Each classroom in all areas now, has at least one computer available for students. There are ten computers used on a regular basis in the music area. They are used as tools for the music teachers to do the composition and used for the music programs particularly. I believe that there is at least one computer in the technology and design area. The technology area it is used as a CAD computer, which has for drafting program. Also, there are ten laptop computers based in the library. They can be booked, during the day, out for use in classrooms by students and they can also be booked by staffs to take home so staff can use that laptops if they do not have their own computers.

We are a tech-focused school, which is why we actually built up that number of computers in the school. In the science department a mini lab area has six computers. The six computers are actually split into three and three in two small areas. One of the computers in one of the two small areas, which linked to the network, is dedicated to the air watch-monitoring program but it can also be used for research. There is no limitation for teachers to use computers in school hours or after school's hours.

E-mail and Internet There is a network server in this school so all computers are networked. Teachers can access Internet from all classrooms. All staff rooms have at least one computer, which is linked to the network. It was just a matter of logging the computer on to the Internet; which staff who has computer at home can access Internet from home. We made a policy when we first went into all this with Internet use.

It was not going to be very effective if staff were not familiar with the Internet themselves. They will not use it if they do not know how to use it or are not familiar with how to get into it. We arranged that for all staff to be able to use computers and access Internet if they have computers at home they can log in by phone and use the Internet through our server. Two or three years ago, I
actually went to Internet in the Curriculum Travel Training course so I ran about four courses last year and the year before. I ran that course for all the staff who were interested in Internet here on different nights of the week. Teachers could have a chance to come along to use computer/Internet so it had increased the number of teachers who can use e-mail and the Internet for professional development and for also classroom use. Basically, it gives pointers for how to use computers for research, for professional development and how to get on to a list server. Teachers can actually join professional lists so they can share information with other people. For science staff, including me, we can get onto Catalist and share information. I know the society and environment people are doing similar things and so do other people in various departments here getting into sharing information with other teachers.

Most teachers have e-mail addresses. In fact, I think science teachers have three: one to do with University, one to do with professional development and one for private use. I have one and I use it. I check my e-mails constantly and it is a really good way of keeping up with everything. I know Boby who is also our curriculum improvement person. He regularly uses Internet for that kind of exchange in information and I am sure that other teachers do too. We have got a couple of staff in this year who are very competent in using that technology, one came from Austria where again I think they are a tech-focused school too so I think they are up to date with what is happening in the Internet.

Boby and I had some contacts with people in Sweden a couple of years ago. It was a project that the Swedish were running about genetics. It sort of started and went for a little while and then disappeared. I think she changed school or something so it is not any longer running. That is the one I can think of that we had run here with sharing. I am not sure whether Boby has done any other project or not but as far as I know he is not doing any one at the moment. The Swedish e-mail, it was a contact made by Boby. He got that e-mail through a contact with that person then he passed it on to me. I used it while I was running a little Internet club with the kids at that time. Boby and I communicated with her for a while. The only other thing we have done is I suppose it is not research. I suppose it is the Antarctic voyage. It came through here a couple of years ago. A man came and spoke here so we have a small number of students who make contact while he is down in Antarctica.

Interviewer: What motivates you to use the Internet for your collaboration?
Head of department: I guess it is just a way to keep up to date with things that are going on without me having to go some where else to find it out. I have to get so much information and that so much taking my time so it is actually an extremely convenient way of getting information and sorting it. I find it is possibly a little more convenient than other ways of contacting people and getting that kind of exchange.

Interviewer: Have you received any new teaching ideas or new information from using the Internet for your collaboration?

Head of department: Yes, I can actually join professional lists and can share information with other people. I have subscribed to Catalist and share information and of course I can use the Internet to access Curriculum Council Materials and EDWA and all those sorts of things.

Interviewer: Describe the barriers that make you collaborate less via the Internet.

Head of department: All teachers have limited time that is the limited factor for using computer. When people need to get things done, they tend to do what they are familiar with and if they do not have time to get familiar then they do not use it. In this stage, I say teachers have had brief experiences with computing and in collaboration with other teachers in other schools. In teaching hours, teachers have not much used computers. This stage, I do not think there are any current teachers using e-mail and Internet for collaboration as far as I know.

Interviewer: Would you like to continue using e-mail/Internet to seek your educational or professional goals? If yes, What support services do you need (basic network services, access to information and collaboration skills via the Internet).

Head of department: Oh yes, I certainly would myself. I guess in terms of all teachers using e-mail and Internet. It is the time for teachers to use it, to play with it, to find out what there is and the opportunity for them to go along to professional development and to find out those obvious things. We do try very hard in making available Internet courses here to make teachers to be familiar with what is going on but all teachers have limited time. When teachers need to get things done, they tend to do what they are familiar with and if they do not have time to get familiar with it then they do not use it. That is why I try very hard to get teachers to come along to Internet courses. Learn to use e-mail and get familiar with it, I think this has made a lot of teachers use it now and a
lot more than they did before. Everyone and I always need more computers. I look at schools that have been really successful at this kind of stuff because every member of staff has their own laptop. It will be wonderful if staffs here have their own laptop but we cannot. I mean we have been limited by what is available here. Well, the only way to help teachers to use computers in the classrooms and so on, they have to become familiar with it. Teachers do not become familiar with those sorts of things if they are not ready to access and only few teachers are ready to access. I guess that is a problem. I am lucky because I have a computer at home and I am familiar with it, but there are other teachers who do not have those luxuries.

Interviewer:  
Other issues that you would like to be mentioned?

Head of department:  
We have a school website and so does the science department, which probably is not up to date. At the moment, we do not have time for collaboration via Internet. We do not have a web-manager that has time to update sort of things that is the other thing that demanded of teachers' time. It is an idea that would be great to have that but at this stage of time there is nobody has time to put all those stuffs up to date. If you go into one of those websites, at the moment, probably quite a bit of it would be out of date so I would say I really need a web-manager.

Interviewer:  
Have you ever visited Catalist and STAWA website?

Head of department:  
No I have never been.

Interviewer:  
Have you ever visited Science Across The World website?

Head of department:  
I have never heard about this

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**Apple Senior High School** (Head of science department)

Interviewer:  
Describe all the computers used in your school (location, number, accessibility, limitation and e-mail and Internet).
Head of department: There are three science offices and there are two computers in each of two offices and one computer in the third office as well. There are rooms in between laboratory for student use. I think there are approximate two rooms like that which has about eight computers in each. Then in a couple of physic laboratory there is a computer in each room and all computers are network. There are printers attached to those computers as well. Being new, I am not sure some of the computers here have been purchased through funds for information technology from government initiatives. Some computers have been purchased from the science department through their own funding. In recent years the science department has been offered new computers by information item bank that teachers have established, it has helped to fund a few extra ones. Teachers can use computers at school without limitation, but there might be a monthly downloading time limit.

E-mail and Internet Staff and students have run networked and students have to use password for access Internet. If they do not have password and can not get on to the Internet, they can go to the library and access the Internet in there as well. In fact, the staff members now get morning notices e-mail rather than on the sheet. Daily notices are on e-mail as well on a hard copy. Every teacher has an e-mail address but I do not think every teacher uses it yet. For teachers’ usage the computers at school on science duties during or after school's hours they do not have to pay, but for home’s usage it is their own arrangement. I do not think every science teachers here use the Internet to contact with other science teachers in other schools: maybe just a quick note or communication but not in a formal way or for professional purposes. They use the Internet to communicate or inform between science teachers within the school. A couple of the teachers this year have tried to put some assignment information into the Internet to encourage students to use the Internet facility as a bit of experiment. One teacher particularly is looking at to put the exam solutions on the Internet rather than making numerous copies for kids that the kids do not necessarily want. Teachers make them available on the Internet so students can access tests and solution and just one assignment now because not every student has got the access to computer at home. We just try an assignment to see the students are able to read or get an access or maybe they have not got computers at home but they can get the assignment at the library. In this school, teachers can use computers during school's hours or after school's hours without limitation.
Now, I check my e-mail every morning because my school notices and my daily notice, which come from administration, are on e-mail so I have to read them every morning. I do not get a hard copy in my pigeonhole. I have to look at e-mail to get them to read them. I feel ok to do that but I think that not every teacher is happy about that because until we reach the stage that we have got one computer for each but we have not really got to tally free access to it. It is not easy to get computer for all teachers. At the moment they can get their school notices or daily notices from their pigeonhole and they can read them while they walk back to their classes or when they go to their class. Teachers are very busy but they just go to computer and get e-mail some teachers are saying that is a nuisance doing it that way. For example, if teacher wants to do that maybe someone on computer doing something else. Unless every teacher has got computers that has been the concerned issue came up last week. Checking e-mail not every teacher does that because it is various levels of expertise and interest among him or her. Some teachers do not want to know about it but others are right in there. They want to check e-mail everyday but there is an access problem and also another problem is that a lot of this information in this school is available on the PC but not on Macintoshes. So we have got two system; two types of platforms. Compatibility is an issue too. Passwords are not a problem in this school; the problem is time because the only time that teachers have is their normal preparation time, which they have for preparing lessons that is the only time they can use the Internet. Looking up information on the Internet like school notices or daily notices some teachers see it is time consuming for their Dot Time (preparation time).

Interviewer: Describe your attitude about using the Internet for collaboration.

Head of department: I am quite positive about using the Internet or e-mail and technology and graphic calculators for science and so on. For teaching science there are some or are going to be some teaching problems with the use by all science teachers and even for science teachers to communicate with one another. I am saying that not because we are frightened just because of resistance some offering toward using e-mail and getting notices some thing like that. There will be some hiccups until every teacher has free access to computer or every one has got their own computer. There will be someone who resists any teamwork or collaboration, I suspect. Using e-mail and Internet at the moment it is not particularly convenient because teachers have not taken into computers totally yet. They may do and when everyone has access to computer perhaps a laptop where they can communicate at work, at home or on the way home all that will happen but
not yet. It is not happening yet. Collaborating with people within the school and other schools because of variations in the freedom of syllabuses and what is going on in one school does not tie up or lap perfectly with what is going on in another school so I see less usage there. At the moment the kids probably use Internet more than the teachers do by themselves in the library. They would work on their own Internet access and on their own time but some students just like the teachers there is varying levels of interest. Some students go to the library do at the lunchtime. They get on the Internet and investigate things on their own. Doing all the connecting up and going through the entire site it is very time consuming exercise. Teacher is a very busy person in school if teacher has to sit through it that takes a long time. I would like to have more time on the Internet but I have not got the time at the moment. To get on computer at home but I have to compete with my children because they all doing works and assignments. With sharing it at school, I share the computer in my office with other teachers: I just do not have access when I like to use it sometimes I can not as someone using it. So it is not all that easy at the moment.

Interviewer: Do you want to collaborate? If yes, What support services do you need (basic network services, access to information and collaboration skills via the Internet).

Head of department: It is hard to say, personally or on behalf of the science department. My staff and I probably like to collaborate via the Internet in the future if there are things that value to the science teachers here. We would be silly if not to do that. We would be interested in knowing depends on what we need to collaborate. At the moment, I am not sure what we need and I do not think we need the expertise to get on the computer as teachers here are competent enough to help the others who are less competent. Technical support: we have a technician who is very good but he is overworked because he supports the whole school so I guess from time to time perhaps we need that technical support or extra technical support and expertise.

Interviewer: Have you ever visited Catalist and STAWA website?

Head of department: No I have not visited Catalist website. I may have heard about this website but I have not heard about teachers asking a problem on the Internet. We have talked about the Curriculum Council website, accessed things, and communicated through it. There has not been a discussion about problems there. The Curriculum council website sounds good and they make it easy for us to respond to things like the questionnaire. I can fill out the compulsory education
review questionnaire on the Internet and submitting it on the Internet. Other teachers and I have visited STAWA. It is informative and we can respond to things that are good to be involved. Collaboration in my department is very good. I have been here for six weeks I was at my previous skills for fifteen years: it has been quite a change but people have been very good here. They are very communicative bunch and they get on well. There are no problems regard to collaboration among us and certainly a lot of our works in a big school like this has to be collaborative and of course assessment items have to be created and shared responsibilities. When we are doing assessments and all that sorts of things we have a lot of communications.

Interviewer: *Have you ever visited Science Across The World website?*

Head of department: The process that a teacher goes to this website and looks up a topic and gets information that can be used in the classrooms and communicates with a teacher there by sending information to that teacher by e-mail. I think, all of those process maybe primary school teachers would find this kind of communication is useful. In some respects I think students are doing it: they communicate with other students. What level are you expecting high school students to go to, the acid rain topic for Thailand and Australia are about the same. My year ten students they do a bit on acid rain but what they are expected to know on acid rain it is where we would expect it to be prevalent around the world.

It is fairly straightforward information for year ten. Some kids quite capable so teachers could extend them and collaborate with someone in the world and get a lot more out of them but it does not tend to happen to that extent because they do not set specific assignments. It is hard to extend kids by saying you go to the library and do this bit of work or this project a certain amount of. That does happen but it is not something that happens easily with thirty-two kids in each class. There are physical problems associated with individual programs and whilst that is the aim we cannot get to everyone individually. It is very difficult to achieve in-groups. I have just finished group assignment. They do not always work: some of the kids do all the work and others do nothing. Three students work but the two just do nothing so there are a few practical hiccups for these kinds of things. Some students could work for two weeks but teachers sometimes have to curtail them or some have finished while others have not. What most teachers will do in create a small range of content and that there is a core of content that everyone needs to know and a bit more. It would not extend to the extent in science anyway or warrant a lot of communications between teachers of
different countries. At year ten level or at university level by all means even in year eleven and twelve whilst it would be better there. The curriculum does not encourage that because kids are tough for tertiary entrance exams so teachers have to get through that content in that time and the curriculum do not say students will get more marks for knowing more about acid rain. It is great in theory but it does not always work well in practice. Works but it is not always the appropriate way to go because in upper-school teachers have always got to act in the best interest of students. Teachers know what students want they want to get through exams with good marks. At a tertiary level it is different isn’t it? It has some merit but I do not see it is going to the extent in the high school environment.

Interviewer: Other issues that you would like to be mentioned?

Head of department: The curriculum does not encourage telecommunication because we teach kids for tertiary entrance exams. We have to get through that content in that time and the curriculum do not say students will get more marks for knowing more about acid rain. It is great in theory but it does not always work well in practice. It is not an appropriate way to do that because in upper-school teachers have always got to act in the best interest of students. Teachers know what students want: they want to get through exams with good marks. The curriculum frameworks may enable it to have greater usage. I think with curriculum frameworks where kids are achieving levels and have a great application. I suspect kids will be doing longer-term projects and there will be such a well-defined syllabus so I think in the future will become much more the case those sorts of communication and collaboration.

Five Science teachers
Dave

Interviewer: Explain your role in using the Internet for your collaboration

Science teacher: I use Internet to collaborate in education. In fact, my main use Internet would be collaborated through my education research. I collaborate with my colleagues at Curtin University. I use Internet to get information about research studies that relevant to the research that I am doing. I do not really use Internet much for teaching purposes in school. I use it to find and get only all resources that I need. Collaboration with science teachers here, I get verbally from them or by telephone with teachers in other schools so my use Internet is for research. I do not do for day-to-day teaching. Mainly, I did work with teachers from Rossmary Senior High School on the research project. I do not only collaborate with science teachers here but I also work particular with one person at Science and Mathematics Centre at Curtin University. He is my doctor supervisor. Now, we continue to do the research together.

Interviewer: What motivates you to use the Internet for your collaboration?

Science teacher: I use Internet because I can get rapid responses and it is highly convenient, cheep and free. Especially, I know the people that I collaborate with. I get the responses in a very short period of time so I really like Internet as it is very, very convenient than writing letter or telephone call and it is cheaper. I always use home computer because access at the school is difficult. The school does not have enough computers so I can go home and use my Internet that is available all a time. No one in my family uses Internet from 5 p.m. and 8 p.m. in the evening so I write e-mail and send it at 8 p.m. in the evening. I have enough time. Junk mail, a lot of rubbish stuffs on Internet, times consuming, I come across them all and I never get a junk mail as far as I know. I use e-mail every day, it is wonderful and I do not have any problem.

Interviewer: In what contexts and who do you collaborate via the Internet?

Science teacher: I work with my colleagues at school and also I work particular with one person at Science and Mathematics Centre at Curtin University. He is my doctor supervisor. Now, we continue to do research together. My research is environment in science classroom.

Interviewer: Have you received any new teaching ideas or new information from using the Internet for your collaboration?

Science teacher: No, I get most idea of teaching from colleagues and I get idea from journal
that I read. Particularly, I do not use Internet for that. I use Internet for research.

**Interviewer:** Describe the barriers that make you collaborate less via the Internet

**Science teacher:** No, nothing at all. I know how I can trust people.

**Interviewer:** Do you want to continue using the Internet to seek your educational or professional goals? If yes, What support services do you need (basic network services, access to information and collaboration skills via the Internet).

