

Science and Mathematics Education Centre

**A Strategy for Enhancing Girls' Attitudes Towards
Professional Careers in the Mining Industry**

Carolyn M Somerville Brown

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ABSTRACT

The problem addressed in the study concerned the lack of attraction of girls into professional Mining Industry (MI) careers. The study had four main objectives. The first was to review the literature to determine the reasons why there were so few women currently in MI careers, and then to describe strategies that have been successfully used to increase their participation. It quickly became apparent that while little research could be located relating directly to MI, the broader fields of science, engineering and technology (SET) could be reviewed to include the subset of mining-related careers.

The second objective was to determine the attitudes towards MI careers of a select group of Year 10 schoolgirls, with the ability to proceed to the tertiary prerequisites for MI courses. This was accomplished through the development, implementation and statistical analysis of an instrument, the Mining Industry Attitude Survey (MIAS), designed specifically to focus on MI-related careers, rather than SET generally.

The third objective was to develop and implement appropriate intervention strategies aimed at enhancing the attitudes of the group of girls, as determined through analyses of MIAS and related research. Under the auspices of the Western Australian School of Mines Engineering and Technology Camp, conducted annually in Kalgoorlie, a program of strategies was adapted and implemented over a period of five days at the residential camp.

The final objective of the study was to determine if the intervention program did, in fact, enhance participating girls' attitudes. Using quasi-experimental research methods, quantitative data were collected and analysed from girls attending the camp, as the experimental group, and from applicants that did not attend as the control group. In addition, qualitative data were collected from select girls in the experimental group, during the camp program.

The outcomes of the study are set out in terms of the main objectives, culminating in a discussion of the implications which the stated findings pose for researchers, practitioners of equity programs and employers of future MI graduates.

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The 1995 WASM Engineering and Technology Camp was put together with the help of numerous staff and students from WASM, the staff of Agricola College, women working in the mining industry and the sponsoring mining companies. The cooperation and support of this number of people was greatly appreciated and contributed towards the success of the camp and the enjoyment of the participants. In particular, I would like to thank Ms Sharlene Andrijch, the assistant supervisor at the 1995 WASM Camp, for all her efforts in making the camp a smooth and efficient one.

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CHAPTER 1

INTRODUCTION

BACKGROUND TO THE STUDY

In Australia, the participation of women in all sectors of the workforce, and at all levels, is now viewed not only an issue of equity, but also an economic necessity. The Commonwealth Government, in *Developing Australian Ideas, A Blueprint for the 1990s* (Science and Technology White Paper, 1992), advocated making maximum use of our strong science and engineering base if Australia is to remain internationally competitive. To achieve these goals, the White Paper recognised the importance of utilising the talents of all Australians for the development of our scientific and technological future. The Paper was produced at a time when Australian Bureau of Statistics figures showed women in professional engineering and science careers at 2.9% and 29% respectively (Australian Bureau of Statistics, 1993). Moreover, few women in Australia sought employment in the mining (and minerals) industry (MI) or enrolled in courses of study leading to professional careers within the field. As a significant employer of Engineering and Science graduates, with a higher than average proportion of employees with post-school qualifications, the Australian Mining Industry commanded only 8.7% female employees in all areas of their employment (Australian Bureau of Statistics, 1993). Yet, the development of new technologies for the exploration, extraction and processing of minerals reinforces the need for many more graduates in mining-related engineering and science degrees, of which women represent even today an untapped source. Thus, the under-representation and under-participation of women in the MI-related disciplines of SET have become a cause for concern in our society.

The Sex Discrimination Act 1984 and The Affirmative Action (Equal Opportunity for Women) Act 1986 have ostensibly removed the opportunity and access barriers for women to MI careers. MI-specific career information is widely disseminated from Curtin University of Technology (W.A.), and The Chamber of Mines and Energy (W.A.) is active in its promotion of the industry. Nevertheless, although women comprise 51% of Australia's population, and female enrolments at Curtin University of Technology (W.A.) are representative of our population, their

proportion of enrolments in professional MI courses has peaked at only 14.6% (Curtin University Statisticians Office, 1994). Why is it, then, that exceptionally few women are attracted to MI careers?

The Women into Engineering and Technology Project

In an attempt to redress the problem of under-participation of women in SET courses (including MI courses), the Women into Engineering and Technology (WIET) Project was established in 1992 at Curtin University of Technology (W.A.). Among the principal objectives of the WIET Project was the aim of increasing female enrolment and retention rates in MI-related courses at Curtin University in Perth and particularly the Western Australian School of Mines (WASM) in Kalgoorlie. Consequently, between 1992 and 1996, the WIET Project has notified all female and co-educational high schools in Western Australia, of the annual "WASM Engineering and Technology Residential Camp" (WASM Camp) for Year 10 girls, held in Kalgoorlie. In 1995, girls intending to apply for the camp were invited to participate in this study.

Typically, camp running costs were met by student sponsorship from numerous companies within MI and by Curtin University. In addition, staff and students at WASM volunteered their time and effort to conduct activities for camp participants. Therefore, the WASM Camp was conducted entirely free of costs for all successful applicants. In 1995, sufficient funding was raised to accommodate 32 students and three secondary school teachers.

THEORETICAL FRAMEWORK OF THE STUDY

The Eccles Model Theory

The theoretical framework behind this study was based on the developmental model of Jacquelynne Eccles and her colleagues (1989) for girls' educational and occupational choices. Eccles argues that the under-representation of females in maths and science is due to, firstly, sex-differences in students' confidence in their maths ability compared with ability in English; and secondly, to the relative value students attach to activities and careers involving maths and physical science, compared to the value they attach to other subject matter areas and occupational fields.

The developmental model is based on the findings from two large-scale longitudinal studies conducted by Eccles (1985) at the University of Michigan, of mostly white, middle-class fifth to twelfth graders in south-eastern Michigan, and their parents and maths teachers. Essentially, Eccles argues that because of our culturally based gender-role system affecting the beliefs and behaviours of adults and teachers, and because of the absence of accurate information on which to base their stereotypes of adult occupations, girls develop less confidence in their maths ability, less interest in studying maths and science, and less interest in pursuing SET careers. A general summary of the mediators and their relation to expectations, values and achievement behaviours is depicted in Appendix A (Eccles, 1989, p.38). The consequence for many girls is actualised as negative or ambiguous attitudes towards SET careers.

Furthermore, the developmental model suggests that strategies for change include:

1. Active career counselling from teachers
2. Gender-inclusive hands-on teaching practices
3. Active attempts to change the student's gender-role stereotyped beliefs, self-concepts and values
4. Exposing students to minority and female role models

Consequently, to address the problem of under-participation of women in SET careers, initiatives for schoolgirls, in the form of residential camps and short courses, have become increasingly popular. As the Eccles model would suggest, strategies involving a combination of university-based workshops, career discussion sessions, industry visits and the presentation of female role models, have been trialled for girls at residential camps (Davis & Hollenshead, 1991; Wilkinson, 1992, unpublished paper), and day-programs (Brown, 1993; Evans, Whigham & Wang, 1995, Godfrey, 1997). Initial short-term success in terms of attitude changes towards engineering and science careers have been reported.

STUDY RATIONALE

Both nationally and internationally, few if any of the camps and short courses previously described have specifically documented their objectives as attempts to attract more women into MI careers. While reviewing the literature, it became clear

that there have been no recent studies expressly examining girls' attitudes towards MI careers or their prospective participation within the industry. Hence the WIET Project was timely with its strategies designed around what was currently known about girls' attitudes towards MI careers.

Under the auspices of the WIET Project, the rationale for the development of an instrument to effectively measure girls' attitudes towards MI careers was to implement and evaluate appropriate intervention strategies that were designed to result in enhanced attitudes for participating girls. The desirable consequence of enhanced attitudes is the increased enrolment of girls in MI courses.

OBJECTIVES

In broad terms, this study aimed to develop, implement and evaluate a program of strategies intended to enhance the attitudes of a specific group of Year 10 girls towards professional careers in MI. More specifically, the study had four main objectives. Firstly, a review of the literature would be used to determine the main factors influencing the low participation of women in professional SET careers, and to describe strategies successfully employed to attract more girls into SET courses and ultimately SET careers.

The second objective was to develop, implement and evaluate a valid and reliable instrument to determine attitudes towards MI careers of a select group of Year 10 schoolgirls capable of undertaking the tertiary prerequisites for MI courses.

The third objective of the study was to develop and implement a program of appropriate intervention strategies that would enhance the attitudes of the Year 10 schoolgirls, as determined by the instrument, and from the literature review.

The final objective was the evaluation of the intervention program to determine if the girls' attitudes towards MI careers were enhanced.

RESEARCH QUESTIONS

Through the use of rigorous and established empirical research methods, the study attempted to answer the following research questions to determine whether the objectives were achieved:

- 1) (a) Which are the main factors influencing the low participation of women in SET careers?

- (b) Which intervention strategies have been successfully employed to attract more women into SET careers?
- 2) What are the attitudes of a specific group of Year 10 girls in WA, towards MI careers?
 - 3) Which strategies appear likely to enhance Year 10 girls' attitudes towards MI careers?
 - 4) Will the implementation of appropriate intervention strategies enhance girls' attitudes towards MI careers?

RESEARCH METHODOLOGY

The research described in this study consists of four parts as follows:

1. Target Group for the Research

MI course prerequisites are mostly limited to students with high ability in school mathematics and science and would necessarily include students with an interest in SET or MI careers. Therefore, all Year 10 girls in WA fulfilling the above application criteria were invited to apply for the 1995 WASM Engineering & Technology Residential Camp and to participate in this study. Camp places were filled on a "first-come-first-served" basis.

2. Developmental Phase

To determine Year 10 girls' attitudes towards MI careers, an attitude survey was developed from research in related disciplines, and previous WASM Camp data. All prospective participants of the 1995 WASM Camp were asked to complete the attitude survey ("precamp survey"). Analysis of the precamp survey, together with the literature review, were used to develop new intervention strategies or modify existing ones in an attempt to enhance girls' attitudes towards MI careers. Following on from the successful attitude changes achieved by Brown (1993) and Evans et al (1995), an underlying theme encompassing the intervention program, was the presentation and involvement of professional female role models wherever possible.

3. Implementation Phase

The approach used in this study employed pretest-posttest data collection and experimental-control groups of subjects. However, due to the nature of MI course-entry criteria, total random selection of subjects was not considered appropriate.

Thus the methodology is described as quasi-experimental research as defined by Wiersma (1991). All WASM Camp applicants were asked to complete the attitude survey before (pretest) and after the camp (posttest). The intervention strategies employed, as the experimental treatment, involved the 32 students attending the 1995 WASM Camp. The dependent variable in the study was the attitudes of participants on the Camp. Students comprising the experimental group were those with successful camp application, while unsuccessful applicants comprised the control group.

4. Evaluation Phase

Both quantitative and qualitative analysis of the data was undertaken in this study. To determine the effect on girls' attitudes resulting from implementation of the intervention program, attitude changes were calculated for both the experimental and control groups, and between the groups, using standard statistical methods. In addition, audio-taped recordings with selected camp participants and researcher observations of student behaviour added to the quantitative data, in an attempt to further interpret attitude changes and define intervention mechanisms.

SUMMARY OF FINDINGS

A summary of the main findings of this study, within the context of the study's objectives, and as answers to the research questions, are presented in the following section.

Objective/Research Question 1

The review of the literature indicated that the reasons for few women entering SET courses and careers could best be described through an examination of a broad range of influencing factors, the majority of which act collectively to culminate in negative or ambiguous attitudes. The factors, within the framework of the Eccles model firstly included girls' expectancies for success, as described by:

- the confidence of girls in their maths and science ability;
- the different career aspirations and expectations of girls;
- the encouragement received from home, school and industry to pursue SET careers;

- the stereotyped image of SET and of the people working in SET careers
- girls' interest in school maths and science and subsequent SET careers
and secondly, the importance of the task's value, as described by:
- girls' perceived value in school maths and science and subsequent SET careers.

In addition, a number of "institutional filters" may also result in few women undertaking or completing SET courses, namely:

- course disenchantment,
- a lack of suitable role models and mentors,
- limited or inaccurate career information,
- the maths and science prerequisites for entry,
- the influence of the "critical mass" of women in particular SET disciplines.

While the target group, setting, duration and specific objectives of programs varied greatly, the majority of reviewed programs aiming to attract more girls into SET careers tended to employ many of the same strategies. Almost all programs were single-sex, and either by design or co-incidence, most programs made use of female role models to organise and facilitate activities for girls.

The majority of programs offered participants a variety of activities including "hands on" workshops (Godfrey & Roxborough, 1992; Godfrey, 1997), field trips to local scientific and engineering establishments and seminar-style presentations from professional women in SET (Davis & Hollenshead, 1991; Farmer & McGowan, 1991; Hisscocks, 1993; Wilkinson, 1992, unpublished paper). Several programs included individual project work (Davis & Hollenshead, 1991), round table "questions and answers" (Brown, 1993) and even role playing (Davis & Hollenshead, 1991).

Although intervention programs in this study were reviewed because of their reported successful enhancement of the attitudes of participating girls, the empirical data to support findings were occasionally limited from some programs, often by intent, but sometimes through lack of rigour.

Objective/Research Question 2

To determine the attitudes of a select group of Year 10 girls towards MI careers, the Mining Industry Attitude Survey (MIAS) was developed and implemented prior to any intervention activities. MIAS was based on a synthesis of

similar surveys developed for SET, the literature review, and from data collected from earlier MI-based programs offered to girls.

Factor and correlational analysis of MIAS found that the girls showed exceptionally high positive attitudes towards the value of studying maths and science, followed by interest in these subjects. Observations of students during the camp activities revealed that the girls appeared very confident in their maths/science ability and to choose non-traditional careers. Therefore it was interesting to discover that few of the interviewed girls originally listed SET careers among their future intentions. In addition, most did not intend to pursue all four of the school maths/science prerequisites for MI and SET courses.

The girls showed moderately high scores for the category describing the image of professionals working in MI. However, akin to findings by Kahle (1989), similar contradictory results were obtained when individual items within this category were examined. For example, the data indicated that almost half the girls perceived a stereotyped image of a "miner" as typical of work in MI, and almost one third believed they would be treated differently because they are female. Thus, perhaps not surprisingly, their perceived image of MI and of the value of work undertaken by professionals in MI rated moderately, in keeping with studies by Byrne, (1994) and Dillon (1986) respectively.

However, the girls' knowledge of MI courses and career paths were very limited, especially in the area of their knowledge of the tasks performed by professionals working in MI. In addition, none of the participating girls had had significant interaction with women working in MI, and most were unfamiliar with the Kalgoorlie mining region and WASM. These findings support the data obtained from previous WASM camps (Somerville Brown, 1992-4, unpublished reports).

Objective/Research Question 3

The strategies most likely to enhance girls' attitudes towards MI careers were those that increased their knowledge of MI courses and career paths, and especially the day to day tasks that may be undertaken in MI jobs. The activities should necessarily be presented with the framework of the reported success of reviewed intervention programs developed to attract girls to pursue SET careers. Moreover, because this study utilises the Eccles model (1989) to bring about attitude changes, it

was reasonable to also base activities on the strategies suggested by the model. Thus "hands on" workshops, industry visits and interactive career seminars were designed with diversity and sustaining interest in mind. The involvement of professional female role models in all activities overcame girls' prior lack of contact, and their stereotyped perceptions. Also by necessity, the program needed to be residential at WASM in Kalgoorlie, in order to satisfy the above intentions.

The opportunity to freely discuss pertinent issues and consolidate career and other information was deemed an important influence for attitude change. Therefore, a relatively new concept in the form of a "discussion night" with female role models, was conducted on the final evening of the camp program. The girls were asked to consider, before and after discussion with the role models, the main reasons there were so few women in MI. As discussed further in the next section, their reasons changed dramatically by the close of the activity.

Objective/Research Question 4

Analysis of MIAS indicated that the majority of attitudinal mediators targeted through the intervention program showed significantly increased mean scores from pretest to posttest for girls in the experimental group. In comparison, girls in the control group achieved an educationally significant increase in only two of the eight attitudinal mediators developed in MIAS.

For girls attending the WASM Camp, the greatest positive changes occurred for the attitudinal mediators describing the image of professionals working in MI and student knowledge of MI careers. By contrast, the attitudinal mediator describing girls' perceived value of school maths and science showed very little change between pretest and posttest. However, it is noted that the intervention strategy was able to maintain the exceptionally high mean score of this particular category.

The industry tour strategy appeared to have a negative effect on girls' attitudes in terms of the image of MI, but did appear to increase attitudes in terms of the image of professionals working in MI and in describing the tasks involved. Strategies involving female role models and "hands on" workshops appeared the most enjoyed, through observation of students and interviews with them.

Interviews with camp participants following the intervention program revealed that the majority of those interviewed now intended pursuing more of the four MI-prerequisite maths and science subjects in upper school, than before the

camp. In addition, prior to the camp, few students claimed an interest in SET careers (including MI), but were more inclined towards education and Arts-based careers. Following the intervention program, interviewed girls now included MI-careers among their scope of career interests, particularly Metallurgy. Only one girl claimed MI-engineering courses among her new career interests.

VALIDITY AND RELIABILITY ISSUES

Limitations of the Study

While every attempt has been made to maintain the rigour of this study, there are some limitations in the design and procedures of the research that require consideration when acting on the assertions and recommendations contained within. Firstly, the results and conclusions were based on a small sample of the population of girls (32 in the experimental group) able to proceed to the upper school prerequisites for MI courses. In addition, only ten out of the original 25 girls in the control group submitted postcamp MIAS in time for analysis. Secondly, while triangulation of qualitative data was undertaken for girls in the experimental group, comparable interviews were not conducted with girls from the control group following camp closure. Although it is apparent that answers to certain questions would require actual camp participation, sufficient information may have been obtained from control group participants to enable stronger inferences regarding the effectiveness of the intervention.

Validity

Although participant attendance at the camp was not through any recognised form of random assignment of subjects to experimental treatments, the external validity of this study remains sound. The nature of MI course-entry criteria limits applicants to high ability mathematics and science students. Further, student self-selection on the basis of interest, availability to attend, or any number of other possible reasons does not greatly limit external validity as it was not the intention of this study to enhance attitudes of the general female population. Instead, the intervention was appropriate for those girls who currently meet MI course entry requirements and were able to partake in the WASM Camp at the time of offer. This would be the case generally for female students available to undertake MI courses.

Tuckman (1988) states that research of quasi-experimental nature necessarily implies that there is control of some, but not all, sources of internal validity. Since the WASM Camp had an attendance quota, applicants not attending the camp acted as the control group. Thus, control for selection bias was through assignment of participants to groups based on order of receipt of applications, over which this researcher had no influence, and the applicants had no special knowledge. Further, as demonstrated in Chapter 3, equivalence between control and experimental groups was established through the analysis of the precamp survey on attitudes.

Reliability

In order to satisfy research reliability, quantitative material, in the form of precamp and postcamp surveys used in this study, were standardised and all intervention strategies documented to aid possible future replication. Triangulation of qualitative data was undertaken through pretest posttest data collection, review of the literature, and interviews with selected participants in the study. However, due to the qualitative nature of the intervention program and its implementation, the external reliability was somewhat limited.

SIGNIFICANCE OF THE STUDY

In Australia, both state and federal governments actively encourage the development of policy and implementation of strategies to address the imbalance of female participation within SET courses and careers, and their prerequisite school subjects. Thus, this study potentially has implications for initiatives arising out of equity and access programs at tertiary and secondary education levels, and for the formation of required policies.

Findings from this study may be utilised by the MI and the tertiary sector, in their current efforts to increase the pool of prospective employees and students, with particular reference to the emphasis on women, by the following outcomes:

1. Establishment of a valid and reliable instrument for measuring attitudes of girls towards MI careers.
2. Identifying current attitudes of a select group of Year 10 girls, representative of prospective female MI-students in WA, towards MI careers and courses.

3. Increasing the research evidence regarding the effectiveness of some popularly used strategies for the recruitment of girls into non-traditional careers.
4. Broadening the range of currently used intervention strategies that have been utilised to encourage girls to enroll in non-traditional careers.

On an immediate scale, the intervention program appears well-placed to broaden the range of career choices for the 32 girls attending the WASM Camp. On a comprehensive scale, if enhanced attitudes towards MI are realised as greater female participation in MI careers, the technology base of Australia is positioned to benefit through the security of greater numbers and broader intellectual perspectives.

ETHICAL ISSUES

All WASM Camp information sent to schools and students clearly stated that in 1995 applicants would be *invited* to participate in this study, and as such, student participation did not influence the success of their WASM Camp application.

The identity of participants, their high schools and individuals and companies associated with this study will remain confidential, and their privacy respected. Within the above confidentiality constraints, requests shall be met for data or further information relating to this study.

OVERVIEW OF DISSERTATION

Following this chapter, the first objective of this study is addressed through a review of the literature. Chapter 2 begins by presenting the Eccles model (Eccles, 1989) as the theoretical framework for the research undertaken in this study. The chapter moves on to critique the influences of girls' attitudes towards SET careers, as suggested by the Eccles model, followed by a range of popularly employed intervention strategies and their outcomes. Finally, the WASM Camp, as the background for a program of strategies aiming to enhance girls' attitudes towards professional careers in MI, is described.

The second objective of the study has been addressed in Chapter 3 through a description of the research methodology employed and the development and implementation of MIAS, as an instrument to determine girls' attitudes towards MI careers. To address the third objective, the chapter moves on to detail the

methodology employed in the preparation and development of the intervention program (1995 WASM Camp), and its implementation and evaluation.

To address the fourth and final objective of the study, Chapter 4 presents the separate results and analyses of MIAS, researcher observations made during the camp, and audio-taped interviews with camp participants following the implementation of the WASM Camp. The chapter closes by presenting a number of emerging themes that became apparent in examining the full complement of research data.

Chapter 5 begins by presenting a discussion of each of the four research questions in the light of the preceding chapters. Implications for practice have been described for researchers, the mining industry and the university sector. Finally, the conclusions of the study are presented.

SUMMARY

This chapter began by discussing the inequitable patterns of participation for women in SET careers generally, and MI careers specifically. It moved on to describe the WIET Project as a context within which to conduct this study, and to outline the Eccles model (1989) as a theoretical framework for it. Following, the main objectives and research questions for the study were presented, together with the way in which the research was conducted. Finally, issues of validity, reliability and significance of the study have been discussed and an overview of the dissertation was presented.

CHAPTER 2

LITERATURE REVIEW

PURPOSE

The purpose of the literature review is two-fold. Firstly, current research is used to develop a reliable and valid instrument to examine the attitudes of schoolgirls towards professional careers in the Mining Industry (MI). The second purpose is to critically assess current strategies used to attract girls into SET careers as a framework for a program of strategies to enhance the attitudes of girls towards professional MI careers.

OUTLINE

In preparing this literature review, it became clear that there have been, of late, no studies specifically examining the reasons contributing towards the low enrolment of women in professional MI courses. However, as tertiary courses leading to professional MI careers require the same school prerequisites as other fields of SET, the same cohort of schoolgirls able to undertake careers in SET are also able to undertake professional MI careers. Thus, similarities contributing towards the low enrolment of women in SET careers in general, and to MI careers specifically, can be assumed.

The first part of the literature review examines a model developed by Eccles (1989), for determining how girls make their educational and occupational choices. In particular, the model determines those factors influencing the entry of girls into school mathematics and science, as prerequisites for SET courses. Thus, it is then possible to build a picture of the prevailing attitudes of girls towards mathematics and science, and consequent SET careers.

The literature (for example Godfrey & Roxborough, 1992) confirms that girls consider the SET industry to be of value in the development of our society, and that engineers and scientists make important contributions towards this development. However, girls have conflicting attitudes towards their own participation in SET careers, and hold stereotyped images of those that work in them. This is an

understandable situation given the lack of opportunity girls have had to observe women working in the SET field, or interact with suitable role models and mentors. In addition, while school mathematics and science are considered important to study per se, and as prerequisites of tertiary SET courses, girls see little value in them and appear reluctant to pursue science-based careers themselves. Consequently, SET courses and careers do not attract significant numbers of girls.

The second part of the review examines the variety and effectiveness of strategies currently in place to foster positive attitudes in girls. Literature from Australia, Great Britain, USA and New Zealand is reviewed to include the diverse range of intervention programs in use. The large majority of strategies utilise professional female role models in most aspects of their program. Also, the recurrent theme of giving girls a “taste of technology” with “hands on” workshops, projects and other group work follows along the lines of school-based “work experience”. Unfortunately, many authors and co-ordinators of SET programs for girls do not support program strategies with relevant evaluative research, but rather make intuitive claims of what “should” work or has been done before. Additionally, while most authors have reported successful programs in terms of enhanced attitudes, few have supported their claims with empirical data or controlled for relevant variables. Even fewer programs have claimed success in terms of attracting significant numbers of girls to tertiary SET courses, as a consequence of intervention strategies implemented.

Thus, in the light of current research and as a basis for developing/refining an intervention program, the literature review was utilised to develop an instrument to assess the attitudes of girls towards professional MI careers, and, subsequently, to assess the effectiveness of intervention strategies employed. From the range available, those strategies that had been used effectively to enhance girls’ attitudes towards SET careers were identified for modification, if necessary, to be applied to enhance girls’ attitudes towards MI careers.

BACKGROUND

The under-participation of women in the broad disciplines of engineering and science, has been documented and recognised as a cause for concern of Australia’s technological future (Free, 1992; Byrne, 1993). While attitudes of girls towards

these careers have been examined, and strategies implemented to increase their participation, as indicated earlier, few if any studies have focused on professional careers in the mining industry. This is a matter of concern, given that, at present, less than 9% of those pursuing professional careers in mining-related engineering and science fields are women.

A Model for Educational & Occupational Choices

To determine why so few girls are attracted towards professional MI careers, it must first be established which factors are important in determining the educational, and subsequent occupational choices of girls. Currently, unless girls have the relevant school mathematics and science prerequisites, they are almost certainly disqualified from enrolling in MI courses. Therefore, to identify influences in science/maths choice at high school level, the Eccles (1989) developmental model for educational and occupational choices is used as a framework for this thesis.

