CHAPTER FIVE

EXPLORING THE SCHOOL SCIENCE WORLDS OF SCIENCE PROFICIENT STUDENTS

INTRODUCTION

The analysis of students' rationales in the previous chapter gave the impression that most of those deciding against further science study made this decision because science subjects were not necessary for their future plans. This explanation might be interpreted as indicating that students' experiences of school science had played little part in their deliberations. However, to draw such a conclusion would be to ignore the perspective taken by this thesis, which was that students' rationales do not necessarily reveal all of the influences on their decisions. The study aimed to look beyond the explanations given by science proficient students, to differences and similarities in the ways they perceived, and responded to, the world of school science.

This chapter reports and discusses the descriptions interview participants gave of the structural, attitudinal and dynamic features of junior high school science. Comparisons are made between the perceptions of students in different choice categories in order to determine whether there were differences in the experiences, or perceptions, of students which may be associated with their contrasting decisions. The portraits of school science in this chapter also serve as a reference when discussing congruence and incongruence with students' peer, mass media and family worlds in later chapters.

THE STRUCTURAL DIMENSION OF STUDENTS' SCHOOL SCIENCE WORLDS

The two structures most salient to the deliberations of students in this study originated not from within the science curriculum, but from overarching school and university requirements. The source and influence of these structures - university prerequisites and school timetables - illustrated the porosity of borders between school and school science, as noted earlier. On the other hand, much of what might be regarded as the internal, day to day structure of science classes, for example, lesson organisation, experiments and work groups, are more appropriately discussed later under the heading of dynamics, since they involved classroom interactions and relationships.

University Prerequisite Subjects

Students' enrolment decisions were complicated by the different values attributed to physics, chemistry and biology by universities, through the setting of prerequisites for particular courses. Many students were surprised to find that the priority given to physical science subjects even extended to university courses focusing on biology or environmental science. For example:

> Jennifer*(p)*: Well, I actually had a UAC [University Admissions Centre] guide, or whatever it was, and um, I was looking through most of the science courses, and most of the requisites are maths and either physics or chemistry. Even with the biology courses! I couldn't understand it. (236)

As discussed in Chapter Four, university structures often forced a choice between different subjects on the basis of extrinsic or intrinsic value. To the extent that they attribute differential values to science subjects, university requirements can be seen as shaping the structure of senior science. Like the timetable frameworks discussed below, university prerequisites influence the ways school science is conceptualised by science teachers, school administrators and curriculum designers (Chadbourne 1995), consequently compelling students to reference and reconcile their value systems in deciding between intrinsically and extrinsically valuable science courses. As shown later in the chapter, these structures also influenced students' aspirations and conceptions of science.

School Timetable Frameworks

It was revealed in Chapter Four that line clashes between preferred subjects played some part in decisions by Joanne*(n)*, Thomas*(n)*, Sean*(n)*, Fiona*(n)*, Daria*(n)* and Richard*(n)* to forgo enrolment in senior science courses. However, subject clashes also created some anxiety for five of the fourteen physical science students. While such clashes are often a complication for students choosing senior subjects (Ainley et al. 1994; Mitchell 1997; Whiteley & Porter 1998), seven of these eleven clashes were distinctive in that physics or chemistry had been placed on lines opposite subjects such as music, drama, visual arts and languages other than English:

> Jennifer*(p)*: It was either drop art and do physics, or drop music and do chemistry. (268)

> Thomas*(n)*: I was going to do chemistry, but that was on the same line as music... (89)

Similar clashes were experienced by Melinda*(p)* (physics and drama), Sylvia*(p)* (physics and drama), Greta*(p)* (physics and French), Daria*(n)* (physics and Italian), and Peter*(p)* (physics and visual arts). The students involved were from five of the six schools, indicating that the potential for clashes between such subjects was widespread. This conclusion is supported by Whiteley and Porter (1998) who observed that school subject lines favoured strategically valuable subjects, and that dissatisfaction with the timetable blocks was more common among those choosing subjects for intrinsic reasons. This structure gave the impression of an extrinsic/intrinsic dichotomy of subject profiles, and contributed to an image of physical science subjects as incompatible with, or even in opposition to, more 'creative' subjects.

Whether the placing of intrinsically and extrinsically valuable subjects in opposition was due to the stereotyping of students, issues of enrolment numbers or simply from attempts to cater for the majority of students, the implication for students was that the process was not merely one of choosing between individual subjects, but between diametrically opposed subject profiles reflecting different values. Thus, as discussed in Chapter Seven, subject clashes created a situation in which students were required to reconcile competing values, sometimes with reference to the values held within different worlds.

THE ATTITUDINAL DIMENSION OF STUDENTS' SCHOOL SCIENCE WORLDS

Students' perceptions of how science was commonly conceptualised, valued and promoted by their teachers and classmates contributed to the portrait of school science culture. It should be noted, however, that the cultural features discussed in this section are those seen by science proficient students as inhering in school science, not simply the qualities which they attributed to an individual teacher or class. For example, whereas a student's statement that 'science is fun' was seen as pertaining to school science in general, the statement 'the way s/he taught us was fun' was seen to describe a quality in a particular teacher. Such descriptions were used only where they accorded with a student's overall impression.

Overall, perceptions of school science were remarkably similar, despite students' contrasting decisions. A process of interpreting, comparing and reflecting upon the interview data resulted in the emergence of four conceptual themes around which their descriptions focused. First, science proficient students saw school science as being primarily content-centred. Second, they considered this content to often be unconnected to 'real life'. Third, senior science subjects were commonly characterised in terms of levels of difficulty, and fourth, physical science subjects were regarded as being predominantly of strategic value.

The Content-Centredness of School Science

Nearly a third of interview participants described school science as content-centred, as opposed to being learner-centred, skill-centred or process-centred. Students in all three choice categories perceived it to be a subject focusing on facts, with teachers cast as repositories of knowledge whose main role lay in disseminating and explaining information. Moreover, the facts themselves were often presented in a decontextualised way, ignoring the historical and human circumstances of their discovery or development. Much of this overall impression reflected teachers' presentations of content, for example:

> Yvonne*(n)*: ... in Years 7 and 8 it was more a general science, sort of thing, and that wasn't very interesting at all. Because we never really got into anything. They just said 'Oh, this happens and that happens,' and we sort of went 'Oh ... OK'. (216)

> Melinda*(p)*: ... the way they taught ... it's just sort of 'this is it, this is how it is, and this is what you learn' (191)

Whereas Melinda*(p)*, Peter*(p)*, Greg*(b)*, Yvonne*(n)*, Malcolm*(n)*, Richard*(n)* and Madeline*(n)* reported this as a negative characteristic, the conception of science as a collection of facts nevertheless appealed to others, such as James*(p)*, Hannan*(p)*, Kelly*(p)* and Uzlan*(b)*. For instance:

> Res: What is the attraction of these subjects [physics and chemistry] to you?
> Kelly*(p)*: They're real structured, you're either right or you're wrong, it's not creative and ... I like it because I feel that I'm learning something, like I *am* right or I *am* wrong, and if I'm wrong I've got to figure out why I was wrong, and make sure I get it right next time. (98-99)

Regardless of the type of response, however, the content-centredness of school science was such a ubiquitous perception that it could be regarded as a defining characteristic. Students' descriptions were consistent with widespread concerns about content-domination in Australian (Goodrum et al. 2001; Rosier & Banks 1990) and international science curricula (Apple 1992; Jenkins 1997), where students are often 'force-fed the fruits of academic labour' (Claxton 1996, in Osborne, Driver & Simon 1998). It was interesting, however, to find that in the present study this perception was also common among students who had done very well in science, including those who had chosen to enrol in further science courses. This finding, along with the different attitudes regarding content centredness, showed that it is students' responses to the perception that differed most across choice categories, rather than their perceptions.

Decontextualised Curriculum Content

A second common perception was that school science was a subject of little personal relevance. Despite students' high levels of achievement in the subject, they variously described school science as irrelevant (24 per cent) or boring (22 per cent), with physics in particular being comparable to mathematics in its degree of abstraction (22 per cent). Again, this perception was expressed by students in all three choice categories and in a variety of ways. For some, school science was seen as not relating to the 'real' world:

> Hannan*(p)*: Learning about Newton's Law was about the first thing we did [in a Year 10 physics unit]. For once, science was, like, something I could apply to life.
> Res: Right. So it was ... what? Relevant? Do you mean for the first time or ...?
> Hannan: It was, yeah, I couldn't find the link between what we learn in science and going out into the world and seeing things move and stuff.
> Res: So for three and a half years, you couldn't see the link between what you were doing in the classroom and what is in life, in the world?
> Hannan: Yes! [emphasis] (413-423)

The perceived irrelevance of the content was emphasised when students contrasted the science syllabus with those of other subjects:

> Kate*(n)*: Like, my Mum was laughing at me, [when Kate told her that she was enjoying anatomy in PD/H/PE], she was laughing at me saying 'You realise that you're actually doing a science here?' But I don't mind that, 'cause I can see how it works, I can understand that and put it to use. Whereas the stuff that you actually do in science [classes] you just go 'Where the hell am I going to use this?'

> Res: What is it about the commerce that you enjoyed?
> Yvonne*(n)*: I don't know ... I suppose because it related to the real world and technology and the future more ... that's why I like computers, because that sort of seems to be where we're heading, and that interests me.
> Res: You said that you're interested in [commerce] because it is relevant and interesting for the future and because of the technology. Did you find that your science course related to those three things?
> Yvonne: Probably not. That probably had something to do with it. I never really thought about it like that.
> Res: Did your science course relate to technology?
> Yvonne: Not ... oh I suppose when we did the mechanics and the physics, sort of thing, which I enjoyed, but ... [pause]
> Res: Did it relate to the real world?
> Yvonne: Not the way that they [the teachers] showed it to us. (133-139)

Other students, most commonly those choosing biology/other science courses or no science, described school science as boring or of little personal significance. For instance:

> Richard*(n)*: I just found science boring, to tell you the truth. (104)

> Mark*(b)*: There is a lot more theory than what a lot of us think. And its not exactly that enjoyable, I suppose, all the time, it can get quite boring. (179)

However, topics involving biology were more often seen as interesting and relevant than other science topics. Descriptions such as those below were consistent with the explanations of biology students in Chapter Four, that this subject was often chosen because it was interesting:

> Malcolm*(n)*: With biology, they can say, 'Well, this is what we look like inside. This is what's happening inside you'. And you can see these things. Like, physics was just all, 'This is the rate of acceleration' ... (132)

> Greta*(p)*: Well, I really like biology 'cause basically you get to cut stuff up. (241)

In summary, the perception that school science did not relate often enough to 'real life' was expressed, either directly or indirectly, by James*(p)*, Greta*(p)*, Renate*(p)*, Hannan*(p)*, Mark*(b)*, Greg*(b)*, Madeline*(n)*, Yvonne*(n)*, Kate*(n)*, Stefan*(n)*, Malcolm*(n)* and Richard*(n)*. While these twelve students (32 per cent) did not represent a majority of the interview cohort, the significance of their perceptions was emphasised by the absence of a contrary opinion. That is, no student made comments to the effect that relevance was a characteristic of their overall school science experience. The only mention of attempts to contextualise the content came in students' descriptions of their best science teachers:

> Fiona*(n)*: He made the work interesting, he brought it into real life and stuff. (267)

> Michelle*(n)*: And, like, you'd talk about science and he'd relate it to everyday life as well, and you'd click to it, 'cause it's something that you knew from everyday. (212)

> James*(p)*: ... they talk to you about some other experience, that's got to do with science. (261)

Comments showing that such teaching practices were the exception, rather than the rule, only emphasised the lack of relevance as a general feature of school science. The irrelevance of high school science curricula to students in general has been highlighted in many studies (Bennett 2001; Goodrum et al. 2001; Head 1985; Klein & Ortman 1994; Osborne & Collins 2001; Osborne, Driver & Simon 1998; Rosier & Banks 1990), confirming this to be a widely experienced characteristic of the subject. Again, however, the findings in the present study show that this perception is common even among the most proficient science students, including some choosing to enrol in further science study.

