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ABSTRACT

This paper has the potential for identifying and codifying the home learning environment and parental factors in a unique multicultural setting within Australian schools, and for the establishment of research-based initiatives for more effective collaboration between schools and parents. The Third International Mathematics and Science Study (TIMSS) revealed that home environment factors were thought to be strongly related to mathematics and science achievement in every TIMSS country. This result, in conjunction with Australian students coming from home environments and communities with widely different cultural practices, provides the basis for this recent study. The study combined qualitative (interview and case study techniques) and quantitative (questionnaire and Likert-type instruments) methods. Results indicate that when students found that the manner in which things were learned at home clashed with their school-based learning experiences, they found their school a somewhat confusing experience. Secondly, students who revealed that they had a high respect for authority saw their preferred classroom environment as being one which is characterized by higher affiliation, teacher support, and order/organization compared to those who had a lower respect for authority. The outcomes of this research relate specifically to each of the key stakeholder groups--students, teachers and parents. Sensitive quantitative and qualitative data collected on how students and their parents perceive the learning environments at home and at school can be an essential base for the development of any innovative framework of new strategies and structures to be implemented by teachers and parents. (Contains 36 references.) (CCM)

Influence of Culture and Home Environment on Science Learning

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Preamble

The impact of Information Technology in the school, home and workplace on children and their resource intensive approach to learning, has created real problems for parents as they strive to support and assist their children's study within the home environment. For many of them, particularly those not born in their country of residence – the problem is one, which must concern all participants. One significant question follows: How can parents help create productive learning environments for their children and how are students going to react to these new learning opportunities. This research outlined in this paper has the potential for identifying and codifying home learning environment and parental factors in the unique multicultural settings within Australian schools and for the establishment of research-based initiatives for more effective collaboration between schools and parents.

Aims

To identify and codify home learning environments by determining how:

a) students in multicultural Australian science, mathematics and technology classrooms perceive their home learning environment.
b) parents of students in multicultural Australian science, mathematics and technology classrooms perceive their students' school learning environment and their role in supporting the learning process within the home environment.

To establish research-based guidelines for collaboration between teachers and parents, particularly with respect to technology usage in the home environment.

Background

As in many traditional Western Countries such as Australia, United States and Great Britain, educators should not be complacent regarding the effectiveness of the nation's school science and mathematics programs. For Australia, the most recent internationally comparative evidence is not particularly optimistic. In this recent study, the Third International Mathematics and Science Study (TIMSS, 1996), the largest international study of student achievement ever undertaken, including 45 countries (41 for the first reports) and half a million students, Australian students ranked 12th and 14th in science, and 16th and 17th in mathematics at the eighth and seventh grade levels respectively. Although Australian students outperformed students from countries such as the United States, Germany, Canada, Norway and New Zealand - they fared badly in comparison to many of Australia's Asian trading partners, such as Singapore, Japan and Korea (Lokan, Ford & Greenwood, 1996). In this time of rapid expansion of scientific knowledge, information technology, and the need to maintain Australia's competitive edge in a global economy centering on the Asian region, high quality science, mathematics and technology education is a critical need if our nation is to prosper.

This extensive study revealed that home environment factors were seen to be strongly related to mathematics and science achievement in every TIMSS country. Even though this finding was not unexpected, it still is remarkable to see such a consistent pattern replicated 41 times. Importantly however, relationships between achievement and instructional practices were less clear within and across countries (Beaton, 1996) - and it is this link between instruction and home environment that will is one of the key foci of the study reported here.

Although an examination of home environment factors was not a major thrust of this international research project, strong positive relationships were found between student achievement and having various study aids in the home, including a dictionary, computer and study desk for the student's own use. The number of books in the home also was a positive indicator of student performance as was parents' education. Most typically, students reported watching 1 or 2 hours of television each day as well as spending several hours playing or talking with friends, and nearly 2 hours playing sports. Unfortunately, we know very little about how these home environment factors of typical Australian families affect student learning, particularly in these crucial science, mathematics and technology areas. Little research has been carried out on the issue of home environment factors which predispose parents to be active participants in their children's learning. *Many questions are raised by research of this type – Are some children discriminated against or disadvantaged as a result of their parent's attitude towards providing help at home? What can or should be done about home differences?*

The research evidence is clear that some measure of parental involvement in children's education is a critical link to achieving high quality education (Fraser, 1989; Sloneic & Del Vecchio, 1992; Tobin, 1993; Walberg, 1981). Other researchers have evaluated a number of strategies designed to enhance and encourage teacher-parent collaboration - through process-based interventions (Serpell, 1995; Kellaghan, 1993); via the development and maintenance of cultural awareness and ethnic identify programs (Duquette, 1996; Stavick, 1994); through inter-generational literacy programs (FILM, 1994); via the innovative and highly successful BUDDY System (McMahon & Duffy, 1993); and through collaborative study skills programs (Ban, 1993). The degree to which the strategies can be related to the specific needs and interests of parents and to the unique situations of schools and teachers, appears to have a strong influence on the level of success (Bauch, 1990).