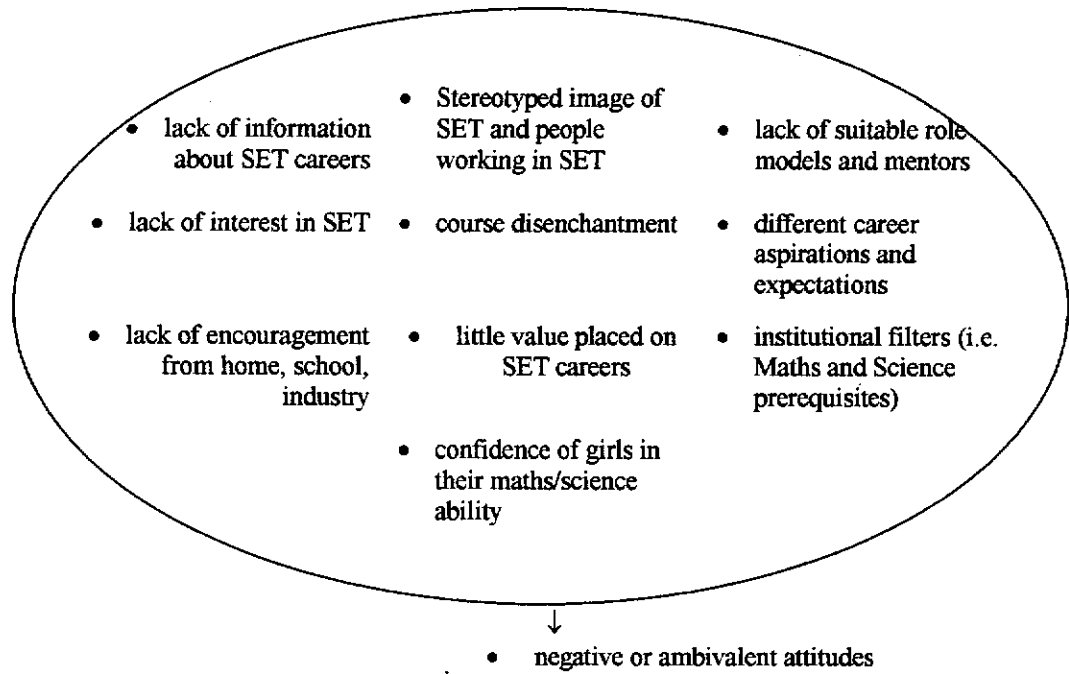
Eccles links academic choices to expectancies for success (defined in terms of confidence in one's abilities and performance) and to the importance of the task's value (defined in terms of interest in the subject matter, and the perceived importance and utility of the subject area). Thus, the Eccles model is built on the assumption that an individual's interpretation of reality has a more direct influence on their expectancies, values, and achievement behaviours than their actual past successes or failures. Her findings indicate that the low entry of girls in school maths and science is due to sex differences in students' confidence in their maths and English ability and the relative value they attach to activities and careers involving maths and science.

Eccles also provides evidence for the powerful influence parents and teachers have on the confidence of girls in their own ability in maths and English, and the subjective task value of these subjects. Additionally, the model suggests that gender roles can affect both educational and occupational choices of girls through direct impact on interests and values in mathematics and physical sciences. Stereotypical gender role beliefs by most girls contribute towards the masculine image of SET careers. Thus, as one would expect, SET careers, of which MI is a branch, have a less positive value for females.

A general summary of the mediators contributing to the low participation of women in SET careers is depicted in Figure 2.1. These mediators, either separately

or in combination, may culminate in negative or ambivalent attitudes in girls towards SET careers.

Figure 2.1 Major Reasons for Few Women Entering SET Careers



From the array of factors listed in figure 2.1, the issues of “institutional filters” and course disenchantment are topics requiring institutional changes in policy and curriculum. While noting their importance to the entry and subsequent retention of women in SET courses, little change can be effected that will directly influence the educational choices of a cohort of girls such as those in this study. Thus they will not be examined further.

Specifically then, in terms of the study reported in this thesis, the Eccles model would suggest that the attitudes of girls, as defined by their educational and occupational choices, may be influenced by strategies concentrating on:

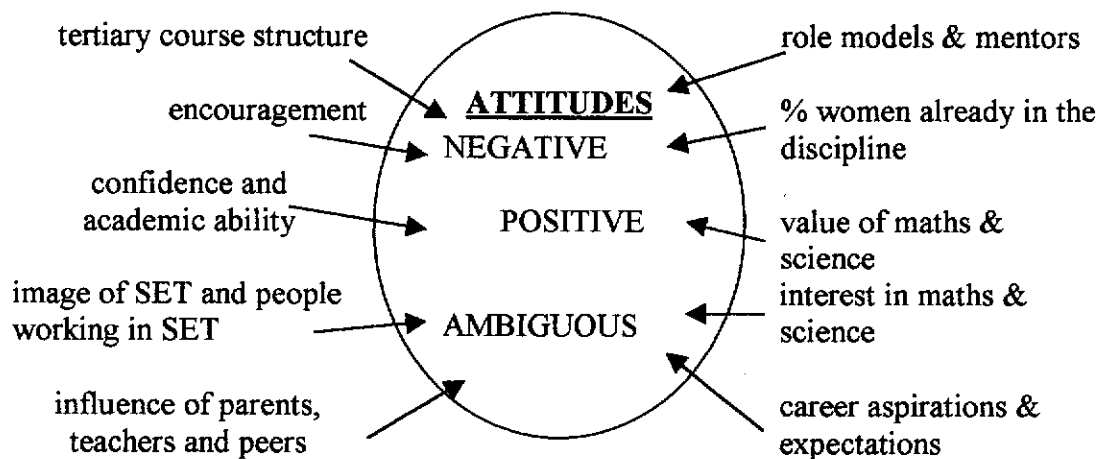
- interest in the subject matter;
- value and perceived importance of the subject;
- confidence of girls in their own ability;
- the image of SET careers and of the people working in them;
- the presentation of suitable role models and mentors;
- accurate career information;
- examination of career aspirations and expectations; and,

- general encouragement.

MEDIATORS OF ATTITUDES TOWARDS SET CAREERS

In the interest of efficacy, attitudes are discussed towards SET careers as a whole, while noting that girls' attitudes towards some areas, for example, biology and environmental engineering, may be more favourable than their attitudes towards physics and geology (with consequence for greater numbers of females in biology and environmental engineering careers). Figure 2.2 depicts those factors contributing towards the range of girls' attitudes towards SET careers.

Figure 2.2 Factors affecting attitudes of girls towards SET careers



Following, the literature review elaborates how each of the above factors is relevant in determining attitudes of schoolgirls towards careers in SET and respective courses of study.

Perceived Image of the SET Industry (The Maleness of Science)

A number of studies have described the perceived image held by high school students of the SET industry in terms of the “maleness of science.” Studies with English school children found that both sexes rated physics, maths and chemistry as being more masculine than feminine, on 4-, 5- and 6-point scales (Weinreich-Haste, 1981). Harding (1986, 1996), in her critiques of science, has concluded that accepted theories, practices and values of science reflect a male perspective. For example,

research by Rossiter (1982) reports that students specifically describe science as a “tough, vigorous, rational, impersonal, masculine, competitive and unemotional” endeavour. Consequently, science has traditionally valorised the rational, objective thinker (traits typically ascribed to males) and classified the intuitive and interpersonal as not science (traits typically ascribed to females) (Lewis, 1993). Others attribute the perceived “maleness” of science in Australia to the transmission of ideas to students through science textbooks and science educators. Ives (1984) for example, in her examination of the ratio of males to females in secondary science textbooks of biology, chemistry, physics and general science, found males represented 5:1 in general science and chemistry, 8.6:1 in physics and 3:1 in biology. In addition she adds that authors of texts used mainly male language (he, his, men, boys ...).

The recurrent themes of context, responsibility and rationale, in association with measures of attitude, are apparent in the literature. School science has traditionally been taught as value free and disconnected from everyday contexts. Questions commonly posed in Australian physics texts relate to, for example, the mass of a lump of putty, the velocity of a speeding bullet or the trajectory of a ball fired from a cannon. However, Lewis (1993) reports that some students, particularly girls, are searching for a context and rationale. In the meantime, the situation for many girls results in a distinct lack of attraction towards science and scientific careers. Lewis’ views are supported by the numerous international research studies and developmental programs attempting to change the science curriculum to be more gender inclusive, or more precisely, to incorporate context and rationale into science lessons based on the experiences of girls, as well as boys (Craig & Harding, 1985; Daniels & Kahle, 1987; Haggerty & Holmes, 1993; Lie, 1983; Raat, Harding & Mottier, 1981; Ravina & Rom, 1989; Rennie, Parker & Hildebrand, 1991).

Perceived image of engineers and scientists and tasks performed by them

A number of studies have examined the attitudes and perceptions of high school girls (and boys) towards people working in SET fields. Godfrey and Roxborough (1992) asked 70 third and fourth form girls in New Zealand to draw a quick sketch of their impression of a professional engineer. The results were mainly images of men, most wearing overalls or boots, and grease, oil and garages were

common. Students also thought that most engineers fixed cars. A similar study conducted by Kahle (1989) involved students from Australia, USA, Norway and New Zealand. Students were asked to draw a scientist. The results were drawings of “a white male, who wears a lab. coat with a pocket full of pens and pencils. He’s middle aged and is either bald or has wild hair framing his myopic eyes. Comments on drawings suggest that he is antisocial or poorly adjusted, but that he is very busy with his experiments” (Kahle, p.4, 1989).

However, even though students’ personal images of scientists (as demonstrated in the above tests) were negative, their more spontaneously descriptive images were very positive. Students described scientists generally as people who were responsible for progress, improved the quality of life and improved the health of the population. But, for the same group of students, science and engineering were definitely not a career choice.

Dillon (1986) has examined the possibility of students picking up anti-technology attitudes in schools from their teachers, or from the influences of conservation movements. She concluded, after surveying boys and girls from Victorian high schools in Years 10 to 12, that although the students did not have strong anti-technology attitudes, girls generally had more negative attitudes, particularly on statements mentioning engineers. From eight statements on science, engineering and technology using a 5-point Likert Scale, the majority of students expressed positive attitudes to technology. However, the girls were significantly more uncertain than boys on every question and at every year level. From these results Dillon surmises that girls are not as receptive as boys to science and technology, although the differences diminish by the time students reach Year 12. Unfortunately, this is too late for girls without the mathematics and science prerequisites to enter tertiary engineering and science courses.

Confidence = Interest in School Mathematics and Science

Eccles (1989) reports that interest in SET careers is a direct consequence of the confidence of students in their maths/science abilities. She claims that, because young women develop less confidence in their maths/science ability (compared to their ability in English, and when compared to males) they have less interest in studying maths and science, and hence less interest in pursuing SET careers. The issue of confidence is further elaborated in research by Parker and Rennie (1986) in

Australia. Their study found that fewer girls than boys handle science equipment, perform science experiments or participate in science-related activities in the classroom. Thus, girls have less practical experience than boys with using science equipment and consequently less confidence. For most girls, the result is a distinct lack of interest in science classes and SET careers that are thought to perpetuate the science classroom. Although Dillon's 1986 study, discussed above, found positive attitudes towards SET fields, interest in these careers was very low from boys and especially girls.

Value of School Mathematics and Science

Historically, school mathematics and science have reflected a male perspective and therefore male rather than female informal experiences as the cultural norm. Consequently, mechanical skills, tinkering with bicycles and knowledge of football trajectories are among the more commonplace contexts used for examples in school curricula. From a student's perspective, a positive relationship exists between the value of maths and science and their relevance. Studies by Gaskell, McLaren, Oberg and Eyre (1993) in Canadian High Schools found that girls see more relevance in biology and chemistry, whereas boys find relevance in physics. Additionally, the idea of relevance is itself gendered. Physics is seen as related to the world of production, high technology and cars; biology and chemistry are seen as related to the environment, the body and household substances (Gaskell et al, 1993). Thus girls find little of value from their classroom experiences on which to base a career in SET, even if they are interested in the subject matter being taught.

Career Aspirations and Expectations

Further research by Dillon (1986) in Victoria, regarding career aspirations and expectations, showed boys rating technical/scientific professions third out of nine categories, representing 13% of the survey group. The same professions were girls' eighth choice (out of nine), representing only 2% of the survey group. Only unskilled factory work was rated lower by girls. Traditional female professions (teaching, nursing, library, social work) were the most popular group for girls' career aspirations and expectations (38% and 37% respectively). Keeves and Kotte (1996) in their examination of sex differences in attitudes towards science in 1983 to 1984,

found, for the ten countries studied, male students generally held more favourable attitudes, and the difference increased with age. Thus Dillon reports that by Year 11 (age 15 to 16 years) major sex differences are found in the areas of subject selection, occupational choice and attitudes to combining work and family responsibilities.

Apart from the noted sex differences in careers aspirations, there also exists what Dillon calls a “consistency gap” between girls’ confidence in female abilities generally, and individual confidence to pursue maths and science studies. These findings are supported by Eccles (1989), Kahle (1988) and Byrne (1993) who conclude that while girls indicate strong approval of SET careers for women generally, individual interest in pursuing them was low. And Dillon also points out that whilst girls strongly approved career ambitions for women, they generally did not accept them for themselves.

A similar situation occurs by the time girls reach tertiary education levels. In their examination of women’s progress in the sciences, Astin and Sax (1996) report on a study by Krist in 1993, examining the motivation of high-ability African-American women making educational and career choices in maths and science. Essentially, Krist’s study supported the Eccles model for academic choice, confirming that achievement behaviour also involved choices made by the individual, influenced by cultural norms and socialisation experiences.

The Concept of Critical Mass

The concept of “critical mass” and its effect on the attitudes of girls’ participation in SET careers has been highlighted by Byrne (1993). In this context, critical mass refers to the proportion of women in a field of SET, beyond which the group needs to move in order to establish a sense of normality, and sufficient to support the group for its members to continue. For example, school Physics is seen as non-traditional for girls because of the low proportion of girls studying the subject. In comparison, school Biology is believed to be normal for girls because of their high enrolment numbers. Thus, Biology has achieved a female critical mass, which may in turn contribute a positive influence on girls’ attitudes towards their participation. Conversely, according to Byrne, because the majority of SET careers have not achieved a critical mass of women (under 30%), girls continue to see these fields as “abnormal” and do not pursue them. In the context of this study, all MI-related courses have not achieved a critical mass of women (all less than 30% female

participation), and it was not possible to change this situation to affect the current cohort of schoolgirls.

The Influence of Parents and Teachers

The value placed by parents on the study of mathematics and science is also a major contributing factor towards girls' reduced participation in SET careers. A number of researchers have documented the role of parents and teachers in shaping attitudes to school mathematics and science, through the child's self-perceptions and task values. Parental advice has been noted by students as one of the most important influences on high school course decision making (Eccles-Parsons et al., 1983). This finding was supported by Brown's evaluation of the use of female role models to increase the participation of girls in school mathematics and science, where she states "... parents remain the single greatest influence on a student's subject choices" (Brown, 1993, p. 502).

Studies by Yee and Eccles (discussed in Eccles, 1989) examining the under-representation of girls in school mathematics and physical sciences have found that (a) parents rate advanced level maths, physics and chemistry as more important for sons than daughters; (b) parents that attributed their child's mathematical success to natural talent than to effort (a male pattern of achievement) developed more confidence in their child's maths ability; and (c) parents think maths is harder for daughters than for sons. Therefore, parents seem less likely to encourage females to take advanced maths courses, chemistry and physics in upper school, and it is difficult for any student, particularly girls, to value and undertake these courses with little encouragement.

The Influence of Role Models and Mentors

Research by Byrne (1993), Eccles (1989) and Taber (1992) has shown that students and their parents, and to a lesser extent teachers, have sex-stereotyped views of the world of work which are reflective of the current gender division of jobs in Australian and North American society, and which limit students' career aspirations. Eccles would go further and argue that the poor image of SET is in part a consequence of the absence of information for girls to base their stereotypes of adult occupations and careers. Given that the numbers of women in SET careers are extremely low, it is understandable that girls rarely observe examples or images of

women, both in the media and through their own experiences, performing in SET professions.

However, while some authors (Fox, 1974) would deduce that the scarcity of such women is itself a barrier to girls' selection of subjects in the SET area, others (Wilkinson, 1992, unpublished paper) would conversely assume that the mere presence of female staff is enough to favourably encourage and influence girls' career choices. In practice, the issue appears to be much more complex and in part relies on defining the type of role model used. Briefly, for role modelling to occur, girls must firstly identify with an older and very visible person important to them, and secondly they must change or model their behaviour to imitate that adult. In terms of encouraging girls to pursue SET careers, a number of studies have looked at the influence of female role models on the attitudes and aspirations of girls. The different types of female role models may include teachers, parents and siblings, peers, undergraduate and working scientists or engineers. This last group of women, studying SET courses and working in SET careers are referred to as "occupational" role models (Brown, 1991).

Evidence supporting the positive effect on attitudes of female role models, is reported by Evans, Whigham and Wang (1995), who presented female role models to students in the classroom as part of their science lessons. The role models were the project director of the Program for Women in Science and Engineering at Iowa State University, and two university students majoring in engineering and agricultural science. Evans, Whigham and Wang found that the intervention was more effective in changing all students' attitudes towards careers in SET, although it appeared to be more successful in changing attitudes of girls, than attitudes of boys. Interestingly, the researchers also found that the presentation given by the university student role models were the most popular with the students, and that girl-only classes did not show significantly more positive attitudes than mixed classes.

Hisscocks (1993), citing engineering students who claim meeting a women engineer as the most important factor in their decision to study engineering, also concludes that it is vital for girls to meet female role models. This finding is also supported by Astin and Sax (1996) who claim that students that encounter role models from the scientific community are more likely to follow up on initial science aspirations.

Mentoring, on the other hand, has not been defined as easily as role modelling. There appears to be little consensus between the sectors from which the definitions originate. In essence, however, Collins (1983) identifies five generic criteria for a true mentor of professional women: [1] higher up on the organisational ladder; [2] an authority in the field; [3] really interested in the protégé's development; [4] influential; and [5] willing to invest extra time and personal commitment rather than mere interest.

Currently, mentoring appears to be used only at the tertiary level, when girls have made the decision to enter SET careers having completed high school. Therefore the influence of mentors on schoolgirls' attitudes was not explored further in this study.

A CRITIQUE OF CURRENT PROGRAM STRATEGIES & THEIR OUTCOMES

Recognising that, for many female students, a combination of several or all of the above issues eventuates in negative or ambiguous attitudes towards undertaking careers in particular SET disciplines, a number of tertiary institutions from Australia, New Zealand, Canada, Great Britain and the USA have implemented strategies designed to recruit and retain more females in SET courses. Among the recruitment methods and mechanisms used, is the subset of strategies selected in this study to enhance the attitudes of high school girls towards SET careers.

A review of the literature pertaining to the programs implemented reveals a number of relevant commonalities and reasons for strategies used. Although no research could be located determining the effectiveness of any particular strategy in comparison with another, it would seem reasonable to use a combination of strategies, as is the case with most intervention programs.

A Cautionary Word on Program Evaluation

In evaluating the question of attitude changes, it is apparent that the majority of reviewed intervention programs have not included sufficient data to support their conclusions. Many programs are still currently gathering and evaluating data, or have not as yet published their results. Davis and Rosser (1996) report that of the US federally funded core programs, only 20% have been evaluated, 32% monitored (statistics collected and reviewed), and 48% have been neither monitored nor

evaluated. Most evaluations were used in-house to improve the next program. Very few of the results examined long-term attitude changes, and in some cases, program successes were based on anecdotal information alone.

Thus, whether any of the ensuing intervention strategies, either singly or in combination, results in the entry of greater numbers of girls into SET courses, and consequent careers, remains a complex question. While some institutions use national trends in female enrolment in degrees to assess program success, others look at their own campus' female enrolment and graduation rates. However, Davis and Rosser (1996) point out that, without formative and summative evaluations, including appropriate controls, it would be dangerous to attribute increases directly to programmatic interventions. Factors such as improvements in high school maths and science preparedness, new university curricula or inspirational professors, may all lead to increased participation in SET courses.

As is the case with almost all temporarily funded intervention programs, the cessation or reduction of funding has resulted in a lack of ensuing information. Consequently, program intervention results seldom appear in peer reviewed journals. Thus, programs reviewed in this study are those that have been evaluated with either quantitative (even if most are lacking in some type of appropriate control) or qualitative data providing evaluation details.

Program Setting and Duration

Program duration and the question of residency would appear to depend on the intended scope of SET careers to be covered, the level of project funding and the range and depth to which activities were undertaken. The settings for a majority of the programs are residential camps or full-day events lasting two days to two weeks. In Canada, Australia and the USA, many intervention programs for high school girls are conducted over their extended summer holidays, which usually coincide with university (or tertiary institution) semester breaks. Utilising these breaks has advantages for both schoolgirls and tertiary institutions. For girls, the implication is they are available to attend program activities without compromising schoolwork and study demands, or conflicting extra-curricula activities. For the tertiary institutions co-ordinating the programs, semester breaks usually imply availability of laboratory facilities and equipment, academic and technical staff, and possible assistance from university students.

Typical of residential programs are the Summerscience Intervention Program (Davis & Hollenshead, 1991) administered at the University of Michigan, the Taste of Technology Program (Wilkinson, 1992, unpublished paper) conducted at the Oxford Polytechnic, and the Discover Engineering summer camp (Hisscocks, 1993) based at Ryerson Polytechnical Institute in Canada. The first camp is of two-week duration, whereas the others are one-week duration. In comparison, the Skills and Opportunities Science Intervention Programs for Girls (Farmer, 1996) at Auckland College of Education, New Zealand is a non-residential two-day program, whereas the Computer Appreciation Holiday Program (Teague et al, 1993) conducted at Deakin University (three days) and then Morongo Girls College (two days) offered 18 participants five days of activities. The longest non-residential program reviewed was offered by the University of Washington, Seattle, titled MESA Summer Science Program for Girls (Cook, 1991). This program consisted of five one-week units, each focussing on a different scientific topic.

Although all programs cited above aimed to enhance girls' attitudes towards SET careers, and target their strategies for students aged 13 to 15 years, it is apparent that the duration of each are greatly varied. Presumably, their treatment of each SET career and the depth of the activities differ significantly. One would also expect the budgets of the programs must also be proportionately different. The setting of the programs appear typically to be at the tertiary institution initiating the program. Only the Computer Appreciation Program (Teague et al, 1993) offered a proportion of the program at a private girls' secondary school. Their reasons were based solely on providing participants with a greater variety of software experiences.

Wilkinson (1992, unpublished paper) describes the four-day residential "Taste of Technology" course offered to girls at Oxford Polytechnic, in the UK. Students studying A level science and technology subjects (aged 16 to 18 years) undertake a large variety of activities designed mainly to give participants an insight into industry, and build confidence. She claims the success of the course, where 40% of students considered themselves more likely to work in technical areas, is due to the large variety of activities that can be offered over four days. However, she also recognises that residency involves substantial costs, and limits the number that may participate. Like the Michigan program and many other residential programs reviewed, successful applicants far exceed the number of successful participants.

The limiting effects of residency and out of school programs may be overcome by conducting programs in schools during class time. Evans, Whigham and Wang (1995) conducted an in-school intervention program to change attitudes of ninth grade students towards science, math and related careers. Their Iowa program, reporting successful attitude change as a result of the intervention, was able to involve 964 students from ten different schools. However, while not stated explicitly, the co-operation of teachers (and principals) was crucial to the implementation of the program and may also be a contributing factor for its success or otherwise.

However, in terms of attitude change, there is no evidence from available data to suggest that residential camps are more effective than non-residential courses, or that 14-day programs are better than 2-day courses. However, residency does raise the issue of entertaining and supervising participants in the evenings, which several reviewed programs have alluded to the onerous responsibility placed on supervisors.

Target Students - level of education and ability

All Engineering, and the majority of Science disciplines with low female participation rates, requires rigorous training in mathematics, chemistry and physics. Such preparation must begin by Years 9 and 10 (14 to 15 year old) in Australia, or their equivalent in other countries. Therefore many intervention programs focus on students that have demonstrated above average ability in Year 9 and 10 mathematics and science. Reasons for targeting this cohort of school students are based on the critical juncture reached between compulsory mathematics and science in junior high school and their optional selection in senior high school. Historically, the percentage of females choosing to enrol in chemistry and physics from the choice of subjects available in upper school, is significantly lower than male numbers. Therefore the assumption is that increasing the pool of females completing Year 12 Chemistry, Physics and advanced Mathematics subjects, would remove the barrier of their ineligibility to enrol in significant numbers into SET courses.

It needs to be recognised, however, that eligibility to enter courses does not necessarily imply that girls will take up the option of enrolment. To illustrate, in Western Australia in 1992, almost twice as many boys completed Physics and Calculus in Year 12 compared to girls (Byrne, 1994). However, at Curtin University of Technology, typical of Australian tertiary institutions offering engineering and science courses, over six times as many males than females undertook an

Engineering course (85% male and 15% female), and almost four times as many males than females (73.4% male and 26.6% female) undertook a Science course (Curtin University Statistician's Office, 1992). Clearly, increasing the number of females with the appropriate prerequisites to enter SET courses is not the only strategy required to increase their participation in SET careers.

Student recruitment and selection

Recruitment of high school students to programs conducted out of school grounds and school time is necessarily by invitation or application. Advertisements are often placed in local newspapers, or notices are sent directly to schools. Several authors cite the importance of identifying a supportive contact within the school and directing all correspondence to that person. In this way, program information has a greater chance of reaching target students.

For reasons already cited, mostly only those students with demonstrated ability in mathematics and science, and interest in SET careers were eligible to attend. The cost of participation in programs is usually not a selection criterion as many programs subsidised participants or were conducted free of charge.

Most programs required some form of school nomination or supporting documentation of student interest and/or ability. Following this basis as a pre-selection, further deciding entry-criteria may vary greatly between programs. The Michigan program (Davis & Hollenshead, 1991) especially attempted to recruit students from particular minority groups. The Oxford Polytechnic program (Wilkinson, 1992, unpublished paper) required a statement from students about why they would like to participate in the course. Various other programs required information about science related extra-curricular activities of students and any relevant work experience undertaken. By contrast, the Computer Appreciation Holiday Program (Teague, Clarke & Lyne, 1993) specifically targeted girls who were displaying little interest in computers but had the ability to study computing. Among their objectives was the intention of creating greater interest for participants.

Recruitment may also be on a "first-come-first-served" basis until all places are filled. There is no evidence to suggest that any particular method of student selection is better than another, particularly in terms of fostering favourable attitude changes. All programs report applicant numbers far in excess of available places, regardless of selection criteria.

Single-Sex Programs

The majority of intervention programs reviewed in the literature are organised and conducted as “girls only” activities. The most obvious reason being that the program's objectives were to enhance the attitudes of girls only towards SET careers and increase only female numbers, rather than those of both males and females. Therefore, only girls were invited to take part in program activities. However, some program organisers also believe that the presence of male participants would adversely effect other “underlying” program objectives. Many programs either state explicitly, or imply, the importance of co-operative efforts and group cohesiveness, and seek to minimise the adverse effects of peer pressure believed to emanate mostly from male students (Tobin, 1987). For example, Davis and Hollenshead (1991) in their report of the University of Michigan Summerscience program, state that the presence of males would result in females not fully participating in activities, and that the program environment would not be fully supportive of women's achievement and success. Clearly, the current co-educational situation in many schools where both boys and girls participate in recruitment activities for SET careers, has not succeeded in significantly increasing the numbers of girls. It could therefore be time to try one or more new approaches.

Presentation of female role models

In an effort to counter the perceived image of engineering and science as male domains, and to help break down some of the stereotyped attitudes towards female careers, all programs reviewed make use of occupational female role models. Women in SET careers are required to facilitate, co-ordinate or supervise activities undertaken by participants, and act as student mentors. Common to most programs for high school girls is the opportunity to meet and interact with women scientists, engineers, academic staff and students in SET fields. However, Davis and Rosser (1996) pose a number of questions regarding what is actually known about the effectiveness of role models. For example, what must a role model actually do to influence students to pursue scientific studies and careers? Byrne's University of Queensland research (1993) sampling ten major Australian institutions found no evidence that mere numbers of women faculty or staff increased the numbers of

undergraduate women in a field. Both Byrne, and Davis and Rosser, agree that more research is needed on role models before their effectiveness is accepted.