The perception of irrelevance was also raised by some teachers in the STS. A subtle, though important, difference was that while students' comments both here and in Chapter Four addressed the curriculum, the teachers' comments were directed at the students and their perceptions. Only one teacher, Ted, implied that the science curriculum itself might be to blame (p. 80). This contrast between perspectives is interesting in that the cause of the problem was seen by teachers and students to lie in different places.

The Relative Difficulty of Different Science Courses

The different science subjects on offer in Year 11 were commonly conceptualised by interviewees in terms of relative difficulty, with physics being considered the most difficult, followed by chemistry and then biology. 'Science for Life' and 'General Science' were seen as the least demanding science courses, and were seldom chosen by science proficient students. What was remarkable about this conceptualisation was that relative difficulty appeared to be the most common differentiating characteristic of these subjects. That is, when students discussed the different science courses, they described them in terms of relative difficulty far more often than, for example, differences in syllabus topics or in classroom practice. According to the students, this conception of senior science subjects was perpetuated by their teachers:

> Res: Why did you decide to choose biology?
> Phillip*(b)*: Well, I like science, and it's the easier of the sciences.
> Res: How do you know that?
> Phillip: um ... Dad [science teacher] told me [laughs]. 'Cause physics and chemistry are both pretty hard. (59-61)

> Kelly*(p)*: The science coordinator said [physics] was a good one to do.
> Res: Did he say why?
> Kelly: Not really, he told us that it was probably the hardest of the sciences to do. (87-89)

> Greg*(b)*: We also have General Science and I was planning on doing that, but the teachers said that a lot of the people that just bludge [waste time] pick that subject. (98)

In this tiered conceptualisation, the selection process involved students fitting into the most academically suitable slot. The perception of physics as the hardest of the sciences was common across choice categories, being expressed by Kelly*(p)*, Hannan*(p)*, Renate*(p)*, Charlie*(p)*, Robert*(b)*, Greg*(b)*, Theresa*(b)*, Phillip*(b)*, Tracy*(b)*, Michelle*(n)*, Kate*(n)*, Yvonne*(n)*, Richard*(n)* and Thomas*(n)*. While some of the physical science students, such as Kelly, Charlie and Renate, saw the challenge of physics as a motivation, Phillip*(b)*, Greg*(b)* and Beth*(b)* felt that physics would be too difficult for them. Beth's description of her science teacher's advice neatly illustrates this conception in practice:

> Beth*(b)*: 'Cause I really like science, and, um, my science teacher advised me that I should be doing a science course, and I really like chemistry, but, she's telling me that it's a very hard subject and that um, if I was to do well at it I'd probably only get in the high 60's [UAI max. = 100] and I went 'aw' [disappointment] 'cause she goes, 'it's very hard'. (59)
> ... So [Dad] went through the book with me and sort of ... he was advising me to do physics, because he thought it was easier, but the subject coordinator was telling him that girls find chemistry easier than physics. 'Cause he was saying to her that he finds physics much more easy to comprehend than biology, and she [subject coordinator] is saying, 'No, you're thinking like a guy. Girls find chemistry easier to relate to than physics.' (88)

The gender stereotyping in this comment was also interesting in that it raised the issue of students being influenced by teachers' or parents' assumptions about the suitability of particular subjects. However, this was the only reference to the gendering of subjects found in students' narratives.

The idea of being classified by teachers as 'good enough' to take a particular science subject contributed to the belief that science subject choice should be based primarily upon ability. This was articulated by Richard*(n)*, Greg*(b)*, Beth*(b)*, Thomas*(n)* and Robert*(b)*. For example:

> Res: Can you think of anyone in school who has encouraged you in learning or doing science over the last 4 years?
> Richard*(n)*: Um ... yes, there was one, a teacher ... actually there were two teachers, um ... by just saying that I should have been taking science because I was good enough to do a few of the courses. (139-140)

On the other hand, most interview participants, like Greg, above, regarded Science for Life and General Science courses as a waste of their time and ability. The conceptualisation of senior science subjects in terms of difficulty levels has been noted by others (Ainley 1993; Barnes 1999; Cameron 1989; Kelly 1988; Mitchell 1997; Osborne, Driver & Simon 1998). Furthermore, these comments are not meant as a criticism of science teachers, many of whom may argue that such advice is sound and practical. Rather, the points to be noted here are, first, that relative difficulty eclipsed all other differentiating characteristics, and second, that this conceptualisation implicated issues such as self-efficacy and the reserves of support from other quarters upon which students could draw. These issues were touched on in Chapter Four, and emerged later, in the exploration of other worlds, as having influenced deliberations.

Distinctions between subjects based on perceptions of difficulty were apparent across all choice categories. However, again the responses of students were different. Some physical science students saw the anticipated difficulty of physics and chemistry as a positive feature. For Peter*(p)*, Kelly*(p)* and Charlie*(p)*, the appeal lay in the intellectual challenge:

> Charlie*(p)*: I quite like some of the more complex physics problems you can do.
> Res: And do you like problems and puzzles, things like that?
> Charlie: Yeah. Um ... getting something out. I mean, if there's a problem that

I've been doing, then I *have* to finish it. (239-240)

Furthermore, for Renate*(p)*, Sylvia*(p)* and Hannan*(p)* the prestige associated with choosing subjects which were regarded as demanding was also an attractive element. For instance:

Renate*(p)*: Someone found out the other day that I'm doing all three [sciences], and they're going, 'Really? Why in the world would you do that?'
Res: Is that a negative response?
Renate: Oh no. It's positive as well, like, [they're saying] 'How can you be doing that, I couldn't be doing that!' sort of thing.
Res: Do people say to you that you are crazy for doing 3 unit maths and all of those sciences?
Renate: Oh, people do, but only because they couldn't hack it themselves, I suppose. Just students.
Res: How does that make you feel?
Renate: It makes me feel ... alright, like, 'Yeah, I know you couldn't do it' [laughs] I think I take my work a bit more seriously than certain other people, as well. (130-136)

In contrast to these expressions of confidence and optimism, those who had reservations about their abilities to cope with the demands were mostly biology/other science students, or those choosing no science subjects. However, Melinda*(p)* and Kelly*(p)* also expressed some apprehension:

Res: Did it encourage you, the fact that [your teacher] said physics was hard?
Kelly*(p)*: Not really, it made me wonder if I'd be able to handle it ... it got me thinking that I could drop it at the end of Year 11 if I couldn't keep up. (92-93)

The issues of confidence and self-efficacy implicated by this conceptualisation are part of an important thread running through this thesis, and are discussed again in Chapter Seven.

The Strategic Value of Physical Science Courses

In Chapter Four it was shown that physical science students often explained their enrolment decisions in terms of the strategic value of physics and chemistry with regard to tertiary options. However, the belief that strategic usefulness was the principal value of physical science subjects was found to be widespread among science proficient students in all choice categories. Many students gained this impression from their science teachers, for example:

Sylvia*(p)*: Yeah, I asked [my science teacher], and they said, 'What sort of things are you looking forward to in the future?' And I said mainly some biological [courses] and he said about how they [universities] teach biology as if you don't have any knowledge about bio. So you should do physics and chemistry because it leaves a lot more doors open. (96)

Madeline*(n)*: He [science 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)

However, this perception was also reinforced from other quarters:

Sylvia*(p)*: And I went to the science [careers advice stall] and there was a girl there who happened to want to do Environmental Science, which is one of the things I've got my eye on, and she said to do physics and chemistry because that's what all the universities want. (77)

> Kate*(n)*: Yeah, I've had people saying, 'You're limiting your options!' [by not choosing a physical science subject]
> Res: Which people are they? Do you mean teachers, or other students or your parents ... ?
> Kate: Like, all three! [laughs] (243-245)

> Res: Who told you that you need to do chemistry?
> Melinda: Um ... basically the [UAC] books again, and I've talked to [the science coordinator] as well about it and he said, 'yeah, you'll need to do it', and, like, Dad says the same thing, and Dad sort of knows. (75-76)

The Universities Admission Centre (UAC) Guide, mentioned in Chapter Four, was also cited by James*(p)*, Roger*(p)*, Kelly*(p)*, Hannan*(p)*, Jennifer*(p)*, Charlie*(p)*, Peter*(p)*, Renate*(p)*, Sylvia*(p)* and Shane*(p)* as having been influential in their decisions to take physical science. The common practice among physical science students of referring to university prerequisites further emphasised the strategic value of physical subjects.

Biology, on the other hand, was seen as having far less strategic value than the physical sciences. No student reported choosing it because of specific university requirements or recommendations, although as reported in the previous chapter, Phillip*(b)*, Tracy*(b)* and Robert*(b)* felt that it might be useful in this regard. However, in terms of status within the school science culture, biology did not appear to be promoted by teachers as strategically valuable.

In all, nearly half of the interview cohort (James*(p)*, Melinda*(p)*, Greta*(p)*, Sylvia*(p)*, Kelly*(p)*, Roger*(p)*, Hannan*(p)*, Charlie*(p)*, Jennifer*(p)*, Renate*(p)*, Peter*(p)*, Shane*(p)*, Uzlan*(b)*, Joanne*(n)*, Madeline*(n)*, Daria*(n)*, Stefan*(n)* and Kate*(n)*), indicated that physical science subjects had been promoted, mostly by teachers but also through the UAC guide, as strategically valuable in terms of university options. Previous research has shown this belief to be common among Year 10 and senior students (Ainley et al. 1994; Barnes 1999; Fullarton & Ainley 2000; Johnson & Bell 1987; Osborne & Collins 2001) and promoted strongly by the universities (Chadbourne 1995; Fensham 1992). However, the importance attributed to the strategic value of physics and chemistry by so many students in this study shows that, among science proficient students, this quality is regarded as the preeminent characteristic of physical science subjects.

There is some evidence, however, that the foundation of this belief may be eroding. First, Australian universities have become less demanding in terms of the prerequisites and UAI cut-off levels for many science courses (Niland 1998; Ridd & Heron 1998). While such moves have been made in response to declines in university science course enrolments, concerns have been expressed in other quarters that 'rigorous prerequisites have been abandoned by science providers at many of Australia's tertiary institutions' (AAS 2002). Thus, the traditional strategic value of high school physical science courses is, in a sense, being undermined by the responses of university science departments to funding imperatives tied to their own course enrolment rates.

A second consideration is that while physics and chemistry are still prerequisites for many medical and engineering courses, the burgeoning fields of university science are the applied science courses, such as psychology and computing science (ACDS 1999), for which physics and chemistry are not usually required. This shift may be seen as also reducing the strategic value of HSC physics and chemistry courses.