The Changing Face of Australian Classrooms

Additional importance is attached to this problem if we recognize that most school classrooms in Australia are becoming increasingly multicultural in nature. Many of our students come from home environments and communities with widely different cultural practices. There is an increasing need for teachers to be sensitive to the important cultural milieu into which their teaching and learning are to be placed (Thaman, 1993). In some cases, the teaching strategies being utilized in secondary school classrooms throughout multicultural Australia are often perceived as being in conflict with the natural learning styles of the students, their home learning environment, mores and values (Waldrip, 1994; Sloneic & Del Vecchio, 1992). These disparities can also be exacerbated by continued inappropriate selection of teaching and learning strategies (Giddings & Waldrip, 1994). Okebukola (1986) reminds us that the cultural and home environment background of the learner may have a greater effect on learning than does the substantive nature of the course content.

The recognition of home environment as an important variable in determining positive educational outcomes was recognized in Walberg's (1981) well-regarded model of "educational productivity" which suggests that nine factors require optimization in order to increase affective, behavioural and cognitive learning. Figure 1 shows a subsequent adaptation for multicultural classrooms.

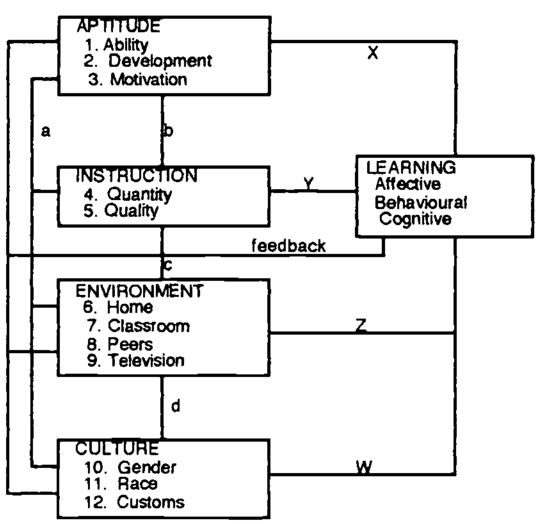

Figure 1. Educational Productivity Model Within Multicultural Classrooms (Waldrip & Giddings, 1996).

These causal influences of student learning include a set of aptitude variables (Ability, Development & Motivation), a set of instructional variables (Quantity & Quality) and a set of environmental variables (Home, Classroom, Peers & Media). Waldrip and Giddings (1996) have argued that a fourth set of variables (under the broad heading of Culture) should be included. Importantly, this study utilizes an instrument (Giddings & Waldrip, 1997) of which one major component measures aspects of a student's cultural expectations and preferred classroom environment (*the Multicultural Classroom Learning Environment Inventory (MCLEI*).

Individual perceptions, rather than class perceptions, are particularly important when we try to ascertain the way in which different subgroups within a class perceive different sub-environments created by the teacher and the class. Consequently, Fraser, Giddings & McRobbie (1995) developed a Personal Form of one of their well-established instruments (the Science Laboratory Environment Inventory) that parallels its Class Form. In similar vein the MCLEI (See Table 1) was specifically designed to tap into an individual's perceptions of his/her learning environment on dimensions relating to culture.

In an interesting and useful line of examination of multicultural settings, Hofstede (1984) meta-analysed data collected from samples of multicultural groups and organizations identifying four dimensions of culture, namely, Power Distance, Uncertainty Avoidance, Individualism, and Masculinity/Femininity. Hofstede' work was based largely on psychology, organization sociology and management theory. This study utilizes an instrument, *the Multicultural Classroom Learning Environment Inventory (MCLEI)*, that contains scales which reflect these four dimensions. This instrument is a significant refinement of a set of cultural scales reported previously (Waldrip and Giddings, 1994).