Brown's Australian study (1993) supports the finding that the presentation of professional role models does break down stereotyped attitudes towards SET careers in both boys and girls, and additionally influence student subject choices in upper secondary school. Unfortunately however, Brown, like Surry and her colleagues (1993) does not elaborate on methods employed by the role models, or if any training or direction was instituted prior to their presentation, thus limiting the external validity of their findings. Of the many studies reviewed using female role models, Farmer's SOS Program in New Zealand (1996) reports on the provision of training for the role models, and the Evans team (1995) detail the actual methods used by the role models to encourage girls' participation in SET. Their methods involved the following:

- speakers being encouraged to describe their schooling background with reference to subjects studied, personal interests and experience with SET careers;
- speakers supporting details about their current line of work with plenty of visual material or examples of their work, if possible;
- speakers being asked to emphasise the importance of continuing to study maths and science at school, and the range of opportunities these subjects may lead to;
- speakers emphasising the enjoyment and sense of achievement felt by working in their field.

It was not known if speakers were asked to, or indeed did, discuss any obstacles to their current career path, or any commonly held dislikes about their work. Moreover, the majority of programs reviewed, utilising the talents of occupational female role models (Davis & Hollenshead, 1991; Evans, Whigham & Wang, 1995; Farmer, 1996; Wilkinson, 1992, unpublished paper) have not presented the role models in a workplace setting, which for MI, presents an entirely different image to that of city-based professionals. Thus, the ethics of not portraying a realistic view of the full work environment in non-traditional fields by intervention programs can be questioned.

Many researchers reporting on women in non-traditional fields, particularly engineering (Byrne, 1993; Newhouse-Maiden, 1995), list course disenchantment, negative peer pressures and inflexible work arrangements as some of the reasons for

the lack of women in SET. These issues should also be examined by prospective students and solutions found, lest the problem be shifted to retention of women in SET, having increased their entry.

"Hands on" Workshops

A widely used strategy in programs of longer duration (two days or more) is the opportunity given to students to be actively involved in "hands on" workshops. Upper secondary school Chemistry and Physics, and tertiary courses in SET have a large laboratory component. Therefore, students are required to manipulate materials, tools and apparatus. Previous research suggests that girls are unlikely to have developed some of the competencies required by the time they complete lower school science and mathematics. For example, Rennie and Rennie (1991) surveyed equal numbers of Year 8 (13 year old) boys and girls from non-government West Australian schools to determine prior experience of a range of "tinkering" activities, including using a glue gun and using a soldering iron. Questionnaire results showed girls' prior experiences to be more limited than those of boys in almost all areas.

However, programs vary significantly in their setting, duration or treatment of activities undertaken in workshops. For example, the Michigan program, catering to group sizes of 70 - 75 students, is based around a "focus project" selected by each participant who spends four hours per day on their project. Participants were given laboratory time and assistance from suitably experienced tutors. Time was allowed to increase technical expertise and for discussion of scientific concepts. The camp culminated in completion of the focus project. The Auckland program, by comparison, with similar group sizes as the Michigan program, has compulsory shorter, once-only workshops, run in non-laboratory settings by suitably experienced female role models. The program concludes with a brief overview of the variety of workshops experienced. The outcome of both types of programs is the familiarity with an increased range of SET careers.

An underlying consequence of 'hands on' activities, apparently known to all professionals working in SET jobs, is the ability to work as a member of a team. Presumably therefore, all programs examined in this literature review especially cite collaborative and co-operative efforts as program objectives and encourage girls to work in groups. Equally however, all reviewed programs (for example Davis &

Hollenshead, 1991; Farmer & McGowan, 1991; Wilkinson, 1992, unpublished paper) do not cite the reasons for these program objectives, other than teamwork being conducive to the way that girls learn. Farmer and McGowan (1991) presuppose that teamwork encourages communication and hopefully increases rapport between participants, creating a learning environment that can be less competitive and more supportive and enjoyable. While the desired outcomes of teamwork make for good program activities, it appears equally important that collaboration in the SET workplace be made more obvious to girls to help dispel some of the negative images associated with lone scientists.

Field Trips

A large proportion of programs of longer duration (1-2 weeks) include visits to local scientific and engineering industries and places of interest. The Michigan Program (Davis and Hollenshead, 1991) and the Oxford Program (Wilkinson, 1992, unpublished paper) allow activities, workshops or projects to be undertaken in an industrial environment. By contrast, the Seattle program (Cook, 1991) includes field trips to industrial sites involved in projects that are related to the week's focus. However, their field trips appear to be passive explanatory tours rather than interactive activities.

Stated objectives of the benefits to participating students include that they are able to witness first hand their potential work environment, and the possible use of equipment and materials. However, much may also be done here to dispel negative images of professionals in SET, as described by Kahle (1988) and Godfrey and Roxborough (1992), as people are seen in typical work situations. Additionally, as female role models are often asked to attend program activities out of their work environment, field trips to appropriate work places would appear to provide the ideal opportunity for girls to form their own conclusions of what it may be like working in SET, from a female perspective. Few, if any, of the programs reviewed appear to use field trips for this purpose. However, workplace visits may also lead to negative images and attitudes on students' career aspirations (Cook, 1991; Somerville Brown, 1992, unpublished report) when students do not like the work environment seen. In this case, group discussion can be a useful tool for both participants and organisers, to deliberate the practicalities of particular SET career paths.

Career Seminars

One of the most widely used strategies in all variations of programs designed to foster attitude changes, are career talks and discussion sessions. They are generally easy to organise, require little funding (as they usually rely on the generosity of speakers), and are able to cater to large audiences. Typically, the career seminar program begins with one or more speakers describing their history of schooling and study leading to SET employment. Specific details about their particular line of work are then elaborated. Questions are encouraged at the end of the speaker's presentation. The effectiveness of seminars in the past, in encouraging girls to enter courses and careers in SET, seems to be confined to disseminating accurate career information, rather than a resultant increase in girls' numbers. More recent initiatives now include career talks and discussion sessions in combination with many of the strategies already discussed in this chapter. Thus, career talks are presented by female university students and occupational role models (Brown, 1993; Evans, Whigham & Wang, 1995), or run in conjunction with "hands on" workshops (Davis & Hollenshead, 1991; Farmer & McGowan, 1991) and visits to industry (Somerville Brown, 1992-4, unpublished reports; Wilkinson, 1992, unpublished paper).

Short term success in effecting attitude change determined by pre and post seminar questionnaires, has been reported by all reviewed programs. In addition, as noted by Brown (1993) and Davis and Hollenshead (1991), many girls report these activities as one the most enjoyable and encouraging of the program.

A STRATEGY TO ENHANCE GIRLS' ATTITUDES TOWARD PROFESSIONAL CAREERS IN MI IN WESTERN AUSTRALIA

Background

The Pilbara and Goldfields regions of Western Australia are two of the major mining centres in Australia, and of significance on a global scale in terms of the production of natural gas, iron ore, liquid petroleum products and gold. However, the Department of Primary Industries and Energy (Australia) has shown the growing demand for mineral products and advances in mining technology will result in a shortfall of professional employees, unless strategies are in place to increase their numbers (The Department of Primary Industries and Energy, Discussion Paper,

1990). The latter discussion paper states what many professionals and educators of MI believe to be the major reasons for low numbers of men, and especially women entering the industry, namely, the critical treatment of MI by the education system. MI is often criticised for its impact on the environment and current teaching of Biology and Ecology may encourage this view. On the other hand, the discussion paper argues that insufficient weight is given to the contributions of MI to the economy.

Additionally, information gathered by the Department of Primary Industries and Energy, and from past surveys of Year 10 girls gathered through the Women into Engineering and Technology Project at Curtin University, suggests that the following may also contribute to students' unfavourable attitudes towards MI as a career choice:

- the general perception of MI as a male oriented career path
- dislike of the isolation and possible hardship some mining jobs entail
- periodic downturns of the industry and related oversupply of trained personnel
- the lag between career choice and getting qualified (most undergraduate courses are four-year full time)
- general lack of knowledge of jobs available, remuneration levels, qualifications required and prerequisite study (The Department of Primary Industries and Energy, Discussion Paper, 1990; Somerville Brown, unpublished reports 1992 - 94).

The Chamber of Mines and Energy (WA) conducts camps in MI courses (Focus on Mining Camp) catering to upper secondary students. These camps are directed at both boys and girls with a stated interest in MI courses or increasing their knowledge about this branch of SET. The main purpose of these camps appears to be sustaining current numbers in MI courses, regardless of sex. It was not possible to obtain any documentation pertaining to the effectiveness of these camps in terms of increased course enrolments or attitude change, if in fact the relevant research was undertaken.

While several of the universities in Western Australia offer programs to encourage secondary students into SET courses, and ultimately SET careers, most are directed at senior students of both sexes, that is, students in Years 11 and 12 (age 16 and 17 years) who already undertake the SET maths and science prerequisites,

and indicate an interest in this area. Of those programs designed to foster interest from girls, almost all activities are university-based (without opportunity for industry-based activity), cover a broad range of engineering and science courses (including those with significant numbers of females), and make little or no provision for parents and teachers to be involved. Like many other intervention programs, data collected are largely post-intervention to determine attitudes or program efficiency, and used in-house for fine-tuning purposes or requisite reporting to funding bodies.

It would appear then, that the multitude of programs available in WA have not led to significant increases in the numbers of females entering MI courses. Moreover, attitudes of girls towards MI careers have not been determined, to enable specific intervention attempts to rectify their current under-representation. In the present study, it was therefore considered essential to firstly determine attitudes of girls towards MI careers and subsequently use this information to develop and implement suitable strategies to enhance their attitudes. It should be noted that, because the study formed part of the WIET Project at Curtin University, in which parents are not included as participants, the intervention program was not able to address the influence of parents on girls' attitudes.

SUMMARY

Prior to implementing strategies designed to enhance girls' attitudes towards MI careers, it is important to firstly understand the factors or mediators that have led to the current position of girls in regard to MI. An examination of the Eccles model for girls' educational and academic choices, as a theoretical framework for this study, led to a number of factors that may culminate in the majority of girls having negative or ambiguous attitudes towards their participation in the broader field of SET careers.

The review of the literature showed that little if any research has been undertaken on girls' attitudes towards MI careers, and therefore this study makes comparable use of the broader field of SET. From the mediators found to influence girls' attitudes towards their prospective participation in SET careers, several were eliminated from further study on the basis of their having little positive effect on the current cohort of girls able to proceed into SET courses. These included the issues of institutional filters, course disenchantment and the concept of critical mass. Of the remaining mediators of attitudes, those that may be influenced by appropriate

strategies in the short term, have been identified and described in this chapter through research from Australia, the United States, Great Britain and New Zealand.

The second part of the review critiques the more popular and successful programs currently used to attract girls into SET careers. Although the programs differ in their duration, setting and emphasis on SET disciplines, there are a number of strategies commonly employed by those claiming short term success. All of the reviewed programs make extensive use of female "occupational" role models from SET careers and courses to facilitate program activities. In the main, programs consist of "hands on" workshops, field trips and industry visits, and career presentations from people currently employed/studying in SET fields. However, while all reviewed programs claim successful attitude changes in participating girls, few offer supporting empirical data or control for relevant variables such as girls' prior experiences with workshop equipment.

Finally, information gathered by the Department of Primary Industries and Energy, and the WIET Project at Curtin University both indicate that girls especially, hold negative attitudes towards MI per se, and have limited knowledge of MI as a career option.

At the time of reviewing the literature, while many programs attempted to encourage girls into SET careers, only one program in WA was directed specifically towards attracting more girls into professional MI careers, namely the "Western Australian School of Mine Engineering and Technology Residential Camp for Girls."

CHAPTER THREE

METHODOLOGY

PURPOSE

The purpose of the Methodology chapter is to describe and report how:

- i. an instrument to determine the attitudes of a select group of Year 10 girls towards MI careers was developed and implemented;
- ii. the instrument and previous research were utilised in modifying and implementing an intervention program to enhance girls' attitudes towards MI careers.

Secondly, the chapter will describe how quantitative and qualitative data were gathered and analysed to determine if the intervention program changed girls' attitudes towards MI careers.

OUTLINE

This chapter begins by describing the research design employed in this study and the preparation and implementation of an attitude survey used to determine Year 10 girls' attitudes towards MI careers and school maths and science. Analysis of the attitude survey assisted with the development of a program of strategies designed to enhance girls' attitudes to MI careers. It is noted that analysis of the attitude survey indicates that girls' interest and value of school maths and science were high, as were girls' perceived images of professionals working in MI. However, girls' knowledge of MI careers, courses and work-related tasks was limited and sometimes misinformed.

The chapter then moves on to define the objectives for an intervention program and to describe how the attitude survey results and literature review were utilised in adapting the program used by the WIET Project at Curtin University, namely the WASM Camp. The next section outlines the strategies employed at the WASM Camp to enhance girls' attitudes towards MI careers and the method of implementation.

The final section describes the methods of evaluating the intervention program in terms of both positive changes in attitude for participating girls, and the effectiveness of the strategies implemented.

RESEARCH DESIGN

Methodology

The design of this research, as defined by Wiersma (1991), is regarded as quasi-experimental. While the classic elements of pre-test, post-test, experimental and control groups are retained as per true experimental research, the assignment of subjects to groups through random methods is not appropriate. Rather, it was the intention of this study to examine attitudes of a specific group of subjects that had met predetermined research-specific criteria. However, contrary to some quasi-experimental research undertaken, the issue of researcher bias is largely overcome through both secondary school pre-selection of participants, and the order of application receipt as determinants for the assignment of girls to treatment groups.

In order to satisfy research reliability, quantitative material in the form of pre-camp and post-camp surveys used in the study were standardised and all strategies implemented were documented to aid possible future replication. Triangulation of qualitative data was undertaken through pre-test post-test data collection, review of the literature, and through observations of student behaviour, including audio-taped interviews with selected participants.

Population and Sample

Activities offered by the WIET Project, like many similar programs for high school girls, recognise that one method of increasing the potential number of female applicants in non-traditional courses, may be through enhancing the attitudes of younger girls towards the compulsory prerequisites. In WA, Year 10 is the level at which students must choose their tertiary entrance subjects. Thus, WASM Camp-entry criteria are restricted to Year 10 girls capable of undertaking the necessary mathematics and science prerequisites. This equates to students achieving Grade B or higher in both subjects at the time of camp application. At this stage, students need not be committed to undertaking Year 11 Physics, Chemistry, Introductory Calculus

and Geometry & Trigonometry (as SET and MI prerequisites). In keeping with the Eccles model, strategies were designed such that, if the applicants did not intend pursuing (all or some of) the appropriate MI prerequisites in upper school, then WASM Camp attendance would encourage them to do so. Additionally, students wishing to attend the WASM Camp should have an interest in SET careers generally, or the desire to learn more about professional careers specifically related to MI.

The importance of teacher influences on the educational choices of girls has been previously reviewed in Chapter 2. Arguably, any strategy aimed at enhancing the attitudes of girls, should also aim to enhance the attitudes of their teachers and give teachers support in doing so. Few, if any, teachers or school career counselors appear to have significant knowledge of careers in MI. From surveys of teachers (including career counselors) and parents of previous WASM Camp participants, few could name other careers in MI apart from Geology (Somerville Brown, 1992, unpublished reports). While it was not the intention of this study to report on teacher attitudes towards MI careers or of any attitude changes effected by the WASM Camp, it was intended for teachers to support (and encourage) student camp application, have the opportunity to attend the WASM Camp, and increase their knowledge of MI careers. These objectives were facilitated by sending schools "primer" information outlining annual WIET project activities (including the WASM camp) well before the application date (Appendix B1).

Inducements include the prestigious nature of the camps, the broad range of camp activities and courses covered, and the potential opportunities afforded both school and student through WASM Camp attendance. For example, WASM has been able to achieve one hundred per cent employment for their graduates for the last twenty years. Also, attending teachers and students made valuable contacts with professionals and educators in MI, who were often willing to conduct career talks or industry tours for schools.

To provide all Year 10 girls with the opportunity to participate, the WASM Camp was conducted free of charges for all successful students and teachers. Funding was raised, through the WIET project, from MI company sponsorship of students, with Curtin University sponsoring attending science teachers. Funding constraints and accommodation space within WASM facilities limited the number of participants to thirty-three, and science teachers to five. With myself and one

assistant as camp supervisors, the total WASM Camp number for 1995 allowed for forty places.

In April 1995, specific WASM Camp applications were mailed to all Western Australian co-educational and girls' secondary schools (Appendix B2). To ensure interested students would be informed of the camp, three separate applications were mailed to each school. Applications were directed at each school's Senior Mathematics and Science teachers, and at Career Counselors. Camp information called for interested students, with grade B or higher in Maths and Science, to be nominated by their maths or science teacher. Applications were to be made by return facsimile before May 12. Students and teachers were advised, when applying, that in 1995 the WASM Camp would include participation in this study and other regular survey research as part of the WIET project.

From the Western Australian pool of Year 10 girls, eligible at this stage to proceed to Year 11 prerequisites for Engineering and Science courses, 59 nominated places and 23 reserve places for the WASM Camp were returned to Curtin University by the closing date. Applications represented 32 secondary schools, including government (19) and non-government (13) schools, from metropolitan (21) and country (11) regions.

Preparation of the Instrument: Mining Industry Attitude Survey (MIAS)

As there was no survey available to determine the current views of girls towards MI careers, the MIAS was constructed to include measures shown in past research to be associated with students' attitudes towards maths and science careers. Items were developed using relevant parts of the School Science Survey (Rennie & Parker, 1994) as a model. From the original scales, 14 items that referred to "science" were expanded to include maths, physics and chemistry. In addition, 42 new items were developed using the premises of the Eccles model for educational and academic choice, and from previous WASM Camp surveys (Somerville Brown 1992-4, unpublished reports). From the Eccles model, preparation of items for MIAS involved an elaboration and extrapolation of several mediating factors, relating to issues of career choice. A diagram of the mediators affecting attitudes was presented in Figure 2.2, and has been modified here from SET careers in general, to examine MI in particular. Additionally, only those factors that are likely to be influenced by strategies implemented in this study, have been retained. Thus "tertiary course

structure", "the percentage of women already in the discipline" and the "influence of parents, teachers and peers" have not been included. The refined and modified list is presented in Table 3.1 (Factors 1 - 8). Additionally, because attitudes of Year 10 girls towards mining careers are largely novel, it was considered helpful when programming strategies to know the student's:

- prior knowledge of mining industry courses and careers
- history of contact with professionals working in mining industry (Factors 9 & 10).

Table 3.1 Influences affecting attitudes of girls towards MI careers

1. perceived image of the mining industry
2. perceived image of professionals working in mining and the tasks performed by them
3. level of interest in school mathematics and science and subsequent mining careers
4. value of school mathematics and science and subsequent mining careers
5. encouragement
6. confidence and academic ability
7. influence of role models and mentors
8. career aspirations and expectations

Survey items were designed around several of the factors in Table 3.1. To keep the survey concise and not too time-consuming, several assumptions were made regarding the attitudes of girls with the potential to participate in an intervention program. The assumptions were based on prior research into attitudes of girls towards SET careers and are discussed in greater detail later in this chapter under the heading "Program development and adaptation". At this point, however, it suffices to say that a certain level of encouragement (factor [5]) from parents and teachers is assumed because the girls have agreed to participate in the intervention. For similar reasons, the career aspirations and expectations (factor [8]) of the girls may also be inferred to relate to SET in general, if not MI in particular. Academic ability (factor [6]) in maths and science is known to be of a high standard by necessity of the prerequisites required for MI courses. Finally, the influence of role models and

mentors (factor [7]) could prove to be a separate study by itself, and has in fact been the subject of studies undertaken by other researchers (for example, Brown, 1993). However, based on the experience of past intervention programs conducted by this researcher (WASM Camps 1992-4, unpublished reports) and others (for example the Summerscience Program conducted by Davis and Hollenshead, 1993), it has been shown that Year 10 girls have had little if any prior contact with professionals in MI and SET (factor [10]). Therefore the possible influence of role models and mentors on girls attitudes towards MI careers, is limited at this stage.

While the above assumptions regarding factors [5] to [8] and [10], were made prior to the development of an intervention program, and therefore not surveyed, no assumptions were made following the intervention. Rather, their effects on girls' attitudes were determined using qualitative methods as is discussed in the evaluation section in this chapter.

Consequently, by grounding survey items in the remaining factors [1] to [4], and [9] from Table 3.1, 56 pre-test items were trialled prior to the 1995 WASM Camp. The trial group consisted of 34 Year 10 girls from a metropolitan secondary school. All students were of grade B standard or better in maths and science. After minor grammatical modifications, the pre-test MIAS (Appendix C) consisted of 56 compulsory items comprising 47 seven-point semantic differential-type items and 9 four-point Likert scale-type items. Three different stems were provided for the semantic differential-type items; "I think the mining industry is a field which ...", "I think people with professional jobs (ie. Surveyor, Mining engineer Geologist ..) in the mining industry .." and "I think high school maths, physics and chemistry are subjects which ...". The stem provided for the Likert-type items was "I think ..." and responses about the frequency of attitudes were indicated with Strongly Agree, Agree, Disagree and Strongly Disagree. The final item (Item 57) was an optional open response for written comments from participants. Students were invited to comment further on any aspect of the survey or the mining industry in general. University faculty and secondary teaching staff reviewed all items for content validity.

Precamp Survey

Upon receipt of WASM Camp applications, the 82 nominated students were mailed one copy each of MIAS. A covering letter for schools, parents and applicants

was included explaining the purpose of MIAS. The requested Survey return date of 12 May, 1995 coincided with the closing date for WASM Camp applications. At this stage prospective applicants had no knowledge of the success or failure of their application. 57 MIAS were returned, comprising 32 successful applicants (experimental group) and 25 unsuccessful applicants (control group). By 19 May, 1995 all applicants were notified of the success or otherwise of their application.

Postcamp Survey

On the final day of the WASM Camp, Friday 7 July, the 32 participants of the experimental group were given MIAS for the second time. The purpose of completing the survey again was explained to the group and all survey sheets collected by the camp closure at 5:00 p.m. The following week, the 25 control group participants were mailed (at school) MIAS for a second time, with a covering letter of explanation and requested to return the survey by Friday 4 August, 1995 (Appendix B4). Only ten surveys were returned from the control group.

WASM CAMP PROGRAM PREPARATION

Analyses of the Precamp MIAS data were used to assist with the preparation of a program of strategies designed to enhance participants' attitudes towards mining industry careers.

Analysis of Precamp MIAS

The *Statistical Package for the Social Sciences* (SPSS) (Tuckman, 1988) and *LabVIEW*® (National Instruments Inc., 1993) were used to analyse precamp MIAS data as indicated in Table 3.2.

Table 3.2 Precamp Statistical Test Summary

Purpose	Statistical Test	Group Tested n = # in test group	Statistical Package
1. determine the effectiveness of the instrument	Principal-components rotated-varimax factor analysis, correlation	experimental + control group n = 57	SPSS
2. demonstrate equivalence between experimental and control groups prior to the camp	mean, standard deviation, effect size	experimental group n = 32 control group n = 25	LabVIEW® LabVIEW®
3. evaluate the attitudes of respondents prior to the camp	mean, standard deviation	experimental + control group n = 57	SPSS

Results

Effectiveness of MIAS

Semantic differential-scale responses to 47 items were analysed using a scale of 1 - 7 with the most positive response assigned the value "7." Likert-scale responses to 9 items were analysed using a scale of 1 - 4 with the most positive response assigned the value "4."

Factor analysis, a tool widely used in educational research, was used to reduce the large set of variables to a smaller set called factors. The factors were used to explain any underlying principles connecting all the variables together. Thus, analysis of the data using the principal-components rotated-varimax method of factor analysis, on items 1 to 47 of the Pre-camp MIAS (57 cases) indicated five factors defined girls' attitudes towards MI careers as shown in Table 3.3.

Table 3.3 Factor Analysis of Semantic Differential-type Items 1 - 47

Factor/Category Name	Description of Factor	Number of Items
PROFIMAGE	General description of work and image of engineers and scientists	12
TASKDESC	Specific job description of duties, conditions and career path	9
PREREQUISITE	Maths, science skills and experience required	8
MSINTEREST	Interest in school maths, physics & chemistry	6
MSVALUE	Value of school maths, physics and chemistry	5

Seven items had inconsistent factor loadings and were eliminated from further analysis of the Precamp MIAS. The nine Likert-type responses were too few in number to warrant factor analytical techniques. Instead, a correlation matrix of the nine items determined that three categories best described this group as shown in Table 3.4.

Table 3.4

Correlation Analysis of Likert-type Items 48 - 56

Factor/Category Name	Description of Factor	Number of Items
PROFVALUE	Value of tasks performed by scientists and engineers	3
MIKNOWLEDGE	Prior knowledge of the industry	3
MIIMAGE	Image of the Industry	3

A statistical analysis of items within each factor or category, including item mean scores are shown in detail in Appendix D1. When the total of eight categories were compared against the list of ten mediators developed from the Eccles model, five of the mediators matched favourably, as shown in Table 3.5.

Table 3.5
Attitudes Towards MI: Eccles Model Vs MIAS

Eccles model mediators	Categories of MIAS Precamp Survey
[1] perceived image of the mining industry	Image of the Industry [MIIMAGE]
[2] perceived image of professional working in mining and the tasks performed by them	Perceived Image of Working in the Mining Industry: [a] general description of work and image of engineers and scientists [PROFIMAGE] [b] Specific job description of duties, conditions and career path [TASKDESC]
[3] level of interest in school mathematics and science and subsequent mining careers	Interest in school maths, physics & chemistry [MSINTEREST]
[4] value of school mathematics and science and subsequent mining careers	Value of: [a] school maths, physics and chemistry [MSVALUE] [b] tasks performed by scientists and engineers [PROFVALUE]
[9] prior knowledge of mining industry courses and careers	Maths, science skills and experience required [PREREQUISITE] Prior knowledge of the industry [MIKNOWLEDGE]

Several of the items that did not load onto factors did require some knowledge of MI per se, or contact with people within the industry, but these items were not analysed further at this point. The confidence of girls to enter non-traditional courses, as distinct from confidence as a reflection of interest and in their own academic ability, was not determined through MIAS. As described later in this chapter, qualitative methods were designed to examine confidence as a mediator of attitude change. However, because analysis of the main body of data elicited matching categories between MIAS and five mediators from the Eccles model, it can be postulated that MIAS is a valid instrument in describing girls' attitudes towards MI careers.

Reliability of MIAS

To determine if MIAS can be used as a reliable instrument, it was necessary to demonstrate equivalence between experimental and control groups prior to the camp. Effect sizes were calculated to determine if there were any differences between the way camp participants (experimental group) and non-participants (control group) responded to the categories obtained by factor analyses. The effect sizes were obtained by subtracting the experimental group's mean score for each category from the control group's mean score, and dividing this difference by the pooled within-group standard deviation. The means for each category are shown graphically in Figure 3.1 below, and in tabular form in Appendix D2.