The four themes discussed above involved the most commonly expressed beliefs, values and attitudes pertaining to school science. However, the portrait presented is not necessarily comprehensive. For instance, it does not include the many less common observations made by these students. In this regard it is appreciated that a larger interview cohort may have amplified the significance of minor observations. This was a limitation of the study, as discussed in Chapter One. Additionally, there were two cultural characteristics attributed to science in the literature which were not greatly evident in this study. These were the male orientation of some science subjects, as mentioned in Chapter Two (Jones, Howe & Rua 2000; Kleinman 1998; Sjøberg & Imsen 1988; Solomon 1997), and the conception of science as a construct of Western society which may disenfranchise students from other cultural groups (Atwater 1993; Fensham 1988; Hodson 1993; Maddock 1981; Reiss 1993).

As to the first of these issues, the quote from Beth*(b)* used earlier (p. 103) was the only indication that a particular option was seen as being more appropriate for one gender than for the other. Indeed, the only other references to gender in the narratives were one by Mark*(b)*, about girls dominating the Year 10 science awards each year, and comments by Robert*(b)* and Joanne*(n)* that girls tended to work more efficiently in practical tasks. Likewise, there was no evidence that school science culture favoured or disenfranchised students of any particular ethnic background. However, this is not to conclude that such issues were not manifest in the science classrooms of these students. Rather, it is doubtful that students would be able to consciously articulate either of these issues without substantial prompting from a researcher. In any event, it is unlikely that students who had experienced such bias over four years of school science would still be represented in substantial numbers among those demonstrating high levels of proficiency in the subject.

THE DYNAMICS OF STUDENTS' SCHOOL SCIENCE WORLDS

The interviews explored students' perceptions of the interactions between students and teachers, and among classmates, which were most characteristic of experiences in science classrooms and laboratories. Again, the perceptions of students in different choice categories were remarkably similar, enabling the outline of a collective school science pedagogy to be constructed from recurring themes, the most common of which are presented below.

Teaching Dynamics

The lecture model

The teaching method most often reported was a lecture based approach whereby the teacher stood at the front of the lab or classroom, talking and writing notes on the board:

> Roger*(p)*: Everyone seems to teach the same.
> Res: And what's that?
> Roger: Just write it up on the board and talk to you about.
> Res: Write it on the board and talk about it ... uh hmm.
> Roger: The demonstrations and stuff, it's all very similar. (549-553)

Teacher centred approaches were described as typical by 20 students (54 per cent), from all of the schools and in all three choice categories. The use of this teaching model, where teachers were seen as 'information-givers' (Gallagher 1993), was consistent with the previously noted conceptualisation of school science as content-focused. It was also an approach criticised by about one third of the students as being used too often:

> Charlie*(p)*: Sometimes I don't understand things, and I just keep ... not understanding things. A lot of what we do is just copying stuff from the board, so it doesn't really connect. (30)

> Shane*(p)*: He just kept on writing. We didn't do any experiments or anything. We just wrote, for whole periods and whole doubles [double periods] and that.
> Res: Do you mean that you just wrote for a whole double period?
> Shane: Yeah.
> Res: No experiments at all?
> Shane: Oh ... he did a few, but only about four in the whole year. (233-237)

While this last comment referred to one particular teacher, it was provided by Shane as an example to illustrate the teacher and content centredness of his overall school science experience. The ubiquity of teacher centred pedagogies in the school science experiences of these students, and of the 'chalk and talk' approach in particular, was consistent with findings from other Australian studies (Goodrum et al. 2001; Lokan et al. 1996). It was again the case that perceptions of school science culture by science proficient students vary little from those of Australian students more generally. This recognition furthers the impression that high achievers in school science, including those choosing to continue with science subjects, are doing so in spite of the negative aspects of the subject, rather than because they had different perceptions or experiences of school science than those achieving at lower levels. This impression is discussed further in the chapter summary.

The importance of motivation

There was an expectation among interview participants that the teacher's role as knowledge broker needed to be augmented by skills in presenting the content in an interesting way. Too often the teaching lacked a motivational component, as these examples demonstrate:

> Kate*(n)*: The work was pretty boring as well. It was geology, but I'm sure if he'd wanted to, he could have found some way of making it better for us. (403)

> Melinda*(p)*: um ... the way [the teacher] taught was unenthusiastic, they didn't try and make it interesting or try to help you understand it better. (191)

Nonetheless, students were appreciative when teachers used motivational approaches:

> Richard*(n)*: My Year 7 teacher was great, I loved science in Year 7. (103) ... it was the expression that she used in teaching it, the way she taught it, she was more practical in the way that she did things ... she kept your attention ... she enjoyed teaching. (266)

Comments such as those by Kate*(n)* and Melinda*(p),* above, were consistent with the depiction in the previous section of school science as irrelevant or boring, although here the criticism concerned teachers rather than the content. It was also a comment made more often, and more emphatically, by students taking no science courses than by those in the other categories. Although experiences varied from student to student, it was evident that, more often than not, the approaches taken by teachers contributed to the perception of school science as decontextualised and uninspiring.

Teacher-student rapport

In their explanations in Chapter Four, none of the students taking no senior science were willing to attribute this decision directly to their experiences of science teachers, despite in some cases being critical of their teachers. This reluctance accorded with the finding, also reported in Chapter Four, that few science teachers considered students' decisions to be greatly influenced by such experiences. Nevertheless, further exploration of students' narratives found that the personability of the teacher was consequential in terms of students' overall responses to school science. Jennifer, for example, acknowledged the positive effect of one teacher's recognition of her as a developing individual:

> Jennifer*(p)*: They treat you as a person and trust you to do the pracs and stuff, and, um, they used to let you take control of the experiment ... they let you know that you did have some independence, that you are growing up. (588-590)

The importance of good teacher rapport was emphasised by over half of the students. While many made positive comments, the focus on 'facts' was seen by others to reduce the capacity for developing a personal dimension to the student/teacher relationship. Although this might also be a criticism of other subjects, there were two characteristics, related to the content-domination of science, which were seen to reduce this capacity. First, the 'chalk and talk' pedagogy limited the opportunities for discussion and other activities encouraging personal contribution. This criticism was made by James*(p)*, Melinda*(p)*, Sean*(n)*, Richard*(n)* and Malcolm*(n)*. For example:

> Melinda*(p)*: A lot of the work was just copying, just notes, there wasn't a lot of opportunity for discussion or anything like that. That's what has been good about this year ... there's been a lot of talking and discussion. (191)

Furthermore, four of the schools rotated specialist teachers through Year 10 classes for a set number of weeks, in order to provide students with a taste of physics, chemistry and biology topics. However, this practice emphasised the priority given to content over the quality of teacher/student relationships. The rotation of teachers was criticised by Peter*(p),* Greg*(b)* and Kate*(n),* who all commented that teachers didn't even have time to learn their names:

> Greg*(b)*: And ... I don't know ... I don't really like the way that it works at the moment, every term or so we swap teachers. You never really ... teachers don't know you very well and that.
> Res: Do you think that that is an important thing? [Pause] Do you think that that is a bit of a mistake that they do that [swap teachers]?
> Greg: Probably. It's probably so that you can get a taste, 'cause those teachers can teach, what, biology and chemistry and that ... but I'd prefer to be with just the one teacher. (145-147)

For many students, the establishment of a relationship provided a necessary, or at least desirable, framework within which they could negotiate classroom activities, behaviours and norms. For instance:

> Richard*(n)*: Personally, for me the teacher is the most important thing in the classroom. For learning. (193)

In a content-dominated teaching model, the opportunities for establishing such a framework were restricted. The limited opportunity for rapport between teachers and students, due to the focus on content, has been noted in other research (Osborne & Collins 2001) and contributes to the picture of a school science culture emphasising the assimilation of knowledge above the learning process and the quality of teacher-student relationships.

Efforts by teachers to cultivate rapport and to motivate students can be seen as two manifestations of personal investment on the part of teachers, in that such efforts focused on the student rather than purely on the subject content. As Richard*(n)* and Greg*(b)* commented above, this investment was appreciated and contributed to their enjoyment of the subject. Their comments, and those of others such as Robert*(b)*, Malcolm*(n)*, George*(n)*, belie the responses of science teachers in this study who generally felt that teacher effects were not greatly influential in decisions about senior science. The power of teachers to influence students' attitudes to subjects, and through these attitudes their enrolment decisions, was clearly illustrated by Madeline's experience. Before deciding not to take a science subject, Madeline had originally chosen senior chemistry ...

> ... because of our teacher, last year. He was really good at explaining things and even if we asked, like, really stupid questions he didn't laugh, he sat down and [answered them] (210-211).

However, after finding that this teacher was not taking the senior chemistry class, and having reviewed the course material, Madeline withdrew from chemistry in favour of Modern History. When asked again later about her original decision, she replied 'I just thought I'd be really good and choose science, for my teacher.'(219)

Learning Dynamics

Active and passive learning

Students' narratives also revealed details about conventional student roles within the culture of school science. In keeping with the portrait of teachers as purveyors of knowledge, students' own roles were correspondingly passive and receptive. The most commonly mentioned non-practical activity was copying notes from the board, followed by reading textbooks. Even descriptions of positive teaching characteristics included the predominant use of these methods. For example, Daria's description of her 'favourite' science teacher:

> Daria*(n)*: They taught things, but in a fun way, and in a way that you could understand.
> Res: What about their teaching methods?
> Daria: They used like, verbal, and writing down from the book. (201-203)

The prevalence of copying and note taking added to the picture of science pedagogy based on content transmission. This perception was expressed fairly evenly across choice categories, although as a criticism of individual teachers, it was more commonly noted by students who had decided against further science study.

Practical work

Science classroom activities were described as consisting almost solely of the transmissive dynamics described above, and practical work involving experiments. It was a common sentiment that 'practicals' or 'pracs' were enjoyable and valuable:

> James*(p)*: [With practicals] you get to see the result yourself. It's not just them (the teacher) doing it up on the bench, and you have no idea what they're doing, but you do it yourself, you get to know what you're doing and how you're doing, like that. (271)

> Phillip*(b)*: I found that I learnt more work through the visual, hands on, sort of stuff. Rather than just sitting there and writing it out and reading off the board. (219)

The appeal of practical lessons was expressed by one third of interviewees, from all categories, and reflected the findings by Goodrum et al. (2001, p. 123) that the opportunity to do experiments was, for many students, the most enjoyable aspect of school science.

Group Dynamics

Students were asked about their experiences and preferences with regard to group work. There was very little criticism of this aspect of classroom dynamics, with most students finding that they were given latitude to work in their preferred manner for different activities. They were also able to choose their own work groups, which generally included their friends. Although some students preferred to work by themselves, the majority (68 per cent) thought that they worked better in groups, either for social reasons or for a better learning experience. For example:

> Theresa(b): In a group, in a way, 'cause you get to explain to others how things are and you can ... like some people have different ways of explaining it and you can understand it better, and also ... by yourself you can do it one way, but you don't know if it's right or not. The other people can help you in a group. (328)

This finding was consistent with that of Waldrip and Fisher (1998) who concluded that many students felt better able to learn in a group situation.