**Science teacher:** Yes sure, I think I get enough new ideas from Internet and especially from my colleagues here and also from journal that I read. Moreover, I think I get enough from the research literature and my colleagues at Curtin University as much probably as I can cope with at the moment. I do not need any supports for using computers.

**Interviewer:** Have you ever visited Catalist or STAWA website?

**Science teacher:** No, I have never used Catalist. I do access some websites particularly concern with evolution natural selection. A number of website is very good for the subject that I am teaching and I can get up-to-date information, which is not available in the books, but I do not use Catalist. I remember STAWA and I am interested in what are they doing but at the moment it does not seems to be something that is necessary. I am interested in background leading in natural selection revolution. So, both of websites do not give me any information.

**Interviewer:** Have you ever visited Science Across The World website?

**Science teacher:** No, I have never been that website but it is quite interesting.

**Interviewer:** Other issues that you would like to be mentioned

**Science teacher:** I am writing papers when I have finished I will send drafts by e-mail attachment and also I request papers from other people who send them by Internet too that really the limit of my use. I mainly do with keep in touch with people. It is better than telephone as I can send copy of materials and exchange ideas as much as I can. I fell relax while I do that. I do not get a junk mail as far as I know. I use e-mail every day and I do not have any problem.

**Ricky**

**Interviewer:** Explain your role in using the Internet for your collaboration

**Science teacher:** I give advice, swap strategies, work sheet and so on with science teachers
in another schools. Besides, I work on exam papers and I want different questions or choice questions so my colleagues help me a lot and sometimes I get work sheets from them. I do very little research. Most of time, I prepare things and find suitable materials then pass information on to other science teachers.

Interviewer: *What motivates you to use the Internet for your collaboration?*

Science teacher: To facilitate the process just make it easy and sometimes phone call and books are expensive and it is a cheap way to getting things. Moreover, it is a lot of quicker as I can get an idea from other science teachers without paying money.

Interviewer: *In what contexts and who do you collaborate via the Internet?*

Science teacher: If I need work sheets, information for setting up a new year eight program and some of a new strategy because did not have any work sheets for students. I hunt around on the Internet to find some suitable materials then I download it and pass that information on to other science teacher.

Interviewer: *Have you received any new teaching ideas or new information from using the Internet for your collaboration?*

Science teacher: Yes I have. I already mention before.

Interviewer: *Describe the barriers that make you collaborate less via the Internet*

Science teacher: The big factor is time. The good thing is sometimes I fell it is difficult to find something for my work but collaboration can help me to solve that problem because someone else can help give me websites and I can find it myself. I do not find any barriers to my collaboration just time that make me can collaborate less.

Interviewer: *Do you want to continue using the Internet to seek your educational or professional goals? If yes, What support services do you need (basic network services, access to information, collaboration skills via the Internet).*

Science teacher: Yes I will not stop doing this. I just need other science teachers who are interested in what I am doing to collaborate with and I need good equipment to do it. The most important thing that I need is time to continue my collaboration. I always use computer at home because I do not have a lot of time at school. Probably, the other thing that I would do at school is
just e-mail information to my colleagues.

Interviewer: Have you ever visited Catalist or STAWA website?
Science teacher: No, I have never seen it but I know STAWA.

Interviewer: Have you ever visited Science Across The World website?
Science teacher: No I have never been that website.

Interviewer: Other issues that you would like to be mentioned?
Science teacher: I use computer at home because I do not have a lot of time at school I have a lot of time at home so I use computer at home. The only thing that I would do at school is e-mail. I want some more facilities, which become available for the staff to use it. If I have time in the future, I am very glad to help my colleagues to collaborate. I have one free set in a day and I have to do all marking and preparing. What I do not do here then I do at home but mostly I do at school. I just do not have time and I spend most of time in classroom. I just do not have time so I need more time to continue my collaboration.

Sandy

Interviewer: Describe your attitude about using the Internet for collaboration.
Science teacher: My attitude is I have to find time to sit down at my computer and start to do that. It is easier at this stage to collaborate. My friends and I have done that for years. I suppose, most of that collaboration actually occurs among the six science teachers in my department. The six of us pretty much exchange ideas regularly. For example, if I do a lesson and it is really good, I just mention it or just drop down that few ideas in a piece of paper and put it on everyone desk and if it is a work sheet, I just give everyone a copy. We work very well together and no one among us who is on the connor something likes that. One important thing about collaborating within my department is every science teacher teaches the same kids so they have to get the right activity for them. This collaboration is very easy but to try to do that on e-mail or through website, in starting, everything has to be an electronic, which a work sheet probably is not. For example, if I want to send something to someone else, I have to turn it into an electronic document and that takes time and I am not likely to do that. If that thing is a picture, it will be time consuming to transfer something like that into an electronic documentation. I suppose, it is a cheap value if I look at
books or something which have a lot of websites. Teacher websites are a handy, if I look them up and it has a few really good things but it takes a lot of time and also a lot of stuff that I have to come across. I know already for requiring some specific resources and perhaps I do not have limiting factor so I use something that already there or something that my kids just would not response to so I have taken it in to account my own. I think, the huge volume of stuffs just push me off because to sit down to find something just take me two or three hours quite literally and I have never actually sat down to try to find something specific. I have never actually try so maybe I could but I tend to sit down and look at more generically. The Internet, I just look at what there is and I suppose, I use that less because I am not trying to solve the particular problem. I am just looking at what is there. If I use it to solve the particular problem maybe I might find it is more useful but I just look around and see what is there. The websites might be useful or might not be useful but by the time that comes around to when I use it maybe I lost it, yes, a lot of problems. Besides, when I sit down at the computer all a time and I operate it but it disappears and two or three hours can move really quickly so I have found time is a big factor.

Interviewer: Why don’t you collaborate via the Internet? What are the problems?

Science teacher: I think, it starts to get the same problem is time and I have other things to do such as preparing and meeting so I probably would not do that. If other science teachers want to know something from me then they can come and get it from me. I think, it really fit into the same category weather on communicate with Leeming, just down the road, or weather I communicate with some school in WA. It takes the same is time so just the time factor. I find, I probably solve enough problems with the six science teachers within my department without having to go some where else. I suppose people who have a problem and need help are new postgraduates in the country something like that. STAWA has a mentor program, which try to mach up those new postgraduates with teachers who can help them in the city. I would imagine most of staff at Leeming or wherever near us are pretty much organized and they have what they want. My friends and I have what we want so I do not think anyone tries to ask for help. For me, I can not say collaboration via Internet is a huge benefit to me and I will imagine that other science teachers would feel the same as me. Collaboration is not the worse but I have something else that I need to do.
Interviewer: Do you want to collaborate? If yes, What support services do you need (basic network services, access to information and collaboration skills via the Internet).

Science teacher: I think it is quite specific. I need support materials that come from Education Department of Western Australia (Ed WA) which respects to the curriculum framework especially a changing curriculum and changing assessment. Maybe those sorts of stuff looking at assessing respect to the curriculum framework. I suppose, it needs to be a school with similar criterion but I do not see those sort of things are very much similar with some schools because what other schools do with their kids it is totally different to what I do with my kids. In addition, I really need good activities and new ideas to do in my classrooms. The computing skills in my department; six science teachers, one teacher would have actually none. He just starts on the Macintosh but a school computer basically is IBM. He does not start word processor at home so he can not use e-mail and Internet. Another woman is very good; she does as much as she need on computer.

For the rest of us are mostly seemlier. I can say none of us is an expert that can be a problem as well. There is not an expert in computing in this school that can be a real problem, for example the computer down there has never worked especially the Internet but nobody can fix it. The school has been cabling, which computers are supposedly connected to fast service down here or the library but it does not work. The other problem is passwords; I do not know where my passwords are so now I can not get my password. All of the problems need some body to sit down and solve them out but there is no body in this school dose that. If someone needs to do it, he or she could be an expertise which probably need up to about three people in the whole school and they have to find time to do that. It is falling back on to people like principle and that people do not have time to do that, especially to do a job that is nobody job that could be a problem as well. In theory I can use the Internet in the science department but the password department has got one and I have one but now it has disappeared since holiday. I need a password to use the Internet in the science department because the Internet has been connected to the computer in the front office. Now, all computers in the whole school are connected to Internet so I need a password but I do not have one. The school needs someone to start it out. In theory I can sit down and use the computer to
wherever I want but I can not do it because I do not have a password so I have a complete access but I do not have a password.

All sort of problems that I have experienced that are not corrected or are corrected quickly, I have found it for six weeks so I have not been able to get on to Internet with out using password. No one seem to know what is wrong with that and no one seems to know how it should work. It does not correct properly and the system really never has been running properly. There is no technical support to run the computers in the whole school. There are a lot of problems with the computers. Last year before the computers here were connected to the school system the science department Internet went off so we try to find another provider to prospect on and to find someone who can do it and pay for it. A lot of things are going to happen. There are eight different departments around the school so the problems are not going to happen just one but they are going to happen maybe ten times. It is difficult to run a computing system in the school for fifty-six staff and nine hundred kids and nobody can look after it so I need time and technical support.

Interviewer: Have you ever visited Catalist or STAWA website?

Science teacher: In listening Catalist, which is science association, I get a lot of stuff through that but it is probably junk stuff that I really do not want so I look at my e-mail to find what it is. If I do not know what it is I just get rid it so I just go through and delete anything that I am not sure exactly what it is. When I go home I have part of mail and answering machine. My e-mail, I have found fifteen messages on it. I do not have time to sit down and go through every one that comes up and read the whole things: some two or three pages and some only one line. I do not know what it is; especially it is the time factor. I receive this mail all a time and a lot of it is not relevant to me. My e-mail most through Catalist and they are not relevant to me so I am happy to get rid and losing it.

For junk mails, I have been with Catalist for a couple of months. After a few months I just find what I am doing and I really do not want to open it. Then, I contact them and tell them about the junk mails and I want them to take me off. They changed the guidelines to what can be posted on to Catalist. I think it is too much posted to it and I also think a lot of people have the same ideas as me it is too much stuff there. I have visited STAWA but not regularly. I do not know about anything of it. I have not used it a great deal. I just have a look and I have not actually straight to do anything
from it so that will be a time factor. I do not look down that in enough detail probably stuff there is useful but I do not look down at detail, as I do not have time.

Interviewer: Have you ever visited Science Across The World website?
Science teacher: No, I have not done that.

Interviewer: Other issues that you would like to be mentioned.
Science teacher: If I am interested in particular sort of thing then I might want to use Internet. Time and a lot of stuff make me west my time but rather than use the search engine I use the website. The science department bought a book that has five hundred education websites so I use that book. I look at those websites rather than use a search engine, which have come up with a lot of irrelevant stuff that is very difficult for the search engine to solve it out so I ten to use that book rather than the search engine.

Johnny

Interviewer: Describe your attitude about using the Internet for collaboration.
Science teacher: I tried to do an honour thesis and I contacted a lot of people via the Internet because I though I can collect a lot of data quickly but I did not get one positive response. I did that because I wanted to compare school systems such as English school systems and Australia school systems. My basic understanding is teachers in England using the Internet so if I contacted a lot of English school then I would get a lot of response but I did not get one response, no one wished. From that point of view, I have found collaboration and organizing collaboration is different. If I want to do it again I would make sure by putting some advertisements some way that I could say if you decide to help me you have got to pick up money in the draw for a box of chocolate something like that. This sometimes helps me get on to people to help me.

Interviewer: Why don’t you collaborate via the Internet? What are the problems?
Science teacher: OK, I can and I use computers. I had experiences of using lots of different packages since 1972 in work in engineering. I have been in three different schools; each school has set up in different level. I have found generally, for example, Armadale, when I was there, actually in the classroom there was not a computer. After that time, there were some buildings which have been put some computers in and I was asked if I could teach one science unit to year ten in the
computer room. In that situation I developed the whole course for that particular unit. It was purely base on comprehension exercise on Astronomy and Earth science in the computer. Every student had access to computer at that time so I spent the whole term in science hand on all kids for using computer but it was comprehension by material mainly.

At Cecil Andrews, my second school, there was one computer in the classroom. It was quite difficult to take a class of thirty kids to that room and one person could get on the computer and did what I told to do for the class. I used the compute lab normally at lunchtime with one or two students who were doing CD-ROM for chemistry exercises. From that point of view I have found the management is important more than anything is. I did try one assignment with a lower stream of year ten in this school; they were using Internet sites. I gave them three sites to research music instrument. One of those sites did not work it has gone out-of-date since the Internet sites was researched. Students had to complete the two sites that they had access and it had the access to CD-ROM. What I have found is most of them were actually sitting and wasted time and maybe because of the nature of the class. Students would go home and look at the work in encyclopaedias or books that they have or if they have found in Encarta they would try to copy Encarta.

There are several problems that make me have not been using computers as much as I should. Firstly, I find computers in some ways it is a very powerful tool but in other ways it is a substitute for a book. I can quite often be more efficient using a book. Secondly, the server sometimes is not fast enough at the school. Access to computers is difficult sometimes and sometimes if students are searching it takes a long time and it is a very time consuming. Besides, they can go to the wrong addresses if I have not already put the addresses on the system. At the end of the lesson students have got nothing so that sort of things just push me off a little bit Another reasons that I have found the difficulty with computer is a lot of cut and paste in those works. They cut and paste and they do not even read the material that they do so I will not say I am against using computers. I would say that I have to learn to know how to use them effectively.

I did try to collaborate via Internet but I did not get positive responses this is the main problem that stop me from doing that. May be because I did a thesis and people had no interested in what I tried to do. If I worked with somebody jointly or collaborated with people who were interested in
the same research area as me then I thing I would have had a lot more support and a lot of more
private basis. For example, I contacted some people in a hospital to get some information. I got
very positive and very quick responses from some of the professors so on a private basis has been
good but on my attempted of work to start the research people just put it down. When I did the
research, I mainly contacted with teachers who I did not know their name so if it is personal I think
it would have been a very positive response. Another problem is I concerned a large number of
teachers because I thought the more data that I have the better more reliable of my result would be
so I contacted a lot of people to do survey. I think, the way that I can get the positive response in
that same situation in education I would probably use some sort of enhancement like pride. For
example, if you decide to help me then I would put your name in a draw at the end of system
maybe you can win a small price. I did that in an education unit such as I knocked on the doors of
school and asked for help that was OK and really worked. I did not do anything in this year
because the teaching is very busy, too busy sometimes.

Interviewer: Do you want to collaborate? If yes, What support services do you need
(basic network services, access to information and collaboration skills via
the Internet).

Science teacher: What I think it depends on my question and I have to find out people who
are interested in what I am doing. If they are not interested in my work then they will not response.
I do not think I would need much support. It has basically depended on weather or not they are
interested in what I want to do. For example, I had actually on one occasion that I tried a boost to
boost system on a particular day. It was the boost to boost system using a computer so it really was
not like using telephone. The teacher in America was actually demonstrating her first particular
software to the kids in her classroom. She asked me to participate and I did. I was on there for half
an hour talking voice to voice to different children in America, which it is quite interesting.

Supporting I do not think I need some supports. For the equipment most school at this stage has
at least one or two very fast computers but here in the classroom sounds old and slow. I think I
need guide lines about the particular things that each school is interested in. I am a scientist work in
science all teamwork. I work in several different countries where collaboration between
governments for example British government works with Thai government or British government
works with Africa or Kenya all this is more than teamwork in research team it is teamwork
between different cultures.

Interviewer: Have you ever visited Catalist and STAWA website?
Science teacher: No, I have not done that.

Interviewer: Have you ever visited Science Across The World website?
Science teacher: No, I have not heard about that.

Interviewer: Other issues that you would like to be mentioned.
Science teacher: I could send students to have a look the very good sites if I can develop
purposes system of education, which they are actually learning what they want to learn then I can
see computer is a very powerful tool. If teachers are trying to get students to learn what teachers
want them to learn that it is quite boring for them. It is difficult sometimes to motivate kids to using
a computer like a book. I give them some questions such as what is the purpose of planet and our
solar system. I might not give them a book in that situation and if I tell them to find out what they
can do about solar and energy and give them a selection of sites and give them something more
open indeed. Then students could very welcome up with something very good. I am interested in
teaching science such as how much thing work and I have found that has been very good because it
was written by a teacher. It is very not involve method to explaining things and the kids seem like
it. They go to that site and they find how to photocopy that works it is excellent. It might be good
to actually set up something, which I can get student to collaborate with one another between
schools. I know that has been tried in few countries. I have never tried it because of the
management class of thirty kids to do this sort of study sometimes it is quite difficult.

Max

Interviewer: Describe your attitude about using the Internet for collaboration.
Science teacher: Internet is excellent resource information as far as it is not particular use. Collaboration is just too hard to get organise and too hard to collaborate. I believe, it is too hard for teaching teachers to use Internet a lot.