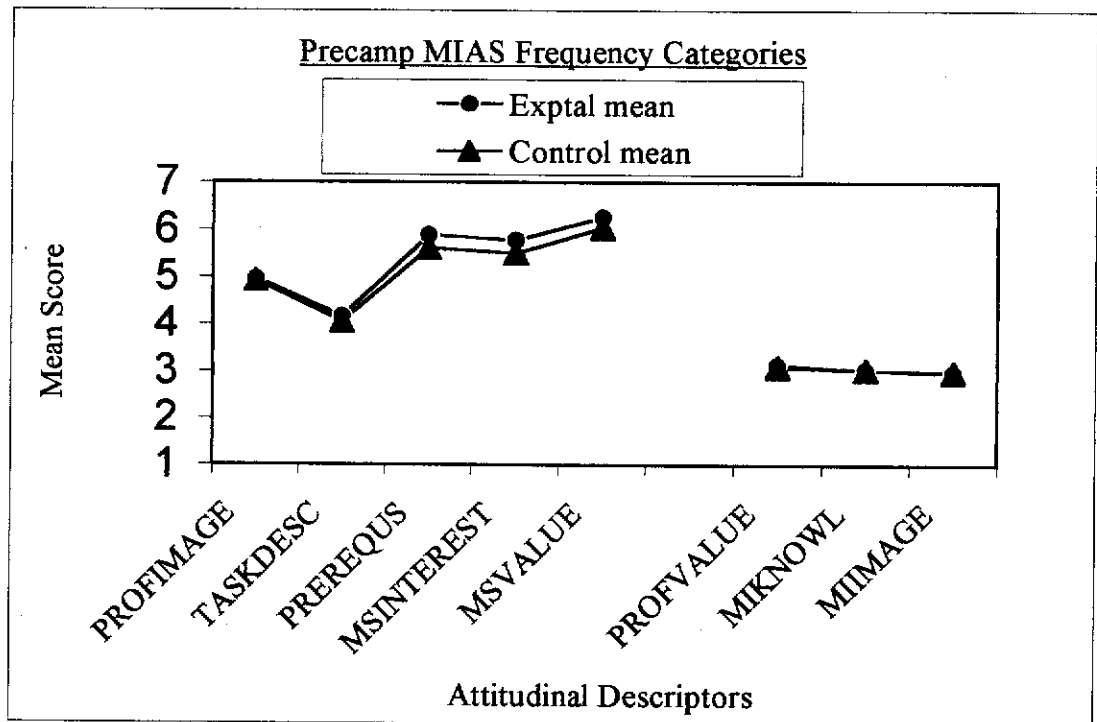


Figure 3.1 Means for Attitudinal Descriptors

An effect size (ES) greater than 0.2 is considered to be educationally significant (Keeves, 1992). As illustrated in Figure 3.1, mean differences between groups were found to be either not educationally significant (ES less than 0.2), or relatively small (ES between 0.2 and 0.25) thus demonstrating equivalence between experimental and control groups and the reliability of MIAS.

Evaluation of Pre-camp MIAS

The purpose of this preliminary evaluation was to assist with the adaptation of the WIET Project program strategies, for use on the 1995 WASM Camp. A statistical analysis of the responses of the combined experimental and control groups (57 cases) is shown in Appendix D1. The whole of group means for each of the eight categories are shown below in Tables 3.6 and 3.7. The mean frequencies for the first five categories (PROFIMAGE, TASKDESC, PREREQUISITE, MSINTEREST, MSVALUE) were obtained through seven-point semantic differential-type items whereas the last three categories (PROFVALUE, MIKNOWLEDGE, MIIMAGE) were obtained through four-point Likert scale-type items. Therefore they fall into two groupings as indicated.

Table 3.6

MIAS Precamp frequency factors (seven-point semantic differential-type items)

Factor/Category Name	Mean Score
PROFIMAGE	4.94
TASKDESC	4.11
PREREQUISITE	5.87
MSINTEREST	5.60
MSVALUE	6.15

Table 3.7

MIAS Precamp frequency categories (four-point Likert scale-type items)

Factor/Category Name	Mean Score
PROFVALUE	3.14
MIKNOWLEDGE	2.81
MIIMAGE	2.95

Table 3.6 shows MSVALUE with the highest mean scores (mean = 6.15) as may be expected of students with high ability in maths and science. From this category, items relating to the relevance of maths and science to future studies, in particular MI, score highly. Students also score well (mean = 5.87) on items pertaining to the importance of school maths and science (PREREQUISITE) as MI prerequisites. The data show that, while students score highly on their interest in maths and science (MSINTEREST), they value the study of these subjects

(MSVALUE) more, and both these categories score more highly than PROFIMAGE. This phenomenon has previously been reported by Dillon (1986) and Kahle (1989), who showed that, although girls indicated interest in maths and science and value their study, they would not undertake SET careers, possibly because of the poor image of SET. Similarly, the data support research by Godfrey and Roxborough (1992) on the image of engineers, since the value of tasks performed by professionals in MI (PROFVALUE) rated highly, but the image of engineers and scientists (PROFIMAGE) rated moderately.

The girls' perceived image of MI (MIIMAGE) also supports past research on the image of SET careers (Kahle, 1989; Lewis, 1992) where value of tasks performed by professionals in MI (PROFVALUE) is rated highly, yet actual work and conditions (TASKDESC) are only moderately rated. For example, an analysis of items within these categories shows that tasks are described as important and interesting, yet the work is thought to be relatively hard and lacking in glamour. These results need to be viewed in association with the fact that students did not know of anyone working in MI and very few girls had met people within the SET area of industry. Hence, specific job knowledge was limited.

Although Table 3.7 shows MIKNOWLEDGE rating moderately high, the category mean was artificially boosted through Item 49: "professionals in mining earn an above average salary" (95% correctly agreed). In fact, Item 52: "to study mining courses I need to have passed Year 12 Geology," was incorrectly agreed to by 53% of the students. Various items that did not correlate into factors were based on having some knowledge of MI. Although these items are not analysed at this point, it is apparent that the girls' knowledge of MI courses, actual tasks undertaken in the job and range of careers, was at best limited.

Additional Information

While the category means depicted in Tables 3.6 and 3.7 provide an overall impression of girls' attitudes, further and more specific information may be gained through an inspection of individual item means and item modes within each of the eight categories. Consequently, the following points have been noted for consideration when planning and implementing strategies:

- About half perceived the typical “miner” image of engineers and scientists working in MI (Item 20)
- 32% believed you needed to be tough to work in MI (Item50)
- 37% believed that they would be treated differently because they are female (Item 54)

Conclusions

If, as suggested by Eccles (1989) and Dillon (1986), interest is a reflection of the confidence of girls in their maths and science ability, then little further emphasis is required on this issue. Results of the Precamp MIAS indicated both strong interest in school maths and science and a sound belief of the importance of their study. However, MIAS results did suggest that the girls had little knowledge of their future use. Both the areas of knowledge of MI jobs and tasks performed, were rated lower than interest and value of school maths and science.

Thus it was clear that the intervention program needed to maintain student interest and enthusiasm for maths and science, and careers they may lead to, and that the relevance and value of maths and science needed to be specifically demonstrated for MI as girls’ knowledge of this field is limited. The most significant area of development was student general knowledge of tasks and duties performed by engineers and scientists within MI - in other words, exactly what the girls may expect when working in MI or studying a MI course. On the one hand, girls strongly responded that MI is an exciting field, while on the other admitting a limited knowledge of the field. Therefore the work and image of professionals in MI needed to be related to the value of tasks performed.

If the results of the Precamp MIAS could be described in one sentence, it would specify that "girls’ knowledge of MI courses and careers was limited, but interest was high." This was an important guiding premise upon which to base the intervention strategies.

- b) undertaking activities within WASM amenities with WASM staff and supported by WASM students
 - c) using local recreational facilities
 - d) working as team members on activities
 - e) visits to local industry and meeting female role models in situ
 - f) bus tour of the local community and surrounding region
-
- 5) boost confidence to enter non-traditional courses by:
- a) opportunities to meet and interact with occupational female role models and WASM students
 - b) discussion of possible problems for women in non-traditional fields and an examination of various solutions
 - c) opportunities to meet and interact with students of similar interests
-
- 6) enhance student's perceived image of MI and professionals working in MI by:
- a) visits to local industry and observing female role models in situ
 - b) allowing discussion opportunities with occupational role models and WASM students
 - c) discussion of mine rehabilitation and conservation issues.
-

The objectives as listed above, were integrated into the program framework as compulsory activities, forming the basis of the 1995 WASM Camp.

Program Development and Adaptation

To date, traditional methods (University career evenings and "Focus on Mining" camps) have not improved female enrolments in MI courses. It thus appeared timely to implement an integrated program of strategies that began with the current knowledge of girls' attitudes, and used proven research methods adapted specifically to the results of MIAS. The foundation for a program of activities had been put in place from previous WASM Camp reports (Somerville Brown, 1992-4, unpublished reports) under the auspices of the WIET Project. Time and scheduling restrictions also dictated the need to have several activities in place well in advance of actual performance.

The 1995 WASM Camp program is presented in Appendix E1. The details of the strategies employed to cover the camp objectives are presented in the

following pages. However, in brief, to be able to keep students motivated and to provide a stimulating variety of activities, each day included a workshop at WASM, a chance to interact with women working in MI, a visit to industry or local place of interest, and a recreational activity. In this way, most objectives were attended to each day to varying degrees, as shown in Appendix E2.

Program Setting and Duration

To embrace the majority of program objectives, particularly those involving realistic work and study lifestyles, it was mandatory that the program be conducted at WASM in Kalgoorlie, a mining town approximately 800 kilometres from the state capital. Therefore, also by necessity the WASM program was in the form of a residential camp. Although several authors (Brown, 1993; Godfrey, 1997) have reported successful non-residential intervention programs, most of MI students' tertiary studies are at WASM in Kalgoorlie, and the majority of their work experience, and a substantial part of their career is in centres similar to Kalgoorlie. Hence, it was considered beneficial and enlightening for the girls (and their teachers) to undertake activities on site, especially as many prospective camp participants were not familiar with the Kalgoorlie region or surrounding industry, both atypical of the Perth metropolitan landscape and industry. In addition, it could be considered morally dishonest to conduct activities encouraging girls into MI in any other than the true environment.

The most appropriate time to conduct the WASM camp was mid-year, before students had made their upper school subject choices. The mid-year break between semesters at WASM was found appropriate as facilities were free for use by the Camp students and WASM staff were available to assist in planned activities. However, very few WASM students were available at this time as most had undertaken vacation employment. This problem was overcome in part by paying university students to work as program assistants during regular working hours, and in part by conducting some activities after work hours. An added bonus of the mid-year break was that many WASM students usually residing at Agricola College, the university student accommodation, vacate for mining jobs out of town. Thus, not only was accommodation available for camp participants, but also of the identical type they may expect when they enter university.

To enable student participation in each of the three departments in WASM (Mining Engineering and Mine Surveying, Mineral Exploration and Mining Geology, and Minerals Engineering and Extractive Metallurgy), the camp program was run over three days and evenings. To ensure variety and keep the pace interesting, each day's program included workshops in one of the three WASM Departments, a visit to local industry, a visit to local places of interest and a fun/leisure activity.

In April, prior to the camp, presenters and facilitators of camp activities were personally informed of the intention of this study and consulted in regard to the purpose of the strategies under development and practicality of their execution. This was important in order to clarify the objectives of the camp and discuss potential problems. A balance between disseminating a lot of information to students, allowing time for "self discovery" and talking over issues, indicated the need for an integrated program. Therefore each of the workshops was designed to relate to an industry visit to give girls the full picture of tertiary study, through to actual work and working conditions.

Perth was selected as the central meeting place and start of the camp. To allow country participants time to travel to Perth, the camp commenced on a Monday and closed in Perth the following Friday. Almost two full days were spent in coach travel between Perth and Kalgoorlie. Although airline travel would reduce travel time to only fifty minutes, the expense was too great to make the camp economically viable. Also, coach travel allowed time for the participants to know each other better, and complete any necessary documentation. The 1995 WASM Camp was conducted from Monday July 3 to Friday July 7 inclusive.

Student Selection and Entry

In 1995, all students applying to attend the WASM Camp were also invited to participate in this study. The Camp could accommodate 32 Year 10 girls, five secondary science teachers, myself as Camp co-ordinator and supervisor, and a female university student (Maths/Physics major) as assistant supervisor. As publicised, camp places were filled on a "first-come-first-served" basis. All applicants were asked to complete and return the Precamp MIAS prior to their notification of camp acceptance. By May 26, following receipt of completed MIAS, all applicants were notified of their success or otherwise. Final WASM Camp

numbers were thirty-two students, and four secondary science teachers (one male, three females). Unsuccessful applicants were asked to continue with their participation in this study by again completing the MIAS at the end of the camp in July.

Implementation of Precamp MIAS Results – spreading the word

In June, the relevant findings of the Pre-camp MIAS were mailed, or passed on verbally to most of the Kalgoorlie personnel involved with the camp. These included workshop organisers and student helpers, career talk presenters and industry tour guides. Unfortunately, not all people assisting could be contacted at this time. Personnel were asked to consider the following points in preparation of camp activities:

- all girls are high ability maths and science students, and are interested in finding out more about MI careers
- knowledge of MI careers and courses was very limited, therefore they would not be familiar with many commonly used terms and abbreviations (for example, “open cut” mining)
- most had not been to the Kalgoorlie-Boulder region before
- none had met a woman working in MI prior to camp
- value placed on maths and science by students was significantly greater than their interest
- value of the work done by engineers and scientists was high, but they had little knowledge of actual tasks performed. The image of MI was slightly biased towards heavy, dirty jobs.
- about half thought that the image of a “miner” was typical of engineers and scientists working in MI

In addition, some of the women that had been invited to give career presentations to the girls were also sent “speakers notes” requesting they include or note the following:

- use as much visual material as possible to highlight their talk
- discuss likes and dislikes of their job
- discuss the relevance of maths and science in their work

- bring any “hands on” samples of their work, for example, minerals at various stages of processing
- indicate whether they experienced any problems as a woman in a non-traditional field, and if so, elaborate possible solutions to overcome them.

Subsequently, all personnel involved with the WASM Camp were invited to discuss any of the MIAS results I had asked them to consider when preparing their camp activity. As a result, lecturing staff at WASM suggested that it may be beneficial for the participants if postgraduate students assisted with the workshops, even though all available were male at that time. The reasoning was that the postgraduate students were closer in age to camp participants than were the lecturers, and would possibly have greater rapport. In addition, the particular area of study undertaken by some of the postgraduate students may be of interest to the camp participants and could lead to ideas of the types of studies they may consider as tertiary students. These suggestions were welcomed for the reasons given, and also because the possibility of undertaking postgraduate studies was given little attention within the specified WASM Camp objectives.

An Underlying Theme – the presentation of female role models

The presentation of occupational female role models was an underlying theme throughout the camp program. Byrne (1993) acknowledges that girls need to observe more than the lone inspiring woman engineer or scientist before they feel comfortable to participate in non-traditional fields. As participants had not met any women working in mining, it was considered essential that women from a variety of disciplines were able to offer their views and experiences to the girls. Thus, female engineers and scientists from the Kalgoorlie mining region were invited to present talks about their current work and previous study at school and university, and to include as much of their personal background as they felt relevant. The role models were selected on the basis of their enthusiasm for their work, interest in strategies to increase the number of females in MI, friendly demeanor and possible rapport with young girls, and their professional representation of MI careers. These same women were among a larger group assisting with industry visits, allowing participants to gain first hand knowledge of the work environment and variety of tasks performed.

Finally, as participant knowledge about MI is limited, camp participants needed the opportunity, both formally and informally, to ask questions and discuss relevant issues with female role models. It was also necessary to allow students time to “digest” all the information before discussion sessions. To facilitate this, an informal dinner was conducted on the last night of the camp, inviting all those professional women and students that had participated in the program. Informal discussion naturally occurred during the meal, and continued in a more organised manner after the meal, with myself as facilitator, directing the mix of students and guests. While the evening’s purpose was to draw together the activities and objectives of the past three days, underlying the “question and answer” session was the intention of boosting the confidence of girls to enter non-traditional fields such as MI. It was considered that this may be achieved through direct encouragement from other camp students, attending teachers and invited guests, through increased MI knowledge, and by discussion of those issues seen to be relevant by the participants.

Previous studies (Kahle, 1989; Godfrey & Roxborough, 1992) have demonstrated that students perceive scientists as older men. Therefore an added advantage of the above strategy, was the fact that the average age of the professional women assisting with camp activities appeared to be about 27 years of age. It was assumed that this would assist with creating greater rapport with the Year 10 students, and dispel the image of those working in MI as being older and male.

"Hands on" Workshops

Excluding the field of Geology, student and teacher knowledge of MI courses was very limited. Therefore each of the three WASM departments conducted a “workshop” for the camp group. A common theme was to begin each session by explaining the department’s courses and the types of job graduates may be involved in. Either the Head of Department or a lecturer from each department undertook this task. Students were then put into smaller groups and taken to various laboratories to work on prepared activities. WASM students assisted with all workshops as “tour” guides and by generally assisting the girls with the task at hand.

As outlined in Chapter 2, Parker and Rennie (1986) have examined the reduced practical experience of girls in handling science equipment, and its relation to reduced confidence in the study of science. Therefore all WASM Camp activities were planned to utilise laboratory equipment and, if possible, designed such that the

girls could take something home as a result of their efforts. For example, the Department of Minerals Engineering and Extractive Metallurgy involved a “gold-panning” activity where various methods are used to extract gold and pyrites from crushed rock. Students were able to use modern and traditional methods to extract the metal and keep the results. Most participants were thrilled by the few specks of metal obtained and appeared more interested to observe gold mining on a major scale.

Although the image of MI is typically one of outdoor work, involving huge pieces of equipment and lots of dirt and rock, the activities undertaken at WASM were designed to cover a variety of environments. Activities such as “rock blasting” were naturally performed outdoors, with girls wearing hardhats and protective glasses. In comparison, using LANDSAT (satellite) to find a likely mineral deposit was conducted in the Computing Laboratory in air-conditioned “office” comfort.

In an attempt to satisfy the objective of relating school maths and science to prospective courses of study (Table 3.8, Objective 3a), laboratory science skills and computational maths skills were needed in order to dissolve precious minerals from their ore samples. The mineral resulting from successfully performing the experiments were kept by the students.

Visits to Industry

To illustrate how study from each of the three WASM departments may be applied in the workplace, three visits to industry were organised in the days following each department’s workshop. For example, the activity based on separation techniques was followed by a tour of the Fimiston Mill operated by Kalgoorlie Consolidated Gold Mine. The mill uses both chemical and mechanical methods to separate ore and metals. Our guide for the tour was a female metallurgist who later attended the camp discussion evening. During the tour, our guide explained that her work was typically both administrative and technical and gave the students a descriptive overview of each area. Perhaps just as significantly, the students were able to see for themselves the work environment of our guide, how she dressed when at work and how she interacted with colleagues from various areas of work.

An added advantage of the industry visits was the opportunity to illustrate an authentic image of the industry, rather than a perceived one. Previous WASM Camp

observations have indicated that students readily noted that MI graduates are working in supervisory positions using their intellectual talents, rather than their manual skills. In other words, they can get dirty if they want to, but this is not an essential job requirement. Moreover, teamwork and co-operation between co-workers is evident and necessary to complete the task at hand, most of which are on a very big scale.

Many of the MI supporting disciplines from non-MI courses were also highlighted during industry tours. For example, damage to the environment has been noted by Dillon (1986) as negatively affecting student attitudes towards SET participation. The industry tour gave students an understanding of the extensive program of site rehabilitation. It enabled them to view the rehabilitation in progress and gain information about careers related to MI, for example, horticulture.

Career Seminars

In keeping with the findings of Brown (1993) and the Evans team (1995), presentations by both women working in MI careers and WASM students in MI courses formed an important component of the camp program. Although neither Brown or Evans document the most advantageous atmosphere or setting for the talks from women, it was anticipated that relaxed, informal presentations best serve the purpose. In the past, lecture theatre venues with formal lectures from the podium conducted for large numbers of students seated in tiers, has not appeared to have increased female numbers.

Further, the small number of girls attending the camp, and the single-sex nature of the program would suggest that informal presentations should create the desired relaxed atmosphere. The girls should be free to ask the questions they feel at issue. Therefore, prior to discussion sessions with invited speakers, the camp participants were put into small groups to discuss among themselves the activities to date and issues of interest to them. The initial objective was to form a list of discussion topics or questions to put to the invited guest speakers.

Discussion Night. While informal career presentations were interspersed throughout the program, the final night of the camp was intended to link most of the activities together. By this stage, all the information regarding courses and industry visits were completed. The participants had collected a large volume of information,

met numerous people working in MI or related industries, had experienced typical WASM student lifestyle and visited areas of the local community. It was now timely to put all the information into perspective, as a prospective woman in mining.

In the presence of invited guests, consisting largely of women working or studying in MI, the girls were asked to consider the following issues:

1. The reasons why there are so few women in professional occupations in MI.
2. Whether the above reasons could be overcome, and if so, how?
3. What could be done to get more women interested in MI careers?

The girls were then divided into smaller groups of five or six students with two of the invited guests joining each group. The list of issues previously raised formed the basis of discussion between students and guests. The girls were also asked to make use of this opportunity to ask questions about particular MI careers and courses. The invited guests moved from group to group during the evening, giving all girls the chance to gain a varied perspective of opinions and careers. In addition, the guests were able to direct their responses specifically to the camp group because of their presence during the earlier discussion of relevant issues. To close the session, the girls were once again asked to report back on the reasons for so few women in professional MI careers.

Program Implementation

The 1995 WASM Camp was conducted for 32 Year 10 girls and three science teachers during the last week of the second school term (July 3 to 7). The group came together at Curtin University of Technology in Perth, and from there, travelled by coach to Kalgoorlie. The main camp activities were conducted over three days and one evening in Kalgoorlie. The final day of the camp was spent in coach travel back to Perth, where the camp officially closed. Whilst in transit, students completed MIAS for the second time and several audio taped interviews were conducted with selected participants.

PROGRAM EVALUATION

As stated in Chapter 1, quasi-experimental research, such as that conducted in this study, implies that there cannot be control of all sources of internal validity (Tuckman, 1988). Although some educational researchers would argue that there

could never be control of any sources of internal validity (due to the complex nature of human subjects and societies), in this study, control for selection bias was redressed through assignment of participants to groups based on sequential order of received applications, over which I had no influence, and the applicants had no special knowledge. The main issue likely to affect internal validity in this study appeared to be control group experimental mortality. Of the original 25 control group respondents to the Precamp MIAS, only ten completed and returned the Postcamp MIAS in time for analysis. Therefore, in the analysis, equivalence between control group Precamp and Postcamp MIAS data was examined to satisfy research internal validity.

The generalisability or external validity of the findings of this study was intentionally limited. From the outset, it was not the purpose of this study to enhance attitudes of the general female population, but to limit strategies to those females who met pre-course entry requirements and were able to participate in the WASM Camp at the time of offer. Thus, the findings of this study are relevant to similar groups of Year 10 girls.

Postcamp MIAS Data Collection and Analysis

To determine the effect on attitudes resulting from attendance at the WASM Camp, participants were asked to complete the MIAS for the second time upon camp closure. Data from pre-camp and post-camp surveys were contrasted and attitude changes were determined for the group overall.

The control group also completed MIAS after the camp had closed to enable some inferences to be drawn regarding the effect of the experimental treatment on attitudes, and to support the internal validity of the research. The students in the control group were mailed Postcamp MIAS to their schools, asking for completion and return by 4 August, 1995 (Appendix B4).

The *Statistical Package for the Social Sciences* (SPSS; Tuckman, 1988) and *LabVIEW*® (National Instruments Inc., 1993) were used to analyse data as indicated in Table 3.9.

Table 3.9

Postcamp Statistical Test Summary

Purpose	Statistical Test	Group Tested n = # in test group	Statistical Package
1. demonstrate equivalence between Precamp and Postcamp control group responses	mean, standard deviation, Effect size	control group n = 25 Precamp control group n = 10 Postcamp	LabVIEW®
2. determine any changes in attitude within the experimental group	mean, standard deviation, Effect size	experimental group n = 32	SPSS LabVIEW®
3. determine any changes in attitude within the control group	mean, standard deviation, Effect size	experimental group n = 10	LabVIEW®

Researcher Observations

During the progress of the WASM Camp, students attended various activities designed to enhance attitudes and to meet the objectives of the camp program. For each type of intervention strategy, researcher observations of student behaviour during the three days of program in Kalgoorlie were noted. The method used for recording the observations were as brief written notes regarding enthusiasm and enjoyment of the activity, the level of understanding as typified by the questions asked by students, and the level of participation or involvement.

Interviews

Audiotaped interviews were conducted on the final day of the camp with 10 students from the experimental group. Students were selected at random and participation was optional. Several students who were not part of the selected group, gave feedback to the interview questions at their own request. Interview questions were determined by analysis of MIAS Pre-camp data, previous WASM Camp data (Somerville Brown, 1992-4, unpublished reports), and observations made on the camp. Spontaneous and varied questions were also asked as the interviews progressed, as typified by everyday conversation.

Determining Attitude Change

For girls in the experimental group, attitude changes could be determined both quantitatively through MIAS, and qualitatively through researcher observations and interviews with students. Positive mean score differences from precamp to postcamp MIAS indicate enhancement of girls' attitudes, whereas effect sizes demonstrate the relative magnitude of the attitude change and enable comparisons between the attitudinal mediators. It was intended that inferences regarding the effectiveness of the intervention strategies employed could be drawn from the magnitude of the change.

Because MIAS did not provide feedback on all attitudinal mediators, for example, career aspirations and expectations, changes in attitude were examined through observation of student behaviour during the WASM Camp, and interviews following the camp.

Girls comprising the control group did not participate in any part of the intervention program. Their attitude changes were determined only through precamp and postcamp MIAS mean score differences.

SUMMARY

The School Science Survey (Rennie & Parker, 1994), and analyses of data from previous WASM Camp surveys (Somerville Brown, 1992-4, unpublished reports), were used to develop MIAS, an instrument for determining girls' attitudes towards MI careers specifically, rather than SET careers in general. Accordingly, the mediators developed from the Eccles model of educational and academic choices (elaborated in Chapter 2), were modified from SET to relate to the mining industry, and were compared with pre-test MIAS findings. The comparison indicated that MIAS was indeed a valid and reliable tool for determining girls' attitudes towards MI careers. However, as MIAS did not provide data describing all of the mediators of attitudes (as per the Eccles model), qualitative data were gathered to provide a more complete analysis.

Analyses of precamp MIAS data revealed that the Year 10 girls admitted a limited knowledge of MI career paths, and positive, though moderate, attitudes towards the work-related tasks performed by engineers and scientists working in MI.

However, their perceived image of MI, attitudes towards professionals working in MI and the value of the work they undertook, was very positive. The analysis also showed the perceived value of school maths and science subjects was extremely positive and interest in them was high.

Accordingly, a program of strategies, adapted from the WIET Project's annual residential camp at WASM, was refined with the aim of increasing the girls' knowledge of MI career paths and the tasks performed by professionals working in MI. In doing so, the strategies were required additionally to enhance the image of MI, and of professionals working in MI and the value of the work they do. The program ought to maintain the high level of interest and value of school maths and science found by MIAS analysis. Following on from the successful attitude changes achieved by Brown (1993), Davis and Hollenshead (1991), and Evans, Whigham and Wang (1995) and an underlying theme encompassing the program of activities was to include the presentation and involvement of female role models wherever possible.