The Moos (1979) human environment dimensions were also utilized in the design of this instrument. Moos (1979) identified three basic types of classification for assessing human environments: a ***Relationship Dimension*** that assesses the extent of interpersonal support and help between participants; a ***Personal Development Dimension*** that assesses personal growth and self-enhancement; and a ***System Maintenance and System Change Dimension*** that measures rule structure and its response to change. For a learning environment instrument to provide a complete picture of a learning environment, aspects of each of these dimension should be assessed. In the table that follows (Table1) scale names, scale descriptions, scale derivations and sample items are summarized.

Scale	Description	Derived From	Sample Item
Communication	Measures the extent to which students share and communicate their ideas with each other.	Hofstede: Individualism vs Collectivism Moos: Relationship *Sociology, Anthropology, Management theory*	'I like to explain my ideas to other students.
Competition	Measures the extent to which the students feel threatened by competition from other students	Hofstede: Uncertainty Avoidance Moos: Personal development *Organization sociology* *Anthropology*	I like to try something even if I might make a mistake.
Authority	Measures the extent to which students control their learning and accept the power distribution within the classroom.	Hofstede: Power Distance Moos: Personal development *Social psychology* *Management theory*	I like to be able to do investigations in my own way.

Relevance	Measures the extent to which students perceive the relevance of what they learn to their own lives.	Hofstede: Masculinity/ Femininity Moos: Relationship *Anthropology*	I like to learn about the world outside the school.
Prior Knowledge	Measures the extent to which students' prior knowledge and experiences are integrated into their learning activities.	Hofstede: Uncertainty Avoidance Moos: System maintenance & change dimension *Organization sociology*	I like my teacher to help me think about what I learned in the past.
Knowledge Transmission	Measures the extent to which students' previous approaches to learning are integrated with new learning approaches.	Hofstede: Uncertainty Avoidance Moos: System maintenance & change dimension *Organization sociology*	I like to help the teacher decide which activities I do.

Table 1. Descriptive Information for Each Scale in the MCLEI Instrument

School Change

Finally, it is necessary to briefly outline the context in which Australian teachers are attempting to improve and enrich their teaching. The late 1980s and 1990s has been an era that has witnessed wholesale restructuring of both public and non-government school systems around the world. The central management mode of the previous century - tight prescriptive control of schools, teachers and the curriculum by and within a centrally devised education system, has been superseded by new designs and solutions, many derived from the private sector (Beare, 1995). Every State and Territory system of education in Australia has been involved in extensive review and restructuring over the past decade, but particularly over the past five years. Amidst the countless reports and strategic plans produced by all States and Territories, a number of common features have emerged which has become the basic fabric on which change is being built throughout the nation. These new structural features include: accent on efficiency and good management practices; devolution of responsibility (Dellar & Giddings, 1991); streamlined political control; emphasis on excellence before equity; the gradual incorporation of national priorities; and the development of a leaner more centralized management structures (Dellar & Giddings, 1997).

From an educational perspective, and in recognition that school-level change has the potential to bring about improvement in the quality of education, the State governments have moved to devolve the decision-making functions within their respective schooling systems. Typically this restructuring process has involved the establishment of "self-managing schools". In such schools, the responsibility for the planning, implementation and review of their educational programs resides with school participants rather than a central office. *Teachers, more than ever before, must now be able to work collaboratively with their colleagues and with members of the wider school community in making decisions about programs and initiatives for the particular students in their schools.* This type of decision-making extends beyond the confines of the individual classroom and may impact on all the other students, teachers and parents throughout the school community.

Militating against the adoption of a genuine whole-school professional perspective by teachers is the prevailing isolation of teachers from each other, the administration and the community (Giddings & Fraser, 1992). This is particularly so of secondary school teachers, where the school tends to be organized around separate teaching areas or departments and teachers are viewed as specialists rather than cross-curriculum generalists. Unfortunately many of the initial changes prompted by devolution, have focused on management and administrative practices -

second order change, rather than on supporting and equipping participants with the necessary skills to extend their professional roles - third order change (Cuban, 1990).

