CHAPTER SEVEN

EXPLORING THE FAMILY WORLDS OF SCIENCE PROFICIENT STUDENTS

INTRODUCTION

The importance of family background characteristics to a wide range of school science outcomes, including achievement, attitudes and participation, has been well documented (e.g. Ainley et al. 1994; Costa 1995; Evans & Fisher 2000; Fullarton & Ainley 2000; Keeves 1975; Kelly 1988; Leslie et al. 1998; Levy et al. 1997; Rickards & Fisher 1999; Woolnough 1994). It is not surprising, therefore, that exploration of the family worlds of science proficient students produced the most substantial and consequential findings of the study. This point is underscored by the scope and detail of this chapter, which begins by reporting findings from the SPQ data concerning reliance on parents' subject advice. This is followed by the presentation and discussion of findings from the interview data, illustrated using pertinent narrative extracts. These findings are reported in terms of the structural, attitudinal and dynamic aspects of students' family worlds that influenced their deliberations. Finally, the implications of these findings for the multiple worlds model are discussed with reference to the second thematic research question, concerning the role of congruence or incongruence on the enrolment decisions of students in this study.

FINDINGS FROM THE SPQ

The first indications from this study that family members were often pivotal in the enrolment decisions of science proficient students, came from crosstabulations of the SPQ data. As shown in Chapter Four, science proficient students tended to rely more upon the advice of their parents than on that of other individuals, indicating that parents were generally seen as having the greatest capacity to influence subject decisions. While ratings for the influence of parents' advice did not differ greatly with gender, location or other background characteristics, there were some variations in ratings between choice categories which were significant enough (p<0.1) to warrant further investigation.

First, female students choosing physical science subjects tended to rate the influence of their fathers higher than did females in other choice categories (see Table J.8 in Appendix J for significance levels). Figure 7.1 shows the greatest rating difference to be found between females choosing physical science subjects and those choosing no science. While a similar tendency was noted among male students, the smaller number choosing no science meant that too many cells had low values, and the pattern could not be verified statistically.





There are a number of possible explanations for the rating differences among female students. These include speculation that females considering enrolment in physical sciences may have consulted more with their fathers, or that fathers may have taken a greater interest in daughters making such choices. While nothing about the motivations of female students or their fathers could be concluded from the SPQ data, this result nevertheless indicated that differences in consultation behaviours, or father/daughter relationships, should be explored in the interviews.

Analysis of students' ratings for the subject advice of their mothers revealed a second difference (p<0.1), this time between male and female students choosing physical science subjects. As Figure 7.2 illustrates, females in this choice category attributed greater influence to their mothers than did males choosing the same courses (see Table J.9 in Appendix J).



Figure 7.2 SPQ ratings for 'Reliance on the Advice of Mothers', by physical science students (n=80)

By comparison, males and females in the other choice categories tended to rate this item in similar ways. Again there could be a number of reasons for a gender difference in ratings by physical science students. However, this finding was yet another part of the emerging pattern whereby science proficient female students choosing physical science subjects were inclined to rate their reliance on the advice of others, including senior students, fathers and mothers, consistently higher than males choosing the same courses and, in some cases, higher than females making alternative enrolment decisions. Other indicators of this pattern, reported in previous chapters, included the greater tendency for female physical science students to consult more widely, and to take less heed of the advice of their best friends, than females in other choice categories. Considered in concert, these findings revealed the greater need for many females choosing physics and chemistry to consult, or to be reassured by, reliable sources regarding their decisions. The degree to which this proposition was supported by the interview data regarding family worlds is discussed in more detail later in this chapter. First, however, the focus turns to the family cultures of science proficient students inteviewed in this study.

THE STRUCTURAL DIMENSION OF STUDENTS' FAMILY WORLDS

As noted in the literature review, students' aspirations and subject choices have been shown to be associated with features of their family structures, such as parental occupation (AAUW 1992; Foon 1988; Fullarton & Ainley 2000; Keeves 1972; Leslie et al. 1998; Woolnough 1994;), parenting structure (Hunt & Hunt 1977; Smith 1992), and family membership (Blake 1989; Marjoribanks 1995). Therefore, the interview schedule sought profiles of family structures as a background against which students' narratives could be contextualised.

Parental Occupations

A number of studies have found statistical correlations between science enrolment patterns and parental occupations. In particular, students whose parents are in professional jobs have greater than double the representation in physical science courses as do students whose parents are in unskilled or semi-skilled jobs (Fullarton & Ainley 2000). In view of these associations it was felt that an awareness of parent occupations may suggest aspects of family culture influential in students' decisions.

Parental occupations for the 37 interviewees are set out in Appendix L. Occupations were categorised according to the Australian Standard Classification of Occupations (ASCO), with occupations grouped according to both skill level, as measured by formal education and experience, and specialisation, which considers the type of skill required (ABS 1997).

The most obvious feature was the high proportion of parents in the professional category. In all, 21 of the 37 interviewees had at least one parent in this category and nine had both, representing approximately 45 per cent of all the parents in the study. Though this is far higher than the 18 per cent representation in this category statewide (ABS 1998), it is consistent with the finding by Rosier and Banks (1990, p. 80) of a strong positive relationship between achievement in school science and occupational status of parents.

A feature markedly different across choice categories in the present study was the specific type of occupation. Among physical science students there was a far higher proportion of parents who were educators, or who were undertaking tertiary courses, than was found in the other two choice categories. Over 71 per cent these students, including Charlie(p), Shane(p), Michael(p), Peter(p), Melinda(p), Greta(p), Renate(p), Hannan(p) and Jennifer(p) and Sylvia(p) had at least one parent who was a school teacher or university lecturer, or who was completing or had recently completed a tertiary course. By comparison, only Phillip and Tracy (biology/other science), and George, Stefan, Thomas and Yvonne (no science), had parents currently, or recently, involved in formal education. Such a contrast was strongly suggestive of a relationship between students' decisions to enrol in physical science subjects, and parents' attitudes towards formal education. This relationship was subsequently explored more thoroughly, and is discussed later in the chapter.

A further observation concerned parents who were engaged in science related occupations (health, science teaching, research, engineering, etc.) and their distribution across choice categories. Given that previous studies had found a positive association between students' aspirations towards science careers, and their parents' levels of science education (AAUW 1992; Leslie et al. 1998; Woolnough 1994) it might have been expected that parents with such occupations would be represented more highly within the two science choice categories. However, this was not the case. Among the fourteen physical science students, Charlie, Michael, Greta, Sylvia, Renate and Hannan (43 per cent) had at least one parent who worked in science related occupations (see Appendix L). Among the nine biology/other science students, Mark, Phillip, Greg, Tracy and Beth (56 per cent) had parents in a science related occupation. However, the representation among those choosing no science subjects was very similar, with George, Malcolm, Stefan, Madeline, Daria and Kate all having at least one parent working in a science career (43 per cent). While the high proportion overall of science proficient students whose parents worked in science related occupations (46 per cent) may suggest some relationship between this characteristic and school science achievement, the proportions above did not indicate an association with decisions to enrol in senior science.

A final feature of interest was that parents from NESBs had far greater representation in the 'blue collar' categories than did parents from ESBs. The criteria for determining NESB status has been set out in Chapter Three. This group comprised James(p), Hannan(p), Salma(p), Uzlan(b), Beth(b), Bruno(b), Theresa(b), Daria(n) and Michelle(n). Of these, only the father of Beth worked in a high status occupation (ASCO Groups 1 & 2). By comparison, of the 28 ESB students, 20 (71 per cent) had at least one parent in a high status occupation. This contrast was noteworthy as it suggested, in this sample at least, that the relationship between achievement in science (given that all students had achieved to a high level) and parental occupation, as highlighted by Rosier and Banks (1990), did not necessarily extend to students of non-English speaking backgrounds. A closer examination of the narratives of NESB students revealed that high parental aspirations for their children were a common feature of this group. This suggested that parental values, for these students at least, were more closely linked to their children's educational outcomes than were parents' careers. This link is revisited when discussing the attitudinal dimension of students' families.

Although the similarities and differences in parental occupations across choice categories were strongly suggestive, it is acknowledged that such patterns may have been more compelling had they been reflected among the larger SPQ population. While questions about parents and their occupations were originally considered for this questionnaire, they were later excluded, partly because they were considered too intrusive, but mainly on the basis of comments by Rosier and Banks (1990, p. 71) that students were often unaware or misinformed about the exact nature of their parents' occupations. At least in the interviews students could describe in detail the types of work in which their parents were involved.

Parenting Structures

A number of the narratives provided insights into the dynamics of parental influence in circumstances where parents were separated. While the qualitative findings are reported later under family dynamics, the data pertaining to family structures are introduced here.

Ten of the interviewees lived in domestic situations where their parents were separated. In each case the student, along with any siblings who had not completed schooling, lived with his or her mother. Degrees of contact with fathers varied from regular weekend visits to none at all. Three of these students, Renate, Greta and Jennifer, had chosen physical science subjects, while Greg and Tracy, had chosen biology. The remaining five, Malcolm, Richard, Sean, Madeline and Yvonne, had chosen no science subjects. When it is recalled that Jennifer(p) also originally chosen no science, the disproportionate representation among students taking no science becomes suggestive of an association between family structure, or family relationships, and science enrolment decisions, particularly given the different SPQ ratings across choice categories for students' reliance on the advice of their fathers. Although unexplored in the literature, this contrast was one of a number of findings which tentatively pointed to the quality of parent/child relationships as influential in science enrolment decisions. This feature was therefore explored in greater detail, and is discussed later with other aspects of family dynamics.

THE ATTITUDINAL DIMENSION OF STUDENTS' FAMILY WORLDS

The second dimension of the family to be explored was the underlying matrix of attitudes, aspirations, beliefs and values within students' family worlds. This dimension has been implicated as influencing students' aspirations (Marjoribanks 1979; 1987; 1990; Ninnes 1997b; Schulenberg, Vondracek & Crouter 1984) and attitudes to science (Osborne, Driver & Simon 1998; Simpson & Oliver 1990) and was therefore of particular interest to this study. Three aspects of this dimension emerged from the narratives as influencing, either directly or indirectly, students' enrolment deliberations. These were students' perceptions of parental attitudes to formal education, their perceptions of attitudes to science within the family and, in some cases woven through these attitudes, the cultural practices of NESB families.

Perceptions of Parental Attitudes to Formal Education

In the discussion concerning parents' occupations presented earlier, parental attitudes to education were implicated as possibly influencing students' science subject choices. This possibility was suggested by the comparatively higher proportion of physical science students whose parents were involved in formal education. Within this choice category, 10 of the 14 students had at least one parent involved in the education system, either as a teacher, lecturer or student. This finding prompted exploration of the interview narratives for aspects of parents' attitudes to education that could then be compared across the three choice categories.

The interview schedule sought students' perceptions of parental influence in their education in general (including extra-curricular interests such as music, language and sport) as well as parents' attitudes and aspirations, revealed via their involvement in subject deliberations. The data generated included references to attendance at school meetings, help with reading, homework or projects, participation in subject choice, personal encouragement, provision of educational resources and structuring of the homework environment, as well as indicators of the educational orientations of parents. Despite the abundance of data, however, few differences regarding overall parental involvement were apparent across choice categories. However, one perception clearly more prevalent among physical science students than those in the other categories was of a parental emphasis on the strategic qualities of senior schooling, in terms of maximising tertiary education opportunities. The differences and similarities in perceptions across choice categories are discussed below. While the discussion is concerned mainly with emergent patterns, the individuality of students' circumstances often required descriptions of illustrative cases.

Students choosing physical science subjects

Perceptions of parents as having a strong strategic orientation towards secondary schooling were revealed by 11 of the physical science students (79 per cent), in a variety of contexts. In the cases of James, Greta, Jennifer, Renate, Hannan and Roger, the context was a mother's regret for lost opportunities in her own education or occupational history. For example:

Greta(p): Well, she used to do pretty good in school before she left. She left before year 10. She didn't even get her School Certificate because she hated school.

Res: Right.

Greta: She couldn't stand it, so she left.

Res: How does she feel about that now?

Greta: I think she regrets it. I think she definitely regrets it now because she's got basically [pause] 'cause no one wants her, to do any work. She can't get work anywhere 'cause she's got no qualifications for anything good and, basically, she's too old. (282-286)

Jennifer(p): [Mum] missed out on going to uni herself because her Mum got sick. She actually got the entrance rank high enough to get into Veterinary Science but she couldn't, so she encourages me a lot to go to university. Res: Does she regret that, do you think?

Jennifer: Um, not so much regrets it, because she didn't have much of a choice, she had to look after her Mum ... But um, I think it's sad that she didn't have that opportunity to go. (319-321)

Roger(p): Um, Mum's always said that, um, 'cause she went through to Year 12 and she was sick of school and so she just went and did a secretary's course, 'cause everyone was doing that. And now, she sort of regrets that she's not in a very high paying job and she would have preferred to have continued with her studies and got a better job.

Res: And she sees a better job in terms of how much it pays? [from Roger's earlier comment]

Roger: Yeah. She says the more money you have, the more things you can do with your life. Like, 'cause we can't really afford to do much, 'cause we've got an overdraft and house payments and stuff. (495-497)

Consistent with Roger's perception of his mother's attitude is his own rating of high pay and benefits as 'very important' in terms of career characteristics (Q. 27). Furthermore, although he also had intrinsic reasons for choosing physical sciences, he was primarily motivated by the strategic qualities of these subjects (see Appendix K).

The regret which James' recognised in his mother's aspirations for her children was strongly linked to the family's Chinese background and experiences as immigrants:

James: [Mum's] the manager, the boss at the restaurant...but she always regrets ... I think it's the main reason ... 'cause she went to school till Year 6, in Hong Kong, and she had to stop and she really regrets it. 'Cause it's actually ... I don't know if you want to hear this ...

Res: Yes, go on.

James: When she came over, it was actually quite bad in Hong Kong when she came over ten years ago, and people over there perceived Australia to be really lucky, 'cause they've got all these social services ... so they came over, but it was actually a hard slog to get where they are now, so that's why they push us along in school. They came to [capital city] and found themselves jobs and had to work their way to getting their own business, and that's why I think they urge me and my brother along. (152)

According to Mak and Chan (1995, p. 86), many Chinese-Australian students regard high academic achievement and acceptance into prestigious tertiary courses as the principal ways of expressing filial piety and repaying such sacrifices. James' narrative contained many examples of how filial piety had influenced his educational decisions:

James(p): 'Cause that is my main aim, to get into uni, 'cause that's what Mum wants, so ... (113)

 \dots I've always asked her about school and all that \dots 'cause her opinion really is the only one I ask for. (144)

It might be recalled from Chapter Four (p. 83) that James had chosen physics because of its strategic value, and despite his lack of enthusiasm for the subject. This decision also reflected his deference to the wishes of his mother:

Res: Have you had any responses, positive or negative, from anyone because of your decision to take physics and chemistry? James: Yeah, Mum approved of it, because ... I told her the reason why and she just goes 'yeah, that's right, keep your choices open' (153-154)

The imperative among migrants to maximise educational opportunities is, however, by no means exclusive to students of Chinese background. Neither is it always accompanied by the cultural compulsion of filial obedience. Hannan(p), who fled with her parents to Australia from Iran, also felt a personal obligation to them to make the most of her school education:

Res: Okay, what do you like about school? Hannan: Um, first of all just the opportunity that I can learn ... because of what my parents went through especially. I know that there are so many people who don't have that opportunity, so I'm incredibly grateful. Res: Did they get a chance to ... what level of education did they get a chance to complete? Hannan: My mother completed uni, but they didn't give her her degree. Res: Right ... Hannan: Because of her religion [Baha'i, in a Shi'ite fundamentalist regime in revolutionary Iran] so, she went all the way and didn't get a degree. Res: What sort of a degree was it? Hannan: Physics. Res: Right. Okay. Hannan: And then my father completed, um, an Army/Air Force training and he was a pilot but then they sacked him, so ... they were fortunate to finish. But then their trouble came with the [pogrom against non-Muslims]. Res: And he was in the Air force there? Hannan: Yes. Res: So when did the tide turn against them and they thought 'we'd better get out of here'? When was that? Hannan: Well, it was, I think, about four years into the revolution and Dad heard from one of his friends about what the Army was going to do to him, his order of execution and everything. Res: Right. Hannan: And he wasn't supposed to know but he heard it. Res: Sure. Hannan: People in those days were just escaping. (23-39)

Hannan's sense of obligation extended to doing her best academically, and not wasting time in class (a criticism she made of some of her classmates), rather than in choosing particular subjects. However, while she maintained that there was no parental pressure on her to take physics and chemistry, her sense of obligation, combined with her perception of these subjects as having currency in terms of university options, influenced her final decision:

Res: Why did you decide to do physics? Hannan(p): Um, that was because it's a prerequisite to a lot of uni courses that I was looking at, and it also sounded quite interesting. I thought maybe my Mum could help me a little bit. Res: Which of those is the primary reason do you think? Hannan: The prerequisite. (202-205) Res: And why did you decide to do chemistry? Hannan: Because it's a recommended prerequisite. It's not compulsory, but a lot of [uni] courses say that it would help. (282-283)

This case, and others discussed in this chapter, illustrate that among some ESB and NESB students, there is a compulsion to maximise educational opportunities which is not necessarily based upon cultural practices, as in the case of James, but on the personal response of students to their parents' experiences. This distinction underscores both the

dynamic nature of culture and the dangers inherent in generalising about cultural values from similar actions in different cases.