The intervention program was implemented at the WASM Engineering and Technology Residential Camp in Kalgoorlie, during July 3 to 7 1995. The girls attending the camp comprised the experimental group, and were chosen in order of application receipt. The control group comprised those students whose applications arrived after camp quotas were achieved. Postcamp MIAS were administered to both groups following camp closure. Triangulation of data was achieved through audio taped interviews with selected students after the camp, observations made during the camp, and from the literature review.

Finally, the intervention program was evaluated in terms of the enhanced attitudes of camp participants with regard to the ten attitudinal mediators derived from the Eccles model.

CHAPTER 4

RESULTS, ANALYSIS & EMERGING THEMES

PURPOSE

The purpose of the chapter is to report analyses which inform answers to Research Question 4 "*Will the implementation of appropriate intervention strategies enhance girls' attitudes towards MI careers?*" Secondly, through collective examination of the qualitative and quantitative results, a number of common themes are presented, that describe both the effectiveness of the intervention strategies, and girls' postcamp attitudes towards MI careers.

OUTLINE

This chapter begins by examining the quantitative data collected through MIAS before and after the WASM Camp, to determine if Year 10 girls in the experimental group had a positive change in attitude towards MI careers. The eight categories of attitudinal descriptors, derived through factor and correlation analysis of the precamp MIAS data, were applied to postcamp MIAS data obtained from both the experimental and control groups of girls. Mean frequency differences between precamp and postcamp MIAS data were calculated to determine attitude changes towards MI careers. Those with effect sizes greater than 0.2 or less than -0.2 were considered educationally significant. Differences between the postcamp MIAS results of the experimental group and the control group were also calculated to determine the reliability of the MIAS data.

The next section of the chapter outlines the results and analysis of the qualitative data obtained during the WASM Camp. Researcher observations of student behaviour during each intervention strategy of the camp program, and audiotaped interviews with selected participants, are presented in order to supplement the results from MIAS, and to provide a fuller analysis of attitudes (as listed in Table 3.1) and stated WASM Camp objectives (as listed in Table 3.8). It is thus noted that all ten mediators of attitude, derived through interpretation of the

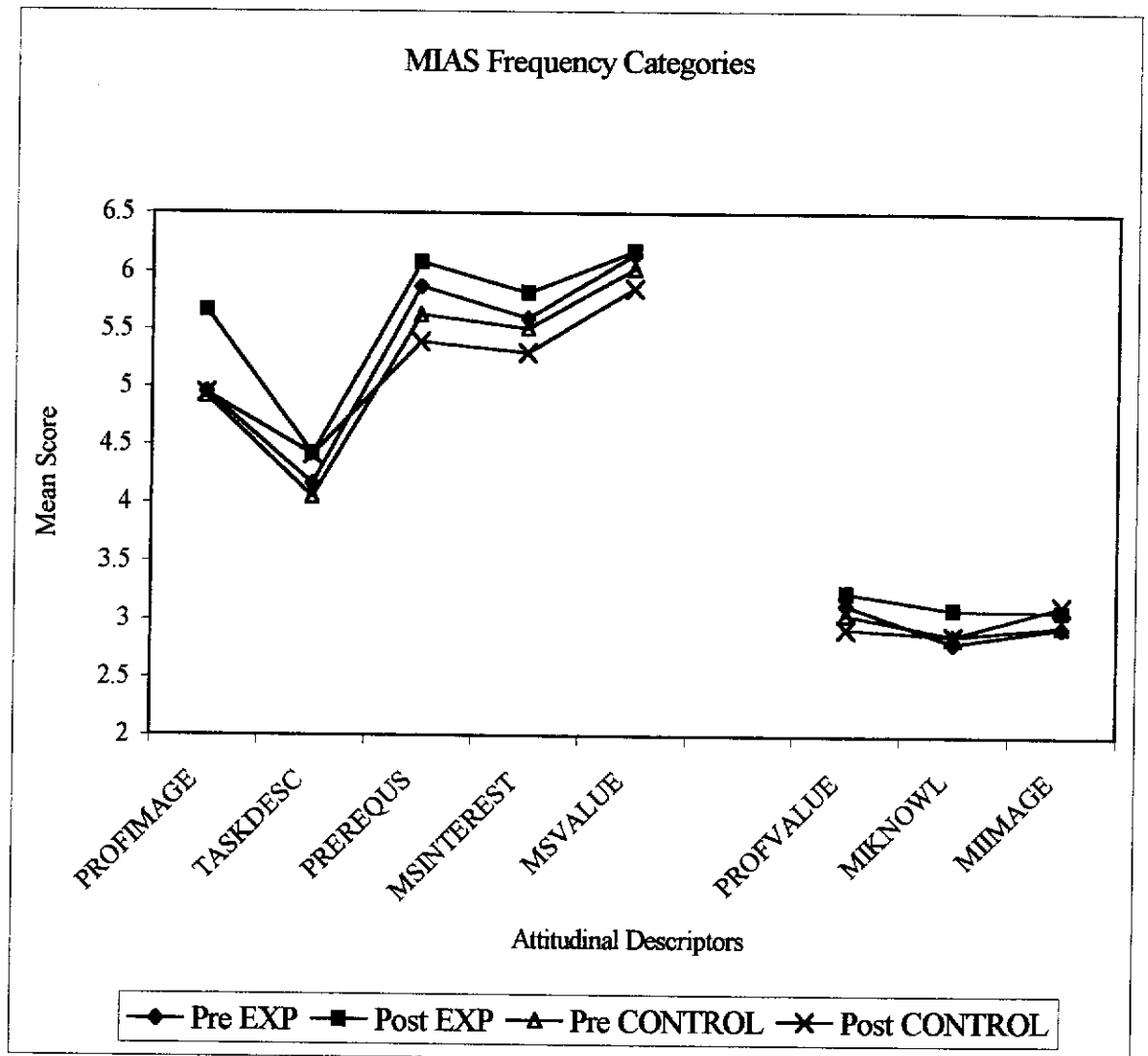
Eccles model, have been analysed by either qualitative or quantitative methods. In particular, the five mediators described through analysis of MIAS were analysed by both qualitative and quantitative methods and through triangulation of the data, the most significant changes in attitude may best be described and understood.

Finally, the combined analysis of the full complement of results led to the emergence of several common themes pertaining to the effect of the intervention strategies on girls' attitudes. In particular, the impact of the various intervention strategies were analysed within the framework of the presentation of female role models.

RESULTS OF MIAS

Determining Attitude Change through MIAS

To compare the attitudes of girls in the experimental group before and after the intervention, differences between mean frequencies of each of the eight MIAS categories of attitudinal descriptors from precamp and postcamp data were determined, and effect sizes calculated. Of the original 32 students in the experimental group completing the precamp MIAS, all completed the postcamp MIAS. Comparable calculations were performed on data received from the control group. However, of the original 25 respondents, only ten girls completed and returned the Postcamp MIAS in time for evaluation. Therefore due to experimental mortality, conclusions drawn from control group data analysis is limited. The Precamp and Postcamp results for both experimental and control groups are shown graphically in Figure 4.1 below and in tabular form in Appendix F1.

Figure 4.1 Mean Frequencies for MI Attitudinal Descriptors: Precamp Vs Postcamp

Experimental Group: Precamp Vs Postcamp

Postcamp data from the experimental group were examined for changes in attitude using the eight attitudinal descriptors derived from MIAS. As may be seen in Figure 4.1, all MIAS categories showed a positive increase between precamp and postcamp data, indicating a positive attitude change in all areas of analysis. However, because only those mean differences with effect sizes greater than 0.2 are considered educationally significant, PREREQUISITES (E.S. 0.18) and MSVALUE (E.S. 0.03) are not considered as significant positive increases.

The greatest positive change between precamp and postcamp responses occurred for the category describing the image of professionals working in MI, PROFIMAGE (E.S. 0.61), and considered by Keeves (1992) as a large increase. A

moderate increase may be observed in the category identifying student knowledge of MI careers, MIKNOWLEDGE (E.S. 0.43), whereas increases in TASKDESC, MIIMAGE, PROFVALUE, and MSINTEREST range from effect size 0.24 to 0.20 respectively, and are considered low positive increases.

Thus, in terms of the Eccles model, results from MIAS demonstrated significant increases in all five of the mediators of student attitudes, from the ten factors listed in Table 3.1.

Control Group: Precamp Vs Postcamp

The control group did not participate in any intervention program and therefore one would not expect any significant change between precamp and postcamp responses. However, TASKDESC, the category including items of job description of duties, conditions and career paths, did show a significant, if low (E.S. 0.32) positive increase, indicating that the students' attitudes had improved favourably. This is an interesting result as the affiliated category describing the image of professionals working in MI, PROFIMAGE, showed virtually no change between precamp and postcamp responses (effect size 0.03). Moreover, PROFVALUE, the category describing the value of work done, showed a negative change (E.S. -0.18), though not considered significant. Similarly, while knowledge of MI courses and careers did not change between precamp and postcamp responses (MIKNOWLEDGE E.S. 0.00), attitudes towards the image of MI (MIIMAGE) showed a low educationally significant increase (E.S. 0.24). In fact, the control group increases for MIIMAGE and TASKDESC were greater than the respective experimental group increases, although the results must be treated with caution for the reasons previously outlined.

The categories relating to students' interest and value of school maths and science, MSINTEREST and MSVALUE, showed low negative changes though not educationally significant. Whereas PREREQUISITES, the category describing the maths, science skills and experience required for MI careers, showed a low significant negative change (effect size - 0.2).

In terms of the Eccles model, results from MIAS demonstrated significant increases in two of the mediators of student attitudes, and a decrease in one mediator, from the ten factors listed in Table 3.1.

Postcamp Experimental Group Vs Postcamp Control Group

Because the control group did show some significant differences between precamp and postcamp mean scores, notwithstanding the results based on a very small postcamp sample, it would appear relevant to compare postcamp experimental group scores with control group scores. Appendix F2 details a comparison of mean frequencies and effect sizes in tabular form.

Large positive mean increases, favouring the experimental group, occurred for both categories pertaining to professionals working in MI, namely PROFIMAGE (E.S. 0.65) and PROFVALUE (E.S. 0.54), indicating large positive attitude changes as a result of WASM Camp attendance. Similarly PREREQUISITES, the category describing maths/science skills and experience required for MI careers, also showed a large positive difference in attitudes between groups (E.S. 0.59).

Moderate positive increases, again favouring the experimental group, occurred for MSINTEREST (E.S. 0.37) and MIKNOWLEDGE (E.S. 0.35), and a low increase for MSVALUE (E.S. 0.26). Finally, as may be observed in Figure 4.1, TASKDESC and MIIMAGE showed virtually no significant difference between experimental and control group mean scores.

In terms of the Eccles model, significant experimental group increases occurred in four out of five mediators of attitudes described through MIAS, and from the ten factors listed in Table 3.1. MIIMAGE was the only mediator for which the control group had a greater mean score increase than the experimental group. However, the increase is not considered educationally significant.

RESULTS OF RESEARCHER OBSERVATIONS

Determining the Effect of the Intervention Strategies through Observations of WASM Camp Activities

As supervisor and facilitator of the WASM Camp program, I was in a position to observe student reactions to the various camp activities, and to note many of their comments while undertaking the activities. Attending school science teachers were able to assist with observations and note-taking when it became difficult for me to personally do so.

Career Seminars

Of all the activities attended, the opportunities to meet and interact with women working or studying in MI, were among the most enjoyed by all. The presenters chose a casual and relaxed format, keeping the pattern informative and biased towards the personal rather than technical. The girls appeared interested and responsive during the presentations. Questions asked of the speakers varied according to the field of work undertaken. For example, it was interesting to note that safety issues were discussed with the speaker representing mining engineering, but not with other seminar speakers.

A recurring theme of the girls' questions related to how the speaker came to be interested in MI, for which the answer was often "by accident." It appeared that while the majority of speakers had made a decision to enter, for example, engineering, they had not considered MI as a branch of specialisation. Once qualified, the women became aware that MI appeared to have many well paid positions available. In comparison, current WASM students explained they had already made the "discovery" of good MI employment prospects and were studying appropriately. However, both WASM students and invited speakers clearly stated that the appropriate maths and science prerequisites in school allowed them to take up the option to enter engineering and science in the first place.

Other frequently discussed topics related to whether the speaker enjoyed living in Kalgoorlie, and if they missed their family and friends. Generally, seminar speakers responded that while they were satisfied with their lifestyle and that the majority currently had partners in Kalgoorlie, most stated that the population was transient. Therefore it was difficult to say where they and their partners may be located in the short term future. For them, this did not appear to be a problem while relatively young, and several speakers saw this as an asset of an MI career.

"Hands on" Workshops

Observations of students during the workshops found them willingly participating and making use of equipment and materials. While most of the MI-specific equipment was new to the students (rock breaker, separation equipment), the majority of the smaller apparatus was typical of school science laboratories. Therefore, the girls' confidence to ask questions and in using equipment did not

appear to be an issue. Students appeared eager to obtain a result, especially if they thought success would result in a gold sample.

All workshops began with an overview of the courses in question, usually from the Head of Department. The onus was then on the girls to ask further in depth questions. While some activities, for example the rock breaking demonstrations in Mining Engineering, created a lot of excitement as pieces of rock flew out across the laboratory, little interest in pursuing the course seemed apparent from the lack of student questions. In comparison, separation techniques allowing the girls to “pan for gold” caused many questions about the prerequisites and career prospects in Metallurgy.

Overall, students commented that they felt “welcomed and wanted” by the WASM staff and found both staff and WASM students friendly and helpful. Several students mentioned that they did not know which course to pursue as they were all made to sound attractive.

Industry Visits

The visits undertaken on the camp varied between tours of working processing plants and mine sites, to tourist underground mine tours. Therefore, the environments varied between practical, and often unattractive work sites, to those that were purpose-built as tourist attractions. When visiting the former, many students appeared surprised and dismayed by the sheer size of mining operations and the immensity of equipment used. Consequently, many of the questions from students related to the physical appearance of the environment rather than any technical aspects. Therefore, it seemed that the girls felt a sense of relief when the tour leader, last seen as a seminar speaker, typically agreed that the “worksite was not pretty” and that mining was executed on a huge scale for economic reasons alone. Tour leaders would explain, with pride, their part in a successful mining operation and some of the work-related problems they have helped to solve. The effect of relating the immediate environment to aspects previously discussed at the career seminars, appeared to reassure the students. Moreover, a renewed respect for the tour leader became apparent, when they were seen “at work” rather than talking about work.

By contrast, visits to the underground tourist mine and the Museum of the Goldfields were very much enjoyed by all students. Both tours conveyed information about the history of the region and of mining generally, and questions from students were largely in this context. In addition, representatives from both organisations made special reference to the role of pioneering women in the development of the Kalgoorlie region, and compared the camp group with them. However, whether the attending girls saw themselves as pioneers, varied between disbelief and nodding agreement.

Small Group Discussion: “Women in Mining”

The final camp activity, following a barbecue with guests consisting of women working or studying in MI, was a group discussion of the topic “Women in Mining.” The girls' responses to the discussion topics were recorded without comment prior to the small group discussions with the female role models. At the conclusion of the evening, their comments were again listed and both sets of results are presented in Table 4.1 below.

Table 4.1

Reasons for few Women in Professional MI Careers

Before Discussion with Female Role Models	<ul style="list-style-type: none"> • Dirty and physical work; • Girls may have stereotyped images of MI; • MI is only advertised as a “man’s job”; • Legal restrictions on women, until now; • Lack of peer group support; • Girls are discouraged from continuing school maths and science; • Women have a lack of self confidence; • Conflicts with women wanting to raise a family; • Possibility of harassment; • Safety issues concerned with MI; • Lack of information received about careers, jobs; • Men working in MI want to keep the industry “male”; • Preconceived ideas of the industry; • Employers hesitant to employ women; • Women need to fighter harder than men for acceptable regulations and conditions.
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After Discussion with Female Role Models	<ul style="list-style-type: none"> • Lack of information received about careers, jobs; • Lack of interest in MI careers; • Reluctance to move away from family and friends.
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ANALYSIS OF RESEARCHER OBSERVATIONS

General Observations

For a group of 32 girls that had not been acquainted prior to the WASM Camp, the rapport and co-operation that developed was encouraging. It was not difficult to motivate and interest the girls in various activities, or necessary to promote discussion. On the whole, the students proved to be articulate and confident in their approach to camp activities. In return, the camp group received substantial attention and positive feedback from the various industries, museum visits and other tours. Students were clearly informed by the various activity facilitators, that the industry welcomed more women and was working towards this goal by supporting programs such as this.

Career Seminars

Analysis of seminar observations indicates that the girls were attempting to find a level on which they could relate to the speakers. Questions regarding the early interests of the speakers and whether they enjoyed living in Kalgoorlie, indicated that for the girls, personal interests was a motivating factor for career choice, as was the issue of moving away from home to work. This observation is supported by the consensus reached by the camp group at the Discussion Night, where again, personal interest and familial concerns were seen as possible impediments to undertaking MI careers. Salary and career prospects only became relevant as secondary considerations or as an added bonus, once specific career interest was sustained. However, the career seminars proved a valuable method of introducing girls to multiple MI disciplines both efficiently and enjoyably.

“Hands On” Workshops

An analysis of the observations during the WASM workshops indicated that the "hands on" experience undertaken helped to consolidate career information received by the girls. While some girls may have had difficulty recalling names of courses, most could describe the course in terms of the particular activity. Certainly by Camp closure, students could describe more of the courses in MI than before the Camp, and were well versed in the relevant high school prerequisites. Thus the workshops were able to provide practical experience for courses that had previously been known by name only. Additionally, WASM staff were "on show" as prospective teachers, in terms of their ability to both sustain student interest and relate to the girls.

The enthusiastic participation of students during many of the workshops indicated that the girls found them to be interesting, set at an appropriate level of ability, and they were confident with using equipment. Interest was also reflected in the number of questions asked about some of the courses. Workshops that had a large demonstration component, or began with lengthy technical explanations, or relied on "chalk and talk" methods, drew fewer questions and did not appear to greatly interest students. By comparison, workshops that were mainly "hands on" and allowed girls to obtain material results from their efforts, were enthusiastically undertaken. Interviews with students support this analysis where greater interest was claimed in courses described in the latter manner. Unfortunately, some courses were judged as unsuitable on the basis of the workshop, while others, particularly Metallurgy and Geology, were thus considered to warrant further inquiry.

Industry Visits

The industry visits proved to be an effective method of efficiently showing students the type of activity and workplace they could be involved in. Consequently, when describing a particular career, students would refer to the visit and tour guide to assist with their description. However, as an intervention strategy to enhance attitudes, it would appear that the industry visits had as many benefits as drawbacks. While the visits gave visual clarification to the career information received, the unattractiveness of some of the mines and mineral processing sites resulted in students wanting to distance themselves from the particular field. Moreover, students

appeared concerned with conservation issues for the first time. At this point it proved helpful to examine and discuss professions that have now become associated with MI, such as horticulture and environmental consultancy.

Therefore, industry tours of working mining operations appeared educationally beneficial, but not an effective intervention method for enhancing girls' attitudes. On the other hand, the tourist-based visits were very well received by students, but did little to inform girls about current courses and careers.

The Discussion Night

The conclusions reached by the girls about the reasons for few women in MI suggest that the confidence of the girls, whether to enter MI courses (as a non-traditional field) or in their own academic ability, was remarkably high. Importantly, encouragement came from the women who had successfully done what the WASM Camp was asking the Year 10 girls to do. This point was not lost on the participants, and mentioned by several girls during the taped interviews. By popular consensus of the camp group, interest appears to be an important issue in determining educational and occupational choices, in preference to, for example salary level, job security, and career path incentives.

As a concluding activity, the discussion format appeared to have few, if any drawbacks. Girls were able to clarify and consolidate the information received from the varied intervention strategies and delve into issues of individual interest.

RESULTS OF INTERVIEWS

Determining Attitude Changes through Student Interviews

During the return coach ride to Perth, ten students were selected at random to participate in separate audio taped interviews. The selected students came from private and public schools, and rural and metropolitan regions. The interview questions, detailed in Appendix G, were asked in random order. While the interviews have not been transcribed, a summation of student responses is presented in Table 4.2. The order of the responses listed in Table 4.2 begins with the most often cited answer, and follows sequentially to the least cited answer. For example, prior to the

WASM Camp, most interviewed girls said they were interested in journalism, while only one student claimed an interest in a chemistry career.

Table 4.2

Summation of Interview Responses

Interview Question (in brief)	Responses
1. Career interest : (a) prior to camp (b) after camp	<ul style="list-style-type: none"> • Varied list including journalism, veterinary science, teaching, chemistry-based career, engineering (generic) • Extractive Metallurgy (mentioned by seven students), Environmental Consultant, Engineering - Mining, Civil, Geologist
2. MI enrolment influences	<ul style="list-style-type: none"> • A course that I really liked/was interested in • <i>"I would like to do a job like Shoena"</i> (female seminar presenter) • be able to earn good wages • a challenging career • an exciting career
3. MI career knowledge: (a) prior to camp (b) after camp	<ul style="list-style-type: none"> • Very limited, if any • Stereotyped image of "miner" working underground, drilling, <i>"using picks and shovels"</i> • <i>"I thought engineers fixed cars"</i> • correct prerequisites for MI courses, what the courses involve • <i>"I thought MI was male dominated, but now know there's lot of women"</i> • MI has more technical work - surveying, mapping
4. Need to be "tough to work in MI".	<ul style="list-style-type: none"> • Physical work if you want it, but not obligatory • Use equipment to do the hard jobs • Need intellectual skills more than manual skills
5. "MI no place for women"	<ul style="list-style-type: none"> • All students disagreed – women can work in any field they choose, provided they have the appropriate skills • Many women in MI now, times have changed. • <i>"MI is one of the most exciting fields a woman can get into"</i>

Additional Student Comments

Several students mentioned that one of the benefits gained from the camp was that they now intended to pursue more of the MI prerequisite subjects in Year 11 than prior to the camp. The main reason given was the range of opportunity made available through undertaking more maths and science.

ANALYSIS OF INTERVIEWS

An analysis of the interviews found that, prior to the camp, girls' career interests included both the arts and science fields, but were comparatively conventional in their range of occupations. While all the careers cited required a tertiary education, those that related to the SET field tended to be science-oriented rather than maths. For example, some of the cited careers were veterinary science, biology teaching and physical education, and "a chemistry-based" career. In comparison, after the camp, interest in maths-based careers were mentioned for the first time (geophysics and mining engineering). However, chemistry-based courses were still the most popular with seven out of ten interviewed students now including Metallurgy as a career interest.

The most popular, and often the only, reason given by interviewees to undertake a particular career, was personal interest. Although some students did mention salary level and being challenged in their work, interest was typically cited first. While students were not directly asked how interest could be induced, it became apparent from their comments that the role models presented at the camp and the workshops attended were the major influences in developing their interest. Role models were mentioned by name as students claimed they would like to do similar jobs:

"Shoena's job sounded really interesting. I'd like a job like that."

(Year 10 girl describing a female chemical engineer facilitating camp activities)

"That environmental (consultant) has a great job - I could do that."

(Year 10 girl describing a female environmental engineer facilitating camp activities)

When elaborating on a particular interest, the girls would often describe the relevant workshop and what they enjoyed about it. For example, one girl describing her new found interest in a geology career, stated that:

"The workshop activity made you want to find out more about the rocks and where they came from. I found it challenging. It made me want to find out more." (Year 10 girl describing the workshop conducted in the Department of Mineral Exploration & Mining Geology).

All students claimed the camp greatly increased their knowledge of MI careers. While two students had had prior contact with professionals in MI, it was mainly camp participation that informed students of the appropriate prerequisites, what particular courses and jobs entailed, and the variety of jobs available. The consequence of their increased knowledge appeared to be greater interest in pursuing MI courses and more of the MI prerequisites. Several girls stated that they now intended to pursue two maths and two science subjects in Year 11, whereas previously they did not.

Prior to the camp, "mining" was used as a generic term to cover all fields within MI, and typically elicited stereotyped images of men at work. For example, one girl stated that:

"I thought they used picks and shovels and did a lot of drilling. I now know that it's much more technical, uses lots of computers." (Year 10 girl describing her image of a person working in MI).

Following the camp students could now specify the particulars of several MI-related careers and in fact found "mining" per se more difficult to describe because of the varied fields. The image of MI had also significantly changed from "getting dirty" and using heavy machinery, to one of working with "dirt" in terms of finding ore deposits, or isolating precious metals.

All interviewed students believed that there were no obstacles for women wishing to enter MI and would encourage interested people to do so. When asked how they would respond to someone who claimed that MI was "no place for a woman," the issue of equal opportunity was supported by the responses from the girls:

"Shoena has the same sort of attitude as me - all people are equal, it doesn't matter if you're male or female, short or tall, you can do whatever job you want." (Year 10 girl in reply to interview question 5).

"I think there is equal opportunity, and women can do what they want to do." (Year 10 girl in reply to interview question 5).

RESEARCH QUESTION 4

Will the implementation of appropriate intervention strategies enhance girls' attitudes towards MI careers?

In terms of factors affecting attitudes derived from the Eccles model for academic and occupational choices, the results imply that girls' attitudes overall are more positive after the intervention, in comparison to their attitudes before the intervention and when compared to girls from the control group. The analysis of the quantitative data from MIAS, shown to describe five attitudinal mediators, resulted in higher mean scores for each factor after the intervention, indicating more positive attitudes.

Although not all changes in attitude described through MIAS are considered educationally significant, analysis of the qualitative data lent support to the findings of several mediators. For example, their perceived image of professionals working in MI and general knowledge of MI careers, have been demonstrated as more positive through both postcamp MIAS and interviews with students. Moreover, those factors that did not achieve post-intervention educationally significant increases, have been shown firstly to have had high mean scores prior to the intervention, and secondly to have had significantly higher post-intervention scores than girls in the control group. For example, MSVALUE, the factor describing girls' attitudes towards the value of maths, science and MI careers, resulted in the lowest increase in mean score following the camp. However, MSVALUE initially had a mean score equal to 6.15, the highest of the MIAS attitudinal descriptors, and postcamp, was significantly greater than the mean score of girls in the control group. In fact, the control group's postcamp mean score of MSVALUE had shown a negative attitude change. While it may be claimed that postcamp mean score increases could be due to testing, or participants attempting to please the researcher, triangulation of the data has minimised these possibilities. Further observations of girls during camp activities and postcamp interviews support the positive attitude changes observed in the quantitative analysis.

Of the remaining attitude mediators as yet not described through MIAS, analysis of the qualitative data indicated post-intervention positive attitude changes for girls attending the WASM Camp. Once again, factors akin to girls' confidence in their academic ability were remarkably positive precamp, and remained so postcamp. Although similar qualitative methods were not employed to obtain data from girls in the control group, equivalence between groups has been demonstrated through precamp MIAS analysis. Therefore, it may reasonably be assumed their attitudes remained unchanged ten weeks later (when MIAS was administered for the second time), while noting that not all influences affecting attitudes may be controlled.

Consequently, when all the evidence is taken together, because the attitudes of girls in the experimental group have been demonstrated to be more positive following the intervention, and in comparison to those of girls in the control group, it may be inferred that the intervention strategies appeared to successfully enhance girls' attitudes towards MI careers, at least in the short term.