Research Approach

The overall study combines qualitative (interview & case study techniques) and quantitative (questionnaire & Likert-type instruments) methods. The overriding methodology is best described as multi-site qualitative research with the essential strengths of case study methodology being complemented by a comparative perspective. The research consisted of four distinct phases. The first phase of the project involved the identification, development and validation of an instrument designed to measure: (1) characteristics of individual student's home learning environment (e.g. resources available at home, time spent by students on science & school work, language spoken at home, etc); (2) aspects of a student's cultural expectations and preferred classroom environment (*the Multicultural Classroom Learning Environment Inventory (MCLEI)*); (3) student perceptions of classroom environment (utilizing a classroom environment measure based on the Classroom Environment Scale [CES]); (4) previously validated reasoning/inquiry skill test items based on the New Jersey Test of Reasoning Skills(NJTRS) and reported in Lipman (1985); and (5) attitude items from the Test Of Science Related Attitudes [TOSRA] (Fraser, 1979, Fraser, 1981). The development, validation and piloting of this multifocussed instrument were reported in Giddings & Waldrip (1997).

Following the pilot study, the instrument was administered to a comprehensive sample of science students across three Australian states. The total sample involved approximately 1800 students from 60 science classes at the lower secondary school level (spread approximately equally between Years 8 and 9, each in a different school). These particular state systems were chosen to reflect differences in the ethnic mix of their multicultural classrooms.

The selection of regions and schools was guided by a desire to maximize the application of such generalizations to other contexts. The aim was to select regions as similar as possible, particularly in terms of their socioeconomic characteristics. While there will inevitably be differences between regions, it is hoped that some of the extreme differences can be reduced so as to provide a better basis of comparison from one State/Territory to another. The choice of state schools in preference to private or Catholic schools was designed to enable a more comprehensive investigation of systemic influence, an important variable in the Australian context. With the assistance of regional officers, the intention was to make the schools as representative as possible in terms of socioeconomic characteristics.

The second phase of the study, and reported in this paper, focussed on the data obtained by this instrument relating to associations between scores on the science reasoning/enquiry skills test, cultural and attitude items, and identified characteristics of the home learning environment (e.g. resources available at home, time spent by students on science & school work, language spoken at home, etc).

The third phase (currently being undertaken during 1999) involves a closer case study of two representative schools in each State. Again, the selection of regions and particular schools from within those regions, was guided by a desire to maximize the application of any generalizations to other Australian contexts. Both subjective impressions and responses to the student and a new parent instrument guided the selection of subjects for the qualitative aspects of the study. The basic aim of this phase is to try to understand the teaching of science, mathematics and technology from the perspectives of the individual students, teachers and parents - through their eyes.

The fourth and final phase of the project involves the development, implementation and evaluation of a school-based professional development model, which incorporates home environmental factors in its design. This phase of the study is intended to offer more than the results of a number of traditional case studies, because as the initial focus of analysis was the individual teacher, student and parent, the perspectives of these people will be essential in understanding the perspectives and problems of teachers and parents in general. Additionally, in this way the research findings will be able to be translated into strategies, structures and processes that can be applied across a wide range of Australian secondary school settings. It is hoped to report details on these two phases at NARST 2000.

Results

(1) Associations between Cultural Scales (MCLEI) and Learning Environment (CES)

Associations were explored between the MCLEI scales and the five learning environment scales (Affiliation, Involvement, Teacher Support, Task Orientation, Order & Organization). Results indicated that when students found that the manner in which things were learned at home clashed with their school-based learning experiences, they found their school a somewhat confusing experience. That is, they perceive their environment less favourably.

Similarly, students who revealed that they had a high respect for authority (and authority figures) saw their preferred classroom environment as being one which is characterized by higher affiliation, teacher support, and order/organization, compared to those who had a lower respect for authority. In particular, these students preferred a much higher level of order and organization. Students who were not threatened by competition tended to react positively to closer ties with fellow students, viewed teacher support as being positive and non-threatening, and were much more likely to become involved in various forms of classroom interaction. Students who revealed through the culture questionnaire that they viewed many classroom roles as being gender-related saw teachers and students with distinct gender roles in the classroom and tended to seek a classroom environment that was highly ordered, organized and on-task.

(2) Associations between the Cultural Scales (MCLEI), Attitude, Reasoning/Inquiry Scores

Simple correlational analyses were used in examining the degree of association between each of the MCLEI scales and students' attitudes, and between each of the MCLEI scales and raw scores on the reasoning/inquiry items. All the scales of the MCLEI were found to be associated with the two outcome measures.

These general associations were further investigated using multiple regression. These multiple regression results were obtained when the whole set of six environment scales were separately regressed on attitudes and inquiry skills. Beta weights and significance levels were also carried out for each MCLEI scale and it is noteworthy that there was a significant degree of congruence when compared to the simple correlational analysis. This process revealed that the number of significant regression weights, was four for attitudes (Communication, Competition, Relevance & Prior Knowledge) and two for reasoning/inquiry (Authority and Prior Knowledge).

