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AUTHOR Ainley, John
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ABSTRACT

In previous research, participation in science studies in senior secondary school has been related to background characteristics of students and to earlier achievements and interests. This paper reports an investigation of participation in courses in senior secondary schools in Australia which embody different science orientations. Two science-oriented course types were identified: (1) a physical science course type which included both physics and chemistry and was followed by 15 percent of students; and (2) a biological and other science course type which included two science subjects other than the physics and chemistry and was followed by nine percent of students. As a generalization, participation in a physical science course was most strongly shaped by earlier achievement in numeracy, interest in investigative activities, and gender. In comparison, participation in a biological and other science course was shaped by investigative interests, social, and curriculum influences. Among males, the influence of earlier achievement on physical science participation was independent of socioeconomic status. Among females, earlier achievement influenced participation for those of higher socioeconomic background but not for those of lower socioeconomic background. This suggests that differences in social processes are operating and that conventional expectations regarding women in science still limit some females in senior secondary school. (Author/ZWH)

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WOMEN'S PARTICIPATION IN SCIENCE COURSES AT SCHOOL: PERSONAL CHOICE AND SITUATIONAL CONSTRAINT

John Ainley, Australian Council for Educational Research

ABSTRACT

In previous research, participation in science studies in senior secondary school has been related to both background characteristics of students and to earlier achievements and interests. This paper reports an investigation of participation in courses in senior secondary schools in Australia which embody different science orientations. Two science-oriented course types were identified. The first was a "physical science" course type which included both physics and chemistry and was followed by 15 per cent of students. The second was a "biological and other science" course type which included two science subjects other than the combination of physics and chemistry and was followed by nine per cent of students. As a generalisation participation in a physical-science course was most strongly shaped by earlier achievement in numeracy, an interest in investigative activities, and gender. In comparison, participation in a biological and other science course was shaped by investigative interests, social, and curriculum influences. Among males, the influence of earlier achievement on physical science participation was independent of, and much stronger than, socioeconomic status. Among females, earlier achievement influenced participation for those of higher socioeconomic background but not for those of lower socioeconomic background. This suggests that differences in social processes are operating and that conventional expectations regarding women in science still limit some females in senior secondary school.

INTRODUCTION

The subjects studied in the senior secondary years are a major influence upon the educational and career options available to young people. Differences in patterns of subject choice which are associated with student background are often seen as involving issues of equity between groups (Oakes 1990). Concern over equity in subject choice is expressed in relation to science because it is regarded as the basis for entry to many programs of professional education. The relatively low levels of participation by young women in science courses at school means that a range of vocational choices are subsequently denied to them. This paper explores the influence of various influences on participation in school science; with special reference to the differences between young men and young women. It reports on the factors which influence participation in science-oriented courses by students as a whole. It also explore the question of whether different combinations of factors might apply to males and females (Kelly 1989; Ainley Jones & Navaratnam 1990; Crawley & Koe 1990; Oakes 1990).

The paper is based on a large scale national study of subject choice among senior secondary school students in Australia in 1990. It takes the view that, rather than any particular subject, it is the combination or package of subjects studied by students in the senior secondary years which influences their personal, career and educational futures. Therefore its main focus is on science-oriented combinations of subjects, referred to as course types, rather than individual subjects. A particular combination of subjects says more about a student's educational orientation than does enrolment in any given subject (Hofstein, Ben Zvi, Samuel & Kempa 1977; McEwan, Curry & Watson 1986). For example, many senior secondary students enrol in biology

but only a small fraction of those students include another science subject as part of their course. Hence some biology students would be considered to taking a science-oriented course but most would not.

PERSPECTIVES ON PARTICIPATION IN SCIENCE COURSES

Much of the literature on subject choice considers characteristics of students such as gender and social background. An extensive body of literature has examined gender differences in participation in individual science subjects and has consistently shown substantial differences in favour of males in the physical sciences (Harvey-Beavis, in press). Although it appears the size of these differences may reduced in recent times the gap remains wide (Dekkers, De Laeter & Malone 1986). Explanations for gender differences have often invoked ideas related to occupational aspirations, social influences in school and outside, opportunities to study science in the earlier years of school, and the nature of science curricula in schools (Kelly 1988; Willis 1989; Oakes 1990).