SUMMARY

The most important finding which emerged from the exploration of students' school science worlds was the similarity of descriptions of school science provided by students making contrasting enrolment decisions. In addressing the first research question, the study had anticipated finding differences in students' descriptions of their school science experiences which might explain their decisions to forgo, or continue with, further science study. However, it was demonstrably *not* the case that science proficient students choosing physics and chemistry, for example, described a more attractive picture of their school science experiences than did those choosing not to continue with science. While details of experiences in various classes, and with various teachers, differed from student to student, there was general agreement about the most prominent features of the world of school science. These included an emphasis on course content, rather than on the learner, and the importance of faithful transmission of this content from teacher to student. Often the content was seen as decontextualised and personally irrelevant, although individuals responded differently to this perception. For many physical science students, the irrelevance of the content was less of a concern, with much of it being seen as an abstract challenge, similar to mathematics. Furthermore, the strategic value of physical science subjects was of greater priority to these students than was the anticipated relevance of the syllabus. For many students taking no further science, however, the void between what was addressed in school science, and what they regarded as personally relevant, was too great, and not compensated for by other qualities of senior science.

For all the emphasis on course content, it was ironic that students' deliberations about senior science subjects did not revolve around curriculum issues, such as the skills or knowledge associated with different subjects. Rather, the various science subjects represented different levels of difficulty, prestige and instrumental utility, with physics and chemistry respectively embodying the greatest amounts of these qualities. Hence, from the perspective of students entering senior science, a culture already existed which, in effect, persuaded them to make choices based upon a type of cost/benefit analysis of the type used in commerce. Issues of 'cost', such as subject difficulty and degree of abstraction, were commonly weighed against strategic 'benefits', such as university entrance, maximisation of post-school options and even prestige. These characteristics were promoted by teachers, and reinforced by school and university structures, to the extent that they were, for these science proficient students, inherent features of the culture of school science. Deliberations about science enrolment therefore involved each student referencing their sense of self-efficacy, the nature of their motivations (intrinsic and extrinsic), their orientations (present and future) and their post-school aspirations.

Finally, it was found that the descriptions of school science by science proficient students, including some who intended to pursue a career in science, were substantively similar to those of science students in general, not only in Australia (Goodrum et al. 2001; Lokan et al. 1996), but in the UK (Osborne & Collins 2001; Reiss 2000). This finding again indicated that it is not these students' perceptions of school science that were so different, but their responses. Thus, as suggested in Chapter Four, the most important influences on science proficient students' enrolment decisions seem to lie outside the world of school science curriculum, shaping their responses to science experiences and perceptions. Thus, the focus now shifts to the exploration of students' other worlds.

CHAPTER SIX

EXPLORING THE PEER AND MASS MEDIA WORLDS OF SCIENCE PROFICIENT STUDENTS

The previous chapter concluded that the key to understanding the different enrolment decisions of science proficient students was more likely to be found outside the world of school science. Exploration of students' other worlds did indeed reveal influences which contributed substantially to students' different responses, though the majority of these influences were found within family worlds. Nevertheless, investigations of peer and mass media worlds also revealed several intriguing and consequential findings. As these were relatively few in number, the results and discussion regarding peer and mass media worlds are presented together in a single chapter.

EXPLORING STUDENTS' PEER WORLDS

Introduction

The exploration of students' peer worlds was prompted by Costa's (1995) finding that friends often had an important influence on students' responses to school science. However, the review of the literature in Chapter Two found widely divergent opinions regarding the influence of peers on subject choice. Therefore, few assumptions could confidently be made about peer influence on the enrolment decisions of science proficient students based upon earlier research.

As in the previous chapter, the analysis conceptualised peer worlds in terms of structural, attitudinal and dynamic dimensions. The structural dimension included the size, gender mix and ethnic composition of peer groups to which interview participants belonged. Such details provided a profile of each student's peer world, so that influential relationships with particular peers could then be given a context. Particular attention was paid to characteristics of the primary friendship group, which, for nearly all students, consisted of other Year 10 students in their school. However, due to the relatively high level of influence attributed to senior students by SPQ respondents (see Table 4.1), relationships with older students were also explored. The attitudinal dimension, concerning the values, beliefs and attitudes common to each peer world, was explored through discussions about shared interests, attitudes to both school and science, and thoughts about the subject and career deliberations of others within the peer groups. Finally, the dynamics of the peer worlds were examined through descriptions of the history of the current friendship groups, and of peer interactions both within and outside science classrooms.

As noted in the introduction, peers did not feature in students' narratives to the same extent as family members, particularly when discussing subject deliberations, despite the fact that most questions about influence were not directed to any specific world. Whereas students' references to the direct, or indirect, influence of family members generated a total of 735 text units in NUD*IST, responses concerning peers in the same context produced only 208 text units. As a consequence, it was not possible to construct portraits of peer worlds with the same richness of detail as was the case with their family or school science worlds. Hence, the findings in this section are presented as they relate to the three choice categories, rather than under the headings of structural, attitudinal and dynamic dimensions of the world, as is the case when reporting explorations of the other three worlds.

From this point onward, comparisons can be made between salient features of students' school science worlds, as described in the previous chapter, and those of their other worlds. Congruency and incongruency between features of students' peer and school science worlds, and the implications for the second research question, are discussed at the end of this section.

Students Choosing Physical Science Subjects

The peer worlds of physical science students were quite diverse in terms of their size, gender mix, ethnic background, subject profiles and interest in science. Mapping the different dimensions did not reveal any noteworthy patterns regarding the structural, attitudinal or dynamic characteriestics of peer worlds described by this group. While a few students, such as Charlie and Peter, had friends who shared their personal interest in science, such interest appeared not to be a characteristic of most friendship groups. In this respect, the peer groups of physical science students in the present study were different to those of Costa's (1995) 'potential scientists', which she characterised as including students of similar interests, priorities and subject profiles. Indeed, findings revealed throughout this chapter indicate that many physical science students, particularly females, made very different enrolment decisions to their friends. As similar contrasts with Costa's findings were found in other choice categories, the implications are discussed later in the chapter.

There was a conviction among physical science students that the opinions and choices of peers had not influenced their own enrolment decisions. This was stated unequivocally by nine of the fourteen students (64 per cent), of whom the following extracts were typical:

> Renate: [My best friend] was basically influencing me to do what she was doing, so I wasn't really going to listen to her. She wanted me in her class, but I wouldn't concentrate. (108)

> Res: And you said your peers, they're down pretty low there [on the SPQ ratings]. So why is their opinion not so important to you?
> Jennifer: Oh, because they're not the ones who are going to live my life ... for the rest of my life, so ... (332-333)
> Jennifer: ... Like, I didn't do a subject just because my friends are doing it. One of my closest girlfriends, I'm not in any of her classes this year, which is sad, but I'm not going to choose it just because my friend's in it. (290-292)

> Res: What about your friends? Were they very influential in your decisions?
> James: They weren't influential, but we discussed ... after we chose our subjects ... well before we chose them we discussed what we needed.
> Res: What about doing the same courses as your friends? Is that very important?
> James: No, not now anyway. (284-287)

James' use of the term 'needed' (285), where he could have used 'wanted', was indicative of the strategic imperative of his motivations. It was interesting to observe that the strategic value of physical science subjects, which came to the fore in previous chapters, was again highlighted by students in the context of peer influence on subject choice. For some students, such as Jennifer, above, the angst revealed in their descriptions of trying to resolve intrinsic and extrinsic imperatives gave credibility to their assertions that, in deciding about science subjects, the choices and advice of friends had been discounted. The best example of such angst was found in this extract from Sylvia's narrative:

> Res: And what did your friends say about your taking physics and chemistry?
> Sylvia: um ... I told them what I've been telling you, about which subject I should take, and they were going more with what I felt. They said 'Yes, if you hate physics, don't do physics, do the biology.' And then I said that I didn't need the biology, I needed the physics. But they were really going with my feelings. If it had been the other way around, they would have gone 'yes, yes do the physics'.
> Res: What do you mean [by saying] 'if it was the other way around'?
> Sylvia: Well, it doesn't matter what circumstance it was, if I said that this is how I feel, but I'm not sure, they would have said, 'yeah, go with your feelings.'
> Res: OK, I understand. But you didn't go with your feelings?
> Sylvia: No, I didn't. I went with what people say is the best.
> Res: What people are they?
> Sylvia: Um, the careers advisor, the science teachers, a few older students ... yeah.
> Res: So you took the advice of these people over that of your friends of seven years?
> Sylvia: [laughs] They were more concerned about whether or not I'd have fun in the subject, and whether or not I'd enjoy it. (97-106)

For Sylvia, the deliberation process crystallised her understanding of the motivations behind her decisions. In general, the picture which emerged from comments such as those above was one in which physical science students recognised that peer emphasis on personal relationship values was secondary to their own future aspirations. Sylvia's recognition that her friends were concerned with the intrinsic qualities of particular subjects was echoed by Melinda, Renate, Shane, Greta and Jennifer. For the most part, the concerns of peers related to the difficulty of chosen subject profiles, for instance:

> Melinda: Lots of kids ... basically everyone I've talked to about all my subjects, everyone says, 'Oh my God! I can't believe you're doing all that.' They just think it's too much work, basically. (127)

In other cases, the comments concerned the demands that physics and chemistry would have on the student's social life. For instance:

> Shane: My mates said how it's going to be a lot of work, and that I won't be able to go out much. (95)

Such comments tie in with the findings in previous chapters that physics and chemistry were perceived by the general student population as being substantially more difficult than most other subjects. However, in line with the observation made in Chapter Five, some of the extracts above also implied that students attempting these subjects enjoyed a higher status among their peers. The prestige associated with enrolment in the physics and chemistry has also been recognised by other studies (e.g Johnston & Spooner 1992).

Only two physical science students indicated that the appeal of having friends in their courses had been a consideration in their decisions. In both cases, the consideration also revolved around the anticipated difficulty of particular subjects:

> Greta: [discussing her choice of physics] I'm okay if I don't have [close friends] in one or two subjects, because I work better with other friends. I need the friends in each subject, especially if it's a subject I don't like ... and also if I get my friends in my classes, they'll help me with the work ... (310-312)

> Peter: I wasn't going to pick subjects where I had no friends ... most of my subjects have some friends.
> Res: Would it have worried you much if you'd chosen something, or because of lines or something, you'd taken a subject and found that none of your friends were in it?
> Peter: It would depend on the subject. I wouldn't really mind if it was something like art. Something like maths, it helps to have friends.
> Res: How does that help?
> Peter: Aw ... we mutually benefit from each other when we don't understand something. Keep each other from going insane. (132-136)

However, such considerations were clearly secondary in the minds of these students to other, future orientated, motives. In fact, both Greta and Peter noted that the main purpose of having friends in difficult classes was to provide academic support, rather than companionship. The distinction between instrumental and affective motivations for wanting friends in particular subjects is one not often made in studies concerning peer influence on enrolment decisions, an oversight which may explain some of the contradictions in findings noted in Chapter Two.

The finding that physical science students attributed little influence to their peers in the matter of subject choice was supported, to some extent, by the SPQ data. Crosstabulations between choice categories and ratings for reliance on the advice of best friends showed that students choosing physical science subjects tended to rely less ($p<0.01$) on this source than did students in the biology/other science and, to a lesser extent, no science categories (see Table J.7, in Appendix J). The rating patterns from the contingency table are illustrated below, in Figure 6.1. The highest possible rating ('relied very much') was not chosen by any student completing the SPQ, and was left out of crosstabulations. The proportions within the higher and lower rating options in Figure 6.1 were consistent with a greater reluctance by physical science students to be influenced by the advice of best friends. Further crosstabulations revealed no significant ($p>0.05$) differences between the ratings of males and females.