Interviewer: Why don’t you collaborate via the Internet? What are the problems?

Science teacher: The Internet is so big so how do I find who doing the research, what they are interested in. I am a person who surf Internet a lot. I would say each week I will spend at least two or three hours on Internet so I look around science stuff and I do try to find out what is going on but it is just too hard to find what I want. I would guest a lot of people have the same feeling like me that Internet is hard, huge and it is limited. I mean, I have not yet found anything that I want. There is a lot of stuff perhaps some scope nothing excited.

Interviewer: Do you want to collaborate? If yes, What support services do you need (basic network services, access to information and collaboration skills via the Internet).

Science teacher: Yes, I can see it will be great. It will be very useful if I can do large experiments. Using resources from around the world it will be good to share information and get resources from other teachers but as far as day-to-day teaching it is very difficult. I enjoy collaborating and I will be very happy to involve in everything but I can not find anyone who is interested in doing the same area as me. Moreover, I have not got time or expertise to produce my own website so how it is going to happen. I would like to have a training website construction or training in works web search. Probably, there are new search engines or something like that, which I do not know about them and I am still using the old one. I think, probably I need support about time and training

Interviewer: Have you ever visited Catalist and STAWA website?

Science teacher: Yes, I have been there.

Interviewer: Have you ever visited Science Across The World website?

Science teacher: No, I have not done.

Interviewer: Others issues that you would like to be mentioned.

Science teacher: If someone give me the right direction, I think I will get involve in collaboration but now I have not found the right direction. In fact, no one has time any more so
that most teachers are just in a hurry to get to everyday work. I do not have time even to think about how to do things better I am too busy.
Appendix 8

A summary of network messages on Catalist.
(1999-2001)
<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Sender</th>
<th>Subject</th>
<th>Brief message</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher36</td>
<td>Websites for Ecology</td>
<td>Needed, some interesting Australian websites for year 10 to study wetlands and forest ecosystems and any good hands on practical work with a view of doing further research back in classroom about small aquatic invertebrates and vertebrates plus identifying all the water birds.</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher5</td>
<td>Re: Scientific Report</td>
<td>The writer was told by his lecturers that “third person” was no longer appropriate and the “I” word is now OK. This made writing case studies a lot easier and more natural. Maybe scientists need to catch up and add a human element to their report writing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University</td>
<td>Re: Scientific literacy</td>
<td>“How to Write a Report” was suggested to science teachers. This material is available on the sender website: <a href="http://www.Curtin.edu.au/curtin.dept/smec/ipd">http://www.Curtin.edu.au/curtin.dept/smec/ipd</a></td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher13</td>
<td>Scientific Reporting</td>
<td>Science teachers discussed about using the traditional, third-person or passive voice in writing scientific report.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher35</td>
<td>Re: Scientific Reporting</td>
<td>This teacher suggested that teachers could stress to students that the scientific report had to be written in the third person passive or the timeless present tense and avoided unnecessary words, slang, feelings or opinion and avoided mixing tenses in a confusing way.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University</td>
<td>Re: Scientific literacy</td>
<td>The sender explained that if he talked to his next door about his research he would probably use the first person in his discussion and if he reported to his peers he would use the the third person passive.</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>University</td>
<td>What the major journal say</td>
<td>Thank you for the comments on scientific reporting about the “person” used in writing. There is no policy on “person”, it’s the author(s) choice.</td>
</tr>
<tr>
<td>Year</td>
<td>Teacher</td>
<td>Subject/Role</td>
<td>Message</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>--------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher38</td>
<td>Project physics</td>
<td>Physics teacher would like to have the Project Physics Handbook by Horowitz Group Books Pty.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>STAWA</td>
<td>Earth and beyond strand</td>
<td>STAWA invites science teachers to attend a special Earth and Beyond PD.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher2</td>
<td>How to select a textbook for outcomes Science</td>
<td>Eight guidelines for selecting a textbook suitable for constructivist, outcomes-based science were suggested.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>University</td>
<td>Graduate certificate in information access</td>
<td>New Graduate Certificate in Information Access and Delivery is suggested to students. This Certificate taught entirely over the Internet. Students who are interested in could contact University of Canberra.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>University</td>
<td>Science teaching project</td>
<td>A University needs five volunteers for a research and professional development project on science teaching standards.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher1</td>
<td>Subscribe</td>
<td>Re: Done, replied to one SHS that subscribed to Catalist.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>College</td>
<td>Physics and/or chemistry teacher</td>
<td>Tuart College had a part-time vacancy for an experienced physics or chemistry teacher.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher40</td>
<td>Popcorn</td>
<td>Thank you people who replied about the popcorn, it is both physical (the popping caused by the water) and chemical (cooking of the corn).</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher39</td>
<td>Year 11 chem papers</td>
<td>A new teacher needs yr 11 chem test and exams.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher41</td>
<td>Year 11 Physics</td>
<td>A new physics teacher needs physics programs, test, assessments or assignment.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher41</td>
<td>Health education</td>
<td>A new lower science teacher needed activities or ideas on smoking or drug for year 8</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Teacher9</td>
<td>Biological</td>
<td>I have three months off on 1s1</td>
<td></td>
</tr>
</tbody>
</table>
and thought I would do some good work on Biological Field studies. It occurred to me that we could get more kids on the road to biology in year 11 if we guided year 10’s into the fun and excitement of field work. However, no one here has taught this and no written materials at the school. Please e-mail if you have some information, regarding any available Text material, activities and assessment.

Western power launched Shock Proof, a free electrical safety kits for WA high school science teachers and students, and asked science teachers to include Shook Proof materials in their classroom.

The Science and Mathematics Education Centre invites all teachers, researchers and educators to the following seminar: Schooling for What in Mauritius? Creating an Integrated Picture through Socio-Cultural Analysis.

The 30th International Physics Olympiad had been completed in Padua, Italy. Teams from 62 Countries, mostly made up of 5 students and 2 leaders, competed in a 5 hour theory exam and a 5 hour laboratory exam. The 5 Australian students got two silvers, two bronzes and a honourable mention. The best score were Iran.

The project Atmosphere Australia is starting activity week again in early August, 31 schools from Aus, USA, Canada, NZ, UK and Hong Kong involved, e-mail if you would like to join in the project.


The use of catalyst by person or groups for personal or financial gain is discouraged. STAWA has other avenues which advertising can occur such as
journals or newsletters. If a person is unsure about his/her posting is suitable for catalist should first seek the approval of the catalist "listowner" which is the chairperson of STAWA's Electronic Communications Committee. Currently this person is Rod Blitvich.

<table>
<thead>
<tr>
<th>Date</th>
<th>Type</th>
<th>Subject</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>University</td>
<td>Re: Policy</td>
<td>The best way to avoid a large attachment on catalist was to announce that there was a resource, people who wanted could e-mail privately.</td>
</tr>
<tr>
<td></td>
<td>Teacher4</td>
<td>Policy</td>
<td>Mike, your work on profiling is very innovative and appreciate. Keep it coming.</td>
</tr>
<tr>
<td>1999</td>
<td>Teacher2</td>
<td>Re: Catalist</td>
<td>The writer strongly disagree about catalist limited the volume of e-mail posted or the size of attachment as he see catalist is the best place to inform what's happening in science in the school and e-mail is a tool to stimulate professional association. E-mail could be enjoyed by science educators across country.</td>
</tr>
<tr>
<td></td>
<td>Teacher5</td>
<td>Re: Policy on the use of Catalist</td>
<td>The sender greatly please to receive e-mail with attachment and support “professional interaction and co-operation between Science Educators in Western Australia.</td>
</tr>
<tr>
<td>1999</td>
<td>University</td>
<td>Of interest?</td>
<td>Wanted: American Physicists, from The New York Times is used as the idea to talk about there are so few good young American physicists, so that the vacancies must fill with foreign-born scientists.</td>
</tr>
<tr>
<td></td>
<td>Teacher2</td>
<td>Re: Outcomes A CD-ROM of science networking</td>
<td>A CD-ROM of science curriculum materials for the Energy &amp; Change strand of the science learning area within the Western Australian Curriculum Framework is suggested. The writer invites other science teachers to try Activity 5 from this material in their classrooms and give him some comments.</td>
</tr>
</tbody>
</table>
on the style and format of the activity. Then they can co-operate in a science networking group.

1999 7 Teacher2 Re: What’s happening in outcomes science

Greatly thanks to many people who respond to his Activity 5 and who support and encourage him to continue his works. The sender would like to here from colleagues who were developing curriculum resources.

1999 7 Teacher2 Is my Classroom Constructivist? Teaching, which underpin The WA Curriculum Framework could move their classroom pedagogy towards constructivism. Elizabeth Murphy at her website provides online a Constructivist Checklist.

1999 8 Swan catchment centre

The Ribbons of Blue Reflections 1999 Schools Competition which is being sponsored by the Water and Rivers Commission is open to all primary and secondary students in WA.

8 STAWA Assessing student’s learning using outcome statements

Teachers of years k-10 who were interested in classroom effectiveness and meeting the requirement of the WA curriculum Framework were offered a major session at the Professional Development session. There were several topics such as “Assessing student’s learning using Outcome Statement in the Working Scientifically and conceptual strands”.

8 STAWA Useful Website

http://tlc.ai.org/tsciindx.htm is the useful website for anyone in any field of science teaching.

8 Teacher21 One for the caped constructivist crusader from catalist

Three useful websites were suggested for people who wanted to have a look new books by a constructivist.

1999 8 Teacher14 Trees

Students have been doing for the Tree planting program. This is the website www.oceanree.wa.edu.au/ follow the links to the Science Pages, Field Studies and
The sender emphasises that teachers need to co-operate as a team to share the load of implementation of the WA Curriculum Framework. Teachers need all the support that they can get in the provision of constructivist & outcome focussed curriculum resources for use in their classroom. There is an extreme lack of curriculum resources that are truly constructivist & truly outcome focused, suitable for use in primary & secondary classrooms. So that catalist is an excellent way of showing small samples of teacher designed curriculum materials that teachers & university lecturers can co-operate to ensure that a high standard of exemplar curriculum are used in primary and secondary classrooms.

To answer "What is science", chapter 4: How we learn science of The Florida Science Curriculum Framework was suggested to study which is available online at http://watt.enc.org/online/ENC1267/126736.html

The Florida Department of Education has online an Interdisciplinary Curriculum Planning tool v 2.0 available in Two versions, Elementary and Secondary, which can be used With both Windows 95 and With Macintosh platform. The URL for the download website Is as follow: http://www.firm.edu/doe/curric/prek12/ecpt.htm

The writer disagreed about the restriction of e-mail's attachment on catalist. He suggested that users should be encouraged to distribute
materials in this format as many users would not be able to post to a website for download or would not bother. The distribution of materials and PDF could be encouraged.

8 Teacher7 Policy and Attachment

The writer emphasised that catalist was set up to support all teachers. If a fellow STAWA who produces a resource that much more relevant to states syllabus than others should not be stopped rather encouraged and allowed them to attach that resource with their e-mail.

1999 8 STAWA member Re: Policy and attachments

I like and use pdf files. I “do not” like receiving unsolicited in any form as they take extra time to download, take up space on my hard disk, and require extra housekeeping. I want to be able to choose whether to get the attachment. As a member of Catalist, my vote goes to a message saying what is available and where to obtain the pdf file/attachment I do not want other people to decide for me whether I need the attachment. I feel that all posts to a mailing list should be in a basic format. Please do not use html, coloured text, vcf files, or any “clever stuff”. Remember that there is enormous variation of computer types/software/experience out there and that many system cannot cope with the latest gimmick. We must not assume that everyone has the latest gear.

1999 8 University What is Science?

The sender invites people to express their ideas after finished reading the following statement: to gathering knowledge about the world and organising and condensing that knowledge into testable laws and theories is the system of science. The success rely on the willingness of scientists to expose their ideas; this requires the open exchange data and abandon or modify accepted conclusion when faced with more reliable evidence.

8 Teacher8 Response

Scientist has the ability to make,
to the
What is
a
Scientist?
create, modify, define, destroy
or damage anything that they
desire. The sender would like to
include a morals or ethics as
some scientists do good science
rather than monetary reasons.
Moreover, he argue that chemical
and biological weapons is not real
science.

1999 8 Teacher2 Re: Constructivism should develop science
in Physics sylla
instruction
Suggestion: science teachers
should develop science
syllabuses from the underlying
premise of Science For All
so Constructivism could be
used in physics classrooms in WA.

1999 8 Teacher Sherbet
recipe info
needed
If anyone can give me the correct
ratio of citric acid/bicarb/icing
sugar to make sherbet with my
year 8’s.

8 Teacher13 Chemistry
survival
kit for
beginning
teachers
If anyone out there can help
with materials (year or term
plans, assessments,
worksheets, lesson plans,
ideas for lessons etc) to get the
STAWA website for beginning
chemistry teachers up and
running,

8 Teacher2 Re: The Minds On Physics
Constructivist Curriculum materials developed
by the UMass Physics Education
Research Group is
recommended using in WA
physics classroom as the MOP
materials are well researched
and founded upon the latest
learning theories, including
constructivism.

8 Teacher2 Classroom ‘Mine-on’ & ‘Hand-on’
Action constructivist, outcomes-focussed
Research learning activities for the Energy &
Change Strand is developed. The
sender invite science teachers to
try this activity in their respective
classrooms and level student
responses using the student
outcome statements. Then use
e-mail to exchange sample student
responses and discuss the results
with each other.

8 Teacher 48 Investigating With regards to the use of
Scientifically Multiple choice items as
At a recent STAWA PD course on the Curriculum Framework, one participant explained how they used multiple choice items and then asked students to justify their selection in a written statement. I think this idea has got potential and would like to try.

1999 8 Teacher 49 Its all done by mirrors Wanna do some groovy light experiments with a graphic calculator? Try using a mirror to reflect the infra red beam around a corner. Or a prism from a Hodson light box.

1999 9 STAWA Member Future Science A one day professional development conference to be held on 26th November, purposes were to look at curriculum change but other areas as well. There were more room for people to present short papers at Future Science.

9 Teacher1 Petty cash EDWA Schools HOD science and Lab Tech of government high schools were asked about a petty cash system.

1999 9 University Mock TEE density Needed comments from all science educators about the density of exams on her daughter’s “mock TEE” timetable. She had exams in 5 days with 3 in 2 days. The sender thought it was too much for student.

9 Teacher12 Unidentified subject! A teacher explained the Mock TEE schedule dilemma.

9 Teacher14 Exam Density A teacher replied the Mock TEE density and greatly interested to hear from other schools.

1999 9 Teacher15 Exam Timing A teacher explained that the 12’s sit their Mocks during the two weeks of school holidays. Then the school gave students the first week of term 4 off as compensation so teachers can mark the papers, do the grades and so on.

9 Teacher16 Exams A teacher replied that his school the Exams were commenced in the second week of the upcoming
holidays and include the first week of term 4, and were Thursday nicely spread out over 2 weeks.

9 Teacher5 Help! Toshiba Pentium laptop had been given to use with CONASTA 2000 but the mouse did not work properly. Could anyone help?

1999 9 Teacher5 Evasive mouse!! Thank you to many people who gave suggestions about solving the mouse problem with the Toshiba laptop. It works well; this is how wonderful Catalist can be used to help each other.

1999 9 Teacher1 Curriculum Framework I had the pleasure of attending STAWA’s Curriculum Framework PD Workshop. What did I learn? One speaker put us in the picture by making links with the Overarching Statements and made us think about Science Rational and Why We Teach Science.

1999 9 Teacher 45 Whimhurst machine Just curious as to where one might buy a Whimhurst machine? My lab tech and I have rung everyone that we can think of so far and all say that they are unable to get any. Thank to Malcolm I did get a copy of some of the handouts of a recent PD. I am interested in any information that people are willing to give in relation to implementing an outcomes based classroom. I would appreciate any information, no matter how trivial, text recommendations, example activities and assessments.