Student Background

In addition to establishing a wide gap in science participation between males and females, the literature on subject choice links other aspects of student background with science course participation. Socioeconomic background has been identified as associated with participation but the links are unclear. Given that some mathematics and science subjects are seen as prestigious, in the sense of the access provided for professional preparation, it is argued that students from high socioeconomic, and culturally enriched, home backgrounds would participate to greater extent than other students in those courses (Teese, 1989). Contrary to this, it is also argued that the orientation of those courses to applied science and engineering careers provides an appeal for working class males (Teese, 1989). Such an argument suggests that there may be interaction effects involving gender and social background contributing to a more complex picture than is sometimes painted. Similar contradictions arise in relation to non-English speaking background. Comparatively high participation rates in science among students of non-English speaking background have been attributed to high educational aspirations especially since those subjects might be less dependent on language and literature than humanities subjects. Again it is argued that these influences may impact differently on males and females (Ainley *et al* 1990).

In addition to establishing associations between subject choice and student background some the literature on subject choice concerns characteristics more closely associated with schools and their outcomes: achievements and interests.

Earlier School Achievement

High levels of earlier school achievement are associated with participation in science-oriented courses and, within science-oriented courses, in physical rather than biological science courses (Hofstein *et al* 1977; Lantz & Smith 1981; Berryman 1983; McEwan *et al* 1986; Jones 1988). Ormerod and Duckworth (1975) suggest that this pattern arises because physics and chemistry are seen as difficult and are chosen only by students who perceive themselves to be competent. The invocation of self-efficacy as an interpretation of the effect of achievement on subject choice is supported by a study of students who chose science majors in higher education (Betz & Hackett 1983) and by a study of the differences between males and females in the development of career preferences (Kelly 1989). Kelly adds the observation that the role of perceived competence is stronger for males than females. A further interpretation for the selectivity of participation in the physical sciences invokes processes of channelling which take place in schools rather than the exercise of choice by students (Lamb 1989; Oakes 1990). Either because students study in areas in which they feel capable, or because of the different advice (or even

prescriptions) given to students (eg. to maximise their subsequent choices of study and career), it is generally found that science course participation is higher among high achieving students.

Interests

Students' interests and attitudes have been consistently linked to participation in science-oriented courses in senior secondary school (Ormerod & Duckworth 1975; Lantz & Smith 1981; Berryman 1983; Milner, Ben Zvi & Hofstein 1987; Kelly 1988; Tamir & Gardner 1989; Oakes 1990). One quantitative synthesis of the results of a number of correlational studies concluded that attitudes were central to the choice of science studies, once the influence of achievement was controlled (Steinkamp & Maehr 1983). Given the evidence that interests are an important influence on subject choice there remain differences in the way interests are conceptualised in different studies. Some refer to whether it is interest in science subjects at school or to science as an area of human activity (Tamir & Gardner 1989). Others refer to whether interest is a response to a current experience of science study (Kelly 1988) or to a more general "person orientation" (Collings & Smithers 1986). It seems likely that when interest in science is measured the result is an interaction of an enduring pattern, formed as a result of cumulative experiences over many years, and the more immediate response to particular subjects at school.

Few studies have explored the possible link between interests and "perceived usefulness" of studies in science, even though both are linked to continued studies in science. Matyas (1987) suggests that the best predictor of a science career interest is a positive feeling about science classes. It would be expected that subject choice would be shaped by interest and vocational plans, or a combination of both. One interpretation of an association between interests and intended occupations is that both are manifestations of occupational interests which are shaped by experiences through school but which are more enduring than a particular response to one subject. On this basis it seemed likely that there would be an association between vocational interests and subject choice. It would be expected that investigative and realistic interests would be associated with participation in science-oriented courses (Lokan and Taylor, 1986).

Schools and Curriculum

Curriculum and school environment are also argued to be potential influences on participation in science courses. It is argued that some types of science curricula tend to be of greater interest to female students (Willis 1989). This argument applies both to the curricula in the senior secondary years (where choices are made), and to curricula in the earlier years (where interests are shaped). In the Australian context these influences are manifest in differences among states (curricula at senior school level being determined by state authorities), school type (government and non-government) and location (city and rural)(Dekkers *et al* 1986)

A Developmental Perspective

Subjects studied in the senior secondary years can be seen as being shaped by the interactive influence of interests, aptitudes, and opportunities (Oakes, 1990). Because choice of subject depends on this wide range of influences, and constraints, it would be expected to be associated with the characteristics of students and their schools. Students progressively make choices as they move through school. Patterns of subjects making up the courses of senior secondary students are not seen as simply arising from decisions taken at Year 11 and Year 12. From a developmental perspective, students develop a sense of competence in various curriculum areas and interests in different types of activities in response to social influences and experiences both in and outside of school. They form longer term educational and occupational ambitions, and receive advice from a range of sources. One view of these influences is to envisage *subject preferences* as being formed over a longer time frame and *subject choices* as the

manifestation of those preferences within a context of more immediate constraints and opportunities (Care & Naylor 1984). Understanding the differences in participation in science between young women and young men needs to take account of the interests and competencies developed in earlier years of schooling as well as the situational constraints (such as the availability of subjects) which operate at the time choices are made.