Descriptions by Greta, Hannan, Jennifer and Renate, of their mothers' regrets for lost opportunities were accompanied by details of how these women responded to their situations by undertaking tertiary courses to improve their employment prospects:

Greta(*p*): Mum does a lot of TAFE [Institute of Technical and Further Education] stuff with science. She did Vet[erinary] nursing and at the moment she's doing an Applied Science course at uni.

Res: Oh right. So she's going up to [city] to study? [a return journey of 200km] Greta: Four days a week ... um, see she picked the course because it's got a better employment rate than anything else, it'll qualify her for lab work and sort of, like, doing wine testing and things like that. (263-265)

Jennifer(p): She's doing a TAFE course in computer applications and programs. Res: Oh right.

Jennifer: Um, she has some computer skills but she wants to update them. To improve her chances of getting a job. (514-516)

Renate(p): Like, she's at uni now. And she never got what she wanted, she went and got married young and all this. But she's actually setting out to do what she wants to do now [Bachelor of Teaching] ... She was actually working at [small country town] as a teacher's aid, ... and then the Principal there said, 'Look, you should really go to uni and do it [get tertiary qualifications] and get real money.' [laughs] And so she did. (237)

Hannan(p): Before the nursing degree, [Mum] was saying that it was hard to be qualified for something like that, but she'd worked in like, fish and chip shops and child care centres and things like that and you would say well, you know, it's a bit sad that she went through that time in uni [completing a physics degree in Iran] for nothing. But now she says that it's lovely to have a job where she's gone to uni (612) Res: Is she nursing here, locally?

Hannan: Yes. At the Hospital. Res: And she's happy with that?

Hannan: Yeah, loves it. (617-620)

In each case, the regret harboured by the mother regarding lost opportunities or unrealised potential was accompanied by action, signifying to the daughter that education is a valuable commodity which, through effort, can enable and empower. To this extent, the attitudes and responses of these women exemplified the extrinsic value of education. Students' perceptions of the strategic qualities parents attributed to higher education, and by association, to secondary schooling, served to influence them to maximise their own educational opportunities, with enrolment in physical science subjects being regarded as one way of achieving this. Of the six students discussed here, James, Roger, Renate and Jennifer made this association explicit. For example, Jennifer's reconsideration of her original decision to not take a science subject, and her subsequent enrolment in physics, occurred because, on reflection, she felt she was limiting her post-school options. The flow of her narrative linked this decision to her mother's own educational experience and current attempts to improve her prospects, as previously described:

Jennifer(p): But um, when I thought about it and realised I wanted some options, [Mum] said 'Yeah well, change back to a science and do that.' Um, I think overall she was in favour of leaving my options open instead of just having that one closed career [photojournalism], in case I change my mind. So, um, I figured I might as well do a science and leave my options open. (349)

While the actions of these women also demonstrated that formal education can be taken up later in life, descriptions of the sacrifices which they and their families made in order to accommodate mature age study made this option appear far less desirable than making the most of earlier educational opportunities. Greta's mother, for example, had to travel far, and was often late home from university lectures, while Greta, Jennifer and Renate were required to do much of the housework:

Res: Does that put much pressure on you, having your Mum as a full time student? Renate: It does, but it's not that bad. We pull our own weight around the house and ... if things get really bad, I'll buy the groceries for the week or something. (234-235)

It is important to note that, in each of the six cases discussed above, parental regret was revealed apropos of some more general discussion concerning motivation, and not as a result of direct questioning. This highlights the role that such an issue played, consciously or sub-consciously, in the decisions of these students.

The consideration of mothers' regrets in the enrolment deliberations of such a high proportion (43 per cent) of the physical science students was an unexpected finding. Little has been written specifically about parental regret in the context of educational aspirations (Brantlinger 1985; Laosa 1982), and nothing regarding the implications these would have for senior science enrolment. While Coleman (1988) highlighted the singular importance of mothers' college aspirations for their children, he did not speculate on the mechanics of this association. From the evidence presented here, the connection appears to be between students' awareness, through the limitations of their mothers' situations, of the strategic value of formal education, and recognition of the significance of particular subjects, including physical science subjects, in maximising this value. This conclusion is supported by students' own rationales for their choices. As shown in Chapter Four, although Jennifer, Renate, Roger and Hannan also had intrinsic reasons for their choices, their primary motivations were strategic. As for Greta and James, they did not like physics at all; for them it was a means to an end. Furthermore, all six students had taken 3 units of mathematics, a more demanding course generally chosen for extrinsic reasons (Ainley et al. 1994). The question of why, in each of these cases, only the mother's circumstances were linked to students' rationales is a more complex issue, involving differential relationships within the family. Hence, as is the case with many of the issues raised here, it is more appropriate to discuss this further in the section concerning family dynamics.

Students' awareness of their parents' conceptions of formal education as primarily strategic was not limited to the context of regret. The fathers of Melinda and Peter, for example, were completing university degrees part time, thereby providing examples not only of how they

valued education, but of the concept of present sacrifice for future benefit. The strong influence of these two fathers is described later in the chapter. The parents of Kelly and James made them aware of parental expectations by pointing to the academic success of older siblings. Michael's mother, a secondary maths/science teacher, advised him to take physical science subjects, even though his career preference was for law. When asked whether, given this preference, there was a need to take physics and chemistry he referred to her recommendation about 'keeping everything open' (87).

Sylvia chose high level (3 unit) mathematics and English courses, as well as physics and chemistry. Her awareness of the expectations of her parents, and their own educational achievements, was revealed in her rationale for choosing strategically useful subjects over others which she enjoyed more, such as biology, art and drama:

Sylvia(*p*): And if I'd chosen, say, drama [in which she had been involved for the previous six years] and Visual Arts, for example, I must admit that ... [pause] ... my parents were very studious themselves when they were young, I know that, in the maths and sciences, they did chemistry and 3 unit maths and, yeah, I've been like that all the way through high school, and they expect me to keep on doing that. (85)

Despite her personal misgivings about taking physics (p. 114), Sylvia's own orientation was consistent with her perception of her parents' attitude:

Sylvia(*p*): [Drama] was enjoyable, but it just wasn't going to get me anywhere (34) ... I feel I'm a career oriented person and I feel [choosing Drama or Visual Art] is throwing away a perfect opportunity ... I want to get good marks, good UAI, and good experience so that I can go on, and get a career. (85)

The extracts used in this section are representative of the narratives of 11 physical science students who saw their parents as valuing schooling, at least in the senior years, in terms of future orientation and strategic utility above intrinsic benefits. While the narratives of Charlie, Shane and Salma, who were not mentioned above, did not support this finding, neither were they discrepant cases. Rather, their narratives lacked sufficient data on this issue to enable valid conclusions to be drawn. While in Charlie's case it could be argued that his parents' refusal to buy a television on the grounds that it would interfere with his education, was sufficient evidence to include him in this group, this comment was not supported to the same extent by other, more direct, references to his parents' attitudes to education, as were those of the other students discussed above.

Students choosing biology/other science subjects

Perceptions that parents emphasised the strategic value of education were found among students in the other choice categories, but to a considerably lesser extent. Among the nine biology/other science students, only Uzlan, Greg, and Tracy provided indications that their parents held attitudes to education similar to those of parents of physical science students, above. For example:

Uzlan(b): My parents aren't putting any pressure on me, it's just that I know that they want me to go to university - they don't care how I get there, they just want me to go there. So I thought I'd better just go safe and pick the subjects that I'm

good at. (104) Res: What advice were you given about the biology? Uzlan: My sister said to do that, because its easy. (108-109)

However, as shown in Chapter Five, issues of self-efficacy among these students mitigated against the choice of physical science subjects. More common within this group was the portrayal of parents' attitudes as having an intrinsic orientation, often characterised by deference to the priorities of the student. For example:

Res: What about your Mum and Dad? Mark(b): I told them what I was doing and they just said 'well if that's what you want to do, then that's what you can do - just as long as you like it, and that. (58-59)

Beth(b): [Dad's] been saying, 'You've got to choose stuff that you like.' My Mum was saying 'It's up to you, you've got to be happy.' (76)

Phillip(b): My parents see it as my decision more than anything. What subjects and which way I want to go. All they can do is sort of tell me and show me what the course is about. (82)

Johnston and Spooner (1992, p. 47) referred to this as the 'as long as you're happy' syndrome, which they saw as being associated with lower parental aspirations than were found among students choosing physical science subjects. Findings from the present study, however, do not imply that the parents of biology/other science students were less involved in, or concerned about, the education of their children. Rather, these students described different parental values, which focused more on the intrinsic benefits of particular choices. The sentiments above also reflected the students' predominantly intrinsic rationales for the choice of biology/other science, as reported in Chapter Four. Thus, there was a degree of alignment between perceived parental attitudes and students' own rationales.

Students choosing no science subjects

Among those choosing no science subjects, Kate, Yvonne, Malcolm, Richard, Stefan, Daria and Michelle (50 per cent) gave indications that one or both of their parents conceptualised school education in a similar manner to parents of the majority of physical science students; that is, in terms of its strategic qualities. However, unlike the physical science students, alignment between parent and student orientations in all of these cases appeared to be complicated by other issues. In the cases of Kate, Yvonne, Malcolm and Richard, at issue was the quality of the relationship with the parent(s) who held this attitude. Kate, for example, spoke about the frustration she experienced in her subject deliberations because she saw her parents, both doctors, as trying to influence her to take subjects which would maximise her post-school options. Her response to this perception is shown in the following comment:

Kate(n): I make up my own mind, 'cause its my life. I have to be willing to like, work in whatever subjects I'm choosing. I'm not going to do something just 'cause Mum says 'Oh, you should do this.'

... I have no idea what I want to do. So I'm not going to do a science just because it might have some help in what I want to do later! (152)

Unlike most of the physical science students, Kate responded negatively to the perceived parental attitude, choosing nearly all of her subjects, including photography and personal development (PD/H/PE), for the intrinsic reasons of enjoyment and anticipated lower levels of stress. Although Kate also chose 3 unit maths, even this was not for the purpose of maximising post school options. Rather, she was conscious that her parents, peers and teachers would see her subject choices as being beneath her academic capabilities, and therefore chose the higher level math 'because otherwise people would think I'm really slack'. (64)

Similar conflicts between parent and student attitudes to education were apparent in the narratives of Yvonne(n), Malcolm(n) and Richard(n). The common theme was that of a parent having expectations that their son or daughter would choose particular subjects, generally high level maths and science, seen by the parent(s) as maximising tertiary options:

Malcolm: There were things [my mother] wanted me to do that I didn't do. Res: Such as?

Malcolm: Um ... she didn't want me to do Art, I don't think. She was pretty much against Art from the very beginning. And also, there're certain family scholarships, for people wishing to do medicine. And she [said] ... 'look, there's that opportunity there'. And so ... I never wanted to do medicine, and at the time I never wanted to do law, so that was never ... I mean, my mother, of course I'd discuss things with her, but in the end she really did not have much influence over me ... she's someone that I don't really seek advice from. (158-160)

The responses of Richard and Yvonne to their fathers' expectations were also complicated by problematic paternal relationships, or perceptions of dissonance between the attitudes of their fathers and mothers. The four cases presented a curious contrast with those of students choosing physical science subjects, in that of the 11 physical science students who saw their mother or father as promoting a strategic attitude to subject choice, all enjoyed close, supportive relationships with those parents. The effect of relationships on decisions was implicated by this contrast and is therefore discussed in greater detail in the section on family dynamics.

Stefan, Daria and Michelle had all achieved consistently high marks in science and enjoyed close, supportive relationships with parents who emphasised the strategic qualities of formal education. However, in each case other circumstances mitigated against the choice of senior science subjects. For Daria and Michelle, these reasons involved their sense of ethnic identity, and are therefore discussed later under this heading. Stefan's motivations were somewhat different. His parents had achieved at high levels in school, proceeded to tertiary science courses and then to science careers in industry. Stefan's parents encouraged him, with obvious success, to achieve at a high level and his father had encouraged him to take chemistry. Despite his personal interest and high achievement in science, Stefan felt that there was no need to leave any options open in the science field, since he had already decided against a career path in that direction. The key issue which influenced this decision is discussed in detail in the section on parental attitudes to science.

Apart from these three students, and Kate, Yvonne, Malcolm and Richard who were mentioned earlier, the parental attitudes to education described by the other students choosing no science subjects were less oriented towards the extrinsic qualities of subjects. Like a number of the biology/other students, they were encouraged, or in some cases, left, to make choices based upon their own inclinations. For example:

Res: Did your Mother give you much advice? Madeline: No, not really. The only thing she said was 'Well, do you want to do this?' She just thought, you know, it's my decision, I'm the one who has to learn them. (272-273)

Joanne: ... my parents sort of just said 'do whatever you want to'. (144) Res: Did you talk to your Dad at all about it? Is he living nearby? [parents are separated] Sean: Yeah, but I didn't really talk to him about it. Res: And what about your Mum, did you mention it to her, or ...? Sean: Yeah, but she didn't know much about it. (133-136)

As mentioned when discussing the biology/other students, this is not to say that parents of these students necessarily had more apathetic attitudes to their children's education. In fact, there were few differences across choice categories in students' descriptions of parental involvement in homework, extra-curricular educational activities or the provision of resources. Nevertheless, evidence of a parental emphasis on maximising post-school options was absent from the narratives of half the students in this choice category.

Summary of family attitudes to formal education

The following points can be made regarding students' perceptions of their parents attitudes to formal education. As anticipated from the literature (Fan & Chen 1999; Marjoribanks 1987; 1994), this high achieving group reported a generally high level of parental involvement in their education, with most indicators of involvement or aspirations being little different across choice categories. The most conspicuous difference between choice categories, however, was that a greater proportion of students choosing physical science subjects perceived their parents as emphasising the strategic value of senior schooling than did those choosing biology or other science. In this respect, students' descriptions of their parents' attitudes to education were often reflected in their own explanations, as revealed in Chapter Four. For example, most students' choosing physical science subjects provided strategic reasons for this decision, and also described a significant parent as emphasising the strategic value of education. A similar relationship was recognised by Wood and DeLaeter (1986), who found extrinsic attitudes in parents to be related to students' intentions to take physics. However, the present study reinforced the importance of parental attitudes to enrolment intentions by showing that the intrinsic reasons given by students choosing biology/other science also often reflected the attitudes of their parents to education. Furthermore, because this correspondence was found among a group of science proficient students, the study was able to demonstrate that the link between parental attitudes to education and students' enrolment decisions was not necessarily related to academic achievement.