While both male and female students choosing physical science subjects were reluctant to rely much upon the advice of their friends, there were gender differences in the degrees to which these students rated the influence of senior students, as mentioned in Chapter Four. The tendency for female students taking physical science subjects to rely more on the advice of senior students than did male students is illustrated below in Figure 6.2, using the data from Table J.3 (in Appendix J).

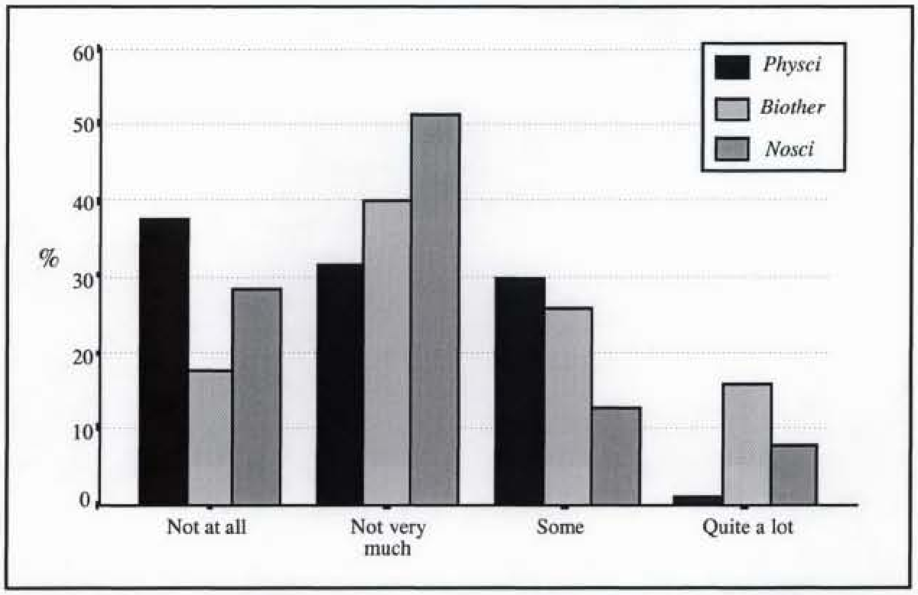

Figure 6.1 SPQ ratings for 'Reliance on Advice of Best Friend', by students in three choice categories (n=169)

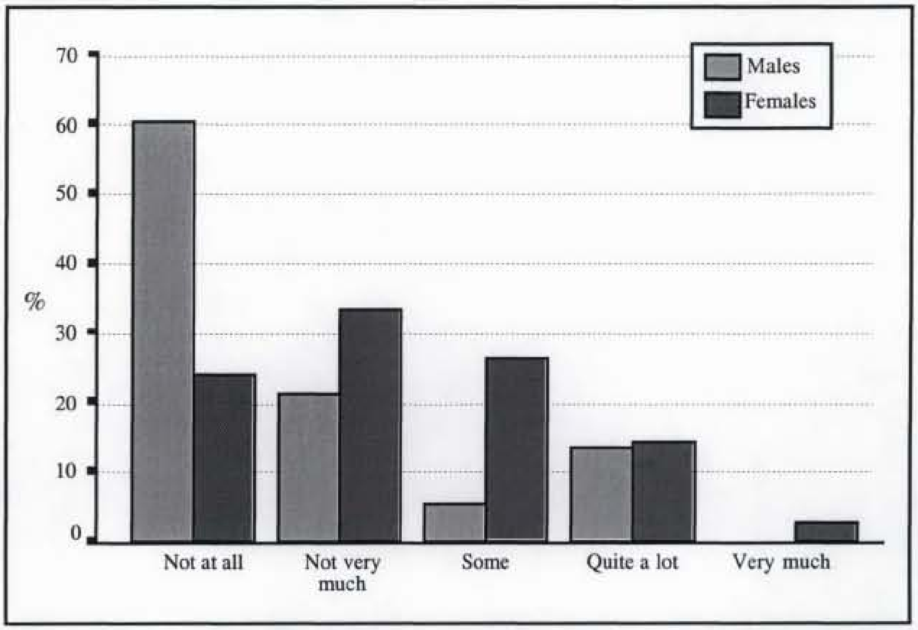

Figure 6.2 SPQ ratings for 'Reliance on the Advice of Senior students', by physical science students (n=80)

Since rating differences between males and females in the other two choice categories were not statistically significant ($p>0.05$), a likely interpretation of the gender difference in this choice category, as suggested in Chapter Four, was the greater need for females taking physical sciences to gain assurance from senior students about choosing these difficult subjects. Support for this interpretation was found within the literature (AAUW 1992; Campbell & Evans 1993; Kelly 1988; Khoury & Voss 1985; Leslie, McClure & Oaxaca 1998; Mau, Domnick & Ellsworth 1995; Stables & Stables 1995) and within the interview data, where the only students to actively seek advice on science courses from non-sibling senior students were four females choosing physical science, Hannan, Sylvia, Melinda and Salma. The situations of these students were similar, in that confidence was gained from discussing options with an older female student who had previously studied physical science. Hannan even commented that her subject profile, which included physics, chemistry and 3 unit maths, was identical to that of her advisor, whom she regarded as a role model. The confidence Salma gained from discussions with her female cousin, who was completing an honours degree in Engineering, is discussed in Chapter Seven.

In summary, the narratives of physical science students, and their relatively low SPQ ratings for 'best friend', demonstrated that their decisions to enrol in physics and chemistry were generally independent of peer influence. Those cases in which close friends had tried unsuccessfully to influence the students to take their other subjects reinforced this impression, and furthermore, re-emphasised the priority given by physical science students to strategic imperatives. Students' perceptions that their decisions were made independently of their peers was consistent with those of the physics students in Kelly's (1988) study. Kelly, however, was conscious that her multiple choice format ran the risk of being potentially unreliable, since 'children know what they are *supposed* to say and prefer to give the *correct* answers' (1988, p. 8, her emphasis). In contrast, the interview extracts presented above demonstrated convincingly that decisions by science proficient students to take physical science subjects were made with little regard to the choices or advice of friends. This confirmation is an important contribution of the present study.

Students Choosing Biology/Other Science Subjects

The most obvious feature of the narratives of biology/other science students regarding peers was that, while discussions about friendships in general were as extensive as those in the other choice categories, peers were very seldom mentioned in the context of subject choice. Of the aforementioned 208 text units concerning peer influence, only 18 were generated by students in this choice category, and these from just four students. Even considering the lower representation in this category, this was a disproportionately low number of references. Nevertheless, this absence of references to friends was interesting in itself, given the higher SPQ ratings for 'advice of best friends' among biology/other science students shown in Figure 6.1. It may be that the relative absence of interview data in this context was due in part to the lack of controversy surrounding the decisions these students made. For example, much of the discussion among physical science students about their peers concerned the reconciliation of competing imperatives, or post-decision incredulity among peers. However, there were no indications that the decisions of students choosing biology/other science were seen by peers as being in any way controversial or unexpected. In fact, the interview question specifically asking about positive or negative responses from others to students' science enrolment decisions (Q. 15, Appendix G), generated a comment from only one student in this choice category, and that related to his parents. In contrast, the same question asked of physical science students generated 14 descriptive text units while students choosing no science subjects responded with 11 descriptive text units.

This contrast provided some insight into general peer expectations regarding students' science enrolment decisions. Physical science students indicated that the decision to take two or more science courses often prompted comments from friends and classmates, being in excess of peer expectations. It is shown later that students choosing no science subjects spoke of peer expectations that they would take a science subject. Biology/other science students barely mentioned peer expectations at all. These findings point to a general expectation among peers that science proficient students would take some senior science, but not an excessive amount. Substantial variation from the norm, such as choosing both physics *and* chemistry, or choosing no science at all, often met with peer comment. However, the choice of a single science subject, such as biology, was expected and therefore elicited little comment. This interpretation was consistent with the finding reported in Chapter Five that the decisions by students to choose biology/other science were generally in accord with their positive attitudes to, and personal interest in, science. Thus, the choice of these biology would not have come as a surprise to friends who knew of these interests, as illustrated in the cases of Robert and Tracy:

> Res: You mentioned that some friends have encouraged you in science.
> Robert: Yep, like some of those six [best friends[and some of the girls [outer group] also, they're, like encouraging me, 'cause like they know how I like marine stuff and animals. (112-113)
>
> Tracy: Um ... I always collected animals, little insects. My friends always called me 'Mother Nature' [laughs]. (138)

It may be the case that since interest in science was well known, the decision to take science did not require the same degree of consultation as, for example, the case of Sylvia*(p)* (p. 116), nor would it have generated the same degree of post-decision comment as with Melinda*(p)* (p. 117). In addition, no student choosing biology/other science reported timetable clashes involving their preferred science subject. Thus, there was no requirement for peer support in deliberating over such clashes. Although these ideas are conjectural, they go some way towards making sense of the relative dearth of data among biology/other science students in this context, and the critical peer comments regarding decisions by other students to take two or three science subjects, or no science at all. Further research, focusing exclusively on peer expectations within similar groups, is needed to determine the validity of these possibilities.

Students Choosing No Science Subjects

Students in this choice category made reference to their peers about as often as did those choosing physical science subjects. As with the other choice categories, no patterns could be discerned within the structural, attitudinal or dynamic dimensions of students' peer worlds to suggest that cultural characteristics of peer groups were associated with their decisions. Likewise, there were no indications that science was not generally valued within the peer groups of these students. George, for example, enjoyed mining for opals and other precious stones on a lease he shared with his friends. Malcolm, Stefan, Richard, Helen and Michelle also referred to friends who were personally interested in science, or with whom they shared an interest in science. For instance:

> Malcolm: Yes, I was quite interested in biology. A friend of mine is a zoologist ... (132)
>
> Richard: I've got other friends who are interested in science and maths and that sort of thing. (61)
> If I need help I go to a friend of mine who's quite into science and who thought I should have done [a science subject] as well. (147)

With regard to peer influence on subject choices, there was a certain symmetry with the comments by physical science students. Whereas the latter spoke about choosing physics and chemistry in spite of the reservations of their peers, more than half of those deciding to forgo science were made aware that they, too, were going against the expectations, and in some cases the wishes, of their peers. The unconventional nature of their decisions was most clearly articulated by Joanne, Stefan and Michelle:

> Res: Have you had any responses, positive or negative, from anyone because of your decision not to choose a science subject?
> Joanne: It sort of ... people were sort of surprised ...
> Res: Students? Or adults or ... ?
> Joanne: Students, mainly. They just automatically assume that because you're in that [top] class you'll take that subject further. It's mainly just the students, because everyone in that class is doing a science except for me, and in other [lower] classes, most people are doing at least one science, so it just surprises them.
> Res: And what have they said to you?
> Joanne: They just say 'Really?', then sort of don't really say any more about it. (148-152)
>
> Stefan: um ... some of my friends are a bit amazed that I'm not doing science. (97)
>
> Michelle: Oh ... like when you say, 'I'm not doing a science', some people look at you funny, like 'You're not doing a science?' (129)

This expectation was felt most strongly by students whose closest friends were taking science. For instance:

> Res: Have you had any responses, positive or negative, from anyone because of your decision not to choose a science subject?
> Helen: Yeah, some of my friends have said that it's not a good idea ...(70)
> ... one of my close friends is doing two sciences, like she wants to do something with science later in life, she thinks its pretty good ...
> Res: And has her enthusiasm rubbed off on you at all?
> Helen: Oh a bit, but it hasn't changed my mind. (61-64)

Again, these situations do not reflect the peer worlds of Costa's (1995, p. 316) 'other smart kids', which were described as 'inconsistent with the world of science'. Not only did many of the students choosing no science subjects in the present study have friends taking physical sciences, there was also no indication that these students had been influenced by friends to forgo science in favour of other subjects. Thus, like the physical science students, those taking no further science were not greatly influenced in their decisions by the opinions and choices of their peers. Further comparisons with Costa's (1995) conclusions are made in the next section.