The extreme values for each of the MCLEI scales (Communication, Competition, Authority, Relevance, Prior Knowledge & Knowledge Transmission) can be characterized in such a way to reflect a number of distinct profiles of "typical" Australian (Year 8 -9) science students. Table 2 outlines the scale names and the continuum dimensions (as reflected by the extreme values) for each of the MCLEI scales.

Scale	Continuum Description
Communication	Collaborative vs Individual
Competition	Competitive vs Uncompetitive
Authority	Democratic vs Autocratic
Relevance	School Science vs Real Science
Prior Knowledge	Curiosity vs Subject Oriented
Knowledge Transmission	Student-centred vs Teacher-centred

Table 2. Continuum Dimension for MCLEI Scales

The following three profiles reflect some of the variations derived from considering the associations of such dimensions with achievement in science (raw scores on the reasoning /inquiry items).

Profile # 1 – Students who revealed themselves to be highly competitive, preferred a non-collaborative, teacher-centred approach to learning, and enjoyed a school science (textbook) approach to their studies, tended to achieve higher scores on the science reasoning/inquiry skills test.

Profile # 2 – Students who revealed themselves to be non-competitive tended to be those students who favoured student-centred teaching which focussed on real-world science and were curiosity driven in their view of science. Students with this profile tended to achieve in the middle range of performance on the science test, although the standard deviation revealed large differences between the best and worst students.

Profile # 3 – Students who performed poorly on the science test tended to be those students who saw little congruence between their school approach to science learning and what they saw in the real-world (home & society), were non-competitive, and did not have any strong views on the kind of classroom approach they preferred their teachers to take.

Students' degree of "enjoyment of science" (TOSRA scale) in relation to their achievement in science (raw scores on the reasoning /inquiry items) is shown in Figure 2. The relationship appears to be a direct one.

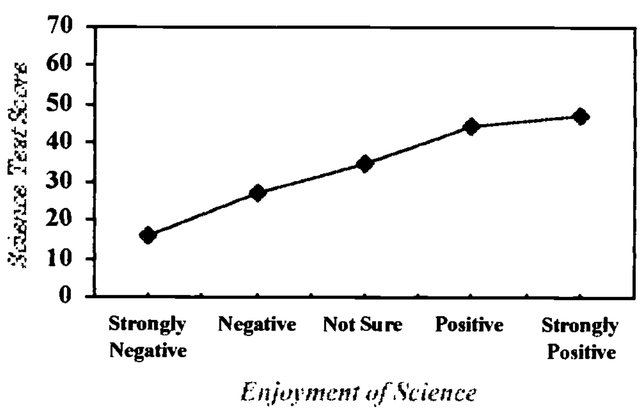

Figure 2. Enjoyment of Science

Although the correlation is not high it does reflect a significant association (0.27), and as a group an interesting pattern is identifiable. It appears that there is a positive relationship with the variable "enjoyment of science", but that its effect is most strongly noted at the negative end of the attitude scale and reaches a plateau as the students are identified as having a positive attitude towards the subject.

(3) Associations between Home Background variables and Reasoning /Inquiry Scores

The instrument used in the study identified a number of characteristics of the student and his/her home learning environment (e.g. resources available at home; time spent on science & other school work, country of birth of parents & students, language spoken at home, etc). Three specific variables are discussed in this paper. The are: the language spoken at home; home technology access (computer/educational software[Encyclopedia Britannica CD]/ internet); and time spent on science at home (homework, interest, hobbies).

Across countries, an important variable in explaining student achievement, particularly in literacy and related subject areas, has been whether the main language spoken at home is also the main language of instruction. This part of the study supports this contention for science learning. Figure 3 indicates a strong pattern of achievement favoring English speakers over both mixed language home environments and non-English speaking environments.