The relationship between perceptions of parental attitudes to formal education, and students' own explanations for their decisions, can be interpreted in terms of cultural capital (Bourdieu

and Passeron 1977). While cultural capital is more commonly associated in the literature with educational qualifications and institutions (Grenfell & James 1999), it also includes the attitudes and dispositions of parents towards education (Collins & Thompson 1997). For example, the extrinsic and intrinsic orientations of parental attitudes to education described by physical science, and biology/other science students respectively, can be regarded as two forms of cultural capital. Bourdieu and Passeron (1997) argue that such dispositions are transferred from parents to children as part of a process of cultural reproduction. While the concept of cultural capital is usually evoked in the context of social class theory, and has been criticised by a number of writers as being too socially deterministic (Hatcher 1998; Hodkinson & Sparkes 1997; Jenkins 1982), it nevertheless has considerable merit in terms of explaining the correspondence between parents' attitudes (or at least, students' perceptions of these attitudes) and their children's' science enrolment decisions, particularly since different types of cultural capital have been implicated in other contexts involving students' decision making (Grenfell & James 1999; Hodkinson & Sparkes 1997).

Further evidence of the influence of cultural capital in students' decisions is introduced later in the chapter. However, the most interesting finding in this section was that half of the students choosing no senior science described parental attitudes to education similar to those depicted by physical science students. Indications were found in the narratives of the former group that other issues interfered with students' incorporation of their parents' attitudes. The most prominent of these issues was the quality of parent/child relationships, and the confounding influence that this had on alignment between students' decisions and parental expectations or aspirations. The influence of family relationships on enrolment decisions resonated with Coleman's (1988) emphasis on the importance in education of 'social capital' within the family. However, as social capital concerns family dynamics, its influence on the enrolment decisions of science proficient students, is developed later in the chapter.

Perceptions of Attitudes to Science within the Family

The interview schedule contained questions designed to elicit students' perceptions of the attitudes to science among family members. These questions addressed indicative characteristics of the world, such as the provision of science related resources, help with science homework, projects or hobbies, shared family experiences of science (e.g. discussions, bushwalking, watching documentaries or science related television programmes, subscribing to science based magazines, etc.). A strong positive engagement was regarded as indicating 'advocacy' or 'support' for science interests. Advocacy was seen as the promotion of generic science, deriving from a family member's own interest in and enthusiasm for science. Support, on the other hand, was encouragement of the student's school science which was not necessarily grounded in a personal enthusiasm for science. Though advocacy and support could each theoretically involve both school and extra-curricular science engagement, within the narratives advocacy tended to concern 'generic' science, while support unaccompanied by advocacy generally related to school science.

Students choosing physical science subjects

Of the fourteen physical science students, Michael, Hannan, Salma, Sylvia, Charlie, Peter, Kelly, Jennifer, Greta and Melinda (71 per cent) described examples of advocacy or support

for science by family members. The advocacy/support varied in terms of both the type of parental behaviour and its significance to the student. This last dimension was important in terms of appreciating the degree of influence parental attitudes to science had on students' decisions.

The most common way in which a child's science interests were encouraged was through the provision of science related resources by parents. Sylvia, Greta, Hannan, Jennifer, Charlie, and Salma all described scenarios where interest in generic science was advocated in this way. The resources included books, magazines, kits or other items encouraging scientific curiosity. For example:

Greta(p): When I was [younger] they had this whole series, like, 'How My Body Works' and so I had the whole series of that.
Res: Right.
Greta: 'Cause it was, like, really easy to understand.
Res: That they [mother and grandmother] bought for you?
Greta: Yeah. And, like, every week a new one would come out and for \$5, you got, like, a model. Yeah, and you got a bit of the body in each thing and you had to put together the model. And it was easy to understand and it was really interesting. (455-459)

Like Greta, Hannan responded positively to her mother's encouragement of interest in science:

Hannan(*p*): Um, my Mum bought me a science encyclopaedia set. Res: Yeah? Wow. Hannan: *And* I used to read it! [laughs self-deprecatingly] Res: When did she do that? Hannan: Um, Year 7, 8 maybe. (505-509)

The purchase of the science encyclopaedia was of particular significance to Hannan due to the limited financial resources of the family at that time (see p. 142). It is also noteworthy that her mother provided this resource, since Hannan portrays her mother as being very influential in her enthusiasm for, and continuation of, school science.

The provision of science related materials and knowledge by parents can also be seen as an endowment of cultural capital (Bourdieu & Passeron 1977), in the sense that these are assets that parents consider will enhance their child's general education and, hopefully, their schooling outcomes. Likewise, the language used by parents, and their attitudes towards science, are also forms of cultural capital which, if congruent with the language and attitudes of teachers, can benefit students in their education (Bernstein 1971; Collins & Thompson 1997). Ten of the physical science students (71 per cent) described the provision by parents of non-material cultural capital related to science. Salma, Sylvia, Melinda, Greta and Hannan, for example, recounted how their mothers or fathers would often discuss science related issues at home. Usually the discussions were in the context of a current media story, but in the cases of Sylvia, Greta and Hannan, they were often part of conversations concerning their parents' working day. For example, Hannan's mother had recently begun work as a nurse, and Hannan spoke of being fascinated by some of the more interesting cases in which her

mother was involved. Similarly, Greta was very interested in the university science course in which her mother was enrolled:

Greta(p): It's sort of, like, ... you sit down and have conversations about, like ... she comes home and I say, 'What did you do today?' and she says, 'Oh we cut this up and put it on a slide' and we talk about what she does in her class and I find it really, really interesting sometimes. (276)

For Sylvia, the interest in science she had shared with her father over a long time held a great deal of significance for her:

Sylvia(p): Right from when I was little I used to say things like 'Dad, why is the sky blue? Dad, why is this ... ?' And he, being a bit of a scientist himself, used to give me all the scientific explanations, and I used to enjoy it. I was never really aware of it at the time, it was just a natural thing that became a part of me. I'm not sure whether I was a curious child ... like on a five hour trip to the snow, for example, it used to be just me and him, and I used to ask about the stars in the sky, or asking about where he works, 'cause he works at the nuclear reactor. About splitting the atom, about nuclear medicine. Res: How old were you at this stage? Sylvia: Oh, that would have been about four years ago [age 10-11] And he used to give me [explanations that satisfied me] and I used to go 'oh yeah, wow!' That just made me go ... I've always gone 'wow' to the earth that we have around us. I find it amazing. Res: So, where do you think you may have got that 'wowness' from? Sylvia: Yeah, probably Dad, and ... yeah, Dad. Res: And can you think of anyone else who has encouraged you in science? Sylvia: No, he'd be the number one encourager [laughs]. Yeah. (118-124)

These extracts not only reveal shared interests in scientific ideas and processes, but also something about the tenor of the parent/child relationships. This emerged as a key issue and one revisited in the discussion on family dynamics.

Salma, Sylvia, Jennifer, Peter and Charlie noted incidents where parents had encouraged them to participate in scientific activities or clubs outside school. Though the contexts were quite different, the degree of encouragement was significant enough to be remembered years later. In one extract, Salma recalled her father showing her 'little bugs and leaves' (235) under his microscope. She also noted that he encouraged her curiosity about gadgets from an early age:

Salma: When the video or the stereo would break down, I'd try and open it, just to have a look, I wouldn't touch anything. Res: Were you encouraged to do that, or were you told 'get away from that'? Salma: No, encouraged, like, sometimes they'd open it up, and I'd just have a look in, to see what's in there. (226-229)

In Charlie's case, the involvement of his parents, who were both biochemists, was more formal. This extract begins with an explanation of his involvement in the 'Double Helix Club', a nationwide science forum for young people. Charlie had initially become involved through his friends when in primary school.

Charlie: Have you heard of the Double Helix Club? ... I'm part of the committee that runs things. We discuss what we can run, and either find someone to run it or run it ourselves.

Res: How did you become involved in that [organisational] side of things? Charlie: Through my parents. See, it was a committee of adults, but it got to that point when [they thought] I should help run things. Res: So, how did your parents get involved in it? Charlie: My Dad, when he took me to a few of these activities, and sort of started talking with the people who ran it, and there was a shortage of members for the committee, so he sort of volunteered. (197-201)

Peter's parents also encouraged him to join the Double Helix Club when he was in primary school. As noted in Chapter Six, there was, in the cases of Salma and Sylvia, a degree of congruence between their family and mass media worlds with regard to interest in science related documentaries. Again, however, this shared interest appeared to be dependent upon the quality of the parent/child relationship.

The extracts above provide insights into parental advocacy of science in general, and were not necessarily related to school science. However, in the cases of Michael and Salma, positive attitudes towards science by family members were directed more toward school science. For example, Michael's mother was a science teacher, and he acknowledged her help and encouragement with his science homework and assignments throughout secondary school. For Salma, her father's advocacy for science (described earlier) was complemented by the practical support she received from another quarter:

Res: Can you think of anyone outside of school who has encouraged you in learning or doing science? Salma: Probably my cousin [female, completing an honours degree in Materials Engineering]. Res: Is that the same one you were talking about before? [as influential in her decision to choose physics] Salma: Yes. Res: How did she encourage you? Salma: Um ... well if I have [physics] problems I'd ask her how to do them ... and, like, she'd get me to do them, and then most of the time they'd be right. And she'd say, 'yeah, you're pretty good at doing this'. (169-174)

The positive reinforcement recognised in this last line was important to Salma in terms of her self-confidence in physics. This recalls the conclusions from Chapter Four about the role of self-efficacy in science subject choice, particularly in the cases of female students.

The examples above illustrate the varying degrees to which science related cultural capital was seen as being provided by parents or others within the family. However, within the physical science choice category there were four students, James, Roger, Renate and Shane, who described family worlds in which there was no particular advocacy or support for science. Of these, James, the Chinese-Australian student introduced earlier in this chapter, was the only one to report a negative parental attitude to science. As noted previously, James' mother was the most influential person in his deliberations and he attributed the majority of his subject decisions to her wishes and expectations. However, he commented that she was less than enthusiastic about his choice of physical science subjects:

James: But, Mum ... see I actually told her I might want to do this, like, a science degree, and she goes, 'they're really boring, are you sure you can handle that?'. That's what she said, like research and testing this and that, and she said it would be really boring. (228)

From this and other extracts of James' narrative it became apparent that science was seen by his mother primarily as a school subject, though one which had currency in terms of increasing her son's tertiary options. Neither James nor his mother had any enthusiasm for science as an extracurricular interest, and James often used the term 'boring' when discussing his own attitude to it (see, for example, p. 127).

Shane, Renate and Roger were described family worlds which were unremarkable, or even poor, in terms of science related cultural capital. For instance:

Res: Can you think of anyone outside of school who has encouraged you in learning or doing science? Roger(p): Um, ... I don't think so. Res: For example, did anyone buy you books on science, or give you toys or kits? Roger: Uh, ... like the male relatives I have, they are, um, labourers and stuff, like my Dad's a bricklayer, and Mum's never really been any good at science. She's

never liked it. I don't really think I've really done anything outside of school. It's always been for courses and that. (326-329)

This lack of science related cultural capital was very interesting considering Roger's obvious enthusiasm for science. His decision to take physics, chemistry, engineering science and two aviation courses stood in stark contrast to the lack of specific encouragement in science interests from his parents, although he noted their strong support for his education in general. Likewise, although Renate and Shane enjoyed support for their education from within their families, neither could recall occasions or situations where they had been encouraged to take an interest in science. The irony was not lost on Renate, who 'loved science' and had enrolled in senior physics, chemistry and biology courses. As the following dialogue progressed Renate became more reflective and puzzled:

Renate(p): Mum's always encouraged me to do whatever I really wanted to do anyway.
Res: But not specifically science?
Renate: No, she's always known that I liked it anyway, so she thought it's fine.
Res: So has anyone bought you, for example, books on science, or helped you with science projects, anything like that ...?
Renate: [pause] ... No [quietly]. (124-128)
Res: Right, and what about when you were younger, any other books, like kidsaged books, on space, or the body, or dinosaurs, or any of those sort of things?
Renate: Not really, no.
Res: So, has school science really been your only contact with science?
Renate: [pause] Yeah, basically. (173-176)

In terms of the suggestion that enrolment in senior science may be influenced by the experiences of science within the home (Farenga & Joyce 1999; Woolnough 1994), these cases are unsupportive. Because of this they are important in underscoring the naiveté of assuming a simple and consistent alignment between the provision of science related cultural capital by families, and the enrolment decisions of students. It is shown later that the web of influences is far more complex than this.

Students choosing biology/other science subjects

Of the biology/other science students, Robert, Phillip, Beth and Greg (44 per cent) described family worlds rich in science related cultural capital. Perhaps the scenario most strongly demonstrating advocacy for science was that described by Phillip. His parents were very supportive of school science, and encouraged him to take senior biology. His father, in particular, was in a position to offer him a great deal of support:

Phillip(b): 'Cause both my parents had done biology all the way through, and my Dad was a teacher of biology [now Deputy Principal at Phillip's school] ... (98) Phillip: He's encouraged me to do a science. And I've always thought, we've all the resources there [at home] so why not ... and I've basically got a teacher at home that I can ask questions of, so why not!

Res: And has he encouraged you along the way, like with assignments and projects?

Phillip: Yeah, he's encouraged me. (118-120)

However, as well as support for his school science work, Phillip described ample evidence of family encouragement of scientific curiosity and the high value accorded science within his home. This included his shared viewing of science related television documentaries (see p. 128) and the provision of science toys/kits:

Phillip(b):... I've done a bit with electricity, with electric circuit boards and stuff. Res: OK, and where did you get those? Phillip: From my parents, just presents and stuff. (152-154)

Beth's description of her father as advocating an interest in science, below, was similar to that of Sylvia(*p*):

Beth(*b*): He'll, like, if we are going somewhere, he'll make comments about stuff, and he'll, like, relate it back to science. Like, he'll look at stuff and say, 'I wonder how they put that up there?' And start talking about these scientific terms, 'cause that's just the way he thinks.

Res: And are you interested when he says this?

Beth: Sometimes, but every now and then, a bit of it goes over my head. But he's sort of science-minded.

Res: Do you ever ask him about his work?

Beth: Oh, he's taken me around the steel works, where he works [as an electrical engineer], 'cause they built a new plant or something, he took me around and showed me around the whole thing. And was explaining it to me. (108-112)

Robert, who aspires to a career in the life sciences, spoke about the priority given school science by his parents. However, his mother also encouraged his long term interest in collecting and observing native fauna. The extract below was a prelude to a number of anecdotes involving his mother supporting, or averting disasters resulting from, this 'hobby':

Res: Can you think of anyone outside of school who has encouraged you in learning or doing science? Robert(*b*): Not really, just basically my parents. Res: Right, how did they encourage you? Robert: Like, when it comes to hard work, they wanted me to work hard at science as well as other subjects, but that was always, like, the main one. Like, if I had any trouble [in science] they were the first ones to help. Res: Right, and what about in primary school, did they encourage you then? Robert: I used to always catch and keep things, in my room or keep them where they should be, and they wouldn't mind me bringing home things and keeping them and seeing how I go with them. Res: 'Wouldn't mind' ? Does that mean they 'wouldn't mind' if you stopped doing it either? Robert: No, cause Mum, Mum especially got attached to all the things I brought home. (116-123)

These three narratives illustrated a high degree of parental advocacy for science, similar to that described by many students choosing physical sciences. This similarity prompted the question of why, if there is a connection between parental attitude to science and student choice, Phillip, Beth and Robert did not choose more science, including physical science subjects. In their rationales (see Chapter Four) all three referred to enjoyment of life science, self-efficacy and perceptions that biology/other students, at another level the three portrayed their parents as having attitudes to education that did not emphasis extrinsic qualities to the same extent as did the majority of parents of physical science students. This contrast provided support for the argument, proposed earlier, that students' impressions of their parents' aspirations and conceptions of education were influential in decisions about taking strategically valuable subjects.

Greg also felt that his father had encouraged an interest in science:

Greg(b): um ... I'm not sure of the timing of this, but my Dad, my real Dad, used to buy me kind of 'sciency' kinds of presents, things like that ... I remember I've got some kind of a science thing and you do all experiments with weather and plants and all that kind of stuff ...

Res: Right. How long ago was this? In primary school?