EMERGING THEMES

While MIAS data have been able to provide reliable information on quantifying attitude changes, and thus permit some conclusions about the effectiveness of the intervention program, MIAS was unable to provide descriptive information concerning individual strategies. Also, the methods used for analyses of MIAS data as presented in this study do not illustrate the girls' attitudes following the intervention. However, researcher observations of student behaviour and taped interviews do reveal descriptive details of girls' attitudes towards MI careers, while providing specific information about particular intervention strategies. In addition, several attitudinal mediators, not described through MIAS, may now be detailed.

Thus, analysis of the collective data leads to a number of common themes which bear upon the effectiveness of the intervention strategies and also provide a "before and after" picture of girls' attitudes. Therefore, the following section of this chapter attempts to further explore several attitudinal mediators and account for observed attitude changes in terms of the influence of the intervention strategies. Finally, comment will be made on the effectiveness of the intervention program in terms of observed attitude changes.

Attitude Change

Two Areas of Greatest Change

Earlier in this chapter, MIAS has been shown to be a reliable tool in quantifying changes in several attitudinal mediators. Two significant findings from MIAS, in terms of factors influencing attitudes and strategies developed to enhance them, were girls' increased knowledge of MI careers, and changes to their perceived images of people working in MI. These were also the attitudinal descriptors from the precamp MIAS data with the lowest relative mean scores within each type of analytical category. These results may best be explained by examining the qualitative data obtained in this study.

Discussing knowledge of MI first, participating Year 10 girls were found to have had very little knowledge of the range of MI courses and careers, other than Geology, and over half of those surveyed incorrectly believed Year 12 Geology to be prerequisite study for MI generally. This student misinformation was compounded by the fact that most participating girls do not intend to study Year 12 Geology, and therefore assume self-disqualification from MI courses. Moreover, it is very difficult for girls to become interested in careers they have no knowledge of, especially in preference to those that are familiar or receive wide publicity. For example, this study found that many girls were discouraged by the perceived isolation of MI jobs and the necessity of leaving home. However, girls within this group indicated teaching career interests, but appeared unaware that in WA many new teachers begin their careers in centres much smaller and more distant (from Perth) than Kalgoorlie.

The second noteworthy outcome of this study was the significant improvement to the participating girls' perceived image of people working in MI. Data from this study indicate that, prior to the WASM Camp, most girls held gender-stereotyped images of people working in MI, and very few girls were previously acquainted with professionals working in MI or with the Kalgoorlie region. Following the WASM Camp, MIAS data and interviews with girls indicated that more felt they could relate to people working in MI, and described the work as interesting.

Career Aspirations and Expectations

Taped interviews and researcher observations both indicate personal interest as the primary motivating factor for career selection, regardless of issues such as remuneration and employment prospects. Even though the career information from WASM staff and invited speakers emphasised the excellent job prospects, above average salary and job satisfaction that may be gained through MI courses and careers, most students cited interest as their only motivating factor. Therefore, it appears that although the objective of broadening the range of career choices was achieved, in conjunction with increased MI knowledge, the career expectations of students remained essentially the same.

In Chapter 2 it was established that the Eccles model links academic choices to expectancies for success, and to the importance of the task's value. Thus, Eccles summarises that the low enrolment of girls in school maths and science is due to sex differences in students' confidence in their maths (and English) ability and the relative value they attach to activities and careers involving maths and science. Applying the Eccles model to this study, we find that girls' perceived value of studying maths and science remained exceptionally high from precamp to postcamp. Similarly, the girls' perceived knowledge of the maths and science skills and experience required for MI courses was high before the camp, and post-intervention, did not significantly increase. In addition, analysis of the qualitative data indicates that confidence, as defined in terms of their interest in maths and science, was also very high for the camp group. Lastly, selection criteria determined that all participants were of above average ability in maths and science. Thus, given these facts, the collective inference, based on the Eccles model, would be to assume a significant proportion intend to enroll in two maths, physics and chemistry in Year 11, and possibly to have a stated interest in pursuing SET careers. As revealed by interviews with students, this was far from being the case.

Before the WASM Camp and contrary to expectations, relatively few students indicated that they intended pursuing all four maths and science prerequisites for MI and SET courses. In addition, very few students claimed ambitions to follow careers from these fields. However, both postcamp MIAS and interview data reveal that after the intervention, a greater number of girls now intended to undertake more of the maths and science prerequisites for MI and SET

courses, and to add MI to their future careers choices. Thus, factors other than girls' confidence, ability and perceived value of maths and science have resulted in a positive attitude change.

Two issues become evident in discussing this finding. Firstly, this study supports research by Eccles (1989), Godfrey (1997) and Kahle (1989), who conclude that girls' perceived value of maths and science is greater than their interest in these subjects. However, contrary to assumptions made in this study and by researchers and co-ordinators of similar intervention programs (as detailed in Chapter 2), strong interest and value in maths and science and great confidence in their own ability, does not necessarily translate to girls undertaking more maths and science in upper school. This phenomenon is well known and frequently observed in WA secondary schools and the obvious consequence is girls' lack of participation in SET and MI careers.

As reported in studies by Eccles (1989), given the pattern of misinformation and lack of encouragement, compounded by the lack of role models available to girls, greater incentive is required for girls to pursue upper secondary maths and science subjects. The implication for the university sector perhaps is that similar intervention programs need not concentrate their efforts on these particular attitudinal influences. Instead, greater emphasis could be given to strategies that develop (and sustain) girls' interest in MI careers, similar in design to the interventions implemented at the WASM Camp.

Secondly, the complex interaction of all the attitudinal factors influencing occupational choices is evident. For example, among the stated objectives of the WASM Camp were those attempting to maintain the high level of girls' interest and value of maths and science, and increase other factors such as knowledge of MI careers, image of MI and those working in MI. Analysis of the results revealed that the WASM Camp was successful in achieving these aims, especially in the light of the control group's postcamp results. In fact, for girls not a part of the intervention, a mean score decrease was observed for factors describing interest and value of maths and science. Therefore, while the combined effect of all factors influencing attitudes appears to result in camp participants claiming greater likelihood of pursuing more maths and science and MI careers, the relative importance of each of the factors influencing attitudes was not determined by this study. In addition, the relative

importance of the strategies implemented to bring about the desired attitude changes cannot be determined.

Effectiveness of the Intervention Strategies

The Intervention Strategies: conflicting messages

Analysis of the qualitative and quantitative data obtained from the various intervention strategies appear in some instances to culminate in conflicting attitudes of girls towards MI careers. For example, the findings of this study indicate that before participating in the WASM Camp, girls had a very limited knowledge of the range of careers available in MI or the skills and experience required. In addition, the majority of girls held preconceived stereotyped images of professionals working in MI and of the industry per se. The images held before the camp, as described by students during interviews, were always male, of a "miner" or truck driver, sometimes toiling underground, usually working alone. Additionally, many students believed typical MI work to require manual rather than technical skills. Few, if indeed any, students were aware of professional careers in MI not directly associated with the mechanics of getting ore out of the ground. It appears that students did not envisage the processing of minerals, or the location of mineral deposits as MI career options. Therefore, the intention of several camp objectives was to present girls with a complete picture of MI disciplines by introducing each MI career or course with the context of the various strategies.

However, it appeared that once supplied with information pertinent to "other" aspects of mining, the majority of student interest rested in the new found area of mineral processing, rather than, say, mining engineering, even though their preconceived images had been dispelled. In addition, the WASM workshop focusing on mining engineering did not appear to invoke much student interest, and, it is noted that there were no female WASM students in this discipline available to assist the camp activities. In contrast to girls' lack of interest in MI-engineering careers, professional role models representing engineering at the "discussion night" and career seminars were enthusiastically received and personally very popular with the camp group.

On the other hand, students appeared to have conflicting attitudes towards some of the careers they had previously shown an interest in during the career seminars and WASM workshops. For example, most students were not familiar with

WASM, Kalgoorlie or the local environment and industry. However, making students familiar with these adjuncts to studying MI, may not have necessarily enhanced their attitudes. In particular, observations of students during industry visits reveal their discomfort and distaste of many of the MI working environments. However, it is possible that the largely passive nature of the site visits were found boring by the girls, in comparison to the active and fun workshops. Further, many students were concerned by the prospect of leaving family and friends for future study or work.

It appeared that for the camp group, career choice is connected to the girls' perception of an attractive work environment and desirable social circumstances, in this case, being close to family and friends. It would be tempting to assume that the image of MI (MIIMAGE) and the value of work performed by professionals in MI (PROFVALUE), both of which achieved only a low positive increase on postcamp MIAS analysis, were affected by the girls' distaste of the outdoor work environment, the relative isolation of Kalgoorlie and the inevitable separation from family and friends. However, the predominance of each of the above influences was not able to be determined in this study, although their effect appears to pose an impossible barrier for intervention programs such as this, and for the recruitment of women into MI. Moreover, excluding industry visits from future intervention programs may improve girls' attitudes towards MI per se, but would introduce a moral dilemma that may have repercussions on course retention rates for women.

The Influence of Female Role Models

All intervention strategies were framed within the objective of providing girls with accurate and current career information from professionals within the MI field. This objective was achieved through the extensive assistance from women working in mining-related careers and from students at WASM. Although all WASM academic staff facilitating workshops were male, female WASM students often assisted during these activities. Also, because of the relatively recent entry of women into professional MI careers, most women were younger than their male colleagues, and many appeared to be in comparatively higher positions of responsibility than women of similar ages in other professions. As a general summary of characteristics, the women assisting WASM camp activities were articulate, friendly and

approachable, enthusiastic about their work, and would like to see an increase in the numbers of women in MI. By contrast, their opinions of the Kalgoorlie region were varied, as were their career and familial expectations and feminist beliefs.

Generally then, the image of professionals in MI observed by girls during the camp was very different from their perceived images, and as already noted in the interviews, many girls found they were able to relate to these women. While in reality, the image of "typical" (defined as in greatest numbers) professionals working in MI may be more popularly represented by a young male graduate, the increased visibility of the female role models did dispel the stereotyped image of mining, and are representative of professional women working in MI. Therefore it is not surprising that one of the greatest positive changes in attitude occurred in the area of the girls' perceived image of professionals working in MI. PROFIMAGE showed the greatest mean score increase (E.S. 0.61) from pre to post camp. In comparison, girls in the control group did not show a significant increase (E.S. 0.03) between surveys. When this result is viewed in the light of data indicating that few girls were previously acquainted with anyone from the MI field, and that many held gender-stereotyped "miner" images prior the camp, the powerful influence of the role models becomes evident.

It is interesting to note that although all interviewees stated that some of the most enjoyed activities were those involving female role models from MI, only two students, out of ten interviewed, saw these women as bearing an influence on their career decisions. Most girls stated that the factor most likely to determine their career choices was their personal interest in the career. Only one student included career salary level as a determining factor, but even this was secondary to her interest.

"Discussion Night" Methodology

Through researcher observations and interviews with students, the Discussion Night was found to be the most valued and enjoyed of the camp activities. While similar intervention programs extensively use female role models to present, coordinate and conduct activities, few if any of those reviewed use the format employed at the WASM Camp, or give sufficient detail of method to allow replication. Brown's study (1993) on role model methods (reviewed in Chapter 2) did

not supply information regarding how the role models were briefed before meeting with students, or how the women were chosen to participate in the intervention. Both the Brown and the Evans, Whigham and Wang (1995) studies document the intervention format in terms of ten to fifteen minute presentations from role models followed by informal "question and answer" sessions. From a review of the literature, the format described in this study has not been used before, nor has detailed procedures on briefing role models been supplied.

Covering 10 Attitudinal Mediators

The advantages of the "discussion night" format implemented at the WASM Camp are relevant to the participating girls, the women acting as role models and the camp supervisor or researcher. The presentation format provided all parties with the opportunity to consolidate information and signals received so far, and clarify outstanding or pertinent issues. The advantage for the role models was they were able to witness the processes that led to girls deciding which issues require further discussion, thus invoking specific introductory discussion points. For example, the masculine image of the industry, and adjunct issues such as harassment, were thought by girls to be impediments to women's participation in MI careers. These issues were discussed with women from various fields in MI, each with their own experiences. The role models were able to offer their opinions on the issue and possible solutions, should the need arise. Also, the girls were able to decide the relative importance of the issue when formulating attitudes towards career choices. The outcome in many cases was to resolve the issue as no longer being an impediment.

The list of reasons derived by the camp group for the low numbers of women in MI (refer to Table 4.1) gave the researcher, in particular, an insight into girls' attitudes towards MI careers generally. Many of the reasons listed bear upon issues from each of the ten attitudinal mediators derived from the Eccles model (refer to Table 3.1). For example, as listed in Table 4.1,

"dirty and physical work" pertains to Mediator 1: the Image of MI,

"girls discouraged from continuing school maths and science"

pertains to Mediator 5: Encouragement,

and

"*conflicts with women wanting to raise a family*" pertains to Mediator 8: Career Aspirations & Expectations (Table 3.1).

Moreover, observations of student behaviour and conversation during the discussion session bear upon several of the attitudinal mediators not directly addressed by the girls' list of reasons in Table 4.1. For example, the issue of girls' interest in maths and science, or lack of it, was not initially put forward as a reason for women's low MI participation. However, data from MIAS, observations of students' discussions and interviews with them, all indicated that girls' interest was strong, and consequently not an issue. Although, it is important to note that this did not necessarily translate into interest in MI careers, as previously discussed (in "Attitudinal Influences") and is evidenced by girls' post-discussion conclusions and postcamp interviews. Therefore, it would appear that while the intervention strategies succeeded in creating greater MI interest, this may not be sufficient to result in pursuing a MI career.

SUMMARY

WASM Camp attendance appears to have successfully enhanced the attitudes of participating girls towards MI careers. For girls in the experimental group, all MIAS categories showed a positive increase between group precamp and postcamp mean scores, indicating a positive attitude change in all areas of analysis. However, not all changes were considered educationally significant. While the control group's results need to be treated with caution due to experimental mortality, some significant differences were found between precamp and postcamp MIAS mean scores. Therefore analysis of postcamp MIAS data was undertaken to determine differences between the experimental and control groups. The findings supported the effectiveness of the intervention strategies for all mediators of attitude change examined through MIAS.

Observations of students and taped interviews revealed information that described girls' attitudes whilst participating in the intervention program. Moreover, attitudinal mediators not examined through MIAS were now able to be described. For example, girls' career aspirations were found to be within the range of conventional occupations as described by Dillon (1986), and their expectations were

generally limited to finding the job "interesting". Contrary to the Eccles model, the high level of girls' interest and value of school maths and science, did not initially translate into pursuing these subjects in upper school.

Qualitative analysis of the data also provided robust descriptions of the effectiveness of the intervention strategies. For example, the "hands on" workshops proved a successful strategy for giving girls practical experience of MI courses and a useful introduction to some of the MI careers. Those based around active participation were the most enjoyed and inquired about, in contrast to workshops with a large demonstration component and this may have contributed to some of the girls' obvious dislike of many working mine sites.

By far, the activities most enjoyed were those involving women working in MI, and those that enabled girls to ask questions of a non-technical nature. The "discussion night" format proved ideal as a conclusion to tie together much of the preceding abundance of information and as a forum for the appropriate role models to provide encouragement for the girls.

CHAPTER 5

DISCUSSION, IMPLICATIONS & CONCLUSIONS

INTRODUCTION

The overall aim of this study was to increase understanding of the factors affecting girls' attraction to or rejection of MI careers. The experimental part of the study sought to attract more girls into professional MI careers through the auspices of the WIET Project based at Curtin University and WASM. The study was divided into four main objectives. The first objective was to determine the reasons why there were so few women currently in MI careers and to analyse strategies successfully used to increase their participation. The second objective was to determine the attitudes towards MI careers of a select group of girls, with the ability to proceed to the high school prerequisites for MI courses. The third objective involved the development and implementation of appropriate intervention strategies aimed at enhancing the attitudes of the group of girls. The final objective of the study was to determine if the intervention did, in fact, enhance participating girls' attitudes. Each of the four main objectives were defined in terms of research questions and will be addressed accordingly in the following discussion.

DISCUSSION

Research Question Number 1

- (a) Which are the main factors influencing the low participation of women in SET careers?*
- (b) Which intervention strategies have been successfully employed to attract more women into SET careers?*

To determine the reasons for the low numbers of women in MI careers, a review of the literature was undertaken and presented in Chapter 2. As little had been published in relation to women in professional MI careers, and because MI careers may be considered a branch of SET careers, both requiring mostly the same maths and science prerequisites, it has been inferred that factors influencing women in SET may be applied to women in MI. Similarly, those strategies designed to attract more women into SET careers could be used as a framework for MI.

In describing the range of factors affecting women's participation in SET, several researchers (Byrne, 1993; Dillon, 1986; Eccles, 1989; Lewis, 1993) have pointed to the negative or ambivalent attitudes of schoolgirls towards their prospective participation in SET careers. In particular, longitudinal studies by Eccles (1985) had resulted in the development of a model for girls' educational and academic choices. The model, presented in detail in Eccles (1989) and outlined in Chapter 2, was used as a framework for this study.

Common to the majority of studies reviewed, the reasons for the low numbers of girls pursuing SET careers is presented in Figure 2.2. Of the various factors influencing girls' attitudes towards SET careers, those influences that would have little effect on the current cohort of girls able to undertake the prerequisites for SET careers have not been examined further in this study.

In answering the second part of the research question, it was revealed that the intervention programs designed to increase female numbers in SET courses had varied objectives and employed heterogeneous methods. However, a number of strategies were common to the programs reviewed. Most programs were limited in their desired aims by lack of funding and few programs utilised rigorous methods to test the effectiveness of the strategies implemented. However, the intervention programs reviewed in this study did report successful attitude changes in the girls attending, in terms of at least some of the reasons listed above for their low rates of participation in SET careers.

The intervention programs varied from fortnight-long residential camps (Davis & Hollenshead, 1991) to once-only sessions conducted during class time (Evans, Whigham & Wang, 1995). The focus was usually on girls with the ability to enroll in the prerequisites for SET courses. Most programs of week-long and longer duration employed the use of a mixture of strategies designed to inform, encourage and expand girls' career choices. Common to all reviewed programs was their extensive use of occupational female role models to facilitate and supervise all aspects of student activity. Once again, while the majority of programs report successful intervention, due to the influence of the female role models, few document sufficient detail to permit replication, or employ rigorous analysis.

The WIET Project at Curtin University had previously conducted week-long residential camps for Year 10 girls at WASM in Kalgoorlie. Therefore, it was deemed appropriate by this researcher, in the capacity of WIET Project Co-ordinator,

that the structure for the 1995 WASM camp would be modified in the light of the information gained in this study. As little information regarding girls' attitudes towards MI careers could be located in the literature, it seemed pertinent to tackle this issue before deciding which intervention methods to employ.

Research Question Number 2

What are the attitudes of a specific group of Year 10 girls in WA towards MI careers?

Based on information gathered in the literature review about girls' attitudes towards SET careers, and analysis of previous WASM camps (Somerville Brown, 1992 - 4, unpublished reports), a survey, MIAS, was developed and trialled to determine the attitudes of Year 10 girls, with proven ability in maths and science, towards MI careers. In early April, Year 10 girls from secondary schools in WA were invited to apply for the 1995 WASM Camp and complete MIAS as part of their participation. By the closing date for applicants, 57 girls had returned their completed MIAS.

The methodology used in this study was of quasi-experimental research, as total random selection of participants was not appropriate, although pretest-posttest experimental-control group methods were employed. Equivalence between experimental and control groups was demonstrated before the camp, thus lending credence to the reliability of MIAS.

Factor and correlation analysis of precamp MIAS led to eight categories of attitudinal descriptors. Previously, a list of mediators were derived from the range of attitudinal influences examined in the literature in Chapter 2. This list was further modified to specifically describe MI careers and consequently presented as ten factors or mediators, in Table 3.1. The eight categories derived from MIAS were then compared against the list of 10 attitudinal mediators developed from the Eccles model for girls' educational and academic choices. The eight MIAS categories (shown below right, in capital letters) matched with five mediators:

1. Girls' perceived image of the SET industry = MIIMAGE
2. Girls' perceived image of engineers = PROFIMAGE and scientists and of the tasks performed by them = TASKDESC

3. Girls' interest in school maths and science = MSINTEREST and subsequent MI careers
4. Girls' perceived value of school maths and science = MSVALUE and subsequent MI careers = PROFVALUE
9. Prior knowledge of MI courses and careers = PREREQUISITES & MIKNOWLEDGE

Analysis of precamp MIAS data revealed that the girls' interest in (MSINTEREST), and value (MSVALUE) of studying maths/science was very strong, in keeping with studies by Kahle (1985) and Lewis (1992). Similarly, their knowledge of the maths/science skills and prerequisite subjects (PREREQUISITES) required for MI careers was also very strong. Therefore, positive attitudes were inferred for these mediators. The image of professionals working in MI (PROFIMAGE) rated only moderately, whereas the value of the work they do (PROFVALUE) rated moderately high. The image of MI per se (MIIMAGE) also rated moderately, though not as well as PROFVALUE. Hence, positive attitudes are again inferred, though not as strong as those for MSVALUE, MSINTEREST, and PREREQUISITES. Finally, student knowledge of the day to day tasks and skills needed for MI jobs (TASKDESC) was limited, as was their specific knowledge of MI careers/courses and what they entailed (MIKNOWLEDGE). Thus, while attitudes were positive, these two mediators were the weakest of those examined through MIAS.

Prior to the intervention program a number of general assumptions were also made regarding the attitudinal mediators not described in MIAS analysis, through this researcher's experience from previous WASM Camps and camp data (Somerville Brown, 1992 - 4, unpublished reports). However, triangulation of the postcamp data enabled a more rigorous examination of the remaining mediators. Thus, it was reasonable to assume a high level of *encouragement* (Influence No. 5, Table 3.1) to explore MI careers because WASM Camp application required the support of teachers and parents. Application criteria was restricted to girls of high maths/science *academic ability*, and *confidence* (Influence No. 6, Table 3.1) to pursue MI careers was assumed as the girls had indeed applied for the camp. However, the girls' *career expectations and aspirations* (Influence No. 8, Table 3.1) were assumed to not

include SET careers generally (and MI specifically) thus indicating the need for intervention programs such as the WASM Camp.

The girls were assumed to have had very little *contact with professionals working in MI* (Influence No. 10, Table 3.1), and therefore the *influence of role models and mentors* (Influence No. 7, Table 3.1) were also taken as minimal.

Research Question Number 3

Which strategies appear likely to enhance girls' attitudes towards MI careers?

Given the findings of the precamp MIAS, the objectives of the WIET Project, both detailed in Chapter 3, and experiences and reports from previous WASM Camps, a list of objectives for the 1995 WASM Camp was determined and presented in Table 3.8. The over-arching theme to be employed for all strategies was the extensive use of female role models, whenever possible, due to the reported success from many similar intervention programs, and the limited experience participants were assumed to have had with women in MI. The strategies implemented in the camp program were modified from those described in the literature review that were deemed appropriate for the objectives of this study and have been described in detail in Chapter 3.

Thus, activities that might increase the girls' knowledge of MI careers and courses, and their knowledge of the tasks typically performed by those working in MI, should significantly enhance attitudes. Additionally, activities that improve the girls' perceived image of MI, and of professionals working in MI, would also enhance their attitudes. Finally, the intervention program needed to include activities that maintained the girls' interest and value of maths/science and the value of the work performed by those currently employed in MI careers.

The residential format of the intervention program allowed girls the opportunity of "hands on" workshop activities at WASM, mining industry tours, and the chance to become more familiar with Kalgoorlie and Agricola College (WASM's student residential facility). Also, a significant number of professional women, WASM staff and students, representing a broad range of MI disciplines were thus available for the camp group to meet with and discuss pertinent issues. In this way, participants could gain first hand career knowledge and form their own impressions

of MI courses and adjuncts to studying MI. Additionally, courses and consequent careers were examined from several different perspectives including how and where they are undertaken, and by those who undertake them.

The methodology employed in this study did not enable the success, or otherwise, of the various strategies to be determined individually. Instead, the camp program as a whole, comprising the range of intervention strategies, were found to successfully enhance the girls' attitudes, and these are discussed further in the following section. However, from the range of strategies implemented during the camp, the most enjoyed activities appeared to be the workshops and the discussion night, as evidenced by both researcher observations of students during these activities, and interviews with students. The industry visits appeared to do little in terms of attracting girls into MI careers, although they appeared helpful in developing more positive attitudes towards professionals (particularly women) working in MI as evidenced by comments from girls during the taped interviews.

Research Question Number 4

Will the implementation of appropriate intervention strategies enhance girls' attitudes towards MI careers?

Program evaluation included both quantitative and qualitative analyses. Comparisons between precamp and postcamp MIAS data were undertaken for experimental and control groups of girls. Triangulation of qualitative data took the form of taped student interviews, researcher observations of students during camp activities and through the literature review.

From analysis of MIAS data, the majority of attitudinal mediators targeted through the WASM Camp intervention program resulted in significantly increased mean scores from girls in the experimental group. Because their scores in MIAS were generally higher than comparative scores from girls in the control group, it was concluded that the strategies implemented at the 1995 WASM Camp successfully enhanced girls' attitudes towards MI careers. Attitudinal mediators that did not show significant postcamp increases in mean scores were high before the intervention, and subsequently remained so, whereas similar mean scores for girls in the control group decreased. However, it is noted that conclusions drawn from control group data need to be treated with caution due to experimental mortality.

IMPLICATIONS FOR PRACTICE

Research Methods

While many intervention programs aim to enhance girls' attitudes towards non-traditional careers, few appear to strictly document the strategies employed, thus hindering replication by those following. In addition, few of the reviewed programs have attempted to relate the stated objectives to the types of strategies employed, thus potentially limiting their rigour for researchers or program co-ordinators not wanting to employ all of the program's objectives, but rather a limited selection.

This study has attempted to provide sufficient detail to replicate strategies that effectively and positively changed girls' attitudes towards MI careers. In addition, the intervention activities have been related to the objectives they are intended to cover, providing a useful framework for smaller or more specific intervention programs. And as the majority were developed and modified from current SET programs, they may successfully be transposed from MI back to SET careers.

Although the attitude survey (MIAS) was helpful in determining attitudes before the camp, and post-intervention attitude changes, MIAS did not report on all influences affecting girls' attitudes. In the interest of keeping the survey concise and non-time consuming, several attitudinal influences were not examined that may have been. In addition, this study has found that girls with ability in maths and science show strong interest and value in these subjects, and confidence in their ability. It may be assumed that Year 10 girls generally, with ability in maths and science, would exhibit similar attitudes. Therefore, while MIAS was useful in establishing this fact, it should no longer be necessary to include survey items on the aforementioned issues when surveying similar groups of girls. The implications for future researchers would be for MIAS to concentrate on items that would describe girls' attitudes about their:

- 1) Perceived image of MI and professionals working in MI
- 2) Career aspirations and expectations, with particular reference to:
 - a) Interest - as they would define it
 - b) Course location
 - c) Job location
- 3) Knowledge of MI courses and careers

- 4) Previous experience of female role models, and professionals working in MI.