1999 9 Teacher2 Re: Constructivist asked if I could provide them with some references on Constructivism in Science Education. I have selected my top 8 websites relating to Constructivism. For example, http://www.stemnet.nf.ca/~elmurphy/emurphy/cle.htm
<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Section</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 9</td>
<td>Teacher3</td>
<td>Touch powder</td>
<td>A science teacher asked how to make touch powder (ammonium tri nitrate).</td>
</tr>
<tr>
<td>1999 9</td>
<td>University</td>
<td>Touch Powder</td>
<td>The 1966 edition of Inorganic Chemistry (Cotton &amp; Wilkinson) states that nitrogen trichloride is an ‘exceedingly explosive and treacherous compound’ (p. 354); nitrogen tri-iodide is ‘explosive’. Translation: don’t syntheses them, especially not in a school science.</td>
</tr>
<tr>
<td>1999 9</td>
<td>Teacher1</td>
<td>Biology and Human Biology exam questions</td>
<td>Question: one of the Physics teacher pointed out to me that Heinemann put out a Physics Bank of thousands of questions for Year 11 and 12. There is no such thing for Human Biology/Biology. Does anyone out there know of something similar for Biol/H.B? Answer: at one stage Applecross Science dept. were marketing a Multiple choice item bank for Human Biology. I think there was also a Biology. The item bank runs in a software package called LXR apple test which runs on the Mac OS, I am not sure if it runs on Win doze</td>
</tr>
<tr>
<td>1999 9</td>
<td>Teacher 50</td>
<td>Re: Biology and Human Biology exam question</td>
<td>We use WA test papers for all our Year 12 exam papers. The price and quality is very reasonable. The Applecross Database is also suitable for WINDOWS and is available In Word format compete with graphics.</td>
</tr>
<tr>
<td>1999 10</td>
<td>Science curriculum council</td>
<td>Finals of ASHB student competition</td>
<td>The 7 short listed finalists presented their work at a Symposium at the Dept of Anatomy &amp; Human Biology at UWA. It was great with 7 very high standard projects offered and all were worthy recipients of the book prized kindly donated by MacMillan Education Australia and Pearson Education Australia. The first prize was awarded to Emmaly Phil.</td>
</tr>
<tr>
<td>Year</td>
<td>Month</td>
<td>Role</td>
<td>Action</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>1999</td>
<td>10</td>
<td>Executive</td>
<td>Officer</td>
</tr>
<tr>
<td>1999</td>
<td>10</td>
<td>Education</td>
<td>Manager</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Teacher1</td>
<td>PhysicsTeachers</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>University</td>
<td>Summer AstronomySchool</td>
</tr>
<tr>
<td>1999</td>
<td>10</td>
<td>Teacher2</td>
<td>Re: Was Socrates a Constructivist</td>
</tr>
</tbody>
</table>
| 1999 | 10    | University   | Mock TEE Density 'results'                  |                                                                                                                                                    | I thought I'd summarised the flavour of the comments received to my note on Mock TEE density. All teachers agreed that student welfare / interests should come...
first and administrative convenience last, including teachers. I had the impression that many teachers favoured 'the use' of the Term 3 break, by running exams in all or some of this period or by splitting the exams so that some are run before and the rest after 'the break'. It seems that a number of schools running exams in the break provide teachers with extra time for marking / assessment by giving the year 12s one or more days off.

The writer expressed his great joy as one of many presenters at Future Science 99 which run by STAWA and invited science teachers who jointed his presentation, "Constructivist, Outcome-focussed, Collaborative Learning in Science", to give feedback and share ideas via networking.

Hell for Chemists, question given on a University of Washington Chemistry mid term: Is hell exothermic (gives off heat) or endothermic (absorbs heat)? Support your answer with proof. Most of students wrote proofs of their beliefs using Boyle’s Law gas cools off when it expands and heats up when it is compressed or some variant.

I think it is extremely useful and above all practical, containing downloads in word and adobe acrobat. Find it on: http://www.sofweb.vic.edu.au/assess/kla.htm

I agree that it does contain much that is useful and practical, I would advise WA teachers to screen the information for its suitability to our Curriculum Framework. The Victorian view of an outcomes focus as espoused in their CSF is based on pre-planned units of work and “covering outcomes”. Our Framework focuses first on the need of students and encourages the planning
of specific activities to meet those needs and to enable them to demonstrate their achievement of specific outcomes

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Teacher</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>10</td>
<td>Teacher 46</td>
<td>Cotton real races</td>
</tr>
<tr>
<td>1999</td>
<td>10</td>
<td>Teacher 51</td>
<td>Earth and Beyond Year 8 Science</td>
</tr>
<tr>
<td>1999</td>
<td>11</td>
<td>Teacher 52</td>
<td>Year 11 Chemistry Exams</td>
</tr>
<tr>
<td>1999</td>
<td>11</td>
<td>Teacher 1</td>
<td>Digital Cameras</td>
</tr>
<tr>
<td>1999</td>
<td>11</td>
<td>Teacher 43</td>
<td>Future Science</td>
</tr>
</tbody>
</table>

**1999 10 Teacher 46 Cotton real races**

Can anyone provide me with information on building cotton real races or ideas on open ended “Investigating Scientifically” tasks that has an Energy and Change focus?

**1999 10 Teacher 51 Earth and Beyond Year 8 Science**

Has anyone found an activity on the Solar System that is suitable to assess using levelling according to the new Curriculum Framework? This would be for Levels 2 to 5.

**1999 10 Teacher 10 Human Biology Revision**

I am requesting if anyone has notes on TEE human biology course in a ‘nutshell’. Students are now currently working on their own concise notes but would like to make sure they cover everything. By the way, great idea on sharing of past mock exams.

**1999 10 Teacher 52 Year 11 Chemistry Exams**

It is getting to exam time again and once again I am on my knees, begging. Firstly, I would like to thank all the people who kindly sent me 1st semester exams. If anyone has 2nd semester chemistry exams for year 11 on disk, I would be very grateful if you could e-mail me a copy.

**1999 11 Teacher 1 Digital Cameras**

For those of you looking at purchasing a digital camera:
1) Rechargeable batteries
2) Floppy disk rather than cable

**1999 11 Teacher 43 Future Science**

Well done to STAWA with the organisation of the ‘Future Science’ conference. Thank must go to all presenters who clearly spent a lot of time preparing for the day, it was the great day. This conference will
help in the implementation of the many positive aspects of the Curriculum Framework. I hope it becomes a regular event.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>12</td>
<td>Teacher1</td>
<td>Teacher resources website announcement</td>
</tr>
<tr>
<td>1999</td>
<td>12</td>
<td>Teacher33</td>
<td>PCB boards</td>
</tr>
<tr>
<td>1999</td>
<td>12</td>
<td>Teacher1</td>
<td>Unidentified Subject!</td>
</tr>
<tr>
<td>2000</td>
<td>2</td>
<td>Teacher42</td>
<td>Science in the new millennium</td>
</tr>
</tbody>
</table>

The recent expansion in the commercial use of Australian flora and fauna has sparked a keen debate: will it lead to better conservation, or will it threaten the survival of species? Before taking sides, find out more about the issues on the Australian Academy of Science's Nova: Science in the new website at www.science.org.au/nova/053/053key.htm.
<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>3</th>
<th>Teacher34</th>
<th>Excursions-separation techniques</th>
<th>A secondary science teacher, teaching separation techniques, wanted suggestion about place where students could see these techniques within Perth or surrounding areas.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3</td>
<td></td>
<td>STAWA member</td>
<td>CONASTA 2000</td>
<td>A reminder that early bird registration for CONASTA 2000 has been extended to April 14th.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>School Part-time science teacher sought</td>
<td></td>
<td>The school is seeking someone to assist junior secondary students with general science. It is envisaged that 2 hours per week on a seminar basis would provide support to the school guide in the secondary classroom. It is possible that this would extend to a total of 5 hours.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>Teacher1 Teacher wanted</td>
<td></td>
<td>The school is looking for a part-time Maths/Science teacher.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>Teacher1 Teachers survival kit</td>
<td></td>
<td>If you visit <a href="http://tsk.stawa.asn.au">http://tsk.stawa.asn.au</a> you will find Teachers Survival Kit ready to roll. This site is now ready for you to donate your resources by uploading directly.</td>
</tr>
<tr>
<td>2000</td>
<td>3</td>
<td></td>
<td>Curriculum officer NASA-Distance learning post</td>
<td></td>
<td>Students from around the world are invited to have a video linkup with a scientist, medical scientist or possibly an astronaut. They are particularly keen to help Schools in WA become involved. Because of the Perth- Houston Sister City Program. The website: <a href="http://learningoutpost.jsc.nasa.gov">http://learningoutpost.jsc.nasa.gov</a></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>Aus. academy of science Have your say about Parliament House Website</td>
<td></td>
<td>Parliament House is reviewing its website to improve the site's effectiveness in meeting user needs. Please have your say by completing the questionnaire, which should take about 10 minutes. The questionnaire: <a href="http://www.aph.gov.au">http://www.aph.gov.au</a></td>
</tr>
<tr>
<td>2000</td>
<td>3</td>
<td></td>
<td>University Lecture for year 12 chemistry</td>
<td></td>
<td>The AJ Parker Cooperative Research Centre for Hydrometallurgy 2000 Lecture</td>
</tr>
</tbody>
</table>
for Year 12 Chemistry students 'Gold Extraction from 3000BC to 2000AD' by Professor Ian Ritchie. A series of simple, clear demonstrations will illustrate the chemistry behind gold processing over the last hundred years. By listening carefully, students will have the chance to win a freshly-minted gold coin and trip to a Kalgoorlie gold mine with a mining expert to explain it all.

2000 3 STAWA member Millennium ball for scientis-again

A delightful jotting for scientist! For example, ampere was worried he wasn't current. Boyle said he was under too much pressure. Darwin waited to see what evolved.

2000 4 Teacher1 Pornographic e-mail

I am interested in your responses to the incident that saw Telstra employees sacked? For receiving pornographic e-mail at work. The discussion pointed that using the employer’s Internet facility to conduct personal e-mail was not allowed. What do you think?

4 University Re: Pornographic e-mail

An important question is “what exactly is the company policy and how clearly is it displayed and explained to employees”.

If a company clearly states no private e-mail then I am afraid that is it. The problem is that IT training in schools, Unis, and workplaces is done so haphazardly it is no wonder we have these kinds of problems. In our eagerness to bring the IT world into our classrooms and workplaces we all bear some responsibilities for these problems.

4 Teacher23 E-mail and work use

I am of the opinion that using the phone from work to ring a spouse, work associate or friend in the field would be considered an activity that the average employer would encourage because of the associated benefits of motivation, stress relief and general being a healthy act to encourage, especially if you
are working late, after hours.

Additional food for thought: at what point does "personal" become “pornographic”? Is a naughty story pornographic? What if it is in Latvian? Are pictures of unclothed people porn? What if they are painted by Rubens? Are blood-dripping violent scenes porn? Plants reproducing? Fish spawning? I am willing to guess there would be people out there ready to be offended by any or all of these.

As an aside, my tutor group and I watched a rather old video called “10 ways to lose your job”. Conducting private activity in work time or with work resources was one of the 10.

We have had problems of staff locking up computers with their connections to Comm Bank Share trading areas. This was eventually dealt with by disciplinary action by the principal. Until he intervened the staff members involved simply ignored other staff requests to not tie up the lines and computers for their personal profiteering. Share trading in school time with interference to other staff is a highly suspect activity and in my opinion professionally unethical. Do others have similar stories in this area of the use of computers in schools?

Several years ago a collaboration between the Australian Institute of Physics, the NSW Science Teachers Association and the Department of School Education, lead to the development of a manual for high school science teachers called "Getting it to Work". The Department of Education and Training has now placed this book in the web for all to download. See: www.dse.nsw.edu.au/stand/Cgi/staff/F1.0/F1.1/teaching/Index.htm
I was asked this question by a yr 8 student of mine. "If oxygen is a gas, and hydrogen is a gas, how come water is a liquid".

Keep it simple. The strength of the attractive force between the particles determines the state of matter of a particular substance. Both oxygen and hydrogen are purely symmetrical molecules and have weak attractive forces between them, hence their low boiling points. Water molecules have much stronger force between them as a result of the structure of the molecule, hence a much higher temperature is needed before the molecules have enough energy to break away from each other and go to the gas phase.

What a terrific question-don't turn this kid off, science is about finding the right questions, not finding answer. There is no completely easy, one-line answer to their question. Year 8 student might be satisfied with something like: Hydrogen and oxygen combine chemically to make water. We see that because it has different properties (like melting and boiling points) to the stuff it's made of.

Other have answered the chemistry of this very nice question but another interesting aspect to consider in that over the several thousand degree or so temp range that water can exist, it only exists as a liquid for a few of that range.

Many students often have trouble searching for reliable information on the worldwide web. Here is an interesting article that details how to prepare students for cyberspace by turning them into 'infortectives'.

http://www.fno.org/text.grazing.html
Nice hands on activities using household 'bits'. Great for the classroom. It's created by Peter Macinnins who is considered a bit of a guru on Australia's most active science discussion site-ABC Science Matters http://www.ozemail.com.au/~macinnis/scifun/

The job: 1 class Chem 12, 1 class Chem 11 and lower school science to make a full load or just the chemistry if someone is interested in a part-time job.

Couldn't resist this one. For example, The new system is NUTS-the new Universal Taxation System-and although it may appear to be complicated, it is easy to understand. Basically, it is STUFT-the Simplified Tax Unit for Financial Transactions.

This is breast cancer awareness month. Do regular breast self-exams and have annual mammograms if you are a woman over the age of 40. And encourage those woman you love to do the same.

They are a collection of cute answers collected by a teacher. For instance, 'When you breathe, you inspire. When you do not breathe you expire'. 'Blood flows down one leg and up the other'.

It's difficult to imagine how a novice could predict his/her needs in a totally foreign environment. Here with what I would have liked in my first year. For example, a reduced teaching load for a short while to allow a lower-stress transition into the workplace.

The sender suggests many ideas about new teachers. For example, reduced yard duties. So students could torture them less, and so they could prepare at school
instead of endangering any formative relationships they might have by working from wash up time till one o’clock.

2000 11 Teacher20 Weightlessness

The concept of weight and weightlessness are explained.

11 University "apparent" Weightlessness?

An answer about weightlessness and some comments from the sender. For instance, most of our "discussions" relate to definitions & interpretation not to misunderstanding of the Physics involved; they are about usage of Words. Thus my point of view is that the term 'inertia' has long outgrown its usefulness and rather than struggle to find ways of making it palatable, physics and physics teaching would be better off without it. This is easy to achieve because the term is not in common usage. Not so with "weight" and in order to reduce conflict with the "everyday" usage of the term and experiences of "weightlessness", my view is that the "best" definition of "weight" is not W=mg (I'm aware of ~4 different definitions all with their plusses and draw backs).

2000 11 Teacher19 Weight & Weightless

My interpretation is that weight is the term for "that force that acts upon an object due to gravitation attraction". Mathematically, F=mg. Once students become aware of the fact that humans cannot feel their own weight, but can feel other force, then they can grasp what people mean when they say that they are "weightless". These students can start to understand that at no time in the foreseeable future will humans ever be weightless in the true physical sense.

2000 11 Teacher20 Momentum and inertia

To clear any confusion among teachers or students, attached below are two explanations which highlight: a) the clear distinction between inertia and
momentum in "classical" mechanics. b) that the term "weight" and "weightlessness" are consistent, even with respect to frames of reference in free fall.

2000 11 Teacher13 Yet still more on inertia etc

Good point about weight & weightlessness, We (physics teachers) do the Orwellian "doublethink" thing all the time. Then we wonder why the kids are confused. Disagreement about definitions is not just semantics-definitions are not just words. They are the bases of the metaphors by which we process and make sense of information. It's always fascinated me how models (Newtonian inertia, relativity etc) take on lives independent (it seems) of the people who employ them.

2000 11 Teacher2 Re: Choosing constructivist curriculum materials

The sender recommended the fourteen points for selecting a suitable science textbook series for use with lower school students. For example, the textbook series should promote a 'thinking curriculum' based upon integrated 'minds-on & hands-on' learning activities where students are continually challenged to think.

11 President STAWA Future Science update

The latest update on the Future Science Conference, Thursday November 30th (mainly country teachers) and Friday December 1st for all teachers. This conference is being staged by STAWA and RACI at UWA. As from Monday 13th Nov. the STAWA office will be the contact point for all queries.

2000 11 President STAWA Youth ANZAAS 2001 conference

Youth ANZAAS 2001 is conducting a residential conference in Adelaide from January 15th to January 19th 2001. Students eligible to attend are those who have an interest in science and are currently (2000) enrolled in secondary school/colleges and are in either year 10, 11 or 12. The program for the conference includes excursion, lectures and workshops.
Nominating one student per school, nominated students will be required to submit with their nomination, a 200 words statement on the topic, “Why attending the Youth ANZAAS 2001 Conference will be of benefit to me.

2000 12 Faculty of Agriculture engineering course offer UWA Extension Summer 2000 Course-“An Ordinary Genetically Engineered Life” On January and February.

2001 2 Teacher1 Help for beginning teachers Beginning teachers of Physics and Chemistry may find some help from my website: http://members.iinet.net.au/~pcoghlan/

2001 2 Teacher1 Like to Win $50 In recognition of the need to boost donations to the Teachers Survival Kit, STAWA has earmarked $200 in prizes to be awarded over the next 4 months. These prizes will be awarded at random to people whom uploads a resource to the Teachers Survival Kit during that month. Last month we had only one donation to the TSK.