Greg: Probably in Year 6, I think I did that for a little while ... and I remember he used to get me these ... inventor's kits, and you could make like, rubber-band powered cars, and things like that. (234-236)

However, with the departure of his father from the family home when Greg was in Year 7, his interest in science waned. Though he was aware of his mother's interest in science, this certainly did little to encourage him to take physical science subjects:

Greg: Mum always tells me about how she did two sciences, and all this ... Res: Is that including biology? Greg: I don't think she did biology, I think she did physics and chemistry. And she was always telling me that she didn't like them, and she wishes that she did biology. (158-160)

Once again the influence of parent/child relationships is implicated in this student's attitude and consequent decision. Greg's case is explored further in the discussion on family dynamics.

The remaining biology/other science students, Theresa, Tracy, Uzlan, Mark and Bruno, could not recall any particular examples of advocacy or support for science, generally describing family worlds unremarkable, or poor, in terms of science related cultural capital. Uzlan, for example, noted the ambivalence of his parents towards biology when discussing his subject selections with them: Uzlan(*b*): They thought it was a good choice to do more commerce, economics, and those studies. Res: What did they think about the biology? Uzlan: Aw ... they didn't really care about that. (138-140)

The lack of advocacy for science was surprising in the case of Tracy, whose father was a metallurgist. However, as with Greg, a problematic relationship with her father appeared to have reduced his influence. This aspect of Tracy's story is also discussed later.

Students choosing no science subjects

Of the fourteen students not enrolling in senior science, only four, Stefan, Daria, Malcolm and Kate (29 per cent), described family worlds rich in science related cultural capital. In each of these cases, however, it was apparent that other issues complicated their subject deliberations. The descriptions and complications for each student are set out below.

Of the four, the narrative provided by Stefan indicated the strongest advocacy and support. His parents were industrial chemists, employed by a large pharmaceutical company in the capital city, and Stefan provided a litany of examples indicating the high value placed on science by them, for example:

Res: Can you think of anyone outside of school who has encouraged you in learning or doing science? Stefan(n): Um ... probably Mum and Dad, because they have the background knowledge. Dad helped me if I needed some help ... and I've got some books, like Dinosaurs and Space and that sort of thing. Res: Which your parents got for you? Stefan: Yeah. Res: Did you read them much? Stefan: Yeah (enthusiastically) I'm an avid reader. I read National Geographic, 'cause Dad has a subscription, he's got all of them since 1976, so I've got [all the issues] from '83 [Stefan's birth year] onwards. (119-124) Stefan: For my work experiences, Mum and Dad know a professor of telecommunications, electrical and computer engineering, and I did (work experience) there, and that was good as well. (157)

Stefan also enjoyed watching science documentaries on television (see Chapter Six), often with his mother. In terms of parental engagement with science and encouragement of these interests, Stefan's narrative had much in common with those of students choosing science, in particular Charlie(p), Sylvia(p) and Phillip(b). In the context of his parents' reaction to his decision to forgo senior science, Stefan also revealed his father's support for school science:

Stefan(n): Dad said that if I chose a science he'd help me ... my sister did chemistry and Dad helped her. (81)

From this evidence it would appear as though Stefan's parents had provided fertile ground for his development of a positive attitude towards science and, indeed, Stefan also provided many examples illustrating his personal interest in 'generic science'. However, his parents were involved in science on a day to day basis and all of Stefan's impressions were not necessarily positive. As revealed in Chapter Four, for example, Stefan's father had given him the impression that science careers were not well paid (p. 91). In addition, Stefan stated that his mother had recently resigned her job as a chemist to study other fields:

Stefan(n): Mum was in science, she worked at the same pharmaceutical company [as Dad]. She was a product developer, but now she's studying at uni, - ancient history, archaeology, anthro-paleontology - by correspondence. (196)

Thus, Stefan had received mixed signals concerning his parents' attitudes to science. On the one hand, science was seen by them, and him, as personally valuable and interesting. Yet, as a career it was not regarded by Stefan as an attractive option, particularly given his response to Question 27, where he nominated high pay and benefits as being important features of a prospective career. Stefan's career preference was for law. The influences on his decisions to forgo further science study in favour of law therefore corresponded closely to those which science teachers proposed in Chapter Four. However, of the fourteen students deciding against science enrolment, Stefan's was the only explanation to support the teachers' proposition.

Daria's father was an electronics technician running his own business. She spoke not only about his willingness to help with her school science, but his enthusiasm for scientific explanations of phenomena:

Daria(n): My Dad always likes to tell us information, and give us facts. Like, we were coming down from holidays, we got out of the car, and he had to show us all the stars, and he always does things like that. Like, if the waves break a certain way ... or when we go camping he teaches us where the rips are. Res: Did you enjoy that, when he stopped and showed you all the stars and things? Daria: Sometimes I do, sometimes I don't really care about it. Res: So he's been doing that for a number of years. Daria: Yeah, since I was born! (116-120)

This scenario is similar to those found in the narratives of Sylvia(p), Melinda(p) and Beth(b), all of whom perceived that science was clearly valued and advocated by their fathers. Consistent with this attitude, all four females felt positively about science, and had originally chosen at least one physical science subject. However, as detailed later in the section on cultural practices of NESB families, Daria's circumstances and personal values combined to influence her choice of a career path involving languages and business, rather than her original option of computing science.

Up until he was in Year 7, Malcolm's family world was one in which science was highly valued. Malcolm saw his father as an advocate for science, both in his career as an industrial designer and more generally. Malcolm spoke of looking through his father's 'New Scientist' magazines and the science books he'd been given, and of his interest in his fathers' designs for boats and airships. However, it appears that his father was the sole advocate of science within the family. His departure from the family home when Malcolm was 12 years old, as well as the subsequent physical, social and emotional distance between them, resulted in a general devaluing of science within his family, due to neglect. This shift clearly paralleled Malcolm's changing attitude to science, in which he regretted the loss of interest, but lacked the motivation to rekindle it:

Malcolm(*n*): It's difficult with science ... I'm still very interested in it, and I used to even get 'New Scientist' [magazine] and read that. I'm thinking of subscribing again, but ... um ... [long pause]. There's a possibility that ... um, no one else in my family, except my father, is really into science, and that was ... a thing there ... [voice trails off]. (230) Malcolm: ... there was an interest [in science], myself, that I tried to maintain. Res: What about when you had projects or such at home? Did anyone take a particular interest in your science projects? Malcolm: No. My mother's not much of a science person. (189-191)

This example emphasised the dynamic nature of families and their cultures, as well as how attitudes and values are tightly bound to the relationships within a given world. Malcolm's story is revisited when discussing family dynamics.

Kate's parents were both medical doctors, as were her grandfather and her uncle. She was aware of a number of science resources in her home, including books, computer games and science kits. She also noted that the topics of conversation around the dinner table were very often concerned with medical matters. The prevailing atmosphere was, as she described it, 'sciency' (335). However, Kate's story, like Malcolm's, was complicated by relationships within the family and Kate's own search for identity, both of which issues impacted on her subject choices. Her story, therefore, is also expanded upon later in the chapter.

Among the responses of the other ten students in this choice category there were no examples of positive family attitudes to science. There were no indications of overtly negative attitudes, either, though for Thomas there was a subtle message in his father's reaction to his initial decision to take chemistry. The context of the following extract is that Thomas' father was a high school music teacher. Over the course of the interview it became clear that Thomas had a very close relationship with him, sharing interests in sport, music and computing. Thomas was asked about his parents' reaction to his subject choices:

Thomas(*n*): Well originally they said, when I showed them my options [including 3 unit maths and chemistry], they looked at me and go, 'you're going to be busy, *extremely* busy!' My Dad did chemistry in his HSC, and he said it's a lot of work. And [later] when I told him I'm doing music instead [of chemistry], his eye's lit up! Res: What if you'd told him that you're doing, say, both physics and chemistry? Thomas: He would've hit the roof! (laughs) Res: Why? Thomas: It's so much work! (162-166)

The fact that this dialogue was in response to a question asking why Thomas had changed his mind makes it clear that the opinion of his father was consequential in his final decision. Once again, enmeshed within the perception of attitudes was the dynamic of the relationship.

Summary of family attitudes to science

It is apparent from the discussion above that a higher proportion of physical science students (71 per cent) described family worlds rich in science related cultural capital, compared with those taking biology/other science (44 per cent), or no science (29 per cent). While quantitative extrapolations are problematic in this sample, the contrasting proportions at least suggested the possibility that the provision of science related cultural capital by families were

associated with the enrolment decisions of science proficient students. Although associations have previously been found between parents' attitudes to science and those of their children (Aikenhead 1996; Costa 1994; George & Kaplan 1998), these relationships have not been extended to include high school enrolment decisions. Although the present study did not establish a quantitative association, the explorations of family attitudes to science provided unique insights into the different ways that science was conceptualised and valued within the families of science proficient students, as well as the responses of these students' to their perceptions. The narratives of students such as Sylvia(p), Salma(p), Greta(p) and Phillip(b), above, highlighted the links between their parents' attitudes and their own, and how these links were facilitated by the quality of the parent/child relationships. On the other hand, consistencies between decisions by Madeline, Sean and Joanne, for example, to forgo senior science, and the low levels of science related cultural capital they described in their family worlds, were also evidence of these links.

As with many of the findings so far, the decision to choose biology/other science was associated less strongly with aspects of the sociocultural domain explored in this thesis. It seems that the issue of self-efficacy, shown in Chapters Four and Five to be strongly associated with the choice of these subjects, was such a dominant influence that attitudes within the worlds had relatively little impact.

Perhaps the most interesting finding, however, concerned Malcolm, Kate, Stefan, and Daria, whose families provided abundant resources of science related cultural capital, including positive parental attitudes to science, but who decided to forgo further science study. These cases were not consistent with Costa's (1995) model in which family attitudes to science were reflected in students' responses. This inconsistency suggested that other issues can confound the influence of parental attitudes. In the cases of Malcolm(n) and Kate(n), the positive family attitudes towards science were found to be complicated by problematic relationships with the individuals who held these attitudes. The importance of family relationships, and social capital (Coleman 1988) in particular, to science enrolment decisions had not previously been examined, and provided a new direction for investigation, particularly in cases where students' choices were inconsistent with parents' values and expectations. The issue of social capital, and its influence on students' deliberations, is discussed later in the chapter. Before leaving the attitudinal dimension, however, it is important to revisit those decisions mentioned earlier as having been influenced by the cultural values and practices of particular NESB families.

Cultural Values and Practices of NESB Families

In discussing the deliberations of James(p) and Hannan(p), above, references were made to the influence of their families' ethnic backgrounds on their enrolment decisions. This study found that ethnically related cultural practices and values also played a part in the motivations of other students. However, there are a number of caveats associated with the observations made concerning ethnic backgrounds. First, the interview schedule was not constructed specifically to draw out issues related to ethnicity, but rather to address them as they arose in the course of the interviews. Hence, if influences relating to the cultural practices within a student's family did not emerge in their responses, the issue was not pursued. Second, it should be recognised that the family attitudes and values discussed in this section reflected the socioeconomic circumstances and personal experiences of the families, as well as heritage issues. Nevertheless, attempts were made, with reference to other research, to determine whether the experiences related by particular students were common among members of the ethnic groups to which they belonged. As Hartley (1995, p. 2) notes, 'it is both legitimate and meaningful to talk about the values underlying, for example, Filipino families, Chinese families [etc.] despite the diversity within these cultures.' As a consequence, this report should be seen as descriptive rather than prescriptive.

The interview participants identified as coming from NESB cultures included Hannan (Iranian-Australian), Salma (Lebanese-Australian), Uzlan (Turkish-Australian), Beth (Italian-Australian), Theresa (Spanish-Australian), Bruno (Italian-Australian), Daria (Italian-Australian) and Michelle (FYR Macedonian-Australian). The terminology used above (e.g. Lebanese-Australian), while admittedly somewhat awkward, was chosen because it recognised dual identity and because it was considered the best compromise among the variety of appellations used in the literature, all of which have their own subtle nuances (Hartley 1995).

In most of these cases, aspects of NESB cultures appeared to have no more influence on enrolment decisions than did aspects of the majority, Anglo-Australian, culture. However, language difficulties or unfamiliarity with the educational system were found to have influenced students' sourcing of advice. For example, Salma(p), Hannan(p), Uzlan(b) and Theresa(b) all consulted sources other than parents because they felt that their parents were not conversant with the mechanics and implications of subject choice. For example:

Theresa(*b*): Well ... [my mother] sort of left it to me to choose because, like, my parents don't really know much about, you know, what subject is better or not ... (116)

This was, however, an issue of familiarity with the system rather than simply one of ethnicity, with research showing that involvement by NESB parents tends to vary with a number of factors including length of residence in the country (Myhill, Herriman and Mulligan 1994; Ninnes 1997b). Furthermore, it is not an issue limited to parents from NESBs, since Madeline(n) and Robert(b), two ESB students, also acknowledged the limitations of their parents' understandings of the implications of subject choice.

Of greater relevance to this study were the narratives revealing that students' decisions about choosing science were explicitly influenced by aspects of their cultural backgrounds. The cases of James(p) and Hannan(p) illustrate how these aspects can influence students to enrol in physical science subjects. As noted earlier, James' deferred to the wishes of his mother in choosing subjects which would maximise his tertiary options. Compliance with the expectations of parents is common among Chinese-Australian students, where the primacy of the family is promoted as a fundamental cultural value characterised by respect for, and obedience to, parents (Mak & Chan 1995; Siann, Lightbody, Nicholson, Tait & Walsh 1998). James' respect for his parents was accompanied by recognition of the sacrifices they had made in building a life in a new country and providing a good education for their children.

The particular courses chosen by James, 3 unit mathematics, physics and chemistry, are commonly taken by Chinese-Australian students (Chan 1988; Fan 1996; Myhill, Herriman and Mulligan 1994) because they are associated with university entrance into the most prestigious courses and professions (Mak & Chan 1995). James' subject profile also favoured technical subjects rather than those demanding a thorough grasp of English, a decision influenced by his mother:

James(p): [In English classes] technically I'm supposed to be behind everyone else, because I'm Chinese, and, you know ... that's what Mum thinks, she always reminds me. (146)

This opinion reflected research showing that many Chinese migrant students use a bicultural adaptation strategy in subject choice (Sue, Zane & Lim 1984, in Mak & Chan 1995), capitalising on strengths and minimising exposure to English intensive subjects (Tobin & McRobbie 1996). In James' case the use of this strategy was interesting since he was born in Australia and it was apparent from the interview that he was articulate with a very good command of English. Nevertheless, it is clear from the extract above that it was his mother's perception, rather than his own, which held sway.

As noted in the case of Hannan(p), deference to the aspirations of parents is not limited to students of any one culture. Furthermore, students such as Renate(p), Greta(p), Roger(p) and Jennifer(p) demonstrated through their narratives that parental sacrifice or regret can affect the deliberations of students of all backgrounds. However, James' filial obligation to maximise educational opportunities, and his choice of subjects which are not English intensive, were typical of many Chinese-Australian students, a high proportion of whom also enrol in university science, medicine and engineering courses (Betts 1994; Smith 1996).