Analysis of MIAS may have been simpler, and possibly more reliable, had all items been of the same style, namely semantic-differential items. This would allow comparisons between all attitudinal influences examined, rather than creating separate groups when reaching conclusions about the effectiveness of the strategies.

The Mining Industry

There appear to be no easy answers to some of the concerns of young girls with the ability to undertake MI careers. Possibly the issues that may be most easily rectified are those attempting to increase students' knowledge of the range of MI careers and tasks undertaken by those working in MI, and to change their perceived image of professionals currently employed in MI jobs. Findings from this study would recommend using strategies that:

- 1) Incorporate accurate and current images of women working in MI;
- 2) Captivate and enthuse girls' interest in relation to MI careers by emphasis on the modern, professional aspects of MI jobs, with particular reference to chemistry-based careers;
- 3) Increase girls' general knowledge of MI courses and careers and rectify some misconceptions about MI course prerequisites;
- 4) Offer school-organised work experience activities and opportunities to students, comparable to those offered in other disciplines;
- 5) Compare MI careers with careers traditionally undertaken by girls, particularly in terms of job location, skills required, possible familial and social circumstances, and job satisfaction.

The approach taken in this study combined a number of objectives within each strategy. Given that this approach was met with qualified success (at least in the short term), it appears to provide a sound basis for action to promote MI careers to girls in the future.

While it may be possible for the industry to emphasise aspects of mining that are attractive to girls, such as the interest, excitement and sense of achievement that may be gained, solutions to their concerns about leaving family and friends, also need to be addressed. Similarly their distaste of the landscape surrounding mine sites must also be taken into consideration. Possible solutions may include the promotion

of "fly-in-out" jobs, and the introduction of a "buddy" system for new recruits and students. Perhaps also, issues pertaining to mine rehabilitation require greater promotion and explanation by the industry.

The University Sector

The findings of this study hold a range of implications for tertiary institutions attempting to attract more females to MI courses in particular, and SET courses generally. The costs per head of the program outlined in this study are high due to the provision of accommodation, meals and transportation for the group. In addition, relatively few students are able to participate due to factors other than cost. For example, limited accommodation spaces at Agricola College, compounded by allowing sufficient equipment for all girls attending workshops restricted the camp number to 40 students, in comparison to the 82 applications received. Rather than change the camp format, these issues are difficult to overcome given the success and enjoyment of the residential format.

However, time and resources may be more advantageously utilised through more rigid student selection procedures, and through some changes to the strategies implemented in this study. In other words, some unproductive activities in the current format may be overcome through changes to the WASM Camp quality rather than quantity. Observations of students found that by day's end, they appeared exhausted by the amount of information received. Also, students were asked to make academic-interest judgements on the basis of one workshop. Because comparable intervention programs are usually conducted by university departments with low female enrolments, the following are noted for consideration by program planners:

- 1) Selection procedures require greater clarification for school teachers as it was discovered that some schools were using the WASM Camp as a "reward" for their most able students. In this regard, application procedures for the WASM Camp may be refined further through co-ordinator selection of students with an interest in pursuing science and engineering careers.
- 2) It may be pertinent to concentrate on fewer disciplines during the program, rather than the full range of courses available. Several workshops within the same discipline may clarify and broaden student course perceptions.

- 3) The responsibility of supervising students, especially during the evening/night can prove onerous, particularly if several students require attention simultaneously. A possible solution that retains the residential format may be to billet girls with families from local schools.

In addition, this study and previous WASM Camps suggested that attitudes of girls may be enhanced most effectively by strategies that:

- 1) Utilise professional female role models and WASM students to present, facilitate and participate in activities, ensuring that the role models receive detailed preparatory instructions and suggestions.
- 2) Ensure all activities are facilitated by men and women who appear to be enthusiastic about their job, communicate well with Year 10 girls, and appear friendly and approachable.
- 3) Give girls a "hands on" opportunity to sample typical course activities and limit the number of passive demonstrations.
- 4) Include a "discussion forum" allowing girls the opportunity for questions of a non-technical nature, and the possible resolution of pertinent issues.

CONCLUSIONS

The minerals industry and a number of tertiary institutions offering MI courses have in the past indicated a concern about the low recruitment of female students. While both sectors may have suspected that among the reasons for the low participation of girls is their attitudes towards MI careers, this appears to be the first study to specifically determine what girls' attitudes are, and then attempt to remodel stereotyped images and rectify misconceptions. MIAS, as a tool for determining girls' attitudes, enabled the development of appropriate, specific strategies, and to determine the success (or otherwise) of their implementation.

The research methodology employed in this study enabled comparisons, regarding attitudes, between girls attending the WASM Camp and other Western Australian Year 10 girls with ability in maths and science, and thus potentially able to undertake MI courses. Thus, for the potential pool of female recruits in MI, the conclusions of this study suggest simultaneous action on a number of issues affecting MI career choice specifically, and SET career choice generally. However, before implementing costly and time-consuming intervention strategies, it is wise to

ascertain the current position of girls towards specific factors influencing attitudes, through the results of instruments akin to MIAS. The foundation for an intervention program could then be devised that is both appropriate and specific for the participating girls.

Findings from this study support research by Dillon (1986) and Kahle (1989), regarding girls' positive attitudes towards their interest in maths and science and their greater perceived value of these subjects, even though few girls were intending to pursue SET-based careers. Although the aforementioned studies described girls of varying ability, this study was confined to girls with high ability in maths and science (grade A and B+). However, contrary to research by Eccles (1989), data from this study indicates that girls' confidence in their own ability was extremely high (as was their confidence to enter non-traditional fields). Given these circumstances from which girls make their occupational choices, it is significant that their career aspirations at this stage seem more conventional, restricted mainly in education and the Arts. It is perhaps indicative of the greater effort that will be needed by concerned parents, teachers and program co-ordinators to encourage girls to expand their career options from an early age. However, also indicative of Year 10 girls' narrow range of occupational choices is the need for programs such as the WASM Camp that succeed in expanding their options, while simultaneously providing realistic images, role models and work situations as a basis for future choices.

This study did not attempt to discover if all the intervention strategies were essential for enhancing girls' attitudes, or if any one of the strategies resulted in the desired attitude changes in preference to the others. The ethos behind using a combination of intervention strategies was primarily to cover all the objectives listed for the WASM Camp. Secondly, experience has shown that for SET careers in general, and MI careers in particular, single events such as "Career Night" presentations have not resulted in greater female participation. However, the methodology followed in this study did eventuate in more positive attitudes towards MI careers than before the intervention. Of particular relevance to future researchers and program co-ordinators of intervention strategies are the indications that images and personnel utilised need to be those of women whenever possible. And the "Discussion Night" format, allowing participating girls the opportunity for discussion of issues relevant to them, reveals information that may be useful to students, role models and researchers. For example, the format allowed girls to clarify and

summarise the vast amount of information received, and enabled the camp supervisor a simple method of observing and recording girls' attitudes. For the female role models participating in the discussion, the format enabled them to personalise and focus their responses as appropriate.

It is hoped that MIAS, as a tool for determining girls' attitudes towards MI careers, and the intervention program and methodology described in this study, will provide a suitable framework for future researchers and program co-ordinators attempting to enhance girls' attitudes towards MI and SET careers. Whether the consequence will be increased female enrolments in the desired fields is yet to be seen, and is an issue that should be explored in future research.

REFERENCES

- Astin, H. & Sax, L. (1996). Developing Scientific Talent in Undergraduate Women. In C. Davis, A. Ginorio, C. Hollenshead, B. Lazarus, P. Rayman, & Associates (Eds.), *The Equity Equation: Fostering the advancement of women in the Sciences, Mathematics, and Engineering*. San Francisco: Jossey-Bass Publishers.
- Australian Bureau of Statistics. *Women in Australia*. Canberra March 1993. ABS Catalogue No. 4113.0
- Brown, S.M. (1991). The Use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science. *Contribution to Sixth GASAT International Conference, 1*, pp. 442-450.
- Brown, S.M. (1993). The Use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science. *Contribution to Seventh GASAT International Conference, 1*, pp. 501-502.
- Byrne, E.M. (1988). *Women in Science and Technology: The Institutional Approach*. (Interim Report). WISTA Policy Review Project. University of Queensland.
- Byrne, E.M. (1993). *Women and Science: The Snark Syndrome*. Great Britain: Falmer Press.
- Byrne, E.M. (1994). *Critical Filters, Hidden Helix*. Policies for advancing Women in Science and Technology. Final Discussion Paper produced for WISSET Group 1994.
- Collins, N. (1983). *Professional Women and their Mentors*. New Jersey: Prentice Hall.
- Commonwealth of Australia (1984). *The Sex Discrimination Act 1984*. Canberra: AGPS.
- Commonwealth of Australia (1986). *The Affirmative Action (Equal Opportunity for Women) Act 1986*. Canberra: AGPS.
- Cook, N. (1991). Seattle MESA Summer Science Program for Girls: Using Computers in Science. *Contribution to Sixth GASAT International Conference, 1*, pp. 90-98.
- Craig, J. & Harding, J. (Eds.) (1985). *Contribution to third GASAT International Conference*. London: Centre for Educational Studies, King's College, University of London.

Daniels, J. & Kahle, J.B. (Eds.) (1987). *Contribution to Fourth GASAT International Conference*. Ann Arbor: University of Michigan.

Davis, C. & Rosser, S. (1996). Program and Curricular Interventions. In C. Davis, A. Ginorio, C. Hollenshead, B. Lazarus, P. Rayman, & Associates (Eds.), *The Equity Equation: Fostering the advancement of women in the Sciences, Mathematics, and Engineering*. San Francisco: Jossey-Bass Publishers.

Davis, C. & Hollenshead, C. (1991). Summerscience: A University-based hands-on intervention program for adolescent girls. *Contribution to Sixth GASAT International Conference*, 1, pp. 99-107.

Department of Primary Industries and Energy (1990) *Education and Training for the Mineral Industry*. Canberra: AGPS.

Dillon, S. (1986). *Jobs for the girls: Why not technical?* Melbourne: Knowledge Systems Research.

Eccles, J.S. (1989). Bringing Young Women into Math and Science. Crawford, M. & Gentry, M. (Eds.) In *Gender and Thought: Psychological Perspectives*, pp. 36-58, New York: Springer-Verlag.

Eccles, J.S. (1985). Sex differences in achievement patterns. Crawford, M. & Gentry, M. (Eds.) In *Gender and Thought: Psychological Perspectives*, pp. 36-58, New York: Springer-Verlag.

Eccles-Parsons J., Adler, T.F., Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L., & Midgley, C. (1983). Expectations, values and academic behaviours. In J.T. Spence (Ed.), *Achievement and achievement motivation*. New York: Freeman

Evans, M.A., Whigham, M., & Wang, M.C. (1995). The Effect of a Role Model Project upon the attitudes of Ninth-Grade Science Students. In the *Journal of Research in Science Teaching*, 32 (2), 195-204.

Farmer, B. (1996). Do You Know Anyone Who Builds Skyscrapers?: SOS - Skills and Opportunities in Science For Girls. In L. Parker, L. Rennie, & B. Fraser, (Eds.), *Gender, Science, and Mathematics: Shortening the Shadow*. Science & Education Library: Kluwer Academic Publishers.

Farmer, B. & McGowan, L. (1991). SOS - Skills and Opportunities in Science for Girls: An Intervention Programme to Promote the Physical Sciences. *Contribution to Sixth GASAT International Conference*. 1, pp.108-116.

Fox, G. L. (1974). Some observations and data on the availability of same-sex role models as a factor in undergraduate career choice. *Sociological Focus*, 7, pp.15-30.

Free, R. (1992). *Developing Australian Ideas, a blueprint for the 1990s*. Canberra: AGPS.

Gaskell, P.J., McLaren, A., Oberg, A., & Eyre, L. (1993). The 1990 British Columbia mathematics assessment: Gender issues in student choices in mathematics and science. Victoria, BC: Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights. In Gaskell, P.J. (1993). Participation in Senior Level Mathematics and Science Courses and the Issue of Gender. *Contribution to Seventh GASAT International Conference*. 1, pp. 245-253.

Godfrey, L. & Roxborough, L. (1992). What Does A Professional Engineer Look Like? *New Zealand Engineering*, August, 1, p. 15.

Godfrey, L. (1997). SOS - Skills and Opportunities in Science for Girls: Eight Years On. *Contribution to Ninth GASAT International Conference*. Conference Paper.

Haggerty, S. & Holmes, A. (Eds.) (1993). *Transforming the curriculum: Our future depends on it*. Waterloo, Ontario: The University of Waterloo.

Harding, J. (1986). *Perspectives on Gender and Science*, London: The Falmer Press.

Harding, J. (1996). Science in a Masculine Strait-Jacket, In Parker, L., Rennie, L. & Fraser, B. (Eds.) *Gender, Science, and Mathematics: Shortening the Shadow*. Science & Education Library: Kluwer Academic Publishers.

Hiscocks, P. (1993) Implementing an Engineering Summer Camp. *Contribution to Seventh GASAT International Conference*. 1, pp. 56-65.

Ives, R. (1984). The Maleness of Science. *Australian Science Teachers Journal*, 30 (1), pp.15-20.

Kahle, J.B. (1989). *Images of Scientists: Gender Issues in Science Classrooms*. Australia: National Key Centre for School Science and Mathematics.

Keeves, J.P. (1992). The design and conduct of the Second Science Study. In J.P. Keeves (Ed.) *The IEA Study of Science III: Changes in science education and achievement: 1970 to 1984* (pp. 42 - 67), Oxford: Pergamon Press.

Keeves, K.P. & Kotte, D. (1996). Patterns of Science Achievement. In Parker, L., Rennie, L. & Fraser, B. (Eds.) *Gender, Science, and Mathematics: Shortening the Shadow*. Science & Education Library: Kluwer Academic Publishers.

Lewis, S. (1993). Lessons to Learn: Gender and Science Education. In F. Kelly, (Ed.) *On the Edge of Discovery: Australian Women in Science*, pp.255-280, Melbourne: The Text Publishing Company.

Lie, S (Ed.) (1983). *Girls and Science and Technology: The Second GASAT International Conference*. Oslo: Institute of Physics, University of Oslo.

Newhouse-Maiden, L. & Parker, L.H. (1995). *Don't quote me but ...complementary models of career development*. Curtin University of Technology, Unpublished paper.

Parker, L.H & Rennie, L.H (1986). Sex-stereotyped attitudes about science: Can they be changed? *European Journal of Science Education*, 8, pp.173-183.

Raat, J., Harding, J. & Mottier, J. (Eds.) (1981). *Girls and Science and Technology. Congressbook GASAT Conference 1981*. Eindhoven: Eindhoven University of Technology.

Rennie, L.H & Parker, L.H (1994). School Science Class Questionnaire. Science and Mathematics Education Centre, Curtin University of Technology.

Rennie, L., Parker, L. & Hildebrand, G. (Eds.) (1991). *Action for Equity: The Second Decade*. Perth: National Key Centre for Teaching and Research in School Science and Mathematics, Curtin University of Technology.

Rennie, R. & Rennie, L. (1991). Lego for Girls - A Cautionary Tale. *Contribution to Sixth GASAT International Conference*, 1, pp. 165-172.

Rossiter, M.W. (1982). *Women Scientists in America: Struggles and Strategies to 1940*, Baltimore: The John Hopkins University Press.

Somerville Brown, C. (1992-4). *Evaluation of the West Australian School of Mines Engineering and Technology Camp for Year 10 Girls*. Unpublished Report for the Division of Engineering & Science, Curtin University of Technology, W.A.

Surry, J., Sheasby, M., Collins, J. & Baker, T. (1993). The History, Implementation and Evaluation of a Role Modelling Program. *Contribution to Seventh GASAT International Conference*, 1, pp. 138-147.

Taber, K.S. (1992). Science-relatedness and gender-appropriateness of careers: some pupil perceptions. *Research in Science and Technological Education*. 10 (1) pp.105-115.

Teague, G.J., Clarke, V., Lyne, M. (1993). A Computer Holiday Program for Year 10 Girls. *Contribution to Seventh GASAT International Conference*, 1, pp. 158-167.

Tobin, K. (1987). It can't happen here. In B.J. Fraser and G.J. Giddings (Eds.), *Gender Issues in Science Education*. Perth: Faculty of Education, Curtin University of Technology.

Tuckman, B. (1988). *Conducting Educational Research*. Florida: Harcourt Brace Jovanovich.

Weinreich-Haste, H.E. (1981). The image of science, In A. Kelly (Ed.) *The Missing Half: Girls and Science Education*, Manchester: Manchester University Press, pp.216-229.

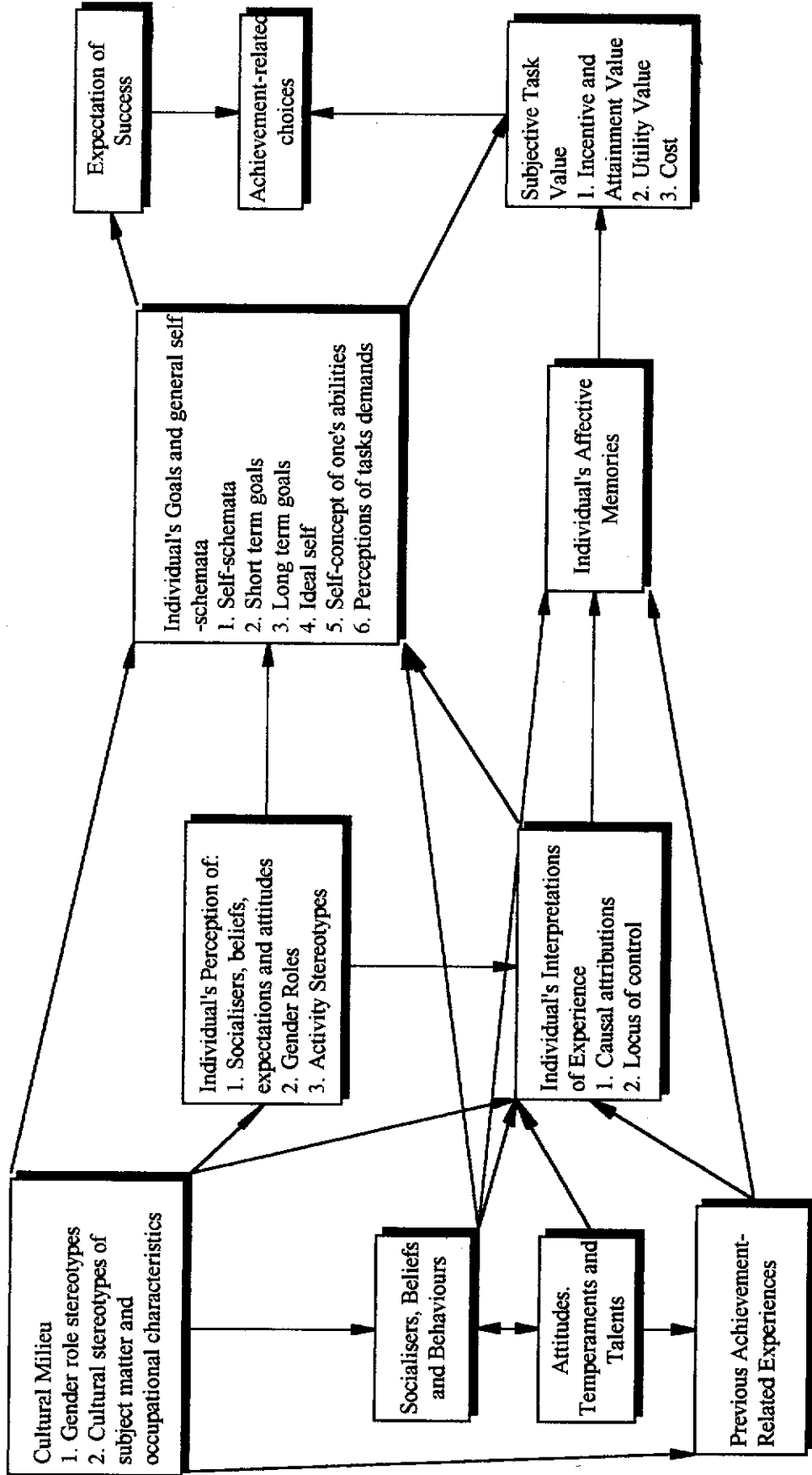
Wiersma, W. (1991). *Research Methods in Education*. U.S.A.: Allyn and Bacon.

Wilkinson, S. (1992). *Giving Girls a Taste of Technology*. Unpublished Paper, School of Construction and Earth Sciences, Oxford Polytechnic, UK.

Eccles (1989)

DEVELOPMENTAL MODEL OF EDUCATIONAL & OCCUPATIONAL CHOICES

Appendix A



Appendix B1

Women into Engineering and Technology
CAMPS & SEMINARS 1995
 for Year 10 girls, Parents and Teachers

Dear Year 10 Coordinator,
 Careers Officer,

1995 Programme ...

I am pleased to inform you of three major activities for Year 10 girls, parents and teachers to be conducted by the *Women into Engineering and Technology Project* at Curtin University and the West Australian School of Mines (Kalgoorlie):

<u>ACTIVITY</u>	<u>DATES</u>	<u>NUMBER OF PLACES</u>	<u>APPLY BETWEEN</u>
[1] Women into Engineering, Science & Technology (WEST) Seminar	June 6 and June 8	60 Student 15 Teacher	3 April - 12 May
[2] WASM Engineering & Technology Residential Camp	July 3 - 7 inclusive	30 Student 5 Teacher	3 April - 12 May
[3] Curtin University Engineering & Technology Residential Camp for Rural Students	September 25 - 28 inclusive	30 Student 5 Teacher	24 July - 11 August

Objectives ...

Careers and academic options will be aimed at girls intending study at University level. The basic aims of the Camps and Seminar are to encourage Year 10 girls to continue their interest in mathematics and science subjects in upper school, and to give participants "hands on" experience in engineering, science and technology courses at Curtin University and the W.A. School of Mines. In addition the Residential Camps afford students the opportunity to experience student lifestyle and gain first hand knowledge of possible jobs through industry visits.

Applications ...

This is the fourth year of Camps and Seminars with demand for places continually increasing. To date, over 500 Year 10 girls have participated in Camps and Seminars run by the *Women into Engineering and Technology Project*. In order to give all schools an equal chance of participating, applications should be made by Facsimile only between the dates indicated.

Places for all activities are filled on a “first come, first served” basis or at the discretion of the Programme Supervisors. A maximum of two students and one teacher per school may apply for each Camp/Seminar. Students should be nominated by their Mathematics or Science teacher on the basis of interest first, and secondly good performance in these subjects (Grade B or better). It is preferable to nominate different students for each activity as some workshops are repeated.

Costs ...

As usual, all Seminars and Camps are conducted completely FREE of charge but participants will need to find their own transport to and from Perth (as necessary). Please note that Teacher relief costs for participating staff will not be met by camp funds.

Info for Students ...

Enclosed with this letter is further information relating to each of the above activities, and application forms. Please photocopy relevant information for students you believe would be interested or who would benefit from attendance.

Any Questions? ...

I am happy to discuss any aspect of this year’s programme with students, parents and teachers. I look forward to another successful year of activities for Year 10 girls and thank you for your assistance.

Ms Carolyn Somerville Brown, Project Co-ordinator
Women into Engineering and Technology Project,
Curtin University of Technology
Tel: (09) 351 7705, Fax: (09) 351 2682

Appendix B2

WEST AUSTRALIAN SCHOOL OF MINES ENGINEERING & TECHNOLOGY CAMP 1995

for Year 10 girls and Teachers

(KALGOORLIE)

LOOKING FOR A GREAT CAREER ? ...

Then the fourth WASM Engineering & Technology Camp for Year 10 girls and Teachers is the event for you. The WA School of Mines (WASM) has been able to boast 100% employment for their graduates for the last three years!

Careers and academic options will be aimed at girls intending study at University level. Types of careers to be covered during the camp include Surveying, Mining and Mineral Technology, Mining Engineering, Minerals Engineering, Metallurgy, Mineral Exploration, Geology and many others.

OBJECTIVES ...

- ♦ to encourage Year 10 girls to continue their interests in school mathematics and science subjects, particularly Applicable Maths, Calculus, Chemistry and Physics.
- ♦ to give participants "hands on" experience in engineering, science and technology courses at the WASM
- ♦ to experience student lifestyle at WASM and Agricola College (student accom.)
- ♦ to examine career prospects available in the Minerals Industry.

DATES ...

3 - 7 July, 1995 (inclusive)

- ♦ depart Perth (Curtin University) - Monday 3 July by coach to Kalgoorlie
- ♦ depart Kalgoorlie - Friday 7 July by coach to Perth (Curtin University)
- ♦ Duration: 5 full days, 4 nights

Room and Board

- ♦ Agricola College (university student accommodation) - offers single rooms with shared bathrooms and toilets, on site squash court, weights room, TV room, dining area - located 100m from the School of Mines and city centre

ACTIVITIES INCLUDE...

- ♦ "hands on" workshops at WASM in the Departments of Mining Engineering & Mine Surveying, Minerals Engineering & Extractive Metallurgy, and Mineral Exploration & Mining Geology
- ♦ Visit to the Underground Tourist Mine including activities in the Gold Room
- ♦ Visit and tour of the largest open pit mine in Kalgoorlie - KCGM Super Pit
- ♦ Visit and tour of Western Mining's Nickel Smelter and Rehabilitation site
- ♦ Visit to the Museum of the Goldfields
- ♦ opportunities to meet and discuss issues with women studying at WASM and working in the mining industry
- ♦ "Women in Mining" discussion evening
- ♦ opportunities to meet Year 10 girls from across WA with similar interests.

COSTS ...

The cost of the camp is completely **FREE** to successful applicants, with places kindly sponsored by WASM, Curtin University and numerous companies in the Minerals Industry.

APPLICATIONS ...

The WASM Camp will be filled on a "first-come-first-served" basis. Applications to attend must be received between Monday 3 April and Friday 12 May 1995. In order to be fair to all schools, only Applications received in this period will be considered. After all Camp places have been filled, further applicants will be placed on a Reserve List in order of receipt.

Applications must be made by Fax on the attached Application Form on:

Fax (09) 351 2682

Participant numbers are limited to 5 science teachers or career advisers, and 30 Year 10 girls (maximum of 2 applicants + 1 reserve per school) who should be nominated by their Mathematics or Science teacher on the basis of interest and good performance in these subjects.

Parental permission is required for students to travel to and from Kalgoorlie and to attend workshops, museums, and mining facilities. Country participants must find their own transport to and from Perth (Curtin University).

MORE INFORMATION ...

Further details may be obtained from:

Carolyn Somerville Brown, Co-ordinator
Women into Engineering and Technology Project,
Curtin University of Technology
Tel: (09) 351 7705, Fax: (09) 351 2682

March 1995.

wasm95/letter/schools/letter1

ATTENTION: C. SOMERVILLE BROWN

WEST AUSTRALIAN SCHOOL OF MINES ENGINEERING & TECHNOLOGY
CAMP 1995 for Year 10 girls and Teachers
(KALGOORLIE)

Monday July 3 - Friday July 7, 1995

APPLICATION FORM

to be received between 3 April and 12 May, 1995
on FAX No (09) 351 2682

(Please Print)

SCHOOL: _____

ADDRESS: _____

TELEPHONE: _____ FAX: _____

NOMINATED BY: _____
(Maths/Science Teacher)

Names & grades of Year 10 girls attending (2 maximum)

1. _____	Maths Grade	Science Grade
2. _____	Maths Grade	Science Grade
3. _____	Maths Grade	Science Grade

(Reserve)

Name of Teacher/Career adviser attending:
(Please Print)

School Contact: _____ (please print)
(for correspondence)

Please Note:

1. For evaluation and reporting purposes, all applicants will be asked to complete and return an attitude survey.
2. Confirmation of acceptance will be sent after 15/5/95, and all applicants should be notified by 26/5/95 of their acceptance or non-acceptance.
3. Camp details will only be sent to successful applicants upon notification of acceptance of places offered.