2001 2 Australian Academy of Science An Invitation to young Biology Teachers If you are a biology teacher who will be 30 or younger on 1 May 2001, you are invited to apply for the Foundation for Young Australian Award to attend the Australian Academy of Science’s ‘Science at the Shine Dome’ Teachers Program on 2-4 May 2001 in Canberra. ‘Science at the Shine Dome’ comprises the new Fellows seminar, awards and admission of new Fellows, education workshop and annual symposium. The topic of the symposium is ‘Cracking the code’ using the code: The Human Genome Project and its Application.

2001 3 STAWA Introducing Information Technology into science teaching: A beginner’s guide A hands on session designed to introduce science teachers
to the Internet and seeing how it can be incorporated into their teaching of science. This session is for those starting out or with limited experience with the Internet.

2001 3 CONSTAWA Conference Your If you are considering a presentation at the CONSTAWA Conference this year, please contact at Info@stawa.asn.au For a copy of the Call for Papers.

3 STAWA Primary Science Seminar Good news! Primary Science Seminar (PRISSEM) is still on 17th/18th March 2001 So come and join us for a stimulating, information sharing, fun weekend.

3 University Triple S Science Fairs Three Free Science Fairs will be held by Triple S (Science for School Students) in 2001.

2001 3 CONASTA Awesome member chemistry and physics tutorials I have come across some great chemistry and physics tutorials. You need to fill out a simple registration from first and you need to install some plug-in as well. You get full access but only thirty days. To enter the portal, go to: http://www.mchmultimedia.com/ Once the plug-ins are loaded, you will be able to view the Tutorials of General Chemistry, Introductory Chemistry Organic Chemistry General Physics and General Physics multimedia-rich Courses.

2001 3 Teacher28 Re: Please explain Gases physical properties do not normally include taste. However, as they diffuse quite readily you can taste them in the mouth as solution in one’s saliva! Sensory
perception is complex and includes skin, eye, nose and taste buds

2001 4 STAWA member

CONSTAWA Please consider the following workshops.
E5 Standards for Highly Accomplished Teachers.
E6 Serendipitous Science: Left Field leaps in Science Research.
E7 The Fly and The Rat.

2001 4 Director of Education

Science competition for 15-18 year old

For all those with 15-18 year old students who may be interested in entering the 2020 Vision competition and making the world a better place. A chance to put those thoughts to an international conference in Bonn. The winning entry will receive a grand prize cash award of US. $500. The winning individual or representative of the winning group will be invited to the 2020 Vision Conference in Bonn in September 2001. A number of runner-ups will be selected. They will receive US. $250 in cash. Competition closes in June 2001.

2001 4 STAWA

Opportunities from the Academy of Science information include:
1) Awards for young researchers to attend the Forum for European-Australian Science and Technology Cooperation (FEAST)
2) Symposium on Genomic research
3) Call for papers for NSSA Space Workshop
4) Lemberg lectures on Australian flora by Dr David Bowman
5) Kanagawa museum of natural history award
For queries contact International Programs officer at the Academy.

2001 4 Teacher

A one in four chance of winning $50!
We are about to draw this month’s $50 prize from people who have donated to the TSK. Currently there are 4 new resources donated
If you donate one of your Worksheets, you have very good Odds of winning $50.

4 “Futurekids Re: E chalk: warning Possible Virus

This message is a virus. If opened it automatically sends the same message to everyone in your address book. Not sure at this point what else it does. My recently updated virus checker did not pick it up.

2001 4 Teacher1 Do not Remove SULFNBK. EXE. It is a necessary file.

4 Teacher1 Warning Possible Virus

I have not had time to follow this up properly, but I received a couple of e-mail today that Look like Viruses.
Title: Homepage
Text: You have got to see this Page! It is really cool!
Attachment: .vbs
Do not open the attachment, It might be a Virus.

2001 4 Project Round the atmosphere world balloon attempt (from Aus)

There will be another round-the-world balloon attempt soon, which PAA Online will be following and discussing weather condition in the upper atmosphere. There will be also activities for students, we follow the round-the-world balloon attempt in June. We will follow the journey on the paa-teachers@rite.ed.qut.edu.au e-mail list and discuss the events and readings along the way. We should be getting balloon lat/lon/speed posted on the journey’s website. The payload will also gather temperature/humidity/pressure/ lat/lon/altitude data along with image and solar panel power. We have dropped wind speed/direction since the balloon itself is a measurement of these. We also have activities for the classroom based around the journey and data give students the chance to discuss the journey on e-mail list: paa-data@rite.ed.qut.edu.au
There will also be the chance to ask questions of meteorologists on the list: paa-ask@rite.ed.qut.edu.au
If you have a class not currently subscribed to the lists, then visit the web page to join in!

2001 5 Project Atmosphere
Earth systems science downloads and things.
Just a quick update for all regarding the Project Atmosphere Australia Online web site and activities We now have available. Earth System Science modules available for download. I have try them here in Queensland with great success and hope you folks get great value from them ! http://www.schools.ash.org.au/paa/ebmodules.htm

2001 5 Teacher29 May I join?
We are currently teaching science to year 10 and looking at subject to offer in year 11 next year. I have been imported from Queensland and have very little idea of how the system works for writing TEE programs in WA and having them approved and monitored. I have contacted the Curriculum council who have sent me some course, I still would like all the help I can get.

2001 5 Teacher47 Teachers survival kit
I am working at the moment, Curriculum Framework and Outcome Statements have not Been seriously looked at yet. I am going / starting to plow on regardless, but finding that as I come to grips with the science Outcome Statements, they are not as easy to differentiate between levels as I had thought it would be. I am having problems levelling. Do you know of any resources that can help with teasing apart the “essence” of each level, or with levelling in general.

2001 5 Teacher1 Re: Chem website
Question: I have misplaced a website address for year 11 and
A teacher request for debate on process-type essay items—here is my two cents’ worth. The only fair way to require Students to respond to process-Style items involves having them respond to a situation where their chemistry knowledge would help. Here are some alternatives
1) comprehension type item—a press article, interview transcript such as stem: transcript of debate between a company spokesman and an environmentalist. response: prepare a report weighing up the pros & cons using chemistry concept as guidelines.
2) lab data- pages from a lab report, stem: here is a section of a student’s report on an investigation of glues and solvents. Some of the pages seem to have stuck together response: write the missing bits of the report based on the information given & prior knowledge of topic.

Our school has bayonet style gas outlets in the labs which at present are connected by a bayonet male plug via an inline tap to our bunsens. In some cases we have bunsens with built in taps to eliminate the need for the inline fitting. We find the tap is necessary As students struggle with the Bayonet fitting while gas Pours Out etc. At present the hose used is fairly patsy rubber gas delivery hose which perishes and is open to vandalism by biro stabbing etc. We have had a plumber in to see what we can do and are looking at circa 1k to get it up to scratch but the hose we have
been quoted on is almost bomb
defence but also very stiff. Has
anyone been through this
exercise recently and can
recommend some solution.

2001 5 Teacher25Re: Gas
Bunsen
Fittings
Have you considered doing
away with Bunsen burners
rather than spending lots of
money on them? How often
do you really need a high heat
source? I do not particularly
like open flames in labs
anyway. We recently solved
similar problems in a couple
of our labs by simply having
the gas disconnected. We
have purchased a few portable
gas burners for the occasions
we really do need them. Some
of the staff do not like the
portable gas burners but the
objections have not been big.

2001 7 Teacher13 Student
journal
The URL below is for an
electronic journal of student
work, mostly from the UK.
There are a few from Australia.
Even the primary articles are
amazing. I recommend this to
all staff and students.

7 Teacher1 Virus
Warning
Please look out for an email
titled “of its own and sits”
It contains an attachment
UNIST.EXE which is a virus.
delete the e-mail and do not
open the attachment.

2001 7 Teacher1 STAWA
websites
down
Both the STAWA websites and
the Teachers Survival Kit have
been off-line for over a fortnight.
The web hosting company we
use has experienced difficulties
and is no longer trading. I have
been trying for 10 days to get
the sites back up, but our
probable new hosting company
has been unable to gain access to
the old host’s server to extract
our sites. My apologies.

2001 7 Teacher30 Science of
mousetrap
cars
I have a group of students
building cars that are powered
by mousetraps. I want them to
do some theory as well as the
practical. Never having built
a car from a mousetraps, I am wondering what science topic I could get them involved in researching to assist. Obviously they would need to look at levers if they build some sort of arm. Friction would be involved depending what materials they use for wheels and what the race track is made of. Would they use gears? Can anyone offer me some other suggestions? These are bright year 6 students, mostly boys.

I am interested in how you deal with preparing Yr 10 prospective Chem/Physics students. One approach is to arrange for the top kids to be in a particular “pathway” which covers the content that was contained in the units 5.3, 6.3 and 6.4 from the old system. An alternative viewpoint regards such streaming as pedagogically unsound as mid to low ability students are denied access to positive role models. This viewpoint is also against “streaming” as a lower level of behaviour and achievement is accepted as the norm in classes that do not have top students. How does your Science department approach this.

Our science department has pretty well abandoned the idea that teachers must pre-teach content in order to prepare students for learning that content. We have opted instead for year 10 courses that introduce students to the skills and techniques that year 11 courses employ. We do not steam in year 10, except that the lowest achieving students are offered a modified course.

We stream our Year 10s so we can prepare our top group for TEE classes and allow other students to do work at the appropriate level for them to
Yr11 at least make some progress. The top Year 10s do:
Term 1: Continuity of Life (modified 6.2),
Term 2: Chemistry for TEE
Term 3: Motion
Term 4: those students who selected chemistry for year 11 will do more chemistry. The rest of the class do something else. Last year we did a topic on Investigation, this year I am looking into some other topics for example, bioethics.

Appendix 9

Science teachers’ network messages were classified into Types of collaboration: *Storytelling and scanning for idea, Aid and Assistance, Sharing and Joint work.*
(1999-2001)
<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Sender</th>
<th>Subject</th>
<th>Summarised message</th>
<th>Types of collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher36</td>
<td>Websites for Ecology</td>
<td>Needed, some interesting Australian websites for year 10 to study wetlands and forest ecosystems and any good hands on practical work with a view of doing further research back in classroom about small aquatic invertebrates and vertebrates plus identifying all the water birds.</td>
<td>- x - -</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher5</td>
<td>Re: Scientific Report</td>
<td>The writer was told by his lecturers that “third person” was no longer appropriate and the “I” word is now OK. This made writing case studies a lot easier and more natural. Maybe scientists need to catch up and add a human element to their report writing.</td>
<td>- x - -</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher13</td>
<td>Scientific Reporting</td>
<td>Science teachers discussed about using the traditional, third-person or passive voice in writing scientific report.</td>
<td>- x - -</td>
</tr>
<tr>
<td>1999</td>
<td>3</td>
<td>Teacher35</td>
<td>Re: Scientific Reporting</td>
<td>This teacher suggested that teachers could stress to students that the scientific report had to be written in the third person passive or the timeless present tense and avoided unnecessary words, slang, feelings or opinion and avoided mixing tenses in a confusing way.</td>
<td>- x - -</td>
</tr>
<tr>
<td>1999</td>
<td>4</td>
<td>Teacher38</td>
<td>Project physics</td>
<td>Physics teacher would like to have the Project Physics Handbook by Horowitz Group Books Pty.</td>
<td>- x - -</td>
</tr>
<tr>
<td>1999</td>
<td>4</td>
<td>Teacher2</td>
<td>How to select a textbook for outcomes Science</td>
<td>Eight guidelines for selecting a textbook suitable for constructivist, outcomes-based science were suggested.</td>
<td>- - x -</td>
</tr>
<tr>
<td>1999</td>
<td>5</td>
<td>Teacher1</td>
<td>Re: Done, Subscribe</td>
<td>replied to one SHS that subscribed to Catalist.</td>
<td>- - - -</td>
</tr>
<tr>
<td>1999</td>
<td>5</td>
<td>Teacher40</td>
<td>Popcorn</td>
<td>Thank you people who replied about the popcorn, it is both physical (the popping caused by the water) and chemical.</td>
<td>- x - -</td>
</tr>
<tr>
<td>Year</td>
<td>Teacher</td>
<td>Subject/Field</td>
<td>Message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>---------------</td>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>5 Teacher39</td>
<td>Year 11 chem</td>
<td>A new teacher needs papers yr 11 chem test and exams.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>5 Teacher41</td>
<td>Year 11 Physics</td>
<td>A new physics teacher needs physics programs, test, assessments or assignment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>5 Teacher6</td>
<td>Health education</td>
<td>A new lower science teacher needed activities or ideas on smoking or drug for year 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>5 Teacher9</td>
<td>Biological field studies and so on</td>
<td>I have three months off on 1s1 and thought I would do some good work on Biological Field studies. It occurred to me that we could get more kids on the road to biology in year 11 if we guided year 10’s into the fun and excitement of field work. However, no one here has taught this and no written materials at the school. Please e-mail if you have some information, regarding any available Text material, activities and assessment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>7 Teacher1</td>
<td>Catalist Policy</td>
<td>The use of catalyst by person or groups for personal or Financial gain is discouraged. STAWA has other avenues which advertising can occur such as journals or newsletters. If a person is unsure about his/her posting is suitable for catalyst should first seek the approval of the catalyst &quot;listowner&quot; which is the chairperson of STAWA's Electronic Communications Committee. Currently this person is Rod Blitvich.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>7 Teacher4</td>
<td>Policy</td>
<td>Mike, your work on profiling is very innovative and appreciate. Keep it coming.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>7 Teacher2</td>
<td>Re: Catalist Policy</td>
<td>The writer strongly disagree about catalyst limited the volume of e-mail posted or the size of</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
attachment as he see catalyst is the best place to inform what's happening in science in the school and e-mail is a tool to stimulate professional association. E-mail could be enjoyed by science educators across country.

<table>
<thead>
<tr>
<th>7</th>
<th>Teacher5</th>
<th>Re: Policy on the use of Catalyst</th>
<th>The sender greatly please to receive e-mail with attachment and support “professional interaction and co-operation between Science Educators in Western Australia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Teacher2</td>
<td>Re: Outcomes A CD-ROM of science curriculum materials for the Energy &amp; Change strand of the science learning area within the Western Australian Curriculum Framework is suggested. The writer invites other science teachers to try Activity 5 from this material in their classrooms and give him some comments on the style and format of the activity. Then they can co-operate in a science networking group.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>7</td>
<td>Teacher2</td>
<td>Re: What’s happening in outcomes science</td>
</tr>
<tr>
<td>7</td>
<td>Teacher2</td>
<td>Is my Classroom Constructivist?</td>
<td>Teachers who desire to use the guiding principles of Learning &amp; Constructivist Teaching, which underpin The WA Curriculum Framework could move their classroom pedagogy towards constructivism. Elizabeth Murphy at her website provides online a Constructivist Checklist.</td>
</tr>
<tr>
<td>1999</td>
<td>8</td>
<td>Teacher21</td>
<td>One for the caped constructivist crusader from catalyst</td>
</tr>
<tr>
<td>1999</td>
<td>8</td>
<td>Teacher14</td>
<td>Trees</td>
</tr>
</tbody>
</table>
the Tree planting program. This is the website www.oceanree.wa.edu.au/ follow the links to the Science Pages, Field Studies and then on to tree planing.

8 Teacher2 Re: Catalist policy The sender emphasises that teachers need to co-operate as a team to share the load of implementation of the WA Curriculum Framework. Teachers need all the support that they can get in the provision of constructivist & outcome focussed curriculum resources for use in their classroom. There is an extreme lack of curriculum resources that are truly constructivist & truly outcome focused, suitable for use in primary & secondary classrooms. So that catalist is an excellent way of showing small samples of teacher designed curriculum materials that teachers & university lecturers can co-operate to ensure that a high standard of exemplar curriculum are used in primary and secondary classrooms.

8 Teacher2 Re: How do we answer "What is science", we learn Science? chapter 4: How we learn science of The Florida Science Curriculum Framework was suggested to study which is available online at http://watt.enc.org/online/ENC1267/126736.html

1999 8 Teacher2 Re: The Florida Department of Education has online an Interdisciplinary Curriculum Planning tool v2.0 available in Two versions, Elementary and Secondary, which can be used With both Windows 95 and With Macintosh platform. The URL for the download website Is as follow: http://www.firn.edu/doe/curric/prek12/ecpt.htm

1999 8 Teacher4 Re: Policy on the use of Catalist The writer disagreed about the restriction of e-mail's attachment on catalist. He suggested that users should be encouraged to distribute materials in this format as many users would not be able
to post to a website for download or would not bother. The
distribution of materials and PDF could be encouraged.

8 Teacher7 Policy and Attachment The writer emphasised that
catalyst was set up to support all teachers. If a fellow STAWA
who produces a resource that much more relevant to states
syllabus than others should not be stopped rather encouraged and
allowed them to attach that resource with their e-mail.