While the cases of James(p) and Hannan(p) illustrated how cultural values were influential in decisions to choose physical science subjects, the circumstances of Daria(n) and Michelle(n) illustrated how such values could also mitigate against such a choice. Both students recognised the advantages of coming from a NESB, and made choices which would utilise the opportunities afforded by this background. As an Italian-Australian, Daria appreciated the value of being bilingual:

Daria(n): Before I went to school, I did Italian school. And I did it for 9 years. And that really helped me right up to this year. And it's pretty easy. Like, my grandparents don't talk to me in English, so it helps me ... (64) My grandfather on my Mum's side, he's pretty smart. He can speak about five languages. (66)

Daria was forced by a clash between subject preferences to keenly consider her motivations. As noted in Chapter Four, this was not an uncommon situation, particularly for students choosing subjects for mainly intrinsic reasons (Whiteley & Porter 1998). Her original decision to take physics had to be reconsidered when she found that she would need to drop Italian in order to accommodate it. Though this situation highlighted structural difficulties in the process of subject choice, the fact that it was a forced choice also implicated values that, in this case, were informed by her sense of ethnic identity. For Daria, an emphasis on the value

of the family, the creation of interpersonal networks and the development of communication skills had been important features of her family and ones she now saw as priorities in terms of career options:

Daria(n): And if I get into uni, and after I finish it, I want to go to Italy. For a year. And you can do a language course there. And I want to do that because my cousins live in Rome. Res: And do you think that Italian will be helpful in your career, or anything in the future? Daria: Yes, 'cause um ... my Mum works in an accounting office, and that's what I want to do. And she says that they need translators, 'cause some of the people can't speak English. And I think that if I have a language background, it might help me. (103-105)

Daria valued the potential benefits inherent in her background above those she foresaw in taking physics. Furthermore, this impasse forced a decision in which Daria redirected her career preference away from Computing Science, her initial choice, to one incorporating her other interests of Italian and Business Studies. Hence, the decision was not only between two subjects but between two career pathways. While other considerations were involved in her deliberations, such as the potential for a higher UAI ranking from Italian on the one hand, and her enjoyment of physics on the other, in the end Daria chose the subject most congruent with her family's cultural values, in the process severing, or at least interrupting, her links with academic science study.

Michelle's situation illustrated how a combination of decision making dynamics and career role modelling within families can influence the decision to forgo science subjects. Michelle's parents and their siblings had emigrated from the Former Yugoslavian Republic of Macedonia (FYRM) and her extended family maintained close ties. The cultural dynamics of the family included an established forum for discussing and advising on future directions for the younger members of the family:

Michelle(n): Well, I relied on my parents, both of them, but maybe my father a bit more than my mother. And my uncles, 'cause their sons and daughters have gone through the HSC. Res: And your aunts? Michelle: Not really, they're sort of ... my uncles have their input, like ... "do this subject". Res: And is that how your family normally does things? Michelle: Yeah, it's a very close family. (75-78)

Though this patriarchal model of networking and decision making within the extended family is common among Yugoslav families (Tisay 1985), it is difficult to determine whether the outcome regarding subject choices was prescriptive or advisory. Certainly Michelle considered it to be the latter, though the advice of her father in particular was very influential:

Michelle(n): Like I was doing HSC Religion, but I changed, 'cause I was talking to Dad, and Dad goes, "I don't think that Religion's really, like, important, it's not going to get you anywhere, like, as in uni or a job. Res: And what did you think when he said that? Did you agree with that? Michelle: Yep. Like, he told me what he thought, and then I made my own decision. (87-89) As well as illustrating the degree of influence he had, this extract shows Michelle's father as valuing subjects for their strategic value. In terms of career options, Michelle discussed how she was influenced by the occupational directions common within her family world:

Michelle(*n*): ... all my family are accountants, so that's obviously a big direction thing for me. So I always think of doing that. They're merchant bankers. Res: What do you mean by 'family'? Michelle: My extended family ... my first cousins are all accountants, and my sister's becoming one as well. Some are here ... some are in London. (171-173)

The influence of the occupations of others within her family on Michelle's own career aspirations can be seen as consequential, given that within Macedonian and other Yugoslav migrant families 'each generation tends to develop a homogeneity in occupational and educational status and life-style' (Tisay 1985, p. 109). It is possible that Michelle's awareness of these occupational models, in concert with the collective family deliberations, influenced her career ideas and therefore her subject decisions. In discussing her career options, Michelle's orientation was towards family sanctioned areas such as business and accountancy, though she did also mention interior design. Regardless, it was clear that she had never pictured herself as pursuing a career involving science:

Michelle(n): My main thing is that I don't want to become anything to do with science. That's the thing.

Res: So you don't think it's going to be relevant to anything that you want to do? Michelle: Yeah, exactly.

Res: And when did you realise that you didn't want to do anything to do with science?

Michelle: ... like, I've always done Advanced [level] science and stuff, like, I enjoyed it while I was doing it, but I've never thought of having science as a career. (68-72)

This last phrase communicated clearly that a science-based career had never been part of her future self-image. Michelle's narrative involved threads of influence originating from relationships within the family, role modelling and conceptions of science, all of which are discussed elsewhere in this chapter. However, it was clear from the narrative that the first two of these issues relate to the particular cultural practices of Michelle's family, highlighting once again the influence of family culture on decisions concerning senior science.

This section has illustrated how cultural practices, values and a sense of ethnic identity influenced the deliberations of four of the students. Where physical science subjects were valued by parents for their status or strategic worth, and obligation to parents was strongly felt, students tended to choose those subjects. In the cases where non-science subjects or career pathways were valued above science by the family, and the student was influenced by this value system, these subjects or pathways were chosen in preference to science subjects. While such findings cannot be generalised to all minority culture students, or even other students with similar backgrounds to those discussed, the unique contribution these cases have made to the study is in articulating science enrolment decisions with the values, attitudes and relationship existing within their families.

Finally, the idea of exploring influences on the deliberations of NESB students originated from the results of quantitative studies (Ainley et al. 1994; Fullarton & Ainley 2000; Myhill, Herriman & Mulligan 1994) which isolated ethnicity as a factor correlating with particular patterns of subject choice. However, analysis of the narratives of James, Hannan, Daria and Michelle indicated that it is probably more salient to see these cases not in terms of ethnic heritage *per se*, but in terms of cultural values and practices common, but not exclusive, to groups with a particular ethnic heritage.

THE DYNAMICS OF STUDENTS' FAMILY WORLDS

Quite a number of the findings presented so far have pointed to the family relationships of science proficient students as having influenced their enrolment deliberations. The emergence of relationships as an issue prompted a more thorough exploration of family dynamics, as far as these could be discerned through the profiles and narratives of interview participants. The exploration of relationships shed new light on why, for example, science proficient students who described similar attitudes to education, or to science, within their families, made very different decisions regarding further science study.

A number of questions in the interview schedule sought to gain as much detail as possible about those family members whom students regarded as having the greatest capacity to influence their decisions. Due to the semi-structured interview format, in which students were encouraged to expand on their responses, these questions generated a large amount of data concerning perceptions of their families in general, and their parents in particular. Because patterns found in the family dynamics were thematic, rather than obviously associated with particular choice categories, the discussion in this section is structured according to the nature of the relationships.

Students' Relationships with their Fathers

Father/child relationships are multidimensional (Bradley & Corwyn 2000), and attempting to tease out those dimensions most relevant to students' decisions was difficult. However, the issue which emerged as having the greatest influence on students' deliberations could best be identified as the amount of social capital (Coleman 1988, 1990) students described as existing in their relationships with their fathers. To a large extent, the resources of social capital in these relationships were built up through the socioemotional investment (Bradley & Corwyn 2000) of fathers in their children, not only with regard to schooling, but in their interests and overall long term development. The many and varied examples of this investment, and its consequences for the enrolment decision of science proficient students, are detailed below.

The most common example of this socioemotional investment was in the level of paternal involvement in the child's education and interests. Peter(p), Charlie(p), Beth(b), Robert(b), Daria(n), Michelle(n) and Stefan(n) all reported a high level of paternal involvement in their activities, generally from an early age. Examples of this involvement ranged from Peter's introduction to reading, to the investment by Daria's father in her soccer interests:

Peter(*p*): [My Dad] encouraged me to read when I was young. He introduced me to 'The Hobbit' first, then 'Lord of the Rings'. When I was a little kid I really enjoyed that. It got me to read. Res: Did you read that yourself, or did your Dad read it to you? Peter: He read it to me. When I was about 7 years old, - each night, to me and my brothers. (61-63)

Daria(n): My brother has been playing for about six years, and I used to go and watch him. I liked playing soccer and I just said to my Dad that I wanted to play, but there was no local team. (31)

... Res: And what did your Dad say when you said you wanted to play soccer? Daria: Oh, he was really, ... he went and asked the club, and got them to organise and register a team and he found a coach, 'cause he was going to do it, but he just started his own business, so he couldn't. And he got my Mum to be the manager, and he helped [set it up]. (34-35)

Melinda(p), Sylvia(p), Charlie(p), Mark(b), Beth(b), Daria(n) and Thomas(n), all made references to activities, interests or hobbies they shared with their fathers. For the most part these took the form of recreational activities, such as the interest in computers and digital music composition shared by Thomas(n) and his father, and the regular skiing trips mentioned earlier by Sylvia(p).

With regard to education, Robert(*b*), Phillip(*b*), Daria(*n*), Stefan(*n*) and Beth(*b*) described their fathers' involvement in their schooling, including help with homework and attendance at school functions. Other indicators of support included the positive contributions, reported earlier, which Melinda(*p*), Sylvia(*p*), Beth(*b*), Phillip(*b*) and Michelle(*n*) felt their fathers had made regarding their subject deliberations. However, the recollection of such episodes addressed only one facet of the father/child dynamic. Further indicators of relationships rich in social capital were found in the language students used when discussing their fathers. Intimations of respect and trust were useful in gauging the reliance which students placed on their fathers' advice. Melinda(*p*), Sylvia(*p*), Phillip(*b*) and Michelle(*n*) expressed this trust explicitly:

Melinda(*p*): [Dad's] pretty good, he knows what he's talking about. Res: So you rely on him? Melinda: Yeah ... he's pretty knowledgeable Res: Do you think he's got a very good idea of your capabilities? Melinda: Yeah. I trust him . Res: Is there anyone else you'd trust with that sort of advice? Melinda: Not really. (102-108)

More often, however, the respect and trust were implied in the sub-text: the facial expressions which accompanied the responses, and the number of times students mentioned their fathers in a positive context. Sometimes this respect was accompanied by, or implied in, expressions of admiration for some quality a student recognised in his or her father. Melinda(p) and Sylvia(p) were impressed by the extent of their fathers' knowledge, while Phillip(b) expressed admiration for his father's patience during Phillip's reckless junior years. Daria(n) admired her father's business acumen, and Michelle(n) was appreciative of her father's efforts in helping her sister gain entry to university, and for the interest he had shown in her own education.

Melinda(p), Sylvia(p), Daria(n) and George(n) saw their fathers as career role models, to the extent that they each expressed an interest in pursuing similar career paths. Furthermore, Thomas(n), Peter(p), Melinda(p) and George(n) recognised that their fathers would be pleased with particular subjects they'd chosen. For example:

Peter(p): I don't really like English that much. But I decided to push myself and go for Related [Related English being the higher level course]. And my Dad was happy that I did Related English, 'cause he's done a few degrees in English. (215)

Individually, each extract may signify little. However, collectively they build a more comprehensive picture of the tenor of the relationship between a particular student and his or her father. While there was not enough evidence to make conclusions about the quality of father/child relationships for all of these students, there was enough to argue that high levels of social capital were described by one third of the interview participants, namely, Melinda(p), Charlie(p), Sylvia(p), Peter(p), Roger(p), Phillip(b), Beth(b), Daria(n), Stefan(n), Michelle(n), Thomas(n) and George(n).

The narratives of 14 other students (38 per cent) contrasted with those above due to the low levels of social capital they described as inhering in their relationships with their fathers. In some cases this was because no socioemotional investment had been made at all, while in others father/child relationships did not extend to involvement in schooling, sports or other interests. The parents of ten of these students were separated, and in all of these cases the children resided with their mothers. As reported earlier in this chapter, degrees of contact with fathers varied from regular weekend visits to none at all. Probing around this issue was sensitive to cues from each student about how comfortable they were in discussing relationships with their fathers.

The most common indicator of little socioemotional investment by fathers was the lack of involvement in their children's educational or recreational activities. On the basis of their descriptions, this was the case for Greta(p), Jennifer(p), Renate(p), Michael(p), Greg(b), Tracy(b), Madeline(n), Malcolm(n), Kate(n), Joanne(n) and Richard(n). Some indications were merely suggestive:

Res: Okay, was there anyone else other than your Mum who encouraged you in sports? Madeline(n): Um, no. It was mainly Mum, and Dad just went along with what Mum said. (73-74) Res: And what about your Dad? Did he show any interest in your [subject choices]? Madeline: No. [abrupt ... unwilling to expand on answer] (411-412)

However, other responses were unequivocal;

Res: Did your father have any input into your subject choices? Renate(p): He's in Antarctica. [laughs, ironically] He never emails us, we don't get birthday presents or Christmas presents. We have no contact with him whatsoever, really. Res: So, would it have mattered whether he was in Antarctica or not? Renate: Not really, no. I wouldn't have asked him. He doesn't really have much of an input into my life at all. (94-97) Four male students, Malcolm(n), Greg(b), Richard(n) and Sean(n), had fathers who had left the family home. The narratives of these students contained references to activities which they had shared with their fathers before the separation. In all cases, these earlier vignettes presented a stark contrast to the lack of involvement and intimacy which characterised their current relationships. Malcolm's story of the science interest he shared with his father, and its subsequent decline through neglect, has already been told above (p. 156). Greg's story was similar, in that the interest in science he shared with his father waned in the years following his fathers' move to England:

Greg(*b*): My real father, he was living over here when I was in Year 7. [Note: Year 7 was Greg's 'best' year in school science]. While he was over here ... he was a marine biologist, and I used to go to his work with him. He specialised in anemones and we used to go down the beach, and watch them and collect things. Res: Was that here? Greg: No. We lived in [nearby coastal town], but me and my Dad used to do this at [city], at the University, and we used to collect things to feed to the anemones, and ... I remember we used to cut them up, cut up anemones, and put them into this paste, like, jelly thing, and see what kind of patterns they made, and that. So I thought that was pretty good. (152-154)

Greg's levels of interest and achievement in school science also declined after Year 7, and it was only the recent external pressure of the School Certificate exams which motivated him to work hard enough in science to achieve his good result.

Sean's(n) father had lived away from the family home for five years, during which time Sean lived with his mother. Sean's responses were self-conscious, and he appeared directionless in terms of his post-school ideas, though he had vague notions of doing art or graphic design. He had not talked to his father about his subject or artistic career preferences, despite his father being a painter and sculptor, and did not think that his father would know about his subject choices.

Richard's(n) parents had been separated since he was in early secondary school. He was close to his mother and spoke of his father as being less supportive of his interests in drama and his aspirations to be a stage or screen entertainer, preferring instead for Richard to pursue a more conventional career path. Richard's father was not a role model for him, and Richard referred to some history of disagreement between them, about which he was unwilling to elaborate:

Res: OK. And did you talk to your father at all about your subject choices? Richard(n): No, I did that ... I chose my subjects ... without him knowing what I chose [laughs]. Res: Does he know what you're doing? Richard: No ... we've had a little bit of a disagreement, so ... [long pause] (119-122)

These four cases had much in common. The fathers appeared to have made little socioemotional investment in their son's adolescence, in terms of role modelling or support. In the cases of Malcolm and Greg, the link between the father/son relationships and decline of interest in science was most apparent, even to them. Further discussion regarding links

between the quality of particular relationships, and decisions about science enrolment, is conducted later in the chapter.

With regard to students' subject deliberations, while Michael(p), Tracy(b), Fiona(n), Madeline(n) and Kate(n) saw their fathers as having had very little input into the process, the fathers of Renate(p), Greta(p), Greg(b), Joanne(n), Sean(n), Malcolm(n), Fiona(n), Richard(n) and Madeline(n) had no involvement at all:

Joanne(n): Um ... I always sort of rely on my Mum. My Mum, she's like academic, and my Dad's not, really ... (84) Res: ... What did he think about your subject choices? Joanne: Oh, he really doesn't ... it doesn't mean anything to him. (97-98)

Although Yvonne(n) acknowledged her father's involvement in her subject deliberations, his influence was not necessarily seen as supportive:

Yvonne(n): 3 unit maths wasn't really my choice, 'cause my father's actually a maths teacher, here ...
Res: At this school?
Yvonne: Yes. So, there wasn't really much of a choice with the 3 unit maths.
Res: Why do you say that?
Yvonne: Oh ... there wasn't even a discussion at all, really. It was just, sort of, ... *known* ... that he just, sort of, said that I was going to do 3 unit maths. And I could tell by the way he said it, there was, sort of, no conversation about it. (74-77)
[revisiting the issue of 3 unit maths] ... Res: How do you feel about that now?
Yvonne: I don't like it. At all.
Res: Are you able to talk to your Dad about it?
Yvonne: Um ... not really.
Res: Is your Mum able to help with this?
Yvonne: No, because she knows that my Dad is very forceful and ... more discipline ... (228-233)

Just as the non-verbal expression accompanying the responses of some students communicated respect or fondness for their fathers, the body language and sub-textual hints in other interviews suggested students were uncomfortable talking about their fathers. This discomfort manifested itself in curt or guarded replies (Madeline(n), Tracy(b), Sean(n)), averting the eyes or looking downwards (Greta(p), Michael(p), Malcolm(n)) long pauses (Richard(n), Greg(b), Malcolm(n)), dismissive tones (Renate(p), Kate(n)) or a degree of sadness in the tenor of the responses (Greg(b), Malcolm(n), Richard(n), Sean(n)). Impressions about relationships were also informed by what was missing from the narratives when compared with those portraying positive relationships. For example, there were no references within these narratives to admirable qualities, trust or respect.