Implications for the Multiple Worlds Model

The second thematic research question guiding this thesis concerned the degree to which Costa's (1995) framework of cultural congruence could account for the different enrolment decisions made by science proficient students. Costa (1995) concluded from her study that congruence and incongruence between peer 'worlds' and those of school and science were associated with students' responses to science. In this regard her findings were similar to those of Astin and Astin (1992), who found that students were more likely to persist with a science course if their peers were also continuing with science.

The narratives of the science proficient students in the present study did not support the conclusions of Costa (1995) and Astin and Astin (1992). There was no evidence to suggest that students whose peers were personally interested in science, or had chosen science subjects, were more likely to continue with science study. Likewise, the similarity of interests and aspirations observed by Costa among the close friends of 'potential scientists' was not found by this study to be any more common among the friends of physical science students than among those of students making other enrolment decisions. In terms of the broader school peer group, the decision to enrol in two physical science subjects was just as likely to elicit adverse comments as was the decision to take no science subjects.

The angst referred to earlier as being experienced by some students who made a choice between the expectations, and even appeals, of their peers, and their other motivations, was consistent with the description of dissonance by Rea-Ramirez and Clement (1998). Yet, among students choosing no science subjects, and those choosing physics and chemistry, there were many who made their decisions in spite of the incongruence between imperatives which created this sense of dissonance.

One possible explanation for disagreements between the findings of this study, and those of Astin and Astin (1992) and Costa (1995), is that they involved students of different age groups. Students in the two US studies were generally eighteen years or older and, consequently, at a later stage of their education. Astin and Astin (1992) for example, were following students through their college years. Having already progressed through various stages of subject choice, their career preferences were more likely to have been aligned with those of their classmates. Thus, the filtering that takes place with each subsequent decision point means that it is crucial when examining peer influence to compare students who are at equivalent stages of their education.

Another point which may explain the contrast in findings is that Costa was concerned with students' attitudes to science and science careers. As has been shown in previous chapters, the choice of senior science by these Year 10 students was not always related to personal interest in generic science, nor to a specific career in science. Rather, students were more concerned with the difficulty and strategic value of the various science subjects.

Summary

In conclusion, the study found that despite peer expectations that these science proficient students would choose some senior science, their various enrolment decisions were little influenced by the advice, or decisions, of their peers. The possibility is recognised, however, that some aspects of peer influence may have been overlooked by the study, since students 'cannot be expected to discuss subtler influences that their friends might have had on them' (Stables 1996, p. 49). Nevertheless, it is the contention of the present study that the narratives of students choosing physical science subjects, or no science, demonstrated they were well aware of peer influence, and in many cases experienced conflict in their deliberations because of this awareness. The richness of these narratives supports the credibility of this conclusion.

EXPLORING STUDENTS' MASS MEDIA WORLDS

Introduction

The motivation for exploring students' engagement with the mass media came from research showing attitudes to science could be influenced by the images of science and scientists propagated through the visual and print media (Chen 1994; Gerbner 1987; Long & Steinke 1994; Ormerod et al. 1989). This study therefore asked whether the enrolment decisions of science proficient students had been influenced by their perceptions of such images.

Although the association between media images and attitudes was the only relevant link found in the literature, the approach taken by the present study was to conduct a broader exploration of this world, the results of which are presented and discussed below. As pointed out in Chapter Two, however, a student's engagement with the mass media differs from their relationships with the other three worlds, in that individuals are relatively passive participants, receptive both consciously and unconsciously to a plethora of data and images, yet with a much more limited opportunity to interact with the sources of those data than is the case within family, peer or school science worlds. The structural, attitudinal and dynamic dimensions of this world were therefore reconfigured to acknowledge these differences. Again, it is stressed that the conceptualisation of students' worlds in terms of these dimensions was merely an analytical device designed to ensure a methodical exploration. In actuality there was a great deal of interplay between dimensions.

Analysis in each dimension looked for differences between choice categories which might hint at an association with particular decisions about science. However, the exploration was equally attentive to individual perceptions and the role these played in each student's decision. The discussion concludes by drawing on findings from these analyses to consider the influence that media images may have had on science proficient students' post-school aspirations. It also discusses whether congruence or incongruence between this world and others was found to have had any bearing on students' deliberations.

The Structural Dimension of Students' Mass Media Worlds

The structural dimension comprised the set of media formats with which the students were able to engage, and the science content accessible through these formats. The content included science related television and radio programmes, movies, magazines and newsprint articles. Books, such as novels, were not included in this investigation, since images of science and scientists found in novels were not mentioned in the literature. The exclusion of this potential source of images is recognised as a limitation of the study. As was the case with other worlds, it was students' perceptions of the structures impacting on their engagement with the media that were pertinent to the study. Thus, media formats or content sources which may have been available, but were not specified by the students, were ignored.

The most commonly accessed medium was television, with interviewees reporting an average of about two hours viewing each day. To a large extent, the structure of students' engagement with the different formats was influenced by their parents. For example, some parents restricted their children's access to television, or to the internet. In other cases, the viewing preferences of parents took precedence over those of the students. Roger, for example, commented that his father 'basically controls the TV' (434). Because such considerations necessarily affected the viewing dynamics, they are discussed in a later section.

Access to newspapers and some magazines also depended a great deal upon their provision by parents. Thus, a feature of this world was that its structure was shared, and in many cases configured, by family members, in a way that students' school and peer worlds were not. The issue of congruence between family and mass media worlds was therefore of particular interest to the study, and is revisited in Chapter Seven.

A majority of the sources of science content nominated by interview participants were accessible through television. When asked to name science related programmes of which they were aware (but did not necessarily watch), only eleven student (30 per cent) could name more than one programme, and eight students (22 per cent) could not name any. The non-fiction science programmes nominated most often were 'Quantum', 'Beyond 2000' and the mini-series 'Life of Birds', all of which were screened on public television. Commercial television programmes were mentioned far less often, but included 'Totally Wild', 'The World Around Us' and in a few cases, documentaries on the Discovery Channel. With regard to fictional science related programmes, students nominated a range of science fiction series ('The X Files', 'Sliders', 'Neongenesis Evangelion', 'Red Dwarf'), forensic or detective programmes ('Water Rats', 'Inspector Morse'), medical/hospital series ('E.R.', 'Chicago Hope'), and a variety of science fiction movies (most commonly 'The Nutty Professor', 'Jurassic Park', 'Junior', 'Back to the Future'). There was no evidence that students in any one choice category were generally more aware of science related programmes than were those in others.

Radio was accessed by nearly all of these students, though only as a source of music and news. The internet, accessed by about half of all students, was also not considered a source of science content, except when researching for the occasional school assignment. In relation to newsprint, most students accessed newspapers at least once a week, although only two students recalled recently seeing a science related article. Most of the access to magazines involved celebrity or lifestyle magazines. Few students were able to nominate science related magazines, though 'Double Helix', 'National Geographic' and 'New Scientist' were mentioned by Charlie*(p)*, Stefan*(n)* and Malcolm*(n)* respectively. In each case these publications were subscribed to by parents.

In setting out science proficient students' perceptions of the general structures of their mass media worlds, two issues of further interest to the study were found. First, parents' often configured students' engagement with the mass media, by limiting or otherwise structuring access, or by their own habits of engagement with the media. The second finding was that students' perceptions of science through the mass media were obtained predominantly through television programmes and movies. These findings tie in with other aspects of students' engagement with the mass media, as detailed in the following sections. However, since some understanding of the dynamics of engagement with the mass media is required to appreciate aspects of the attitudinal dimension, the conventional order of discussion has been changed.

The Dynamics of Students' Mass Media Worlds

Mapping the dynamics of this world involved first exploring details of science proficient students' engagement with the various media formats. The analysis then focused on the degree of engagement with science related programmes, movies, or print media. A further consideration was the issue of shared engagement, such as the viewing or discussion of particular television programmes, magazine or newspaper articles with family or friends.

In terms of students viewing patterns, it was found that physical science students reported watching, on average, only about one and a half hours of television each school day, compared with about two and a half hours for biology/other science students and around two hours for those choosing no science subjects. The two reasons behind the lower average viewing time of physical science students were of greater interest to this study than the quantitative differences. First, two of these students watched no television at all during the school week. Viewing in both cases was restricted by parents so as not to detract from study and homework. Charlie's parents refused to buy a television, while the parents of Melinda restricted her television access to weekends:

> Melinda*(p)*: I'm not allowed to watch TV during the week. I'm only allowed to watch it on the weekends. Mum and Dad have always had the rule, even with [my older brother and sister]. (142)

A similar parental attitude to study was revealed in James' explanation of why he had no internet access at home:

> Res: Do you have access to the internet?
> James*(p)*: No. Mum won't let me. She says homework's more important.
> Res: So because of your work, no one in the family can use the internet?
> James: Yep. My Dad really wants to use the internet, but he can't, ... Mum says no. Until, probably, I'm out of school. Or at uni. (196-199)

These explanations pointed to the influence of parental attitudes to education, which are discussed in more detail in the next chapter.

A second contributor to the lower viewing hours was the recent relegation of television viewing by many physical science females to a lower priority. Renate*(p)*, Sylvia*(p)*, Jennifer*(p)*, Hannan*(p)* and Melinda*(p)* all commented that their own priorities regarding school work and television viewing had changed. For example:

> Sylvia: Last year in particular I was watching all these shows ... now, looking back, I found that to be a lot. I've lost my interest in it, and I've got more work to do. (163)

This reallocation of time did not apply to all female students choosing physical science subjects; Greta, for example, watched five hours of television per day. However, it is noteworthy that while five of the eight female physical science students mentioned a recent reassessment of their priorities, no male students choosing these subjects, or female students in other choice categories, expressed similar sentiments. This contrast is consistent with the tendency noted throughout this study for females taking physical science subjects to be more concerned than others about their demanding subject profiles and, therefore, more cautious about activities which might compromise school performance. While no clear conclusions can be drawn about this contrast due to the sample size, it does suggest an intriguing direction for further research. Apart from the two observations noted above, however, there were few differences across choice categories with regard to engagement with elements of the mass media.