8 Teacher8 Response to the What is a Scientist? Scientist has the ability to make,
create, modify, define, destroy or damage anything that they
desire. The sender would like to include a morals or ethics as
some scientists do good science rather than monetary reasons.
Moreover, he argue that chemical and biological weapons is not real
science.

1999 8 Teacher2 Re: Suggestion: science teachers should develop science
Constructivism in Physics syllabuses from the underlying
instruction premise of Science For All so Constructivism could be
used in physics classrooms in WA.

8 Teacher27 Sherbet recipe info If anyone can give me the correct ratio of citric
acid/bicarb/icing sugar to make sherbet with my
year 8’s.

8 Teacher13 Chemistry survival kit for beginning teachers If anyone out there can help with materials (year or term plans, assessments,
worksheets, lesson plans, ideas for lessons etc) to get the
STAWA website for beginning chemistry teachers up and running,

1999 8 Teacher2 Re: The Minds. On Physics Constructivist Curriculum materials developed by the UMass Physics Education
curriculum Research Group is recommended using in WA
material in Physics physics classroom as the MOP
materials are well researched
and founded upon the latest learning theories, including constructivism.

1999  8  Teacher2  Classroom Action Research  ‘Mine-on’ & ‘Hand-on’ constructivist, outcomes-focussed learning activities for the Energy & Change Strand is developed. The sender invite science teachers to try this activity in their respective classrooms and level student responses using the student outcome statements. Then use e-mail to exchange sample student responses and discuss the results with each other.

8  Teacher 48  Investigating Scientifically Action Research  With regards to the use of Multiple choice items as constructivist assessment items. At a recent STAWA PD course on the Curriculum Framework, one participant explained how They used multiple choice items and then asked students to justify their selection in a written statement. I think this idea has got potential and would like to try

1999  8  Teacher 49  Its all done by mirrors  Wanna do some groovy light experiments with a graphic calculator? Try using a mirror to reflect the infra red beam around a corner. Or a prism from a Hodson light box.

1999  9  Teacher1  Petty cash EDWA Schools  HOD science and Lab Tech of government high schools were asked about a petty cash system.

9  Teacher12  Unidentified subject!  A teacher explained the Mock TEE schedule dilemma.

9  Teacher14  Exam Density  A teacher replied the Mock TEE density and greatly interested to hear from other schools.

1999  9  Teacher15  Exam Timing  A teacher explained that the 12’s sit their Mocks during the two weeks of school holidays. Then the school gave students the first week of term 4 off as compensation so teachers can mark the papers,
do the grades and so on.

A teacher replied that his school the Exams were commenced in the second week of the upcoming holidays and include the first week of term 4, and were Thursday nicely spread out over 2 weeks.

Toshiba Pentium laptop had been given to use with CONASTA 2000 but the mouse did not work properly. Could anyone help?

Thank you to many people who gave suggestions about solving the mouse problem with the Toshiba laptop. It works well; this is how wonderful Catalist can be used to help each other.

I had the pleasure of attending STAWA’s Curriculum Framework PD Workshop. What did I learn? One speaker put us in the picture by making links with the Overarching Statements and made us think about Science Rational and Why We Teach Science.

Just curious as to where one might buy a Whimhurst machine? My lab tech and I have rung everyone that we can think of so far and all say that they are unable to get any. Thank to Malcolm I did get a copy of some of the handouts of a recent PD. I am interested in any information that people are willing to give in relation to implementing an outcomes based classroom. I would appreciate any information, no matter how trivial, text recommendations, example activities and assessments.

A number of colleagues have asked if I could provide them with some references on Constructivism in Science Education. I have selected my
<table>
<thead>
<tr>
<th>Date</th>
<th>Teacher</th>
<th>Subject</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 9</td>
<td>Teacher 3</td>
<td>Touch powder-how to make</td>
<td>A science teacher asked how to make touch powder (ammonium tri nitrate).</td>
</tr>
<tr>
<td>1999 9</td>
<td>Teacher 1</td>
<td>Biology and Human Biology exam questions</td>
<td>Question: one of the Physics teacher pointed out to me that Heinemann put out a Physics Bank of thousands of questions for Year 11 and 12. There is no such thing for Human Biology/Biology. Does anyone out there know of something similar for Biol/H.B? Answer: at one stage Applecross Science dept. were marketing a Multiple choice item bank for Human Biology. I think there was also a Biology. The item bank runs in a software package called LXR apple test which runs on the Mac OS, I am not sure if it runs on Windoze.</td>
</tr>
<tr>
<td>1999 9</td>
<td>Teacher 50</td>
<td>Re: Biology and Human Biology exam question</td>
<td>We use WA test papers for all our Year 12 exam papers. The price and quality is very reasonable. The Applecross Database is also suitable for WINDOWS and is available In Word format compete with graphics.</td>
</tr>
<tr>
<td>1999 10</td>
<td>Teacher 1</td>
<td>Physics</td>
<td>Physics teachers are the most organised as they was the most science teachers who donated teacher resources to STAWA's Teachers Survival Kit Internet Website.</td>
</tr>
<tr>
<td>1999 10</td>
<td>Teacher 32</td>
<td>Standard reduction potential solution</td>
<td>Needed more explanation on reduction potentials, as unsatisfied with a few answers.</td>
</tr>
<tr>
<td>1999 10</td>
<td>Teacher 2</td>
<td>Re: Was Socrates a Constructivist</td>
<td>“Knowledge is only perception”. Socrates (470-399 BC) The Socratic method essentially consists of leading students through a series of questions in order to promote critical thinking. To gain an excellent</td>
</tr>
</tbody>
</table>
understanding of how to apply a ‘Critical Thinking’ curriculum model to the pedagogy within our science classrooms, recommend visit the following websites:

1999 10 Teacher2 Re: Future Science Follow-up
The writer expressed his great joy as one of many presenters at Future Science 99 which run by STAWA and invited science teachers who jointed his presentation, "Constructivist, Outcome-focussed, Collaborative Learning in Science", to give feedback and share ideas via networking.

10 Teacher 46 Cotton real races
Can anyone provide me with information on building cotton real races or ideas on open ended “Investigating Scientifically” tasks that has an Energy and Change focus?

10 Teacher 51 Earth and Beyond Year 8 Science
Has anyone found an activity on the Solar System that is suitable to assess using levelling according to the new Curriculum Framework? This would be for Levels 2 to 5.

10 Teacher10 Human Biol. Revision
I am requesting if anyone has notes on TEE human biol. course in a ‘nutshell’. Students are now currently working on their own concise notes but would like to make sure they cover everything. By the way, great idea on sharing of past mock exams.

1999 10 Teacher 52 Year 11 Chemistry Exams
It is getting to exam time again and once again I am on my knees, begging. Firstly, I would like to thank all the people who kindly sent me 1st semester exams. If anyone has 2nd semester chemistry exams for year 11 on disk, I would be very grateful if you could e-mail me a copy.

1999 11 Teacher 37 Digital Cameras
For those of you looking at purchasing a digital camera: 1) Rechargeable betteries
2) Floppy disk rather than cable

1999 11 Teacher 43 Future Science
Well done to STAWA with the organisation of the ‘Future Science’ conference. Thank must go to all presenters who clearly spent a lot of time preparing for the day, it was the great day. This conference will help in the implementation of the many positive aspects of the Curriculum Framework I hope it becomes a regular event.

1999 12 Teacher1 Teacher resources website announcement
STAWA was proud to announce the Teachers Survival Kit website. The Teachers Survival Kit included Tests, Exams, Assessment Outlines Programs and Worksheets. Visit http://stawa.inature.com.au/ To enter this website a password needed.

12 Teacher33 PCB boards
Needed, the correct ratio of hydrogen peroxide to hydrochloric acid (6M) for etching PCB’s for electronics

1999 12 Teacher11 Unidentified Subject!
Special thanks to two science teachers who kindly read his e-mail at the latter part of term 4 and asked for physics or chemistry 11/12 assignments or other resources, dropped via Catalist or personal e-mail.

2000 2 Teacher42 Science in the new millennium
In March 2000 an ambitious program of science activities commences at the University of Western Australia under the title Science at the New Millennium. The program has been initiated by the Institute of Advanced Studies to encourage cross-disciplinary discussion and collaboration across the campus and beyond. Over the year, at least seven eminent scientists will visit Perth in presenting their ideas to the campus community.
as well as the larger community.

2000 2 Teacher34 Excursions-separation techniques
A secondary science teacher, teaching separation techniques, wanted suggestion about place where students could see these techniques within Perth or surrounding areas.

2000 3 Teacher1 Teacher wanted
The school is looking for a part-time Maths/Science teacher.

2000 3 Teacher1 Teachers survival kit
If you visit http://tsk.stawa.asn.au you will find Teachers Survival Kit ready to roll. This site is now ready for you to donate your resources by uploading directly.

2000 4 Teacher1 Pornographic e-mail
I am interested in your responses to the incident that saw Telstra employees sacked? For receiving pornographic e-mail at work. The discussion pointed that using the employer’s Internet facility to conduct personal e-mail was not allowed. What do you think?

4 Teacher23E-mail and work use
I am of the opinion that using the phone from work to ring a spouse, work associate or friend in the field would be considered an activity that the average employer would encourage because of the associated benefits of motivation, stress relief and general being a healthy act to encourage, especially if you are working late, after hours.

2000 4 Teacher13Workplace e-mails etc
Additional food for thought: at what point does “personal” become “pornographic”? Is a naughty story pornographic? What if it is in Latvian? Are pictures of unclothed people porno? What if they are painted by Rubens? Are blood-dripping violent scenes porno? Plants reproducing? Fish spawning?

I am willing to guess there would be people out there ready to be offended by any or all of these.

2000 4 Teacher24Re: E chalk: Pornographic and I watched a rather old
video called “10 ways to lose your job”. Conducting private activity in work time or with work resources was one of the 10.

2000 4 Teacher1 Re: Share trading

We have had problems of staff locking up computers with their connections to Comm Bank Share trading areas. This was eventually dealt with by disciplinary action by the principal. Until he intervened the staff members involved simply ignored other staff requests to not tie up the lines and computers for their personal profiteering. Share trading in school time with interference to other staff is a highly suspect activity and in my opinion professionally unethical. Do others have similar stories in this area of the use of computers in schools?

2000 5 Teacher1 A resource for physics teachers

Several years ago a collaboration between the Australian Institute of Physics, the NSW Science Teachers Association and the Department of School Education, lead to the development of a manual for high school science teachers called "Getting it to Work". The Department of Education and Training has now placed this book in the web for all to download. See: www.dse.nsw.edu.au/stand.Cgi/staff.F1.0/F1.1/teaching/Index.htm scroll down to Science.

2000 5 Teacher17 Water

Somebody might be able to help. I was asked this question by a yr 8 student of mine. "If oxygen is a gas, and hydrogen is a gas, how come water is a liquid".

2000 6 Teacher18 Re: water

Keep it simple. The strength of the attractive force between the particles determines the state of matter of a particular substance.

Both oxygen and hydrogen are purely symmetrical molecules and have weak attractive forces between them, hence their low boiling points. Water molecules have much stronger force between them as a result of the
structure of the molecule, hence a much higher temperature is needed before the molecules have enough energy to break away from each other and go to the gas phase.

Couldn't resist this one. For example, The new system is NUTS-the new Universal Taxation System-and although it may appear to be complicated, it is easy to understand. Basically, it is STUFT-the Simplified Tax Unit for Financial Transactions.

It's difficult to imagine how a novice could predict his/her needs in a totally foreign environment. Here with what I would have liked in my first year. For example, a reduced teaching load for a short while to allow a lower-stress transition into the workplace.

The sender suggests many ideas about new teachers. For example, reduced yard duties. So students could torture them less, and so they could prepare at school instead of endangering any formative relationships they might have by working from wash up time till one o'clock.

The concept of weight and weightlessness are explained.

My interpretation is that weight is the term for "that force that acts upon an object due to gravitation attraction". Mathematically, \( F=mg \). Once students become aware of the fact that humans cannot feel their own weight, but can feel other force, then they can grasp what people mean when they say that they are "weightless".

These students can start to understand that at no time in the foreseeable future will humans ever be weightless in the true physical sense.
and inertia teachers or students, attached below are two explanations which highlight: a) the clear distinction between inertia and momentum in "classical" mechanics. b) that the term "weight" and "weightlessness" are consistent, even with respect to frames of reference in free fall.

Good point about weight & weightlessness, We (physics teachers) do the Orwellian "doublethink" thing all the time. Then we wonder why the kids are confused. Disagreement about definitions is not just semantics-definitions are not just words. They are the bases of the metaphors by which we process and make sense of information. It's always fascinated me how models (Newtonian inertia, relativity etc) take on lives independent (it seems) of the people who employ them.

The sender recommended the fourteen points for selecting a suitable science textbook series for use with lower school students. For example, the textbook series should promote a ‘thinking curriculum’ based upon integrated ‘minds-on & hands-on’ learning activities where students are continually challenged to think.

Beginning teachers of Physics and Chemistry may find some help from my website: http://members.iinet.net.au/~pcoghlany/
We sometimes give too much credence to texts! I know one text book which showed incorrect algebraic multiplication and some teachers taught the kids the way it was in the book! Gases physical properties do not normally include taste. However, as they diffuse quite readily you can taste them in the mouth as solution in one’s saliva! Sensory perception is complex and includes skin, eye, nose and taste buds.

We are about to draw this month’s $50 prize from people who have donated to the TSK. Currently there are 4 new resources donated. If you donate one of your Worksheets, you have very good odds of winning $50.

Do not remove SULFNBK. EXE. It is a necessary file.

I have not had time to follow this up properly, but I received a couple of e-mail today that look like Viruses. Title: Homepage Text: You have got to see this Page! It is really cool! Attachment: .vbs

I have not had time to follow this up properly, but I received a couple of e-mail today that look like Viruses. Title: Homepage Text: You have got to see this Page! It is really cool! Attachment: .vbs

Do not open the attachment, it might be a Virus.

We are currently teaching science to year 10 and looking at subject to offer in year 11 next year. I have been imported from Queensland and have very little idea of how the system works for writing TEE programs in WA and having them approved and monitored. I have contacted the Curriculum council who have sent me some course, I still would like all the help I can get.
I am working at the moment, Curriculum Framework and Outcome Statements have not been seriously looked at yet. I am going / starting to plow on regardless, but finding that as I come to grips with the science Outcome Statements, they are not as easy to differentiate between levels as I had thought it would be. I am having problems levelling. Do you know of any resources that can help with teasing apart the “essence” of each level, or with levelling in general.

Question: I have misplaced a website address for year 11 and 12 Chemistry. It is from a science teacher.

Answer: The address you looking for is http://members.iinet.net.au/~pcoghlan

A teacher request for debate on process-type essay items—here is my two cents’ worth. The only fair way to require Students to respond to process-Style items involves having them respond to a situation where their chemistry knowledge would help.

Here are some alternatives

1) comprehension type item—a press article, interview transcript such as stem: transcript of debate between a company spokesman and an environmentalist. response: prepare a report weighing up the pros & cons using chemistry concept as guidelines.

3) lab data- pages from a lab report, stem: here is a section of a student’s report on an investigation of glues and solvents. Some of the pages seem to have stuck together response: write the missing bits of the report based on the information given & prior knowledge of topic.

I have a group of students building cars that are powered
by mousetraps. I want them to do some theory as well as the practical. Never having built a car from a mousetrap, I am wondering what science topic I could get them involved in researching to assist. Obviously they would need to look at levers if they build some sort of arm. Friction would be involved depending what materials they use for wheels and what the race track is made of. Would they use gears? Can anyone offer me some other suggestions? These are bright year 6 students, mostly boys.

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<th>Date</th>
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<tbody>
<tr>
<td>2001 5</td>
<td>Teacher12</td>
<td>Our school has bayonet style gas outlets in the labs which at present are connected by a bayonet male plug via an inline tap to our bunsens. In some cases we have bunsens with built in taps to eliminate the need for the inline fitting. We find the tap is necessary as students struggle with the Bayonet fitting while gas Pours Out etc. At present the hose used is fairly patsy rubber gas delivery hose which perishes and is open to vandalism by biro stabbing etc. We have had a plumber in to see what we can do and are looking at circa 1k to get it up to scratch but the hose we have been quoted on is almost bomb proof but also very stiff. Has anyone been through this exercise recently and can recommend some solution.</td>
</tr>
<tr>
<td>2001 5</td>
<td>Teacher25</td>
<td>Have you considered doing away with Bunsen burners rather than spending lots of Money on them? How often do you really need a high heat source? I do not particularly like open flames in labs anyway. We recently solved similar problems in a couple of our labs by simply having the gas disconnected. We have purchased a few portable gas burners for the occasions</td>
</tr>
</tbody>
</table>
we really do need them. Some of the staff do not like the portable gas burners but the objections have not been big.