Evidence over a considerable period of time (Reid, Barrett & Rosenberg 1974; Entwistle and Duckworth 1975; Head 1985; Kelly 1988; Oakes 1990) suggests that the foundations of subject preference reside in the sense of competence and interests which students develop through their earlier school years. Students develop a sense of competence in various areas of the curriculum (such as mathematics), and interests in different types of activities (such as investigative activities) in response to social influences and experiences both in and outside of school, form longer term educational and occupational ambitions, and receive advice from a range of sources. This suggests that in addressing differences in subject choice among social groups attention needs to be directed to competencies and interests as well as to the patterns of choice themselves. Because choice of subject depends on this wide range of influences, subject choice would be expected to be associated with the characteristics of students and their schools.

This is not to deny the importance of the constraints, opportunities and peer influences at the time when subjects are chosen. A much wider range of subjects may be available on a state-wide basis but students' choices are constrained by what subjects their school offers, limitations imposed by the way the school timetable is structured, rules governing subject selection for the various certificates, and limitations as a result of the nature of previous studies (Alexander & McDill 1982). The study on which this paper is based found that approximately two fifths of senior secondary students nominated at least one subject which they wished to study but could not (Ainley *et al* 1990). Eleven per cent of those nominations were in science. The most common reasons given for not being able to study a subject of first choice were that the subject was not offered in the school or that there were timetable clashes; very few students suggested that not completing previous studies prevented them studying a subject of their choice.

When examining the constellation of influences including achievement, interests, and perceived usefulness which were associated with participation in science-oriented courses some scholars place emphasis on a developmental pattern from the earliest years (Collings & Smithers 1984; Head 1985) while others emphasise the importance of opportunities and experiences during school years in forming these orientations (Kelly 1988; Oakes 1990).

DATA AND METHODS

Studies of subject choice require student level data showing all subject enrolments, and other student characteristics, for each student. Such data allow not only an analysis of associations between subject choice and characteristics of students and their schools but also an examination of the subject combinations taken by students.

Data

This paper is based on the analyses from two sets of data: *Youth in Transition* and *Subject Choice*. One was based on a longitudinal study of students moving through school from the time when they were ten years old. The other was a much larger cross sectional study of students who were in the final year of secondary school in 1990. It was possible to construct analogous measures for corresponding variables in each, but it was only in the longitudinal data set that it was possible to explore the influences of earlier school achievement and vocational interests.

Most of the present paper is based on the *Youth in Transition Data* collected as part of an ongoing national longitudinal study of youth (Williams, 1987). Those data contain a rich array

of background information about students including their achievement in late primary school and their interests in various activities in early secondary school. Of the several cohorts forming part of the *Youth in Transition* study the one relevant to the present paper was born in 1970, took part in a study of literacy and numeracy in 1980 when they were then ten years old (Bourke, Mills, Stanyon & Holzer 1981), and were contacted subsequently by survey at the end of each year from 1985 onwards. In 1988, 1319 respondents who had completed Year 12 provided information about the subjects which they studied. These data provide the basis for analyses incorporating measures of achievement and interests.

The *Subject Choice Data* was a large representative data set from six Australian states. It primarily made use of a information from a survey of a large sample of students who studied in the final, and second last, year of school in 1990. In one state system data were supplemented by data from official records. The present paper only uses data from those in the final year of secondary school; a sample 22,000 students (Ainley *et al* 1990). It could provide information about associations between subject choice and the characteristics of students and their schools, but not in relation to achievements and interests.

Variables and Measures

Although variables such as gender and state are self explanatory there is a number of independent variables for which the measures need to be outlined.

- *Achievement* was measured when the students were ten years old and in late primary school in 1980. The tests were tests of basic competency in literacy and numeracy (Bourke *et al.*, 1981). For this paper the variables are represented in quartile form, with the quartiles being defined in relation to those students who reached Year 12.