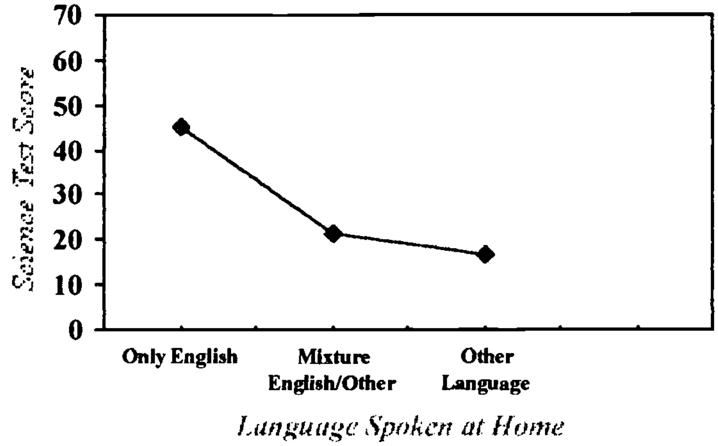

Figure 3. Language Spoken at Home

Students' access to information and technology within the home was measured in relation to the four identified categories of the "Technology Access" variable which were designated as – no computer, computer, computer + (computer plus educational software), and internet (computer + internet access). Graphic illustration of what a correlation of about 0.25 (indicating significant association) between this variable and the students' achievement in science (raw scores on the reasoning / inquiry items) is shown in Figure 4.

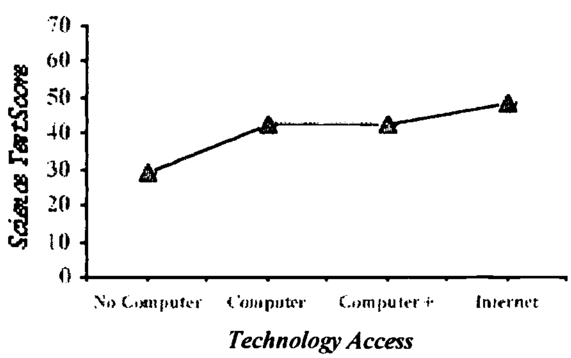

Figure 4. Technology Access

There would appear to be a "diminishing return" effect with respect to this variable in that this variable had a positive relationship with the students' achievement in science (raw scores on the reasoning / inquiry items), but that it reached a plateau once there was regular computer access in the home.

The instrument used in the study identified a number of characteristics of the student and his/her home learning environment. One important characteristic included data pertaining to the time spent on science at home (homework, interest, and hobbies). Out-of-school hours per day spent on homework has previously being positively related to achievement in a number of IEA studies (Keeves, 1995). In this case where an estimate was made of all out-of-school science activities undertaken by the student (including formal school set homework), the variable had a low (0.21) but significant positive correlation (see Figure 5).

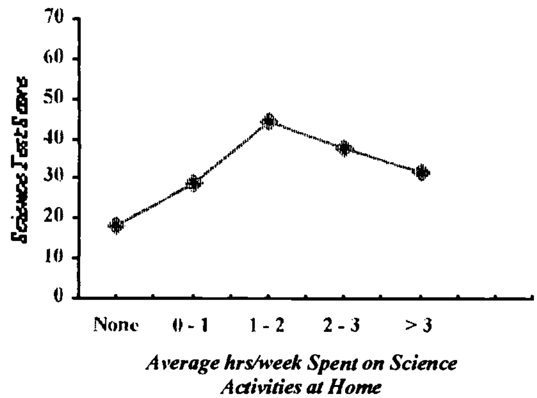

Figure 5. Average hrs/week Spent on Science Activities at Home

Again a diminishing return effect seems apparent, where up to an average of two hours per day would seem to be positive; but that beyond this timeframe, the relationship appears quite problematic – possibly due to the poorer students being required to do more formal homework to keep up with the rest of the class. This would balance the extra time that the really "keen" student may spend on other out-of-school science activities that were not strictly speaking related to set homework.

Overview

The outcomes of this research relate specifically to each of the key stakeholder groups – students, teachers and parents. Sensitive quantitative and qualitative data collected on how students and their parents perceive the learning environments at home and school can be an essential base for the development of any innovative framework of new strategies and structures to be implemented by teachers and parents. Parents are natural teachers, able to reinforce the natural curiosity of their children and provide ongoing encouragement and support.

The rapid onset of the Information Age has however, begun to put enormous strain on parents' knowledge, skills and motivation to help and support their children. This research project therefore, has the potential for identifying and codifying home learning environment and parental factors in the unique multicultural settings within Australian schools and for the establishment of research-based initiatives for more effective collaboration between schools and parents. Currently the case study phase of the project is examining individual schools, teachers, students and their parents is an attempt to identify strategies and interventions that will stimulate parents to become informed, active participants in their children's learning and to provide them and their children's teachers with sound well researched curriculum frameworks and strategies to achieve this task.

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