2001 7 Teacher13 Student journal The URL below is for an electronic journal of student work, mostly from the UK. There are a few from Australia. Even the primary articles are amazing. I recommend this to all staff and students. http://www.Sci-Journal.org/

2001 7 Teacher1 Virus Warning Please look out for an email titled “of its own and sits!” It contains an attachment UNIST.EXE which is a virus. Delete the e-mail and do not open the attachment.

2001 7 Teacher1 STAWA websites down Both the STAWA websites and the Teachers Survival Kit have been off-line for over a fortnight. The web hosting company we use, has experienced difficulties and is no longer trading. I have been trying for 10 days to get the sites back up, but our probable new hosting company has been unable to gain access to the old host’s server to extract our sites. My apologies.

2001 8 Teacher1 Preparing Yr10s for Chem/Physics Yr11 I am interested in how you deal with preparing Yr 10 prospective Chem/Physics students. One approach is to arrange for the top kids to be in a particular “pathway” which covers the content that was contained in the units 5.3, 6.3 and 6.4 from the old system. An alternative viewpoint regards such streaming as pedagogically unsound as mid to low ability students are denied access to positive role models.

This viewpoint is also against “streaming” as a lower level of behaviour and achievement is accepted as the norm in classes that do not have top students. How does your Science department approach this.
Our science department has pretty well abandoned the idea that teachers must pre-teach content in order to prepare students for learning that content. We have opted instead for year 10 courses that introduce students to the skills and techniques that year 11 courses employ. We do not steam in year 10, except that the lowest achieving students are offered a modified course.

We stream our Year 10s so we can prepare our top group for TEE classes and allow other students to do work at the appropriate level for them to at least make some progress. The top Year 10s do:

Term 1: Continuity of Life (modified 6.2),
Term 2: Chemistry for TEE
Term 3: Motion
Term 4: those students who selected chemistry for year 11 will do more chemistry. The rest of the class do something else.

Appendix 10

This appendix presents summarised two kinds selected current science websites: twenty five specific science websites for science teachers and twenty five science websites for general audiences in Australia,
Asia, Europe, America and Africa and their potential for model collaboration: Consulting, Coaching and Teaming.

1. Twenty-five specific science websites for science teachers

Australia

1. STAWA
   http://www.stawa.asn.au/
   It aims to provide professional development and teaching materials for science teachers, to promote the importance of science education and to support teaching science as a professional career. Thus, members are offered many professional activities such as a professional development program and a STAWA mentors’ program. This website was most recently accessed on January 11, 2002.
   It functions as an “expert” supporting science teachers so it is classified as an example of the Consulting model of collaboration.

2. Catalist (listserv)
   This is the listserv of the STAWA website, promoting science teachers’ communication. In the period of this study, its messages were collected and analysed into three models of collaboration. Most messages show the potential for the Consulting and Teaming models of collaboration.

3. The teachers Survival Kit website
   http://stawa.asn.au/tsk/
   This website intends to be a place that science teachers can contribute and download teaching materials. This website was accessed on February 13, 2002.
   Thus, this website offers potential for Consulting and Teaming models of collaboration.

4. Biotechnology Online
   A good website for a secondary science teacher who looking for informational text, case studies, experiments, interactives, student worksheets and advice about modern biotechnology. Moreover, this website plans to help science teachers to recognize the disagreeing points of view on recent practices, and moral questions such as Cloning that develop a present discussion on biotechnology. This website was accessed on February 15, 2002.
   Therefore, it is classified as an example of the Consulting model of collaboration.

5. Science Teachers' Pot of Gold
   Two awards: Cool Site of the Day and a four star rating have been recognized for its endeavour. Accordingly, this is an excellent resource science website for science teachers in Australia as useful science events and websites are grouped and placed into its appropriate web page: Events Calendar, Excursions and School Visits, Resources, Science Links, WWW Science Projects and Science Education Newsgroup. It was accessed on February 18, 2002.
   This website offers potential for the Consulting model of collaboration.

Asia

1. HK Association for Science and Mathematics Education Ltd
   http://www.hkasme.org/
   This association aims to promote education by improving the excellence of science and mathematics education, to provide an implication of communication amongst people worried with the teaching of science and mathematics, to provide opinions involved in science and mathematics education and to widen the professionalism of science and mathematics teachers. Hence, many activities (organization of lectures, seminars, workshops, field trips and Orientation Program for Beginner teachers) and also some publishing (newsletters, bulletins, journals and other educational literature) are offered for its members. Further, this association collaborates with other educational bodies locally and internally, planning to nurturing creativity and promoting interest in science. This website was accessed on March 7, 2002.
This organization performs as a “specialist” and generally works collaboratively with local or different local and overseas institutes. Thus, this website offers potential for two models of collaboration: Consulting and Teaming.

2 Science Teachers’ Association of Singapore

To promote the advancement of Science Education and foster educational, professional, social and cultural interest among its members are the objectives of this association. It provides numerous courses, workshops, seminars and field trips, and arranges some activities such as the Singapore Youth Science Festival, the Young Scientist Badge Scheme, the QUESTA Club and the Science Teachers of the Year Awards. Also, it publishes guidebooks and handbooks for teaching science. Further, the STAS works collaboratively with the Ministry of Education, the Singapore Science Centre, the National Institute of Education and various affiliated Science Associations under the umbrella of the Singapore National Academy of Science. This website was accessed on March 3, 2002.

It offers potential for two models of collaboration: Consulting and Teaming.

3 Asia-Europe Classroom (AEC)
http://www.aec.asef.org/index_static.html

Encouraging the improvement of education through the use of information technology, and also supplying a stronger knowledge and partnership between high school students and teachers in Asia and Europe are goals of this website. Its members are offered a program named International Teachers’ Conference, which was first successfully held in Singapore in September 2001. The 2nd AEC International Teachers’ Conference would be held in Tampere, Finland, on September 11, 2002. This website was accessed on March 8, 2002.

It offers potential for the three models of collaboration: Consulting, Coaching and Teaming.

4 Science Teachers

This website presents results from the seminar for Physics and Chemistry in 1996, which was conducted by Mr. Peter S P Lim at the independent Chinese school. This website shows some pictures of activities that the presenter demonstrated using simple materials to explain science events during the seminar and presents some excellent Physics and Chemistry Tidbits such as 7 colours of UI in a test-tube, Metal Reactivity Expt and Parallel mirrors Puzzle. Also, it presents some students’ appreciated letters after studying with him. This website was accessed on April 8, 2002.

This website offers potential for the Consulting model of collaboration.

5 Asia-Pacific Forum on Science of Learning and Teaching
http://www.ied.edu.hk/apfslt/

To offer a formal online publication place for distributing and sharing of new ideas, research findings and innovative teaching methods, and to encourage academic exchange in using information technology for science teaching and learning for all science or science-related teachers in Hong Kong are objectives of this website. Its target readers and possible contributors are science teachers and student teachers, researchers, scholars, curriculum officers, science inspectors and other science educators in the local, regional and international communities. This website was accessed on April 8, 2002.

It offers potential for the two models of collaboration: Consulting and Teaming.

Europe

1 Association for Science Education
http://www.ase.org.uk/

This website aims to support and advice to individual teachers, schools and local colleges, provide many links with industry and relevant curriculum support materials and offer its members with free journals, discount on books, and indemnity insurance. It is a very good website for science teachers to investigate, especially the Teachers’ Zone (http://www.ase.org.uk/iz.html), which offers many useful websites such as Scishop, Image Gallery, SciLinks.Org.uk, Global Solar Partners and Science Across the World. It was accessed on April 24, 2002.

This organization offers potential for two models of collaboration: Consulting and Teaming.

2 SCIcentre
http://www.le.ac.uk/se/centres/sci/about.html
It is a collaborative project, which creates numerous benefits for Children, Student Teachers, Teacher Mentors, Teacher Training Institutions, Government and Industry. For instance, this website opens children to science before they develop negative views of science, as it believes that a good primary teaching is more likely to produce confident girls and boys who keen to be scientists. It provides a bank of self-study materials, which used to develop primary teachers science knowledge and understanding. In addition, this website offers its products, publications and projects. It was accessed on April 25, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

3  Physics on Stage  
http://www.estec.esa.nl/outreach/pos/  
This is a united programme, which was founded to give teachers from European countries the opportunity to take part in national programmes and international festivals to exchange teaching ideas and materials. The first year of its activities was so successful. Thus, Physics on Stage 2 will be started with a strong emphasis on workshops and an international fair, showcasing the best of each country's contributions. This website was accessed on April 26, 2002.

It offers potential for three models of collaboration: Consulting, Coaching and Teaming.

4  The European Network of Science Communication Teachers  
http://www.ucl.ac.uk/sts/enscot/  
This website aims to bring together institutions and individuals involved in science communication teaching from across Europe, to exchange ideas on good practice in teaching, develop a European perspective for science communication courses and to act as a nucleus for other science communication teachers throughout the European Union. To complete its aims many plans are offered such as workshops, which scientists from around Europe will meet each other and have the opportunity to develop their communication skills by working with leading journalists and academics in science communication. The workshop is not only about communicating science but it is also on communicating European science. Thus, all of the participants in the workshop will have an opportunity to exchange ideas and experiences with European colleagues. It was accessed on May 2, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

5  The European Schools Project  
http://www.esp.uva.nl/  
This project works cooperatively with a network of local and national coordinators in various European countries to assist teachers and students in partaking in the world of Internet-based Computer Mediated Communications and in using Internet's Information Resources to improve learning and teaching. It offers conferences for teachers to use as a place to contact with colleagues in the field of education, learn to know good practices of educational ICT, share opinions and experiences with colleagues and discuss the use of ICT in schools. Also, many collaborative projects for teachers and students are provided. For example, the project "Women all over the World" is offered for female students to become more active in using the Internet and the project "Energy on the Move" provided for secondary school students in different European countries to contact with researchers from all over Europe. It was accessed on May 6, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

America

1  National Science Teachers Association  
http://www.nsta.org/  
It is the largest organization in the world aims to promote excellence and innovation in teaching and learning science for all. To support its goal three major initiatives are offered: Building a Presence for Science, SciLinks and NSTA Institute. Its current members are science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in science education. Those members’ benefits include message board, calendar of events, idea-packed, practical journals, provision on standards, assessment, inquiry-based learning, discounts on books and classroom materials, learn how to integrate technology and teaching, participate in conventions, workshops and other professional development information, network with colleagues nationwide, win awards (for themselves and their students), access to web resources to read all journals online, get involved and help shape teaching at the national level and improve their approach to teaching science. It is a good place for science teachers to collaborate with science educators around the globe. It was accessed on May 21, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.
Educational Resources for Physics Teachers
http://www.ba.infn.it/www/didattica.html

This is an excellent website for physics teachers. It starts with the tables of some outstanding resources, gives physics teachers quick access to those materials. In the tables is a list of links classified in different categories: Geometry and Trigonometry, Chaos and fractals, Data analysis and statistics, Tools, Mechanics, Astronomy, Sound and Waves, Electricity and Magnetism, and Questions and Answers. The AIP produces the Physics Academic Software, which discover the science of physics with interactive educational software. Besides, it offers links to many useful physics resources: The American Institute of Physics. It was accessed on May 28, 2002.

This website offers potential for the Consulting model of collaboration.

The Puerto Rico Collaborative for Excellence in Teacher Preparation (PR-CETP)
http://cetp.crci.uprr.pr/cetpweb/

It is a combined organization aims to improve teacher preparation programs in organization with local and national standards to enhance conceptual understanding of the disciplines to be taught by the future science and mathematics teachers, as well as their mastery of content-specific teaching methodology. Its strategies focused on five main components: Curricular Revision and Assessment; Faculty Development; Student Academic Support; Institutional Policies; and Project Evaluation, which provided on this website. It publishes newsletter that disseminates the numerous activities and achievements of the PR-CETP. All participants in the PR-CETP are invited to submit articles, which presented on partner’s website. It was accessed on June 17, 2002.

This website offers potential for two models of collaboration: Consulting and Teaming.

Atlantic Science Curriculum Project (ASCP)
http://www.chebucto.ns.ca/Education/SPTN/index.html

and the Science Plus Teachers Network
http://www.chebucto.ns.ca/Education/SPTN/page3.html

This project is a combined organization aims to improve science education in the Maritime Provinces of Canada. A small group of authors comprises with five Canadian universities and the participating teachers have begun to write text materials for students: SciencePlus, Maritime Edition. Now the text materials have been adopted widely throughout North America in several editions. The ASCP formed the SciencePlus Teachers Network (SPTN) to link teachers with teachers. Hence, many activities are offered such as INTERACTIONS newsletter, summer institutes and SPTN mailing list. In addition, it offers science education links such as Curriculum Development, Student-based Teaching Strategies and Activities, and Science links-General. It was accessed on June 18, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

Prime Minister's Awards for Teaching Excellence
http://www.schoolnet.ca/pma/home-e.html

The Prime Minister's Awards for Teaching Excellence is a grant for outstanding teachers in all disciplines who provide students with the implements to become good citizens, to develop and grow as individuals, and to contribute to Canada's growth, prosperity and well being. There are two awards: the Certificate of Excellence and the Certificate of Achievement that are suitable for teachers. Moreover, this website provides links to other teaching award programs in Canada such as National Awards, Provincial and Territorial Awards and Teaching Association or Federation Awards. These award programs recognize K-12 educators who go outside the textbook and who take their students away from the traditional classroom walls. Nomination Guidelines and Teaching Resources are supplied on this website. It was accessed on June 19, 2002.

This website offers potential for the Consulting model of collaboration.

Western Cape Primary Science Programme (PSP)
http://www.psp.org.za/
This is an in-service education organization, which works with teachers from the most urgently need primary schools in the townships of Cape Town. It aims to improve the quality of teaching and learning science and related subjects by developing a core of competent primary school teachers. Hence, many activities are offered such as the Primary Science Development Project (PSDP), the Learning Programme Development Project (LPDP), Boland Maths and Science Project (BMS), development of enrichment resource materials and independent longitudinal evaluation of all its operations, and produces high quality teacher support materials such as Life and living, Matter and Materials, Earth and Beyond, Energy and change. In addition, it works with many organizations, for example ‘Teacher’s INSET Project’ (TIP), Boland Primary Maths and Science In-service and Support Project (BMS), Bird Resource Pack Project and Toyota Teach Project to strengthen its activities. Consequently, the PSP has reported that many teachers from Grades 4 to 7 and children in their classes benefited from the work of this programme during 2001. It was accessed on July 2, 2002.

This website offers potential for the Consulting model of collaboration.

2 National Professional Teachers' Organization of South Africa, NAPTOSA

It aims to enhance of all aspects of the existing teachers and every child has a right to have quality education within a fair system of education. To fasten with its primary mission, "Teach with dignity", in year 2001 this website spotlighted on the ideas: efficiency, protection and development so many programmes such as workshops and seminars were offered. All those successful works are presented in Press releases, Newsletter, Biennial report and Archives pages. It was accessed on July 2, 2002.

This website offers potential for the Consulting model of collaboration.

3 Science Education Centre, Soweto
http://www.sec.org.za/

This website aims to change science and mathematics education from a teacher conquered "chalk and talk" method to a learner centered active learning approach by improving teaching methods, teacher's practical work skills and teacher's skills in communication with their learners, increasing the background knowledge of the teacher, assisting teachers in planning reflective lessons, Consequently, many programmes such as Professional Development, Materials Development, Direct Learner Support and Provision of Resources are offered. Also, this website provides excellent Teaching Resources about Maths, Physics, Chemistry, Biology, and HIV/AIDS education, especially the wonderful SEC Crossword Library. This website was accessed on July 4, 2002.

It offers potential for the Consulting model of collaboration.

4 The Teacher
http://www.teacher.co.za/about.html

This is a South Africa's most important monthly newspaper for teachers, presents most recent news, advanced policy developments and useful ideas for the classroom. Also, regular resource pullouts to assist teachers with outcomes-based education are published. Moreover, it aims to inform about good and bad stories of real people in real teaching situations, to bring back a much-needed sense of professionalism and self-importance in the teaching profession, and to give teachers as much help as it can by offering regular columns such as "My Favourite Teacher", "A Day in My Life", Education Around the Globe, Chatterbox, and Chalk dust for teachers to participate. It was accessed on July 5, 2002.

This website offers potential for two models of collaboration: Consulting and Teaming.

5 Chemistry Clinic
http://www.chem.wits.ac.za/ChemClinic/clinic_full.shtml

This organization offers free of charge both e-mail and telephone based educational consultancy services for government and private secondary school teachers in Southern Africa who are involved in the teaching of Chemistry. This website invites secondary school chemistry teachers, who wish to discuss difficult concepts in Chemistry on an informal basis with a fellow scientist and want to try out their own explanations for chemical phenomena on someone who could comment and help them develop those further. Moreover, enquiries received from chemistry teachers relating to any aspect of the teaching of Chemistry will be forwarded to a member of the academic staff in the appropriate chemistry sub-discipline, who will communicate directly with those chemistry teachers by e-mail. It was accessed on July 8, 2002.