There were also few differences across choice categories with regard to students' inclinations to engage with science related media content. About half of the students in each choice category reported sometimes, or often, watching science related television programmes at home. For the most part these were documentary or news/magazine type programmes, though medical and forensic dramas and science fiction series were also watched by a few students in each choice category. Engagement with science related fictional programmes was, however, reported far less often than the watching of sitcoms and soap operas, for example. The finding that levels of engagement with science in the media were similar for science and non-science groups was consistent with the conclusion from Chapter Five that there was little difference across choice categories in terms of science proficient' students own levels of interest in generic science.

Finally, the previous section indicated that parents to some extent structured students' media worlds. Investigations of the dynamics further revealed that students' inclinations to watch science documentaries or to read science magazines were, in many cases, affected by the behaviours of other family members. Since the term 'inclination to engage with' clearly implicates the attitudes of students and others to the programmes discussed here, it is more appropriate that this issue be addressed in the next section.

The Attitudinal Dimension of Students' Mass Media Worlds

Explorations in this world revolved around the question of whether the enrolment decisions of science proficient students had been influenced by images of science or scientists in the media. Thus, it was important to identify students' perceptions of the attitudes, values and beliefs associated with media images of science and scientists. It was also important to investigate students' responses to these images and their own attitudes to science related television programmes in general. A third consideration, noted earlier, was the influence of the attitudes and viewing behaviours of significant others on students' inclinations to engage with science related media content. These three issues had implications for the applicability of the congruency model to students' mass media worlds.

Perceptions of media images of science and scientists

It has been suggested that students' perceptions of the images of science and scientists, via the mass media, affect both their attitudes to science (Basalla 1976; Chen 1994; Long & Steinke 1994; Whittle 1997) and their esteem for scientists (Gerbner 1987; Heuftle et al. 1983). The present study looked for any differences in students' descriptions of fictional and non-fictional scientists that might suggest different responses to media images and, perhaps, different attitudes to scientists and their work. In order to investigate this, students were asked to discuss how fictional and non-fictional scientists were presented in the mass media.

Analysis of the responses to these questions found few differences in students' perceptions of fictitious scientists. Students described them as being mostly male, 'brainy', wearing a white lab coat, glasses and 'weird hair'. These scientists were often seen as eccentric and as working alone or with a 'little assistant'. For example:

> Sylvia*(p)*: Just the basic stereotype, like a mad, crazed scientist, or an absent minded professor. Someone with glasses ... Albert Einstein, with boofy hair, beards, and not really clean cut. A rebel ... and smart. Mostly male, long hair, grey hair. White lab coats. They're working by themselves, though they may have a crazed little side kick, but not [always]. (196)

> Richard*(n)*: Of course eccentric and bizarre, very unsocial, they all wear lab coats for some reason, and they've all got the test tubes with the bubbling formula. And there's always a chalk board with a formula in the background. And they always seem to be more so male than female ... obviously more recently you see female scientists, but most of the time males. I can only think of one female scientist who was in a film, so that's pretty bad. (236)

Such images were provided by students from all choice categories and conformed to the findings of earlier studies involving student populations of mixed science ability (Chambers 1983; Long & Steinke 1994; Schibeci 1986). The observation by Schibeci (1986, p. 27) that images were often unattractive was also reflected in the responses of students in the present study (e.g. mad, old, eccentric, solitary, evil), though, again, these images were provided by students in all choice categories. There were few descriptions which deviated far from these stereotypes. Robert*(b)* and Melinda*(p)* described a hero-scientist, while Roger*(p)*, like Richard*(n)* above, noted that recent movies were more inclined to include a female scientist. Ironically, given her rejection of all things scientific, Kate*(n)* provided the only positive image of a female scientist:

> Res: Can you tell me about any fictional scientists you've seen on TV or at the movies.
> Kate*(n)*: Um ... Scully on the 'X files' [medical doctor and FBI investigator]. She really believes in science, that everything has to have a scientific explanation. And, um ... she won't let anything turn her away from that. And she's a strong female. (350-351)

Thus there was no indication that the students making one particular decision about senior science enrolment described more positive or more negative images than those making another. The possible effects of stereotypical images, such as those described in the narratives of many science proficient students, on perceptions of real scientists, have often been discussed in the literature (Fullilove 1987; Jackson 1992; Schibeci 1986; Summrall 1995) though no definitive conclusions have been forthcoming. Nevertheless, it is lamentable to find such a limited representation of scientists perpetuated in the popular media, particularly since, to a large extent, it is 'the creators of popular culture from whom the [public] receives its portrayals of science and scientists' (Basalla 1976).

Regarding images of real scientists, the most conspicuous finding was that many students (43 per cent), including some who had provided detailed portraits of fictional scientists, were unable to recall having seen real scientists in the media. This inability to describe, or even to recall having seen, a real scientist in the media was found across all choice categories:

> Res: How do you think real scientists are portrayed in the media?
> Beth*(b)*: I don't know. I don't see them very much. (187-188)
>
> Salma*(p)*: I can't think of any. (298)
>
> Roger*(p)*: Um... I'm just trying to think of an example, um... (512)
>
> Joanne*(n)*: If I do hear it, it's not sort of something I pay attention to. (228)
>
> Richard*(n)*: Oh dear, I really can't tell you ... I can't remember. (238)

Those who were able to, described real scientists as being smart, mostly male, more often attired in suits than lab coats, and as working in a team for the benefit of society. Interestingly, almost all of the scientists were seen in medical contexts, for example;

> James*(p)*: They're factual. They're really formal, language wise, like they use big words and such, they look like they're smart anyway, they always wear glasses. In the media they are all male. Like, media wise, you don't see many female doctors saying 'We've discovered this', they always get the guy to do it. (252)
>
> Phillip*(b)*: [They're] presented as people with the answers to problems, like diseases and stuff, to see if they can solve it. They are portrayed as very smart people with a lot of responsibility.
> Res: Are they male or female?
> Phillip: um ... I suppose I see more males than females, but I'm not sure if that's the case. They're usually working in a team. (200-202)

The finding that descriptions of real scientists almost exclusively situated them in a medical context underscores the observation, made earlier, that students' had very little exposure through the media to actual scientists and the range of their endeavours. This is a discouraging realisation, since it has already been observed in Chapter Four that a very limited picture of science careers is gained from science classes. The lack of realistic images of a variety of scientists perhaps enhances the influence of caricatures on students' perceptions. This is another avenue of research requiring a more focused examination than was possible in the present study.

The further observation, by both male and female students, that real scientists presented through the mass media were mostly male could, according to Speckman and Bichler (1999, p. 6), communicate 'the hidden message that science is not a viable profession for women'. However, there was no obvious indication that this had influenced decisions by science proficient female students to forgo science, since the perception by females that scientists were predominantly male was widespread in all choice categories. In fact, it can generally be concluded that investigations of media images revealed few differences at all across choice categories, and nothing which could be associated with particular enrolment decisions.

Students' responses to television science programmes

An earlier section revealed that there were also few differences across choice categories in students' awareness of, and inclinations to watch, science related television programmes. In addition, the responses of science proficient students to such programmes were explored, and found to range from the enthusiastic, to the ambivalent, to the disapproving. However, again this range was found within each choice category, with no tendency for one particular group of students to reveal attitudes markedly different from those in other groups. With regard to non-fiction programmes, for example, while Salma*(p)*, Roger*(p)*, Sylvia*(p)*, Shane*(p)*, Robert*(b)*, Phillip*(b)*, Mark*(b)*, Uzlan*(b)* and Theresa*(b)* spoke positively about science related documentaries, so too did Stefan*(n)*, Michelle*(n)*, Malcolm*(n)* and Yvonne*(n)*. For example:

> Uzlan*(b)*: Last night I was watching a documentary on whether they should kill the smallpox virus, because it only exists in Russia and America. It was on SBS. I like watching SBS, and ABC [public broadcasters]. (166-167)
>
> Stefan*(n)*: I like watching 'The World Around Us' and stuff, they're really good shows ... documentaries I enjoy, especially on animals. I watched 'The Life of Birds'. (165)

And while Joanne*(n)* and Madeline*(n)* expressed very negative attitudes towards such programmes, so too did Renate*(p)* and James*(p)*. For example:

> James*(p)*: I don't watch them, but I know names. 'Quantum'. That is the only science show I know of.
> Res: Do you ever watch it?
> James: *No* [emphatically] No.
> Res: The way you say it ...
> James: It's *boring*! [emphatically], that's why.
> Res: Why is it boring?
> James: It's boring because ... it's not funny, it's not interesting, it's [missing] all the elements of a good show that I'd watch.
> Res: Not interesting, hmm. They'd like to think it was interesting ... but you don't find it interesting?
> James: I don't personally ...
> Res: Well, personally is what we're talking about. Let's say on the show they come up with some new invention, an engine design that uses solar technology or something like that ...
> James: [interrupts] No. Nope. (182-192)

In terms of attitudes to science related television dramas such as hospital/medical series, science fiction or detective/forensic dramas, the same range of responses was apparent in all choice categories. While Greta*(p)*, Hannan*(p)*, Peter*(p)*, Roger*(p)* and Theresa*(b)* included such shows among their favourites, so too did Kate*(n)*, Yvonne*(n)*, Thomas*(n)* and Stefan*(n)*. And whereas Madeline*(n)* had little time for these programmes, neither did James*(p)*, Renate*(p)* and Kelly*(p)*. Thus, there were no noticeable patterns in the attitudes to science related programmes of students in the three choice categories. In summary, therefore, the present study found no suggestion that the students choosing to continue with school science were any more aware of, or interested in, science related television programmes than those choosing not to continue. This finding is consistent with conclusions expressed in previous chapters that science proficient students' attitudes to generic science were not strongly related to their science enrolment decisions.

Shared engagement and parental attitudes to science in the mass media

It was noted earlier that the structure of students' engagement with the mass media was often affected by other family members, particularly parents. However, there was also evidence in some cases that a student's willingness to watch, or read, such material was associated with a similar inclination by his or her parents. For instance, Roger*(p)*, Sylvia*(p)*, Salma*(p)*, Phillip*(b)*, Theresa*(b)*, Stefan*(n)* and Michelle*(n)* often viewed documentaries in the company of their parents:

> Sylvia*(p)*: But, the main place where I hear about [science issues] is not from the News, it's more, like, from 'Four Corners', Dad's always watching them. Or sometimes they have a series of shows. Like they had one called 'What's Your Poison?' about all the drugs, caffeine and alcohol and the effects on people. (175)
>
> Res: Can you name any current television shows which focus on scientific ideas or nature?
> Phillip*(b)*: Um, 'Beyond 2000' I suppose, I've seen that. Dad watches that. And documentaries, I 'spose. I only see them when Dad's watching them and that. I sit down and watch them with him. (157-158)
> ... Res: When did you most recently see or hear of a science issue mentioned in the media?
> Phillip: um ... It would probably have to be last week, on SBS, when Dad was watching a documentary on genetic engineering ... I just sat down and watched it for 20 minutes. (165-166)
>
> Michelle*(n)*: oh ... yeah, if there are documentaries on, my parents always watch them. So, I sit down and watch it.

It was apparent from these and other extracts that the students were disposed to watch these programmes because their parents were watching them, underscoring again the importance of parents in influencing the structure of engagement with mass media. One interpretation might be that students had little alternative if parents were controlling access to the television. Another might be that parents were deliberately encouraging their children to watch such programmes for their educational value. Whatever the reason, these and other extracts revealed that the act of viewing these programmes with close family members, and the recollection of having done so, provided an added significance to the experience for the student. That these contexts were in some way personally significant can be seen from the level of unsolicited detail in responses such as those above. It is unlikely, for example, that Phillip*(b)* would mention his father three times in the extract above, unless his father's presence had meaning for him. Likewise, Theresa's reference to her father, in the extract below, suggested that the shared experience was somehow important to her.