None of the students discussed above aspired to career paths taken by their fathers. In some cases, the tone of responses to questions about their fathers' interests or careers revealed as much about the relationships as it did about students' aspirations:

Res: Okay. And what's your Father doing? Madeline(*n*): An electrical engineer, or something like that. Res: That's something that involves science isn't it? Madeline: Mmm, probably [laughs at irony]. Res: Do you have much of an interest in what he does for a career? Madeline: No, not really. (641-646)

Tracy(b): My father's a metallurgist.
Res: That's a scientific sort of a career, isn't it?
Tracy: I'm not sure.
Res; Has he ever tried to get you involved in that side of things?
Tracy: Nup. [very curt]
Res: Did you ever take much of an interest in the sort of work that he was doing?
Tracy: No [again abrupt. Tracy does not appear comfortable talking about her father] (192-198)

While the nature of Madeline's and Tracy's problematic relationships with their fathers was not revealed, it was clear that neither father was seen as a career role model. Given that similar proportions of students in each choice category had parents involved in science related careers, the cases of Madeline(n), Tracy(n), Greg(n) and Malcolm(n) provided an interesting contrast with those of Melinda(p) and Sylvia(p), for example, who aspired to science career paths similar to those of their fathers.

The influence of parents on the career aspirations of their children has previously been recognised by Moffat et al. (1992, p. 16), who found that 'students who expressed interest in science careers could name a specific adult role model who sparked an interest in science for them.' It is not unreasonable to assume, given the historical male dominance of most science courses and careers, that fathers are more likely than mothers to be potential science career role models for their children. Indeed, this assumption was borne out by students' narratives, and by the fact that two thirds of parents described as having science related occupations were fathers (see Appendix L). Thus, students who have little physical or emotional contact with their fathers have less opportunity to develop role model relationships which might stimulate interest in science careers. Given the lack of science career orientation in school science classes shown in Chapter Five, and the dearth of evocative science career models in the mass media, the absence of a potential science career model in some families may be consequential in terms of students' aspirations. This possibility, which has not previously been raised in the literature, is discussed further in the final chapter.

The final case presented here is Kate(n). Her relationship with her parents was alluded to earlier (p. 145) when discussing their influence on her subject choices. Since Kate did not often distinguish between her parents in her responses, the discussion here concerns her mother as much as her father. Kate's relationship with her parents was complex, and her narratives contained many references to the distance that existed, and which to some extent she maintained, between herself and her parents. Her story was one of vacillating between wanting attention and recognition from her parents, and distancing herself from their expectations. This was illustrated by several examples from her narrative, including the mixed response to her parents missing her soccer carnival the previous weekend. While Kate maintained that she 'wouldn't have wanted them there anyway, 'cause like, soccer's a thing that I do, and it's a chance to get away from my family' (48), it was apparent from her manner, and other comments, that she would have liked them to have seen her win the final.

The key to understanding Kate's reluctance to comply with the perceived aspirations of her parents, and, perhaps, to appreciating the nature of her relationship with them, was revealed in the following extract. Kate was asked whether she had ever considered a career path involving science. She responded strongly:

Kate(*n*): Definitely not! Res: What about when you were younger, say in primary school. Did you ever want to be, say, a doctor or a nurse or a ... paleontologist? Kate: I do not want to be a doctor! My parents are both doctors, so there is no way that I'm going to be a doctor. Res: And that has turned you off doing anything to do with medicine? Kate: Yes [definitely]. Res: Why is that? Kate: Because ... they talk about it all the time at the dinner table! And everyone else is like, 'So, are you going to carry on the family tradition and be a doctor?' Res: Is there a tradition? Kate: Yeah, my grandfather is a doctor as well. And my Dad's brother is a doctor as well. And it's like a very 'sciency' type thing, and you have to get really, really good marks to, like, study medicine. Res: Have you felt that there was pressure on you to do medicine? Kate: [hesitation] No ... Res: In being very 'sciency', as you put it, have they encouraged you to do science? Kate: They know I'm very stubborn [laughs]. And I'm not going to change my mind. (327-339)

The vehemence of Kate's expression underscored the emotions tied to her response. The question was couched in very general terms, yet her immediate response indicated just how sensitive she was to these issues. First, there was a clear and strong rejection of the idea of a science related career. This rejection appears to have had more to do with the personal relationships within the family, and Kate's search for identity, than with a dislike of science, though this may also have been a factor. Despite her claim that there was no pressure for her to do medicine, it was apparent from the earlier reference to family tradition that she did indeed feel some expectation. Her decision not to take science was attributable to a combination of issues, including a lack of confidence in her own ability, and an attempt to make a decision which would mark her as an individual in her family. Both these issues again highlight the role of family relationships in influencing students' decisions.

In summarising the findings regarding science proficient students' relationships with their fathers, levels of social capital described in these relationships ranged from very high, to none at all. In addition to the students discussed above, eleven others (30 per cent) provided little indication of the tenor of relationships with their fathers, or of the degree of support provided, because they were less forthcoming than others in discussing their fathers. While in some of these cases (e.g. Robert(*b*), Theresa(*b*), James(*p*), Salma(*p*)) there were single indications of the quality of relationship, these were not regarded as providing sufficient evidence to identify levels of paternal support.

In terms of the influence of relationships with fathers on students' enrolment decisions, individual cases demonstrated the importance of role model relationships and shared science interests in shaping the attitudes of these students towards science. However, in terms of

patterns across choice categories, there was little to indicate any association between the quality of father/child relationships and the enrolment decisions of science proficient students. As shown later in this chapter, however, an understanding of these relationships led to more profound conclusions linking social capital to students' decisions about senior science.

Students' Relationships with their Mothers

In contrast to the findings regarding relationships with fathers, only the narratives of Kate and Malcolm provided indications of problematic relationships with mothers, and no student described a lack of socioemotional investment by his or her mother. In fact, the narratives of 22 students (60 per cent) described maternal relationships rich in social capital. This finding is in accord with the SPQ results, reported in Chapter Four, showing that science proficient students tended to rely more on the subject advice of their mothers than on any other source. The remaining narratives did not provide sufficient indications for judgements to be made about the quality of mother/child relationships.

Indications about social capital came primarily from descriptions of mothers' support for the educational and recreational activities of sons and daughters. James (p), Kelly(p), Greta(p), Hannan(p), Jennifer(p), Beth(b), Greg(b), Theresa(b), Helen(n), Madeline(n), Richard(n), Michelle(n) and Stefan(n), all provided explicit and varying examples of such support. For example:

Richard(n): Res: Does anyone encourage you in your entertaining pursuits? Richard: Yes, in particular my Mum, sure ... Res: How does your Mum encourage you? Richard: Oh, she ... it's encouragement. Like, she'll tell me exactly what's happening, like if there's a competition coming up, and [say] 'you should go in it'. (54-57)

With regard to subject deliberations, James(p), Roger(p), Peter(p), Michael(p), Tracy(b), Greg(b), Joanne(n), Fiona(n) and Stefan(n) specifically acknowledged the advice and support they had received from their mothers. For example;

Res: Why was your Mum's advice important to you? Roger(p): Um, well she'd been through it, she's been through a similar thing before. I sort of asked about her experiences, and talked about what I'd select, 'cause it was hard 'cause some things I wanted to do wouldn't line up with other things, so I had to drop things. So I just talked about it with her and that. (222-223)

For many students, the frequency and context of their references to their mother were themselves important indicators of the quality of the relationship. Respect and trust were apparent in the narratives of James(p), Roger(p), Hannan(p), Jennifer(p), Greta(p), Renate(p), Robert(b), Phillip(b), Theresa(b), Joanne(n), Madeline(n), Richard(n), and Yvonne(n). For example:

James(p): Because, in the family, out of my Dad and her, and my brother, Mum would probably be the most knowledgeable. Mum knows, she's been there, and she knows what she's talking about, and I've always asked her about school and all that ... Res: And she hasn't steered you wrong yet?

James: Hopefully not (laughs) ... I trust her. (96-98)

Many students also referred to the strength of the bonds they shared with their mothers. For instance:

Greta(*p*): It's just, sort of like, I've got a big connection with Mum ... (274)

Jennifer(p): Oh, well my Mum's just who I talk to the most about anything and she just tries to help me. (317)

Res: And your Mum, have you found her to give reliable advice? Theresa(b): Yep. She hasn't given me bad advice yet! (127-128)

Richard(n): I do go to her with problems and things like that. We've got a close relationship \dots (116)

Roger(p): I have a close relationship with my Mum, so she just helped me with everything. (229)

Renate(p): ... she has a lot of influence on my life. I don't usually admit that, but she does. (100)

Three accounts of close relationships were remarkable due to their similar contexts, and the links between the mother/child relationships and decisions to choose physical science subjects. These accounts were described by Greta(p), Renate(p) and Jennifer(p). The commonalities in circumstance were numerous. First, as noted earlier, in each case the parents were separated and the father had no involvement with the daughter at all. Jennifer referred to her father as 'abusive' (128), while Renate spoke of the animosity between her father and the rest of her family. Greta had no memory of her father at all:

Greta(p): I don't know much about ... anything ... [regarding her mother's relationship with her father] ... well, I sort of know bits and pieces but I'm not really clear on anything 'cause, like, we never really talk about, like, anything back then ... (536)

Second, as indicated above, all three students enjoyed very close relationships with their mothers. Third, as was noted when discussing attitudes to education (p. 139) these students were aware that their mothers harboured regrets about not having had, or not having taken up, the best options when they left school. Fourth, and related to the previous point, the mothers of Greta, Renate and Jennifer were all undertaking tertiary courses in science, science teaching and computing respectively, at the time of the interviews. Finally, the students shared their mothers' interest in these courses. Greta and Renate, in particular, knew a good deal about the science course work which their mothers were undertaking, and had read some of their university course texts. Renate had even helped with her mother's university science assignments.

In addition to being very supportive of their daughters, these women stood as examples, emphasising by their past circumstances and present efforts the importance of formal education in maximising life opportunities. As such, they exemplified the strong, single mother role model which other research (Hunt & Hunt 1977) has found often contributes to female achievement in science. The role modelling apparent in these cases was also consistent with the students' rationales for taking science. All three students revealed that it was primarily the strategic qualities of physical science subjects, supported by a personal interest in general science, which influenced them to take these subjects. The influence of role-models, for females at least, was emphasised by Johnston and Spooner (1992) as being important in the choice of physical science and maths subjects. Furthermore, other studies (Hjelle & Busch 1996; Seligman 1991) have shown that children often model the optimism or pessimism of the primary care-giver, usually their mother. In recognising the clear role modelling dynamics in these three cases, the influence of role modelling by family members became more apparent within other relationships discussed earlier, for example, the cases of Hannan(p), Salma(p), Phillip(b), Sylvia(p) and Melinda(p).

The levels of social capital in maternal relationships could not be established for all students. While in most cases there were indications of a positive or supportive relationship, and no reason not to believe that such a relationship existed, these indications were not considered conclusive enough to allow a confident determination. Furthermore, despite evidence of the influence of mothers on enrolment decisions in individual cases, no patterns were apparent across choice categories.

Students' Relationships with Other Family Members

Although parents were generally the most significant and influential family members in the lives of the interview participants, particularly in the context of educational support, there were two cases in which other family members were attributed this role. Salma(p) maintained early in her interview that she sought no specific subject advice from her parents because of their unfamiliarity with the implications of particular choices. Instead, she was supported, in both her educational decisions and her school work, by her brother and by her female cousin, who was completing an honours degree in materials engineering (p. 151). This cousin was cast by Salma as a role model due to her encouragement, knowledge and career aspirations. The fact that Salma felt she could rely on the help of her cousin, and to a lesser extent, her brother, with regard to senior physics influenced her decision to take this subject.

As noted in Chapter Four, Kelly(p) was influenced to take physics by her brother. Kelly saw her brothers' progress in senior maths, physics and chemistry as a litmus test, and her close relationship with him encouraged her to rely upon his advice:

Res: Why did you chose 3 unit maths? Kelly(*p*): 'Cause ... I don't know, my brother did it. Res: And you're doing physics as well. Why did you decided to do physics? Kelly: Um, my brother did it this year and he did really well at it and I sort of do the same things as he does. (62-65) ... Res: So, your brother's opinion, why is that so important to you? Kelly: Um, ...'cause I'm pretty close to him. We've basically done the same electives in Years 9 and10, and we have the same ability, I like the things he likes. (78-79)

While other students, Uzlan(b), Tracy(b), Michelle(n), and Mark(b), also referred the advice of other family members, only in the two cases above were the quality of the relationships revealed as having strongly influenced students' subject decisions.

THE INTERACTION OF INFLUENCES WITHIN FAMILY WORLDS

To this point, three characteristics of family worlds have been implicated in the enrolment deliberations of some science proficient students. These were their perceptions of parental attitudes to formal education, the resources of science related cultural capital they described in their families, and the levels of social capital which they perceived as inhering in their family relationships. In attempting to make sense of the tentative relationship found between parents' attitudes to education and science, and decisions about taking senior science courses, the importance of social capital in this context was revealed.

Figure 7.3 identifies the science proficient students who described each of these characteristics, and the family members to whom these descriptions applied. Set 'A' includes those students who saw their parents as emphasising the strategic value of high school education. Set 'B' lists the students who described the provision of science related cultural capital by particular family members. Set 'C' includes the students' whose narratives indicated that they enjoyed family relationships rich in social capital. Some students, and relationships, are represented in more than one set, while those students whose relationships with parents were uninfluential, or undetermined, are listed separately for comparison. It is evident from Figure 7.3 that, individually, none of these family characteristics could convincingly be associated with particular science enrolment decisions, due to the seemingly arbitrary representation of students from the different choice categories, which are colour coded. While there were suggestive patterns in sets 'A' and 'B', it was often the case that potential associations between these perceptions and students' decisions were confounded by the quality of individual relationships, particularly with parents. However, when students' perceptions of parental attitudes were reexamined in the light of the relationships described above, new and striking patterns emerged, with profound implications. Figure 7.4 represents the interaction of the three influences on students' science enrolments which emerged from exploration of the family worlds.



Figure 7.3 The three characteristics of family worlds found to have influenced the science enrolment decisions of many science proficient students. Family members associated with these characteristics have been identified by letters: (m) mother, (f) father (b) brother, (c) cousin Key: physical science students, biology other science students, students taking no science



Figure 7.4 The interaction of three characteristics of students' family worlds which were found to influence their science enrolment decisions. Key: (m) mother, (f) father, (b) brother, (c) cousin, physical science students, biology/other science students, students taking no science.

The intersection of the sets in Figure 7.4 produced a number of regions which highlighted distinctions between the family characteristics of students making different science enrolment decisions. The main features of these new patterns are discussed below.