This website offers potential for the Consulting model of collaboration.
Australia

1. **The Community Biodiversity Network (EBN)**

   This website seeks to support and suggest community understanding of biodiversity and its value, to supply easier access to biodiversity related information, and to encourage community involvement in biodiversity conservation. Further, it is looking to create opportunities for cooperative and collaborative efforts with relevant networks and organisations. Consequently, two Internet discussion groups, which help the CBN to promote and advice information quickly and efficiently, are serviced. This website was accessed on February 19, 2002.

   This website has developed into a key source of biodiversity information. Thus, it is classified as an example of the three models of collaboration: Consulting, Coaching and Teaming.

2. **ABC Online**
   [http://www.abc.net.au/](http://www.abc.net.au/)

   This is the only one website in Australia that expands and boost radio and television programmes by putting them to the Internet. It is a huge website, carries more than 500,000 individual web pages, including science and education. Many good plans are offered on the science website: the Lab, Einstein's Legacy, WA Wildflowers Bloom, Science in a Suitcase, Malaria in Malawi, Walking With Beast, Australian Beasts, Dr Karl, Environment, Health and Space. Also, various programmes are provided on the education website such as Oceans Alive [http://www.abc.net.au/oceans/alive.htm](http://www.abc.net.au/oceans/alive.htm), which aims to present information about the sea living things: wheals, jewels of the sea, to provide details about the Australian’s top marine biodiversity areas and to link to local and international ocean websites as well. This website was accessed on February 20, 2002.

   Accordingly, it offers potential for the Consulting model of collaboration.

3. **Australian Academy of Science**

   This website has a robust objective to promote science through a range of activities: recognition of outstanding contributions to science, education and public awareness, science policy, international relations and science and industry. Its numerous plans have been succeeded. For example, it publishes: reports on public issues such as pesticides; science texts: health science, chemistry, geology, mathematics and biology; on-line service for schools; reference books: works on the history of science in Australia have been released. Further, this organisation encourages an international scientific collaborations program among Australian and North America, Europe and North East Asia. This offers Australian researchers the opportunity to collaborate with foreign colleagues, broaden research viewpoints and experience, to exchange ideas, to be accepted in the international arena, to obtain information and knowledge of techniques that will stimulate and advance Australian research, and to be mixed up in large international projects. Thus, the Academy not only produces texts but also supports collaboration for both science teachers and Australian researchers. This website was accessed on February 21, 2002.

   Consequently, it is classified as an example of the three models of collaboration: Consulting, Coaching and Teaming.

4. **Environment Australia**

   The organization aims to advice the Commonwealth Government on policies and programs for the protection and conservation of the environment: natural and cultural heritage places, to manage environmental laws and Australia's involvement international environmental agreements. Hence, a number of major programs are operated such as Bushcare, Coasts and Clean Seas, the Endangered Species Program and Waterwatch.

   This is a great website for exploring details on past, present, future of Australia environment: Antarctica, Assessment and Approvals, Atmosphere, Biodiversity, Coasts and Oceans, Heritage, Industry, Inland Waters, Land Management, Meteorology and Parks and Reserves, and some key environmental activities: Ecologically Sustainable Development, Environmental Education and Great Barrier Reef. This website was accessed on March 4, 2002.
This website is classified as an example of the Consulting model of collaboration.

5  Science websites
http://library.trinity.wa.edu.au/subjects/science/default.htm

This is a great place to investigating information about science: Physics, Chemistry and Biology from Australia and around the globe. The Trinity college presents this website, willing as an effective place for science students and science educators to research in science. This website was accessed on March 5, 2002.

This website offers potential for the Consulting model of collaboration.

Asia

1  Chinese Biodiversity Information System (CBIS)
http://cbis.brim.ac.cn/cbise/index.html

This centre aims to support the ability of investigation and operation of the primary biodiversity information of the following data sources: specimen collections, botanical gardens, natural reserves, field ecosystem research stations, seed banks, geneplasm banks and research groups. The CBIS supports those data sources to develop their competence of biodiversity information management and processing by providing computer hard-ware and software and network facilities, and also offering necessary training for personnel to design, implement and operate the information system. Hence, it is a great place to gather data about biodiversity. It was accessed on April 10, 2002.

This website offers potential for the Consulting model of collaboration.

2  Russian Space Science Internet (RSSI)
http://www.rssi.ru/rssi_hp.html

The major goal of this project is to present Russian space science information. This website was facilitated through the joint cooperation of three websites: the NASA Science Internet (NSI), the NASA Program Support Communications Network (PSCN) and the Russian Space Science Internet (RSSI). All user requests for Russian Space Science Internet connectivity must be permitted and supported by Network Coordination Centre at Space Research Institute RAS. Also, all user requests for Russian Space Science Internet connectivity in St. Petersburg and Region must be legalized and approved by Network Coordination Centre at Ioffe Physical Technical Institute. It was accessed on April 12, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

3  National Center for Genetic Engineering and Biotechnology, Thailand
http://www.biotec.or.th/

The BIOTEC works collaboratively with many international centres such as Asia - Oceania Network for biological Sciences (AONBS) as its main objective is to develop and use biotechnology in order to support technology development in both public and private institutions in Thailand. Accordingly, it is a good place for researchers from local and international private sectors to exchange their experiences and young graduates in Thailand to acquire facilities and other necessary resources for conducting their researches. Its network information and update news on research work is reported through newsletter, which released annually. It was accessed on April 12, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

4  The Fossil Evidence for Human Evolution in China
http://www.chineseprehistory.org/index.htm

It aims to introduce both earlier and more recent fossil hominid discoveries from China. Hence, some evidences of human evolution in China are presented, including a picture gallery of important fossil specimens, maps detailing the distribution of human fossils, and a time line; links to other relevant sites dealing with paleontology, human evolution and Chinese prehistory. This website was accessed on April 15, 2002.

It offers potential for the Consulting model of collaboration.

5  Friends of the Earth (Hong Kong)

This organization aims to raise public awareness, monitor the environmental protection works, and promote sustainable development in Hong Kong. Therefore, many functions are performed such as monitoring the environmental performance of the government and the private sector, implementing the
Polluter Pays Principle, promoting renewable energy technologies, instructing people and organizing training workshops for private sector. It was accessed on April 18, 2002.

This website offers potential for two models of collaboration: Consulting and Teaming.

Europe

1 European Science Foundation
http://www.esf.org/

The ESF aims to facilitate cooperation and collaboration in European science, as it believes that there is much value in bringing together scientists and organizations from different countries to cooperate on projects at a pan-European level. Hence, a wide range of activities is carried. Those activities comprise with five main things: Exploratory workshops, Networks, Conferences, Programmes, EUROCORES and Forward Looks. Each main thing is clearly defined and offers passage to collaboration across borders and scientific disciplines. It was accessed on May 6, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

2 European Cooperation in the Field of Scientific and Technical Research (COST)
http://cost.cordis.lu/src/home.cfm

This website aims to ensure that Europe holds a strong position in the field of scientific and technical research for peaceful purposes. Most of the Central and Eastern European countries are members of the COST. Also, the participation of interested institutions from non-COST member is welcomed. Because of ease access for non-member countries makes the COST a very interesting and successful tool for tackling topics of a truly global nature. The COST is based on Actions. Most domains and actions as well as the Council secretariat and various national coordinators have their own web pages and linked with the COST home page. Thus, a forum is included in the COST website from different groups can discuss and interchange opinions about themes related to COST. It was accessed on May 10, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

3 European Science Education Research Association
http://www.summerschool.dk/esera/home.html

This website aims to enhance the range and quality of research and research training in science education in Europe, provide a forum for collaboration in science education research between European countries, represent the professional interests of science education researchers in Europe, seek to relate research to the policy and practice of science education in Europe and foster links between science education researchers in Europe and similar communities elsewhere in the world. Hence, many activities are provided such as conferences every two years and summer schools for PhD science education students, which they can present and discuss the research works with other PhD students and experienced researchers.

A wonderful editorial policy on this web site is to publish science education dissertation abstracts from European universities and also publish abstracts from non-European countries if a thesis has been supervised or written by an ESERA member. Its member is offered many benefits such as a reduced rate personal subscription to International Journal of Science Education and assistance with producing articles in good English (for non-native English speakers). It was accessed on May 14, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

4 European Thematic Network in Biology (ETNB)
http://www.vub.ac.be/gst/eurobio/

This association aims to advise, in all aspects of biology, to students at universities within the European Union and closely affiliated states in other parts of Europe, to motivate general interests and specific knowledge in European third level education by agreements about joint curricula and about modular courses transportable on a European scale, by other curriculum development and by the promotion of European diplomas, to encourage quality assessment studies, to support solutions of specific problems corresponding to general objectives and common interests, and to look for particular European scopes in biology and motivate their distribution in biology and other third level curricula. Thus, it will be an association for discussions about current European Biology education including basic training as well as PhD studies, new possibilities and plans for future development. It will encourage teaching collaboration on a European scale in biology. This website was accessed on May 15, 2002.

It offers potential for three models of collaboration: Consulting, Coaching and Teaming.
5 BIOLOG-Europe
http://www.biolog-europe.de/index.html

This is an interdisciplinary cooperative research programme, aiming to achieve conservation and sustainable utilization of vital biological resources. The pilot phase of the BIOLOG focuses on two major areas of research: terrestrial biodiversity and biodiversity informatics. There are 13 subprojects in this programme, which can be grouped into three categories: Complexity analysis and monitoring, Experiments and process analysis and Economy, politics and history. It was accessed on May 17, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

America

1 Science Canada
http://www.mts.net/~dforbes/ScienceCanada.html

This website aims to perform as a resource for science educators, students, and parents through Canada by brings together the curriculum links, teacher resources, publishers and suppliers into one website. Thus, many useful websites are collected, grouped and placed into purposive themes such as Canadian Provincial Conferences, Science Fairs and Olympics, Awards and Competition, and Suppliers and Publishers. Especially, science teachers are supplied excellent websites, gathered in the four science areas: Earth Science, Life Science, Physical Science and General Links. It was accessed on June 21, 2002.

This website offers potential for the Consulting model of collaboration.

2 Endangered Jamaican Manatees
http://jamaicanmanatee.freeservers.com/

This website provides a good information about the Jamaica's endangered animal, Manatees that they are not sea monsters, but warm, lovable animals. This project aims to encourage people to save the Jamaican manatees so many programs are provided such as education program on television and radio, articles in the newspapers, presentations at many schools across the Island and questionnaires. Expectantly, this website will persuade people to care for the Manatees' habitat and also urge the ways that they perform with them. It was accessed on June 24, 2002.

This website offers potential for the Consulting model of collaboration.

3 ThinkQuest
http://www.thinkquest.org/

This website provides a highly motivating opportunity for students and educators to work collaboratively in teams to learn as they create web based learning materials and teach others. To support its objective many programmes are offered such as Library, Partnerships, Information, Awards and Recognition, and Frequently Asked Questions. It was accessed on June 28, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

4 Bio. Explorations, preserving the coral seas.
http://www.bioexplorations.com/

This organization aims to increase public awareness of the importance and value of living coral reef ecosystems through education and involvement in the local community and to provide a structure and logistic to help increase scientific understanding and knowledge of living coral reef ecosystems in Central America. Hence, three essentials requirements: preserving the coral ecosystem, studying it, and educating people about the coral ecosystem and its major influence on humans’ future to support its objective are started. This website was accessed on June 28, 2002.

It offers potential for the Consulting model of collaboration.

5 National Aeronautics and Space Administration (NASA)
http://www.nasa.gov/

This is a huge website with 4.1 million public web pages aims to provide a rich information about U.S. using a systematic program of exploration and discovery to investigate air and space, especially in the five programs: Aerospace Technology, Biological and Physical Research, Earth Science, Human Exploration and
Development of Space, and Space Science for increasing the empire of human knowledge. There are many ways to explore this website such as Search Options, Find It on the NASA Web, Organization and Subject Index, and Site map. It was accessed on June 28, 2002.

This website offers potential for the Consulting model of collaboration.

**Africa**

1. **National Botanical Institute SA**  
   [http://www.nbi.ac.za/homepage.htm](http://www.nbi.ac.za/homepage.htm)  

   This is a collaborative organization aims to promote the sustainable use, preservation, admiration and delight of the especially rich southern Africa flora, so the environmental education programmes and retains databases and libraries specialising in information on the southern African plant lives are supplied. This institute comprises with eight National Botanical Gardens and research centres throughout South Africa as a result it can offer many products and services such as Plant Identification, Plant Sales, Publications, Seed, Seed Primer and Venues for Hire. It was accessed on July 9, 2002.

   This website offers potential for the Consulting model of collaboration.

2. **The African Conservation Foundation**  

   To supporting, linking and protecting the wildlife and flora of Africa is the aim of this association. Therefore, all groups working for conservation in Africa are collected and placed together in one central access area, as it is convenient to help that conservations to develop their ability, build partnerships and encourage efficient communication and co-ordination among them. This is suitable to follow conservation work results of every country in Africa. For example, [Nature Kenya](http://www.naturekenya.org/), which aims to promote the study of natural history, and to protect the natural environment, in eastern Africa. So it is involved in a large conservation, advocacy, education, publication, monitoring, research and training. Many projects: Biodiversity Parks Project, Friends of City Park, Friends of Nairobi Arboretum, Important Bird Areas and Training are operated. Building partnership is another important thing of this association, as it believes that successful conservation requires people and organisations to work together. Its members come from all over Kenya and the world, and from a great diversity of backgrounds and professions, who are great concerned about natural conservation. Those members get benefited about being part of a dynamic conservation organization, a monthly newsletter with updates on regular activities, twice yearly Nature Kenya Bulletin and twice-yearly Kenya Birds periodical, opportunity to participate in field outings, regular evening programme of lectures or videos, free entry to the National Museums of Kenya, free use of the outstanding Nature Kenya and National Museum library and reduced rates for books and publications on sale at their front office. This website was accessed on July 12, 2002.

   It offers potential for three models of collaboration: Consulting, Coaching and Teaming.

3. **Science in Africa**  
   [http://www.scienceinafrica.co.za/](http://www.scienceinafrica.co.za/)  

   Science in Africa, the first wonderful science magazine on line in Africa, aims to promote local and international awareness of science conducted in Africa, to give young African scientists the opportunity to showcase their research to Africa and beyond, to give information on scientific and health issues directly affecting society, to give teachers of science in Africa access to resources and information, to encourage debate, informed, thinking and questioning on scientific issues in African society, and to further science communication between African countries. Numerous amazing web pages are offered on this magazine such as Jobs, Funding, Education, Budding Science, Organisations, Letters, Feedback and Archives. Its articles and information are received in two ways: the greater part of information comes from people who are taking the great opportunity to bring science to everyone in Africa, and a few articles come from experts in particular fields. Scientists and organisations across Africa are invited to contribute articles on their research and to state their expert perspective on important and relevant science issues. Further, anyone can submit an article to Science in Africa only if it is based on science and can be confirmed. It was accessed on July 12, 2002.

   This website offers potential for the Consulting model of collaboration.

4. **South Africa Expo for Young Scientists**  
   [http://www.exposcience.co.za/](http://www.exposcience.co.za/)  

   This association aims to give a great chance for learners to exhibit their work, interests and activities in science and technology and to discuss their work with judges, colleague science beginners and members of the community. Consequently, this website is supplied for its audiences to obtain needed information such as
a model of scientific project, writing a report and showing the work. Further, Expo Chat room is provided for sharing and debating on science and technology issues. This website received the 1999 National Science and Technology Forum Award for the most outstanding contribution to Science, Engineering and Technology. It was accessed on July 15, 2002.

This website offers potential for three models of collaboration: Consulting, Coaching and Teaming.

5 South African National Antarctic Program (SANAP)
http://home.intekom.com/sanae/

This program aims to expand knowledge of the natural environment and life in the Antarctic and Southern Ocean through suitable science and technology. It is organised under the favourable of the directorate: Antarctic and Islands of the Department of Environmental Affairs and Tourism, Republic of South Africa. It comprises with three research stations: a meteorological station at Gough Island, a meteorological and biological research station at Marion Island, and a physical sciences research and a meteorological program at the SANAE base in Queen Maud Land, Antarctica. For example, SANAE is South Africa's endowment to the investigation and appreciative of the Antarctic continent. Thus, South Africa bears responsibilities both in research of the Antarctic and as a custodian of this continent of peace. Its newest base is the SANAE IV, which conducts four research programmes: Physical sciences, Earth sciences, Life sciences and Oceanographic sciences. All information about these programmes is available on its website. This website was accessed on July 22, 2002.

It offers potential for the Consulting model of collaboration.