Appendix B3

Dear (*school contact*),

As you are aware, the annual WASM Engineering and Technology Camp was established to encourage females to give consideration to professional careers in the mining industry. The major objectives of the WASM Camp in 1995 are to:

- ♦ encourage Year 10 girls to continue their interests in school mathematics and science subjects, particularly Applicable Maths, Calculus, Chemistry and Physics.
- ♦ give participants "hands on" experience in engineering, science and technology courses at WASM
- ♦ experience student lifestyle at WASM and Agricola College
- ♦ examine career prospects available in the Minerals Industry.

To determine whether these objectives have been achieved, I am conducting two Attitude Surveys - the first prior to the WASM Camp (Precamp Questionnaire) and the second on conclusion of the Camp (Postcamp Questionnaire). I intend to compare responses to questions so that I may establish the effectiveness of activities employed on the Camp. Therefore I will be requesting applicants not attending the camp to also complete Postcamp Questionnaires.

I would appreciate your co-operation in explaining the purpose of the enclosed WASM Camp Questionnaire to prospective participants and returning the questionnaire to my office by: **Friday 12 May, 1995** at the address shown on the letterhead.

Please note that completion of the Questionnaire has no bearing on WASM Camp participation. All Questionnaires are confidential and will be used for evaluation purposes only. It is hoped that evaluation of Questionnaires will result in more effective WASM Camp activities that meet the needs of all participants in 1995 and beyond.

Thank you for your assistance. I am happy to discuss any aspect of the Questionnaires and WASM Camp with teachers, students and their parents.

Regards,

Carolyn Somerville Brown,
Project Co-ordinator.

April 1995

Appendix B4

Postcamp letter to schools

((contact))

((school))

((address))

Dear ((contact)),

The annual WASM Engineering and Technology Camp was held a few weeks ago with great enthusiasm and interest for the students and teachers attending. To determine whether the objectives of the WASM Camp have been achieved, I am conducting a second Attitude Survey on conclusion of the Camp (the first was issued prior to the WASM Camp) to all students that completed the original survey.

The second survey (Postcamp) is identical to the original completed earlier in the year. I intend to compare responses to questions so that I may establish the effectiveness of activities employed on the Camp. I would greatly appreciate your assistance in passing on information to <<students>>.

Please find enclosed sufficient copies of the "1995 WASM Camp Questionnaire Postcamp" for each student that was kind enough to complete the Precamp Survey. As an incentive for students to complete and promptly return the Postcamp Survey, I will draw out the names of **two** students who will each win a Curtin University T-Shirt and book (hard cover) titled "The First 500 million". To be in the running, students need to complete and return the Postcamp Surveys by *Friday 4 August 1995*.

It is unfortunate that not all nominated students are able to attend the WASM Camp. Therefore I have also enclosed copies of information relating to the W.A. School of Mines and the mining industry.

I would appreciate your co-operation in explaining the purpose of the enclosed WASM Camp Questionnaire to students and returning the questionnaire to my office *by Friday 4 August, 1995* at the address shown on the letterhead. All Questionnaires are confidential and will be used for evaluation purposes only.

Thank you for your assistance. I am happy to discuss any aspect of the Questionnaires with teachers, students and their parents.

Regards,

Carolyn Somerville Brown,
Project Co-ordinator.
July 1995

Appendix C

Name: _____
 School: _____

1995 WASM CAMP QUESTIONNAIRE - PRECAMP

I am interested in your opinion of the Mining Industry and how you feel about certain subjects you are doing at school. On the following pages are some questions. There are no right or wrong answers and this is not a test of your knowledge. I am asking for your personal opinion. Please answer all questions as honestly as you can.

On each page you will find a heading like this:

I THINK SCHOOL HOLIDAYS ARE

The rest of the page contains words which describe how you might feel about the heading. There are words at opposite ends of some boxes like this:

THE BEST PART OF SCHOOL LIFE 1 2 3 4 5 6 7 THE WORST PART OF SCHOOL LIFE

Tick the box which best represents how the words describe your opinion about the heading.

For example, if you feel that "SCHOOL HOLIDAYS" are very closely described by the best part of school life, you would tick one the boxes like this

THE BEST PART OF SCHOOL LIFE 1 2 3 4 5 6 7 THE WORST PART OF SCHOOL LIFE

If you feel that "SCHOOL HOLIDAYS" are equally described as the best and worst parts of school life, then you would tick one of the boxes like this

THE BEST PART OF SCHOOL LIFE 1 2 3 4 5 6 7 THE WORST PART OF SCHOOL LIFE

Complete the Questionnaire in the same way:

- ♦ Look at the heading at the top of each page and keep it in your mind.
- ♦ Work down the page ticking one box for each statement.
- ♦ Please give your first impressions and work fairly quickly.

**I THINK HIGH SCHOOL MATHS, PHYSICS AND CHEMISTRY
ARE SUBJECTS WHICH ...**

ARE EASY FOR MOST STUDENTS	1	2	3	4	5	6	7	ARE DIFFICULT FOR MOST STUDENTS	34
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
DO NOT INTEREST ME	1	2	3	4	5	6	7	INTEREST ME	35
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
ARE ESSENTIAL FOR MINING INDUSTRY COURSES	1	2	3	4	5	6	7	ARE NOT ESSENTIAL FOR MINING INDUSTRY COURSES	36
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
ARE USEFUL OUTSIDE SCHOOL	1	2	3	4	5	6	7	ARE NOT USEFUL OUTSIDE SCHOOL	37
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
ARE NOT IMPORTANT FOR GIRLS TO STUDY	1	2	3	4	5	6	7	ARE IMPORTANT FOR GIRLS TO STUDY	38
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
I INTEND TO STUDY IN YEARS 11 AND 12	1	2	3	4	5	6	7	I DO NOT INTEND TO STUDY IN YEARS 11 AND 12	39
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
RATE AS MY MOST LIKED SUBJECTS	1	2	3	4	5	6	7	RATE AS MY LEAST LIKED SUBJECTS	40
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
HELP ME TO UNDERSTAND ABOUT WORLD ISSUES	1	2	3	4	5	6	7	DO NOT HELP ME TO UNDERSTAND ABOUT WORLD ISSUES	41
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
ARE NOT IMPORTANT TO MY FUTURE CAREER CHOICES	1	2	3	4	5	6	7	ARE IMPORTANT TO MY FUTURE CAREER CHOICES	42
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
ARE MORE USEFUL TO BOYS	1	2	3	4	5	6	7	ARE MORE USEFUL TO GIRLS	43
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
CAN LEAD TO INTERESTING CAREERS	1	2	3	4	5	6	7	CAN LEAD TO BORING CAREERS	44
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
I WILL NOT/DO NOT LOOK FORWARD TO AT SCHOOL	1	2	3	4	5	6	7	I WILL/DO LOOK FORWARD TO AT SCHOOL	45
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
INCREASE MY INTEREST IN SCIENTIFIC AND TECHNICAL CAREERS	1	2	3	4	5	6	7	REDUCE MY INTEREST IN SCIENTIFIC AND TECHNICAL CAREERS	46
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
WOULD HELP ME IF WORKING IN THE MINING INDUSTRY	1	2	3	4	5	6	7	WOULD BE OF LITTLE HELP TO ME IF WORKING IN THE MINING INDUSTRY	47
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

TICK THE BOX TO SHOW WHETHER YOU *AGREE* OR *DISAGREE* WITH THE FOLLOWING STATEMENTS:

I THINK ...

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	
THE MINING INDUSTRY DEALS WITH THE NEEDS OF PEOPLE RATHER THAN CORPORATIONS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	48
PROFESSIONALS IN MINING EARN AN ABOVE AVERAGE SALARY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	49
YOU NEED TO BE TOUGH TO WORK IN THE MINING INDUSTRY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	50
PEOPLE RATHER THAN CORPORATIONS ARE RESPONSIBLE FOR ISSUES OF CONSERVATION	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	51
TO STUDY MINING COURSES I NEED TO HAVE PASSED YEAR 12 GEOLOGY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	52
WORKING IN MINING WOULD ENABLE ME TO MAKE IMPORTANT DISCOVERIES/ FINDINGS THAT BENEFIT SOCIETY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	53
IN THE MINING INDUSTRY I WOULD BE TREATED DIFFERENTLY BECAUSE I AM FEMALE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	54
THE MINING INDUSTRY HAS DONE LITTLE TO IMPROVE OUR STANDARD OF LIVING	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	55
THE MINING INDUSTRY IS SENSITIVE TO CONSERVATION OF THE ENVIRONMENT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	56

COMMENTS: Optional only.

(Please write down any comments you have about the questionnaire or other topics).

THANK YOU !

Appendix D1

Statistical analysis by Factors/ Categories on the Pre-camp MIAS (57 cases)

1. PROFIMAGE: Perceived Image of Working in the Mining Industry: general description of work and image of engineers and scientists

Item	Description	Mode	S.D.	Sum	Mean
1.	The mining industry is a field which is exciting—is boring.	6	1.197	313	5.49
2	The mining industry is a field which I have very little knowledge -- I know a great deal	4	1.211	197	3.46
11	The mining industry is a field which day to day involves repetitive tasks -- day to day involves unique and different tasks	4	1.494	248	4.35
14	The mining industry is a field which has jobs mainly suitable for men -- has jobs mainly suitable for women	4	0.708	203	3.56
16	The mining industry is a field which is unfeminine -- is feminine	4	0.852	209	3.67
24	Engineers & scientists in the MI are people I can relate to -- are people I cannot relate to	4	1.294	289	5.07
25	Engineers & scientists in the MI lead dull lives -- lead eventful lives	6	1.377	315	5.53
30	Engineers & scientists in the MI do interesting work -- do boring work	7	1.184	337	5.92
32	Engineers & scientists in the MI are boring -- are exciting	5	1.167	312	5.47
33	Engineers & scientists in the MI are concerned about protecting the environment -- are not concerned about protecting the environment	7	1.578	307	5.39
41	High school maths, physics & chemistry help me to understand about world issues -- do not help me to understand about world issues	6	1.783	272	4.77
47	High school maths, physics & chemistry would help me if working in the mining industry -- would be of little help to me if working in the mining industry	7	0.623	376	6.6

2. TASKDESC: Perceived Image of Working in the Mining Industry: specific job description of duties, conditions and career path

Item	Description	Mode	S.D.	Sum	Mean
3	The mining industry is a field which involves mainly fieldwork -- involves mainly office work	4	0.708	196	3.44
4	The mining industry is a field which means working in remote areas -- means working in towns and cities	4	1.197	181	3.18
5	The mining industry is a field which has unsafe working conditions -- has safe working conditions	6	1.544	273	4.79
6	The mining industry is a field which has low job availability - has high job availability	4	1.234	306	5.37
8	The mining industry is a field which requires physical strength to carry out the work -- does not require physical strength to carry out the work	4	1.333	237	4.16
9	The mining industry is a field which helps to solve society's problems -- creates problems for our society	4	1.063	249	4.37
10	The mining industry is a field which has rough, unpleasant working conditions -- has comfortable working conditions	4	1.231	236	4.14
12	The mining industry is a field which has mainly dirty, unglamorous work -- has little dirty, unglamorous work	4	1.163	194	3.4
18	The mining industry is a field which has more jobs in science than engineering -- has more jobs in engineering than science	4	0.941	237	4.16

3. PREREQUISITE: Perceived Image of Working in the Mining Industry: mathematics, science skills and experience required

Item	Description	Mode	S.D.	Sum	Mean
13	The mining industry is a field which requires substantial knowledge of Maths and science -- requires little knowledge of Maths and science	7	0.915	353	6.19
15	The mining industry is a field which many employees have engineering or science qualifications -- few employees have engineering or science qualifications	6	1.043	331	5.81
17	The mining industry is a field which has poor career prospects -- has good career prospects	7	1.094	343	6.02
20	Engineers & scientists in the MI are not what I think a "miner" is -- are typical of what I think a "miner" is	5	1.649	257	4.51
21	Engineers & scientists in the MI use their maths knowledge daily -- rarely use their knowledge of maths	7	0.946	349	6.12
26	Engineers & scientists in the MI need to be skilled in chemistry and physics -- do not need skills in chemistry and physics	6	1.272	323	5.67
29	Engineers & scientists in the MI have excellent ability in maths & science -- have average ability in maths & science	7	1.12	332	5.83
36	High school maths, physics & chemistry are essential for mining industry courses -- are not essential for mining industry courses	7	1.1	346	6.07

4. MSINTEREST: Interest in school mathematics, physics and chemistry

Item	Description	Mode	S.D.	Sum	Mean
31	Engineers & scientists in the MI are relevant to my future -- are not relevant to my future	4	1.206	307	5.39
35	High school maths, physics & chemistry do not interest me -- interest me	7	1.229	347	6.09
40	High school maths, physics & chemistry rate as my least liked subjects -- rate as my most liked subjects	5	1.247	300	5.26
42	High school maths, physics & chemistry are not important to my future career choices -- are important to my future career choices	7	1.81	330	5.79
45	High school maths, physics & chemistry I will not/do not look forward to at school -- I will/do look forward to at school	7	1.349	309	5.02
46	High school maths, physics & chemistry increase my interest in scientific and technical careers -- reduce my interest in scientific and technical careers	7	1.117	344	6.04

5. MSVALUE: The value of school mathematics, physics and chemistry

Item	Description	Mode	S.D.	Sum	Mean
34	High school maths, physics & chemistry are easy for most students -- are difficult for most students	5	1.467	280	4.91
37	High school maths, physics & chemistry are useful outside school -- are not useful outside school	7	1.131	351	6.16
38	High school maths, physics & chemistry are not important for girls to study -- are important for girls to study	7	1.234	363	6.37
39	High school maths, physics & chemistry I intend to study in Years 11 and 12 -- I do not intend to study in Years 11 and 12	7	0.774	377	6.61
44	High school maths, physics & chemistry can lead to interesting careers -- can lead to boring careers	7	0.675	383	6.72

6. PROFVALUE: The value of the tasks performed by engineers & scientists

Item	Description	% Agree	Mean
48	the Mining Industry deals with the needs of people rather than corporations	63	2.63
53	working in mining would enable me to make important discoveries/ findings that benefit society	88	3.27
55	the mining industry has done little to improve our standard of living	0	3.51

7. MIKNOWLEDGE: Prior Knowledge of Mining Industry

Item	Description	% Agree	Mean
49	professionals in mining earn an above average salary	95	3.16
51	people rather than corporations are responsible for issues of conservation	60	2.71
52	to study mining courses I need to have passed year 12 Geology	53	2.56

8. MIIMAGE: Image of the Industry

Item	Description	% Agree	Mean
50	you need to be tough to work in the mining industry	32	2.79
54	in the mining industry I would be treated differently because I am female	37	2.88
56	the mining industry is sensitive to conservation of the environment	86	2.95

Items with low correlations (eigenvalues < 2.0)

Item	Description	Mode	S.D.	Sum	Mean
7	The mining industry is a field which would involve me moving often -- would involve little travel	4	1.019	202	3.54
19	Mostly work indoors -- mostly work outdoors	5	1.149	283	4.97
22	Engineers & scientists in the MI mainly wear overalls and boots -- mainly wear "office" clothes	4	1.094	208	3.65
23	Engineers & scientists in the MI use computers in their work on a daily basis -- rarely use computers in their work	7	1.232	327	5.74
27	Engineers & scientists in the MI use fine, delicate instruments for their work -- use heavy machinery for their work	4	1.392	214	3.75
28	Engineers & scientists in the MI work as a member of a team - - work mainly on their own	2	1.214	128	2.25
43	High school maths, physics & chemistry are more useful to boys -- are more useful to girls	4	0.371	232	4.07

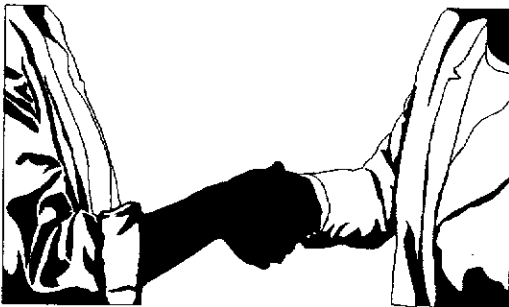
Appendix D2

Precamp MIAS Frequency Factors/Categories: Experimental Vs Control Groups

	Category Name	Experimental mean	Control mean	Effect Size
Factor 1	PROFIMAGE	4.96	4.92	0.03
Factor 2	TASKDESC	4.16	4.05	0.1
Factor 3	PREREQUS	5.89	5.62	0.23
Factor 4	MSINTEREST	5.78	5.51	0.2
Factor 5	MSVALUE	6.25	6.03	0.21
Category 6	PROFVALUE	3.14	3.09	0.05
Category 7	MIKNOWL	2.81	2.67	0.19
Category 8	MIIMAGE	2.95	2.98	0.01

Appendix E1

2003 JULY 05

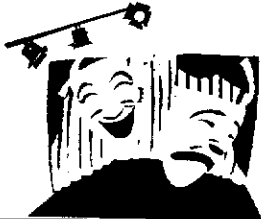
TIME	ACTIVITY	VENUE
8:00 am	Depart Perth	Curtin University
12:30 pm	Picnic Lunch	Merredin
4:30 pm	Arrive Kalgoorlie	
5:00 pm	Allocate rooms	Agricola College
6:00 pm	Dinner	Agricola Dining Room
6:30 - 7:00 pm	Free time - unpack, shower, make bunk, explore College	Agricola College
7:30 pm	<p><i>Evening Activities</i> -</p> <ul style="list-style-type: none"> - getting to know each other - meet female students from WASM 	Agricola Dining Room
10:00 pm	Lights out	Agricola College

DON'T FORGET TO START YOUR JOURNAL and CHECK THE DUTY ROSTER

TUESDAY 4 JULY 1995

TIME	ACTIVITY	VENUE
7:30 am	Breakfast	Agricola Dining Room
9:00 am	<p>OPENING: <u>Prof David Spottiswood</u>, Director, WASM</p> <p>VIDEO: WASM Courses</p> <p>KEYNOTE SPEAKERS: Engineer: <u>Ms Shoena Messner</u> Process Engineer, Kalgoorlie Nickel Smelter</p> <p>Science/Tech: <u>Mrs Marion Cahill</u> Environmental Consultant, Marianna Partners</p> <p>VIDEO: "A Good Prospect" Chamber of Mines & Energy WA</p>	WMC Conference Centre
10:45 am	Morning Tea	School of Mines
11:30 am	<i>WASM Mineral Museum</i>	School of Mines
12:30 pm	Lunch	Agricola Dining Room
	<p>Workshop 1: <i>Dept of Mining Engineering & Mine Surveying</i> Rock breaking: video, demo, talk Mining Methods: video, talk Surveying: hands on, computer demo</p>	School of Mines
4:00 pm	Town centre visit	Kalgoorlie
6:00 pm	Dinner	Agricola Dining Room
7:30 pm	QUIZ NIGHT + prizes donated by the Chamber of Mines & Energy W.A.	Agricola Dining Room
10:00 pm	Lights out	Agricola College


PROGRAM

TIME	ACTIVITY	VENUE
7:30 am	Breakfast	Agricola Dining Room
9:00 am	Workshop 2: <i>Dept of Mineral Exploration & Mining Geology</i> <u>Analysis of Samples & Microscopy:</u> <u>Locating Deposits:</u> <u>Remote Sensing: Computers</u>	School of Mines
11:00 am	Morning Tea	School of Mines
11:30 am	<i>Putting Kalgoorlie Into Perspective</i> Guest Speaker on "Women in Mining"	Museum of the Goldfields
12:45 pm	Lunch	Agricola Dining Room
1:45 pm	<i>Hannan's North Tourist Mine</i> - Underground Mining Tour - Gold Room - Locotrain or Gold Panning	Kalgoorlie
4:30 pm	Town Centre Visit	Boulder
6:00 pm	Dinner	Agricola Dining Room
8:00 pm	FILM NIGHT Viewway Theatre	
10:30 pm	Lights out	Agricola College

PROGRAM

TIME	ACTIVITY	VENUE
7:30 am	Breakfast	Agricola Dining Room
9:00 am	Workshop 3: <i>Dept of Minerals Engineering & Extractive Metallurgy</i> <u>Separation techniques: hands on</u> <u>Flotation techniques: demo</u> <u>Electron Microscopy: demo</u>	School of Mines
11.00 am	Morning Tea	School of Mines
11:30 am	<i>Kalgoorlie Nickel Smelter Tour</i>	Kalgoorlie Nickel Smelter <i>NB: long sleeves, long pants (pref. cotton) and closed shoes</i>
1:00 pm	Lunch	Agricola Dining Room
2:00 pm	<i>Open pit mine - KCGM super pit</i> - Rehabilitation Site - Fimiston Mill	KCGM - Kalgoorlie <i>NB: long sleeves, long pants (pref. cotton) and closed shoes</i>
4:30 pm	Town centre visit	Kalgoorlie
6:00 pm	Dinner - Barbecue with invited guests Small group discussions: <i>"Women in Mining "</i>	Agricola College
10:00 pm	Lights out	Agricola College

AGRICOLA

TIME	ACTIVITY	VENUE
7:30 am	Breakfast	Agricola Dining Room
8:30 am	Depart Kalgoorlie	Agricola College
12:30 pm	Lunch	Merredin
	COMPLETE SURVEYS, JOURNALS & SPONSOR LETTERS	
4:30 pm	Arrive Perth	Curtin University

Appendix E2

WASM Camp Program showing objectives covered.

ACTIVITY Day 1	OBJECTIVES COVERED	VENUE
Evening Activities - - getting to know each other - meet female students from WASM	1. b 2. a, b 3. b 4. a 5. a, c	Agricola Dining Room

ACTIVITY Day 2	OBJECTIVES COVERED	VENUE
<i>OPENING:</i> <u>Prof. David Spottiswood</u> , Director, WASM	1. b, d 2. b 4. b	WMC Conference Centre
VIDEO: WASM Courses	5. c	
<i>KEYNOTE SPEAKERS:</i> Engineer: <u>Ms Shoena Messner</u> Process Engineer, Kalgoorlie Nickel Smelter	2. b 2. a 3. b	
Science/Tech: <u>Mrs Marion Cahill</u> Environmental Consultant, Marianna Partners		
VIDEO: "A Good Prospect" Chamber of Mines & Energy WA	1. a, d 2. b	
WASM Mineral Museum	1. a, b 4. c	School of Mines
<u>Workshop 1:</u> Dept of Mining Engineering & Mine Surveying <u>Rock breaking:</u> video, demo, talk <u>Mining Methods:</u> video, talk <u>Surveying:</u> hands on, computer demo	1. a, b 3. a, b 4. b, d 5. a, c	School of Mines
Town centre visit	1. c 4. c, f	Kalgoorlie
QUIZ NIGHT + prizes donated by Chamber of Mines & Energy W.A.	4. a, d 5. c	Agricola Dining Room

ACTIVITY Day 3	OBJECTIVES COVERED	VENUE
<u>Workshop 2:</u> Dept of Mineral Exploration & Mining Geology <u>Analysis of Samples & Microscopy:</u> <u>Locating Deposits:</u> <u>Remote Sensing:</u> Computers	1. a, b 3. a, b 4. b, d 5. a, c	School of Mines
Putting Kalgoorlie Into Perspective Guest Speaker on "Women in Mining"	1. c 2. a 4. c, f 5. a, c	Museum of the Goldfields
Hannan's North Tourist Mine - Underground Mining Tour - Gold Room - Locotrain or Gold Panning	1. c 4. c, f 5. c	Kalgoorlie
Town Centre Visit	4. c, f 1. c	Boulder
FILM NIGHT Vieway Theatre	4. c, f 5. c	Kalgoorlie

ACTIVITY Day 4	OBJECTIVES COVERED	VENUE
<u>Workshop 3:</u> Dept of Minerals Engineering & Extractive Metallurgy <u>Separation techniques:</u> hands on <u>Flotation techniques:</u> demo <u>Electron Microscopy:</u> demo	1. a, b 3. a, b 4. b, d 5. a, c	School of Mines
<i>KALGOORLIE NICKEL SMELTER TOUR</i>	1. b, c 4. e, f	Kalgoorlie Nickel Smelter
Open pit mine - KCGM super pit - Rehabilitation Site - Fimiston Mill	1. b, c 4. e, f	KCGM - Kalgoorlie
Town centre visit	4 c, f 1. c	Kalgoorlie
Dinner - Barbecue with invited guests	1. b 2. a	Agricola
Small group discussions: "Women in Mining "	3. a 5. a, b, c	College

ACTIVITY Day 5	OBJECTIVES COVERED	VENUE
Travel to Perth: Interviews General informal discussions Complete Postcamp MIAS	N/A	N/A

Appendix F1

Means and Effect Sizes for MI Attitudinal Descriptors: Precamp Vs Postcamp

	Experimental Group		
	Mean Score		Effect Size
	Precamp	Postcamp	
PROFIMAGE	4.96	5.66	0.61
TASKDESC	4.16	4.42	0.24
PREREQUS	5.87	6.08	0.18
MSINTEREST	5.60	5.82	0.20
MSVALUE	6.15	6.18	0.03
PROFVALUE	3.14	3.24	0.20
MIKNOWL	2.81	3.1	0.43
MIIMAGE	2.95	3.09	0.21

	Control Group		
	Mean Score		Effect Size
	Precamp	Postcamp	
PROFIMAGE	4.92	4.95	0.03
TASKDESC	4.05	4.41	0.32
PREREQUS	5.62	5.39	-0.20
MSINTEREST	5.51	5.3	-0.15
MSVALUE	6.03	5.86	-0.13
PROFVALUE	3.05	2.93	-0.18
MIKNOWL	2.67	2.87	0
MIIMAGE	2.96	3.14	0.24

Appendix F2**Means and Effect Sizes for MI Attitudinal Descriptors: Postcamp Experimental Group Vs Postcamp Control Group**

	Postcamp MIAS		
	Mean Score		Effect Size
	Experimental Group	Control Group	
PROFIMAGE	5.66	4.95	0.65
TASKDESC	4.42	4.41	0.01
PREREQUS	6.08	5.39	0.59
MSINTEREST	5.82	5.3	0.37
MSVALUE	6.18	5.86	0.26
PROFVALUE	3.24	2.93	0.54
MIKNOWL	3.1	2.87	0.35
MIMAGE	3.09	3.14	-0.08

Appendix G

INTERVIEW QUESTIONS

1. What careers were you interested in prior to the camp? Are you now interested in any MI careers?
2. What would convince you to enroll in a MI course?
3. How much did you know about MI careers before attending the camp?
4. Do you think you need to be "tough" to work in mining?
5. What would be your response to someone who said "mining is no place for women"?