> Res: Are there any other science fiction shows that you watch?
> Theresa*(b)*: *Any* science fiction movies. There was another one too, I used to watch it with my Dad, he likes science fiction ... (220-221)

The implication was that the act of viewing, and perhaps the content itself, had been given a special significance by the social context. Thus, the quality of the relationships, or what

Coleman (1988) refers to as social capital, between these students and their family members was implicated in the structure and meaning of students' engagement with science in the mass media. For example, it is shown in the next chapter that all of the students mentioned above as viewing documentaries with a parent, enjoyed positive, supportive relationships with that parent. It is also shown that not all students enjoyed such relationships, and that social capital was very influential in other aspects of science proficient students' responses to school science.

The influence of media images on science interest and aspirations

The similarities across choice categories reported to this point give the general impression that perceptions of media images, including the attitudes and values communicated by those images, had little influence on students' deliberations about their science subject choices. While this may have been the case at the group level, where patterns of variation between the choice categories were of more interest than variations between individual students, there was evidence that media images did influence the post-school aspirations of particular students. While these cases do not indicate group trends, neither should they be ignored, since they emphasise the capacity of media images to influence the aspirations of students.

The first observation was that media presentations of scientific matters played a role in arousing the curiosity of some students about the natural world, and germinating in others an interest in scientific careers. Robert's*(b)* interest in animals, described in the next chapter, and his pastime of collecting them and observing their habits, were encouraged by the science documentaries he watched in earlier years. Likewise, Uzlan's*(b)* interest in aspects of geology was stimulated by a television programme:

> Uzlan: I went through a phase where I used to collect bits of coal. And then I used to crack them open and some of them would have fossils of roots in them. I'd break them up and then try to put them back together again. I think I was in Year 5 or 6.
> Res: Do you remember who or what started you off on that?
> Uzlan: I just picked it up on the telly. Just a documentary on the ABC. (152-154)

Sean*(n)*, Yvonne*(n)* and Thomas*(n)* expressed an interest in forensic science which originated with their viewing of fiction and non-fiction television programmes. Until recently, Yvonne and Thomas had even regarded forensic pathology as a preferred career option:

> Res: What TV shows do you like to watch?
> Thomas*(n)*: 'Water Rats' ... all those types of cop shows.
> Res: Do you think there's a link between these and you wanting to do forensics?
> Thomas: Um ... no.
> Res: So, what made you interested in forensics?
> Thomas: Oh ... I thought it was interesting, how you come up with all these deductions by looking at one piece of fibre.
> Res: Where did you see this?
> Thomas: On police shows ... [laughs, recognising his own contradiction]. Not the best example to go by. (193-200)

Though fascinated by the science involved in forensic pathology, Yvonne was deterred because she was 'not very good with, you know, cutting up things' (309), especially when it would involve real people. Thomas' decision not to pursue this career path was more complicated and is discussed in the next chapter. The point, however, is that the initial interest was generated by television images of scientists at work.

Thomas and Yvonne were not the only students influenced towards a science career by media images. Peter*(p)* once had ambitions to be an adventurous scientist:

> Peter*(p)*: ... when I was young I wanted to be an archaeologist or a paleontologist [laughs] 'cause I was interested in dinosaur bones and things.
> Res: You didn't mention that before, when I asked you about different science things you used to be interested in ...
> Peter: Oh ... that was a long time ago. I was also interested in pirates and medieval things and stuff like that,... and archaeology because I watched 'Indiana Jones' movies [laughs]. (332-334)

From his expression, it appeared that Peter had set aside his science aspirations, along with pirates and knights, as a childish notion, in favour of his current career interests, corporate law and computer programming. From cases such as these, it appears that while perceptions of media images, particularly from childhood, did affect some students' enthusiasm for science, over time this enthusiasm was diluted or supplanted by other influences, lessening the appeal of science careers. Because it was outside the scope of this study to investigate in detail the processes contributing to these aspirational changes, they are a matter for speculation and further research. One possibility, however, consistent with the lack of promotion of science careers reported in Chapter Four, is that science educators may have overlooked the opportunity to capitalise on positive media images, or on interesting science issues raised by television programmes. Yvonne*(n)* described one such opportunity:

> Yvonne*(n)*: ... there's one show which I like to watch, with a medical detective, and that was more sort of forensic science. That was quite interesting.
> Res: Did that relate to anything that you've done in school, in the classroom?
> Yvonne: No. We'd done a bit on fingerprinting, but that was about it. (269-271)

The possibility that school science does not sufficiently integrate positive or interesting media presentations of science into the curriculum might also go some way to explaining why many students in this study were unable to recall having seen real scientists on television.

In contrast to the examples above, where fictional scientists stimulated childhood career aspirations, mass media stereotypes of scientists deterred Joanne*(n)* from choosing a science:

> Joanne*(n)*: I don't know ... it's always been one of those things that whenever I picture a scientist, it's just something I can never picture myself as *being* [emphasis]. Because of the images and stuff that I've seen on TV, and so, I just thought, OK, scientist, it's just not *me*. Whereas I can picture myself as being a business person, um ... so I just think, well, I'm not going to be a scientist, [therefore] I'm not going to do science!
> Res: So you do think the images on TV have been influential ...
> Joanne: Yeah. (272-274)

Joanne perceived fictional scientists to be 'sort of really corny, dweeb looking people' (220), and she was unable to provide a description of real scientists in the media. If the caricatures of scientists were her only models, it is little wonder that she could not picture herself in such a role. Her preferences were for law or business, in which careers, presumably, she could imagine herself. It might be recalled from Chapter Four that a small number of the science teachers, and Mitchell in particular, argued that fictional media images of lawyers influenced students to aspire to a legal career. Interestingly, of the five students (Kelly*(p)*, Stefan*(n)*, Joanne*(n)*, Madeline*(n)* and Michael*(p)*) who indicated a first preference for such a career, the last three described how their imaginations had been captured by mass media depictions, for example:

> Res: Can you tell me why you chose Legal Studies?
> Michael*(p)*: I just think that sort of thing is interesting. I went to work experience at the court (house), in the Prosecution Office. (39-42)
> ...Res: How long have you been interested in that [law]?
> Michael: oh ... a couple of years ... I've seen a few movies with that sort of thing, it looked interesting. (49-50)

> Res: And how long have you been wanting to do law?
> Madeline*(n)*: Oh, for ages.
> Res: Since primary school?
> Madeline: Yeah. (564-567)
> ... Res: Mmm. And you can't remember why [you wanted to be] a lawyer? Do you know any lawyers or ... any family friends? Anyone in your family?
> Madeline: No. No one.
> Res: No? Something on TV or ...?
> Madeline: Oh, I used to watch heaps of law shows when I stayed at my Nan's and stuff.
> Res: Yeah? Is this in primary school?
> Madeline: Yeah.
> Res: Like what? What sort of shows?
> Madeline: Um, she always used to watch 'Perry Mason' ... she always watched those ...
> Res: And did you watch them with her?
> Madeline: Yeah.
> Res: Right. And did you enjoy them?
> Madeline: Yeah. 'Cause also we could work out who the killer was and how he did it.
> Res: Okay. Do you still watch law shows or have you watched them up until now?
> Madeline: Yeah. I always watched, not, like the real ones, stuff like 'Ally McBeal' and 'The Practice' you know. They're not really how the law works [apologetically]. Yeah, I always watch those. (584-601)

Madeline's comment that such depictions were 'not really how the law works' indicated that she was not so naive, (or at least did not want to be seen to be so naive), as to mistake the fictional image of law on television with career realities. Nevertheless, such comments illustrate again how media depictions can instill images in students' memories, even at an early age, which they reference when deliberating about suitable career paths. While these images appeared, for Joanne*(n)* and Madeline*(n)* at least, to have successfully ignited their interest in law, the same cannot be said for science related careers. There were no cases in which students' aspirations for a science career were found to have been encouraged by their perceptions of media images in the same way that Joanne*(n)*, Madeline*(n)* and Michael*(p)* were influenced towards law.

Implications for the Multiple Worlds Model

Overall, few links were identified between students' school science and mass media worlds. There was no evidence to suggest that congruence or incongruence (Costa 1994) between aspects of students' school science and mass media worlds had played any part in decisions about senior science enrolment. The students' general impressions of scientists owed far more to the images propagated through the mass media than to images sourced from within school science. The fact that few students could recall images of real scientists suggested that their experiences of school science had done little to modify stereotypical perceptions, by introducing alternative, realistic, images capable of capturing the interest of students. This issue has been raised by Werry (1998), who advocated using the power of the mass media to provide students with positive and evocative images of science and scientists. At the very least, such an approach would provide alternative images to the caricatures most students described.

In terms of the influence of mass media images on students' science enrolment decisions, the fact that similar perceptions were reported by students in all choice categories meant that no general conclusions about such influence could be drawn. As was the case with perceptions of school science, however, individual responses to these images were different. Thus, responses to school science appear to be mediated by influences other than students' experiences within these worlds.

Summary

This section of the chapter addressed the question of whether the enrolment decisions of science proficient students' had been influenced by images of science and scientists in the mass media. It can be concluded, firstly, that the vast majority of such images were perceived through students' engagement with television and movies and, secondly, that the structure of such engagement was often influenced by parents. In general, however, there were few differences across choice categories in terms of students' awareness of, or attitudes towards, science related programmes. There were also few differences in the ways that scientists, both real and fictitious, were perceived by these students.

Despite the similarities in perceptions across choice categories, the analysis did reveal that the dynamics of media engagement and perceptions of science images had some influence on the attitudes of individual students. Where family members enjoyed watching science programmes, for example, there was a greater tendency for their children to join them and also to have more positive attitudes to such programmes and to science in general. This suggested that congruence between family and mass media worlds had some effect on students' attitudes to generic science. The influence of family behaviours and attitudes is discussed in the next chapter.

However, attitudes to generic science again appeared to have little influence on decisions about continuing with school science. Even in the few cases where students themselves made the connection between interest in science and the viewing of science related programmes, this was still a comparatively weak influence on enrolment decisions. By contrast, however, several students did link their aspirations for law or business to representations of those careers in fictional television shows, indicating that television images do have the potential to influence students' aspirations, though not, as far as this study could determine, towards a career in science. It may be the case that while students' are commonly exposed to stereotyped images of scientists when young, these are often not replaced, or balanced by, more realistic images. Thus, students' perceptions of scientists do not always develop as the student matures, and in some cases may be superseded by other media representations to which they can better relate, such as lawyers and business people. This is, however, a proposition requiring more research.

Finally, the fact that media representations of real scientists were not commonly recalled by many of these science proficient students raises questions about their exposure to such representations in science classrooms. This is not to say that teachers do not use videos or television programmes successfully in their classrooms to explain concepts, or portray scientific history. Rather, in the absence of positive images from other sources there appears to be a need to use television to introduce, or to emphasise, positive images of contemporary scientists and scientific endeavours. By linking such images to the curricula, teachers would furnish their students with a context for the curriculum content, as well as a range of positive images for reference in subject enrolment and career deliberations.