The first point to be noted is that no student choosing physical science courses is located outside 'Set C'. This suggested strongly that it was important for students choosing these courses to feel, either consciously or unconsciously, that they were supported by the positive relationships they enjoyed within their families. This support was not restricted to a parent's encouragement to take physical science, as identified by Kelly (1988). Rather, it was a more general feeling of support and confidence based upon a history of socioemotional investment. It was apparent that the majority of physical science students possessed a sense of selfconfidence which was both instrumental in their decisions to take 'more difficult' science subjects, and rooted in indicators of social capital (Coleman 1988), such as trust and encouragement. These indicators were readily apparent, for instance, in Salma's description of her relationship with her cousin (p. 151) and in Melinda's reliance on her father (p. 164). The higher levels of self-confidence demonstrated by female students choosing physical science were also noticed by Johnston and Spooner (1992, p. 66), although in their study this confidence was not linked to resources of social capital in family relationships. One of the clearest examples of this link in the present study, was found in the extract from Kelly's narrative (p. 172) where she attributed her own confidence in choosing physics and 3 unit maths to the encouragement she gained from her relationship with her brother.

For female students in particular, the association between perceptions of high levels of social capital, and the choice of physical science subjects, was also supported by the results in Chapters Four and Five, suggesting that confidence was a more important issue for female students choosing physical science than for females making other choices, or for males in all categories. In the light of these findings, the characterisation by Johnston and Spooner (1992) of female physical science students as self-confident is probably better understood if it is realised that only those females who are self-confident are likely to choose physical science subjects. Johnston and Spooner (1992) also described such students as 'independent'. While the authors do not develop their conception of 'independence', they use the term to describe students who are 'very much in control of their lives' and who are undeterred 'by the reactions of [their] peers and others' to their subject choices (1992, p. 66). Although the female students in the present study who chose physical science subjects did so independently of their peers, from another perspective their decisions were very much dependent upon the qualities of family relationships, which were a foundation for their overall confidence and self-efficacy. From the narrative extracts presented earlier, it is clear that this dependence was, in this sense, a vital characteristic of the female physical science students in this study.

While the links between self-confidence and social capital were recognised mainly in the narratives of female students, this is not to say that confidence was not an issue with males considering physical science subjects, particularly since they were also included in Set 'C'. Rather, male physical science students were more circumspect about attributing their confidence to external sources. This is consistent with studies (Gilbert & Gilbert 1998;

Pollack 1998) showing that male students in general are more likely than females to appear confident in their schooling, and to see this confidence as stemming from internal factors, such as their own abilities.

A second feature of Figure 7.4 is that all of the physical science students are situated within the regions formed by the intersections 'AC' and 'BC', with the majority being found in the region 'ABC'. That is, physical science students described family worlds in which, along with the reserves of social capital discussed above, family members emphasised the strategic qualities of education, or provided science related cultural capital or, more trenchantly, did both. In terms of science subject choice, adequate resources of social capital in family relationships were alone insufficient to influence the choice of physical science subjects, as shown by the ten students who were in Set 'C' only. The quality of the family relationship was effective only in influencing students to adopt the attitudes and aspirations of family members. However, for this influence to favour the choice of physics and chemistry, it was necessary for the student to perceive that such a decision was consistent with the attitudes of the family member(s).

The predominance of physical science students in the centre region 'ABC' emphasises the influence this conjunction of family characteristics can have on science enrolment decisions. The absence of biology/other science students from this region indicated how this conjunction favours the choice of more difficult and strategically valuable science courses, even by students, such as Melinda, Greta, Salma and Sylvia, who had an intrinsic preference for biology over physics and chemistry.

Other studies have recognised the relationship between high parental aspirations and the choice of strategically valuable subjects (Baumgart & McBryde 1992; McGaw 1996; Wood & DeLaeter 1986). Likewise, previous research (Khoury & Voss 1985; Leslie, McClure & Oaxaca 1998; Woolnough 1994) had found the advocacy for science within the home to be associated with the choice of physical science subjects. However, the contribution of the present study to this research was in demonstrating how interpersonal dynamics within the family can moderate the degree to which science proficient students are influenced by parental attitudes or responses. The cases of Malcolm(n), Greg(b) and Kate(n), discussed above, illustrate this point. In general, the perception that only one of the three characteristics illustrated in Figure 7.4 existed within their family worlds appeared not to be sufficiently influential for most science proficient students to enrol in physical science subjects.

The emergence in this study of family dynamics as influential in the enrolment decisions of science proficient students contributed a new context in which Coleman's (1988) emphasis on the importance of social capital is relevant. While Coleman (1988) and others (e.g. Hoover-Dempsey & Sandler 1995; Lareau 1989; Marjoribanks 1994), have focused on the role of family social capital in influencing achievement, it is apparent from the present study that among Year 10 students demonstrating similar levels of science achievement, science enrolment decisions were also affected by this commodity. The evidence is compelling that in the cases of Richard(n), Malcolm(n), Kate(n) and Yvonne(n), the aspirations of fathers or mothers were not complemented by relationships comprising sufficient quantities of social

capital. Hence, the decisions of these students did not align with the expectations of their parents. The recognition that social capital can influence the enrolment decisions of science proficient students has far reaching consequences, not only for science education but perhaps for other research involving students' educational decisions. This point is taken up in the final chapter.

A third feature of Figure 7.4 is that the students choosing to forgo further science study were found predominantly outside the intersected regions. That is, many of these students described family worlds containing only one of the three characteristics conducive to the choice of physical science subjects. This finding identifies the combination of family characteristics as being critical to students' deliberations, rather than any single characteristic. While students taking no science subjects were represented in each of the sets, only Stefan, Michelle and Daria were found in the intersected regions. Even the decisions of these three students involved mitigating elements. For Stefan, it was the negative impression gained from his parents of the realities of a career in science (p. 91). For Daria, it was the clash of physics and Italian on the same subject line, along with other issues involving her values and sense of ethnic identity (p. 160). For Michelle, it was her family's preference for careers in banking and business and the high level of social capital she could therefore call upon were she to follow a similar occupation (p. 161). These exceptions demonstrate that even those science proficient students whose family situations favour the choice of physical science subjects may be diverted from this choice by other considerations which, in the cases of Michelle and Daria, involved other family related values.

A final observation was that few biology/other students were located within region 'A'. This implies that without the strategic imperative originating from within the family, students who have done well in school science would tend to choose science subjects, such as biology, which are more intrinsically attractive. While Uzlan and Tracy described parents who had a strategic orientation, in both cases the students felt that to attempt subjects they considered too difficult would be to risk achieving a lower UAI, thereby missing out on university entrance to their preferred courses. Hence, their sense of self-efficacy persuaded them to make a safer choice. The lack of strategic parental attitudes among biology/other science students was consistent with the predominantly intrinsic rationales they gave in Chapter Four, and the findings of research on more general student populations (Ainley et al. 1994; Fullarton & Ainley 2000).

To further investigate the patterns produced in Figure 7.4, analysis was undertaken to determine whether other background characteristics, such as location, gender, school or school type, may have been responsible for the positions of students within the regions. None of these investigations revealed any patterns within the diagram. There were also a number of students whose relationships with one or both parents were not able to be established from their narratives (see Figure 7.3). Given the findings presented above, and the benefit of hindsight, it would have been useful in the interviews to probe more deeply for these students' perceptions of their relationships with parents. Unfortunately, it was not until the analysis was well underway that the importance of parent/child relationships students' decisions was appreciated. Nevertheless, it is argued that those relationships students were

able to describe provided sufficient indication of the importance of social capital to their science subject decisions.

IMPLICATIONS FOR THE MULTIPLE WORLDS MODEL

To this point, the chapter has focused on those aspects of the family worlds of science proficient students which influenced their science enrolment decisions. However, the second thematic research question was concerned with the degree to which cultural congruence had influenced these decisions. The existence of any congruence or incongruence between cultural features of school science and family worlds was established by comparing students' descriptions of the structural, attitudinal and dynamic dimensions of both worlds. However, determining whether such congruence or incongruence had actually influenced students' decisions, was more difficult, and revolved around the detection of dissonance and resonance within their narratives, particularly with respect to the decision-making processes. Dissonance was described earlier as an internal sense of discrepancy (Rea-Ramirez & Clement 1998) resulting from the consideration of two or more competing conceptions. Resonance was seen as the obverse of this, that is, a sense of confidence or security based upon the reinforcement of observations or conceptions. This study was unable to make a determination about the influence of cultural congruence in every case. Nevertheless, it was considered unnecessary to do so, since a reasonable argument could be made for the influence of congruence and incongruence between cultural features if such influence could convincingly be shown to have played a role in the deliberations of some of the students. The credibility of the case was dependent more upon the soundness of the arguments than upon the number of students to whom it applied, though of course, this issue affected the transferability of any results.

Of the characteristics of school science detailed in Chapter Five, three were found to be pertinent with regard to congruence or incongruence with features within the family world. These were: the extrinsic value of physical science subjects, the content-centredness of school science and the conceptualisation of senior science subjects in terms of relative difficulty.

Congruence and the Strategic Value of Physical Science Subjects

It was within students' discussions about the intrinsic and extrinsic values of particular science subjects that the greatest amount of congruence was recognised. The narratives of 16 students (43 per cent) included both descriptions of the school/university promotion of physical science subjects as strategically valuable, and a parental emphasis on the strategic utility of secondary education. These students were James(p), Melinda(p), Greta(p), Sylvia(p), Kelly(p), Roger(p), Hannan(p), Jennifer(p), Michael(p), Renate(p), Peter(p), Uzlan(b), Tracy(b), Daria(n), Stefan(n) and Kate(n).

That this congruence had also been influential in the deliberations of particular students was evidenced by a variety of cues. First, the close juxtapositioning of students' reference to both school and family advice revealed in five cases that decisions were influenced by an awareness that particular views were reinforced. For example, in Melinda's(p) responses the perspectives of her teacher, her father and the UAC guide book, all of which advocated a

strategic orientation, were located within the same text unit (p. 105). When asked which of these perspectives had been most influential, Melinda was unable to distinguish between the advice of her father and that of the university guide:

Res: ... Are you able to say after our discussion which of [all the factors Melinda had mentioned] had the most influence on your decision to do physics and chemistry next year? Melinda(p): Do I have to pick one? Res: No, but what would be the most influential factor in your decision? Melinda: Probably my Dad and the UAC books. (195-198)

This response suggested strongly that the congruence of family and school perspectives was precipitant in her deliberations. This is further supported by close references to both her father and school sources in her rationale for taking 3 unit maths:

Melinda(p): The UAC books sort of recommend 3 unit maths, um, and Dad sort of thinks I can handle it so I thought I might as well try my luck at it. (56)

These extracts illustrate the mutual reinforcement of attitudes within the two worlds. It is interesting, however, that in deliberating about history, biology and drama, subjects described by Melinda as primarily of intrinsic value, she made no reference to any of these sources.

Other cases in which students referred to both school and family influences in the same response included Greta(p), Sylvia(p), Jennifer(p) and James(p). Even in narratives where congruent influences were not proximate, there were cues that resonance between school and family attitudes had tipped the balance in favour of physical science. For instance, Hannan's comments about the capacity of physical science subjects to maximise post-secondary options were made in the context of her own wish to make the most of her education. Hannan's motivation owed much to the experience of her parents, as detailed earlier in the chapter (p. 141).

A second indication that resonance between school and home conceptions had influenced students to take physical science subjects was found in their discussions of timetable clashes, noted in Chapter Five. In reconciling their decisions to take physics over more intrinsically attractive subjects, Melinda(p), Greta(p), Sylvia(p) and Jennifer(p) revealed the extent to which their motivations were orientated to the future. For example:

Melinda(p):... and physics, I don't know ... I knew I had to ... or it was probably a good idea to do it, but physics and drama were on the same line and I've done drama this year and I really, really, *really* wanted to do it, but in the end, I mean, I'm never going to be an actress or anything, so in the end ...(110)

This is an almost identical rationale to that provided earlier by Sylvia (p. 144), including the reference to future career-related possibilities. It also echoed Jennifer's rationale for dropping Art in favour of physics:

Res: Was that a hard decision to make? Jennifer(p): It was and it wasn't. 'Cause I like doing all that, drawing and painting and stuff, but um, that was more of an interest thing than something that I could use later on ... (267-268)

As well as highlighting the difficulties presented by timetable structures, these extracts typified the sense of resonance between perceptions of parental aspirations and school science promotions found within other narratives, such as those of $\operatorname{Roger}(p)$, $\operatorname{Greta}(p)$ and $\operatorname{Sylvia}(p)$, and emphasised it's role in their decisions to take physical science subjects. In summary, the cases of $\operatorname{James}(p)$, $\operatorname{Melinda}(p)$, $\operatorname{Roger}(p)$, $\operatorname{Greta}(p)$, $\operatorname{Sylvia}(p)$, $\operatorname{Hannan}(p)$ and $\operatorname{Jennifer}(p)$ provided compelling evidence that the school/university conception of physical science as strategically valuable resonated closely with the perception that this quality was highly valued within their families. The narratives also demonstrated that such resonance had been influential in their deliberations. In contrast, there were no physical science students whose narratives indicated a degree of incongruence between these two conceptions.

Like the interference patterns formed by two waves sources, where areas of reinforcement are more noticeable than those of cancellation, the effects of resonance were more identifiable than those of dissonance, since the effects of cancellation were often indistinguishable from areas of no influence at all. Nevertheless, the responses of some students choosing biology/other science, or no science subjects, illustrated incongruence between the recommendations of science teachers and parents. For example, the advice offered to Joanne(n) and Madeline(n) by their teachers was not consistent with the message they received from their parents:

Joanne(*n*): And then I was told, 'cause I asked the science coordinator, 'do you recommend that I do a science?' and he said that, because I didn't know what I wanted to do, it might help [to choose one]. (80) Joanne: ... my parents sort of just said 'do whatever you want to'. (144)

Madeline(n): [The teacher] just told us that, you know, 'science is a prerequisite for most courses' and things like that, 'and it's always good to have science just in case you change your mind about what you want to be'. (381) Res: Did your mother give you much advice? [No advice from father] Madeline: No, not really ... she just thought you know, it's my decision. (273)

However, although these two cases demonstrated some incongruity, there was no evidence that a sense of dissonance contributed to their decisions. For these students, and others, it appeared that rather than dissonance acting to dissuade students from choosing science, it was more a case of there being insufficient resonance to overcome the disadvantages they perceived in continuing with science. This proposition is discussed further at the end of the chapter.

In comparing students' descriptions of influences within their family and school science worlds, a number of cases demonstrated that the congruence of similar conceptions did not always result in the choice of these subjects. Tracy(b), Uzlan(b), Daria(n), Malcolm(n), Yvonne(n) and Kate(n), recognised parental orientations toward the strategic qualities of education and the promotion of physical science subjects as strategically valuable. Yet, in their

deliberations, these students revealed that issues other than congruence were of greater influence. For Tracy(b) and Uzlan(b) the perceived difficulty of physics and chemistry, as discussed earlier in the chapter, constituted too great a risk to their aspirations for university entrance, which were shared by parents. In Daria's case, the recommendations of her science coordinator were reinforced by her father:

Res: And does your father give his arguments for why he thinks you should be doing a science? Daria(n): Yeah. 'Cause when my Mum and I went to see [the science coordinator] for the parent teacher interview, he asked my Mum why I wasn't doing a science [next year] and she didn't know, and he said that it would open up more, like, things you can go into for uni. And she told my Dad, and my

Dad's really upset that I'm not doing it, 'cause it's limiting my choice. (94-95)

Regardless of this congruence between worlds, and despite Daria's own liking for physics, timetable clashes intervened. Daria eventually decided that the opportunities offered by the choice of physics did not outweigh the disadvantages of dropping Italian. As with the cases discussed in the previous paragraph, it is apparent, therefore, that issues other than dissonance influenced Daria's decision. With regard to the last three cases, it has already been established that interpersonal issues complicated the degree to which the aspirations of Malcolm's mother, Yvonne's father and Kate's parents were able to influence their decisions.

Despite the exceptions noted above, there was compelling evidence that physical science subjects were often chosen in cases where the perception that they were primarily of strategic value resonated with students' recognition that such a quality was highly valued by significant, supportive family members. Such congruence is consistent with, and may even to some extent explain, the statistical associations between enrolment in the physical sciences and high levels of parental education and socioeconomic status (Ainley et al. 1994; Fullarton & Ainley 2000; Woolnough 1994) given the strong associations established between these two factors and high parental aspirations (Legutko 1998; Marjoribanks 1987). This argument is also consistent with the theoretical framework of cultural capital (Bourdieu & Passeron 1977), where the most valuable school subjects, in terms of social status and educational opportunities, are advocated most strongly by parents in the higher socioeconomic groups.

The argument that it is the types and amounts of cultural capital with which parents furnish their children that are influential in science enrolment decisions, rather than related factors of occupation or education level, is supported by the tendency among NESB students to choose physical science courses (Ainley et al. 1994; Fullarton & Ainley 2000). The present study, and others (Hartley & Maas 1987; Mak & Chan 1995; Malik 1998; Ninnes 1997b; Parr & Mok 1995), recognised that while the parents of many NESB students choosing physical sciences often have lower socioeconomic and educational circumstances, they generally demonstrate the same aspirations and strategic orientations of ESB parents whose children have taken these courses.

Congruence and the Content-Centredness of School Science

A second characteristic which implicated the role of congruence and incongruence was the content-centredness of school science. While this characteristic appeared to have little direct

impact upon the decisions of most students, there were two cases in which congruence was both evident and influential. For James(p) and Uzlan(b), the concept of school science as a body of knowledge to be memorised, recalled and applied, was congruent with their parents' conceptualisation of schooling, which focused on the achievement of good exam results. For example, Uzlan's(b) perception of the parental imperative for him to 'go good at school, go good at school' (94) motivated him to work hard on memorising and reproducing content in order to achieve well in exams, an approach which favoured science and maths subjects:

Uzlan(b): 'Cause he [science teacher] just gave me the information, and let me learn it myself. Everyone else thought he was a bit boring because he just kept on writing, but I had no problems with that, I just like writing it down and then going home and then studying it. (211)

James(*p*) was also comfortable with a learning style based on content transmission:

Res: What do you mean by teaching? James(p): I'd say, like, actually getting a text book and telling you something you don't know, and how it's done and why it's done ... Res: So, someone telling you about it? James: Yeah, that is what I perceive as teaching. (262-265)

This preference was consistent with his conception of learning as assimilation and reproduction of content, a conception congruent with the emphasis James' mother placed on good exam results:

James(*p*): She *just* over-estimates [my ability] ... she always does that to just push me along, 'cause she's not always at home, she has to work all the time, so she tries whenever she gets a chance, like, to push. Res: And do you try to achieve the goals that she sets then? James: I try [laughs]. I try. Res: What happens if you don't achieve it? James: What happens if I don't? I get shouted at! But I think she only shouts at me to get me going again. But that hasn't happened, thank God [mock serious] in the past two years anyway [laughs]. (104-108)

Hence, these two students were comfortable with a content focused school science culture, since the transmissive teaching mode resonated with the expectations of parents. Such expectations, often found among NESB parents (Blair & Qian 1998; Hartley & Maas 1987; Schneider & Lee 1990) were consistent with the conceptualisation of formal education as primarily involving the assimilation of content and as being measured in terms of examination results.

In contrast, students such as Jennifer(p), Richard(n), Malcolm(n) and Yvonne(n) felt that such a conceptualisation of school science left little room for creative engagement or consideration of alternative approaches. Richard, for example, felt stifled by the one-way flow of ideas typifying his school science experiences. He described 'doing' science in terms of 'getting' and 'processing information' (147) and criticised the lack of a creative dimension:

Richard(n): I think [science] could be done a lot more creatively than it is done at the moment. Res: Do you think that that is something that turns people off science? Richard: I think it does ... well for me personally it does. I think it's also ... it's great to open up your mind to certain types of science, but it's got to be done creatively. (257-159)

The preference for personal input into the learning process was reflected in Richards' subject choices which included drama and music, and within his family and peer worlds where his creative endeavours, particularly in entertaining and broadcasting, were shared and encouraged. In contrast, with the exception of Year 7 science, which he 'loved' (103), he found school science dry and boring. It was evident from these and other responses that this incongruity between the content-centredness and transmissive teaching style of school science on the one hand, and the person-centredness and creativity encouraged within his family and peer worlds on the other, produced a sense of dissonance which was influential in his decision.

A more graphic example of dissonance was found within the narrative of Malcolm(n), who described a situation in which this transmissive pedagogy was incongruent with the dialectic approach to learning promoted within his family. For Malcolm, learning was engaging with concepts and asking questions, an approach fostered by his mother and by his sisters who shared and encouraged his debating and public speaking interests. Malcolm described these interests as 'a family thing' (38), and noted that he was encouraged to apply this approach to school science:

Malcolm(n): ... my sisters always told me that everything in science is a theory, so, therefore, argue with all your science teachers. (122)

However, it gradually became obvious to him that the pedagogy which prevailed in high school science classrooms was not congruent with the approaches favoured within his family:

Malcolm(n): ... some of my [science] teachers I can approach, and discuss things with, but some I can't, I can't at all. It was often because I had differing theories. I wasn't quite willing to accept everything the teacher said, possibly. Res: And were things presented in such a way that they could be argued with, or were they presented as fact? Malcolm: Mainly presented as fact. Um [pause], they never said, 'This is what someone discovered' or 'This is what someone thought 200 years ago'. You know, they always said, 'This is what happens.' So they never presented it as a theory, or as something to be argued against. (127-128)

In addition, some science topics were problematic for Malcolm because he saw them as inconsistent with his religious beliefs. Such aspects of Malcolm's narrative provided evidence of incongruence between worlds leading to a sense of dissonance within the student. The fact that both of the extracts above were located within Malcolm's rationale for not taking science added weight to the argument that this sense of dissonance, in concert with the loss of any advocacy for science that accompanied his father's departure from the home, contributed to his decision to forgo senior science.

The narratives of Richard and Malcolm provided some support for the idea that incongruence and dissonance were influential in some students' deliberations about senior science. For both students, aspects of the culture of school science, as they perceived it, were incongruent with cultural features prevailing in their other worlds. Like Costa's 'other smart kids' (1995, p. 319), neither saw school science as 'intrinsically meaningful', and even the act of moving from classes such as English or drama, in which their personalities, skills and responsiveness were appreciated, into the world of school science, was analogous to crossing a border into foreign territory.

Congruence and the Relative Difficulty of Science Subjects

The characterisation of senior science courses in terms of difficulty levels was another aspect in which congruence and incongruence had implications for students' decisions. As mentioned earlier in this chapter, this conceptualisation resulted in students referencing, either consciously or subconsciously, levels of confidence and self-efficacy in deciding about senior science. In a number of cases these issues related to the reserves of social capital (Coleman 1988) existing in relationships with various family members, and upon which students felt they could rely.

It was demonstrated earlier in this chapter (see Figure 7.4) that there were no physical science students who felt they could not draw upon reserves of social capital within their families. The link between this capacity, and the perception of difficulty associated with physics and chemistry, was most explicit in the cases of Melinda(p), Kelly(p), Hannan(p) and Salma(p), through the inclusion, within their rationales, of references to encouragement and support upon which they could draw in the course of their science studies. For Melinda, the source was her father, while Hannan felt she could rely on her mother's knowledge and support. Kelly's rationale for taking physics and chemistry was the encouragement and support of her older brother, while Salma's decision owed much to her reliance on the support of her brother and female cousin. For the majority of physical science students, however, the link between social capital, and confidence in choosing difficult subjects, was more implicit, with narratives providing a general impression that, in making their decisions, students took their supportive home environments for granted. It was further noted that within this group, the most explicit references to family support for school undertakings were made by females. This finding supports the notion, expressed in previous chapters, that a sense of confidence in support networks was a criterion more thoroughly explored, or at least articulated, by females than by males.

In contrast to the physical science students, there was evidence, within the narratives of some students choosing no science, of lower levels of family support than students anticipated they would require in order to take on more difficult subjects. As with the cases above, this evidence was in some cases more explicit than in others. For example, aspects of Sean's(n) interview, such as his demeanor, negative outlook and lack of involvement in sports or other interests, evoked the image of a student who had low levels of self-confidence, optimism and social capital. The general flavour of his narrative can be appreciated from the extracts below (see also p. 166):

Res: Are you looking forward to coming back to school in Year 11?
Sean(n): ... not looking forward, but [long pause] ... I prefer to come back.
There's nothing much else to do. (24-27)
Res: What are your hobbies and interests?
Sean: [looks downward] Ahh ... not that much.
Res: What about sports?
Sean: I hate sport .
Res: Alright, so how do you spend your time then?
Sean: Um ... read magazines.
Res: What sort of magazines?
Sean: ... just whatever's lying around. (36-43)
Res: What subjects do you think will be most important for your future?
Sean: ... [long pause] I don't know. I don't really know. (199-200)

Despite his 'A' grade, Sean described his academic ability in science as only 'average'. His mother had little input into his subject deliberations and he noted that his estranged father would be unaware of his choices. Though he was in contact with his father, there was little history of help with homework or other aspects of Sean's schooling. In general his senior subject profile was not academically challenging, and had been chosen based upon intrinsic values. His reasons for not choosing physics or chemistry revolved around the perception that he was not good enough. Although he would have liked to have taken biology, it was timetabled against subjects which were of greater intrinsic value.

Malcolm(n), Greg(b), Fiona(n) and Helen(n) had much in common with Sean in terms of their lack of optimism in general and low academic self-efficacy in particular. None of these students described family worlds as having the higher levels of social capital and future orientation typical of the physical science students. Likewise, these four students eschewed extrinsically valuable subjects, and none reported much involvement from parents, and from fathers in particular, in their schooling. Furthermore, all rated their degree of reliance upon the advice of both parents as 'not much', except for Sean who wrote 'none at all'. For such students, the prospect of undertaking demanding science courses was incongruent with their resources of optimism and self-efficacy, which reflected the low levels of social capital they described in their family relationships.

In the cases of Sean(n), Malcolm(n) and Greg(b), much about their self-confidence, their subject deliberations and even their manner when discussing their families, appeared to be related to the quality of their relationships with their fathers, as suggested earlier in the chapter. The influence of parenting structures and estrangement has previously been implicated in measurements of academic achievement (Marjoribanks 1994), but not, until now, in the outcomes of science enrolment decisions. Nevertheless, research in other areas has established an association between low levels of optimism and self-efficacy, and the existence of conflict between parents, and even the separation of parents. Optimism is the tendency to hold positive expectations for the future, and to believe that set-backs are temporary (Hjelle & Busch 1996; Seligman 1991). Peterson (1991, in Hjelle & Busch 1996) noted that optimism is related to the vigor or passivity with which individuals meet challenges. This quality is therefore salient to this discussion, given the conceptualisation of various senior science courses in terms of their anticipated difficulty. Hjelle and Busch (1996, p. 19) found a negative association between a child's optimism during middle childhood and

perceptions of paternal rejection, neglect or indifference. Furthermore, Seligman's (1991, p.145) description of the children of estranged parents as often being sadder, having less zest and a lower self-esteem than other children, was certainly reflected in the narratives of Sean, Malcolm and Greg. While this description was not similarly reflected in the conversation or manner of Greta(p), Renate(p) and Jennifer(p), Seligman (1991, p. 149) also noted that males witnessing disharmony or conflict between parents were often more depressed and pessimistic than were females.

Finally, the argument that deliberations about science enrolments are closely related to selfefficacy and social capital was also supported by the conclusions of Eccles (1993) regarding students' motivations. Eccles (1993, p. 146) not only recognised that parents' attitudes, beliefs and perceptions about their child's abilities were critical mediators of that child's academic self-efficacy, but that the child's self-efficacy was, in turn, an important mediator of course choice. The studies cited above, while borrowed from different contexts, provided strong support for the argument that some science proficient students found the anticipated demands of physical science courses to be incongruent with their own levels of self-efficacy, and that this quality had been affected by the dynamics within their family worlds. While this argument is based upon a small number cases, the evidence here provides strong grounds for the establishment of further research.

Of course, there were other students choosing no science courses who did not raise the anticipated difficulty of these courses as an issue, and who appeared to enjoy high levels of social capital (e.g. Stefan, Daria, Michelle, Joanne). However, these cases should not detract from the evidence, presented in this chapter, that no physical science student described family worlds deficient in social capital, whereas this was the case with several students in the other choice categories. Neither should exceptions weaken the argument that in deliberating about senior science, some science proficient students referenced both the anticipated difficulty of physical science subjects, and the levels of support upon which they felt they could rely, and make judgments accordingly. In cases where the latter quality was not felt to be sufficient, the subjects were not chosen.

SUMMARY

The complexity and scope of this chapter underscore the importance of the family in shaping the aspirations, attitudes and enrolment decisions of science proficient students. Analysis of students' perceptions of their families allowed a number of important conclusions to be drawn. While these are summarised in the final chapter, the most substantial finding, unprecedented in the context of high school science enrolment, was that alignment between the parental attitudes described by science proficient students, and their subsequent enrolment decisions, was strongly affected by the quality of the parent/child relationships. This finding was reinforced by the many instances where divergence between parental attitudes and students' decisions was linked to problematic relationships, usually involving low levels of social capital. While previous studies have highlighted the connection between the quality of parent/child relationships and other educational outcomes (Coleman 1988; Hoover-Dempsey

& Sandler 1995; Lareau 1989), the association between social capital and science enrolment decisions has not previously been articulated to the extent found in the present study.

Within the interview population, there were thirteen science proficient students who described supportive relationships with a family member who they described as advocating the importance of science and/or emphasising the strategic value of education. In every case, the student had chosen to enrol in physical science subjects. Conversely, the absence of such advocacy or emphasis mitigated against the choice of physical science subjects. Furthermore, in other cases where adequate levels of social capital were not perceived to be available, physical science subjects were not chosen. Socioemotional investment and support from family members provided the students with a sense of confidence, contributing to higher levels of academic self-efficacy. In turn, this encouraged students to choose subjects conventionally seen as more difficult or, in the case of females, as non-traditional. Social capital also appeared to contribute to the role modelling dynamic apparent in some family relationships.

By exploring beyond those family characteristics usually measured by quantitative studies, this research was able to demonstrate that indicators commonly associated with science enrolment decisions, such as socioeconomic levels, parental occupation, ethnicity, parenting structures and levels of parental education (Ainley et al. 1994; Fullarton & Ainley 2000; Leslie et al. 1998; Lokan et al 1996; Rosier & Banks 1990; Woolnough 1994), are not themselves causative factors. Rather, they are manifestations of more fundamental influences within the family culture, such as parental aspirations and levels of cultural and social capital.

A second major finding concerned the extent to which cultural congruence was influential in the deliberations of science proficient students. This chapter demonstrated that resonance and dissonance between aspects of family and school science worlds did indeed play a role in the deliberations of several students. Parents' reinforcement of the school science promotion of physical science subjects as strategically valuable was influential in a number of cases. Likewise, in two cases the content-centredness of school science was consistent with the conceptions of education held by parents. Finally, as noted above, in making their decisions many students referenced both the anticipated difficulty of physical science subjects and the quantities of social capital upon which they felt they could draw. It is interesting to note that evidence that congruence had influenced subject choices was found predominantly among the physical science students. Possible explanations for this pattern are discussed in the final chapter.

While cases of cultural incongruence were found among those choosing to forgo participation in senior science courses, it was more difficult to determine the extent to which this incongruence had influenced enrolment decisions. Nevertheless, in a number of cases the content-centredness of school science was felt to inhibit the creative expression encouraged within some family worlds. For other students, the anticipated difficulty of physical science subjects was not matched by sufficient optimism or reserves of social capital.

Because the students choosing no senior science courses did not explicitly recognise sociocultural influences on their decisions, their own explanations often masked the role of any cultural congruence. According to these students, their decisions were attributable to the views that science was unnecessary given their career aspirations, or that the benefits were not worth the anticipated efforts involved in science courses, or that their decisions were thwarted by timetabling problems. The generally unattractive descriptions of school science, among students in all choice categories, meant that rather than incongruence being a decisive influence in decisions to forgo science, it was the congruence between family and school science conceptions which were required for students to choose science subjects, particularly physics and chemistry. This proposition, and its ramifications for the applicability of Costa's (1995) model in this context, are discussed in the final chapter.