- *Students' interests* were based on data gathered from students when they were 14-years-old and in the early years of secondary school. Respondents indicated how they felt about a range of 24 different activities. For each activity they indicated whether it was an activity which they "like very much", "like somewhat", "dislike somewhat", or "dislike very much". The activities were chosen to represent the six major interest fields elaborated in Holland's (1985) theory of vocational choice.

- *Socioeconomic background* was based on the prestige of parental occupations. Respondents indicated which of a list of occupational categories (with numerous examples) was closest to the present or last main occupation of their mother and their father. Socioeconomic status was assigned as the most prestigious of the two, according to the ANU scale of occupational prestige (Broom *et al*, 1977). For this paper it has been collapsed to four categories: low (unskilled or semi-skilled), lower middle (skilled trades), upper middle (clerical, service, small business, shop proprietor), and high (professional and managerial). *Non-English-speaking background* was based on parental birthplace.

- *School system* refers to the type of secondary school attended and is classified as government, Catholic, or non-catholic independent (for convenience referred to as independent). *Location* refers to where the student lived as indicated by questionnaire response which was classified as a capital city, a provincial or other city (more than 25,000 people), and a country town or area (less than 25,000 people).

PARTICIPATION RATES IN SCIENCE AND MATHEMATICS

Just over two thirds of Year 12 students studied at least one full-year equivalent science subject; 30 per cent included at least one subject from the physical sciences (ie. physics or chemistry)

and 45 per cent included at least one subject from the biological and other sciences. In these data two science-oriented course types could be identified.

1. A "*physical science*" course type which included both physics and chemistry: followed by 15 per cent of students. The vast majority of those in a physical science course type also studied more than one mathematics subject ("advanced" mathematics).

2. A "*biological and other science*" course type which included two science subjects other than the combination of physics and chemistry. Nine per cent of students followed this type of course, in which the most common combination involved biology and chemistry. A majority of these students studied just one mathematics subject.

Participation and Student Background

Table 1 records information about the association between participation rates in various science-oriented course types and characteristics of Year 12 students: gender, social background, non-English-speaking background, school type, location and state. It can be seen from those data that the largest associations concerned participation in the physical science course type.

TABLE 1 Participation Rates in Science-Oriented Course Types by Various Characteristics

		Course Type	
Variable	Categories	Physical Science	Biological & Other Science
Gender	Male	23.3	8.4
	Female	8.4	9.1
Socioeconomic	Upper	19.2	9.5
Background	Upper-mid	12.8	7.5
	Lower-mid	11.1	9.6
	Lower	12.5	7.5
NESB	Eng.	13.9	8.6
	NESB	25.9	8.4
Location	Cap. city	15.3	7.8
	Other city	16.4	10.5
	Rural	13.6	8.6
School Type	Government	15.0	8.5
	Catholic	14.6	9.2
	Independent	16.8	9.7
State	NSW	15.8	7.3
	Vic	12.1	7.7
	Qld.	17.8	11.2
	SA	15.0	8.7
	WA	18.0	12.4
	Tas.	8.9	8.0

Source: Subject Choice Data. Data on socioeconomic background, non-English speaking background, and location were not available for Western Australian government schools.

Physical Science Course Type

The results in Table 1 clearly suggest that a number of student characteristics were associated with participation in a physical science course type. Gender is strongly associated with participation in a physical science course type with male participation in this course type being nearly three times greater than that of females. Participation in a physical science course type was also strongly associated with non-English-speaking background with the participation rate for those whose home language was not English being almost double that of their peers of an English speaking background. It was also found that participation in a physical science course was much greater for the high (professional-managerial) group than for the other three socioeconomic groups; in other words the trend across socioeconomic groups was non-linear. In contrast to these associations home location (city or rural) and school type (government, catholic, independent) had only small associations with participation in a physical science course type.

Biological and Other Science Course Type

As shown in Table 1 there were only small associations between participation in biological and other science course types and the characteristics of students and their schools recorded in Table 1. There was a tendency for participation to be slightly lower in government than non-government schools, and for participation to be higher in provincial cities (especially when considered in conjunction with a similar small effect for the physical science course type) compared to either capital cities or rural areas. Since many of the students from the provincial city category are from larger industrial centres this may well reflect the types of study which are valued in those settings. There were two states where participation in this course type was noticeably higher than elsewhere. These states were Western Australia, where human biology attracts considerable enrolments, and Queensland where biological science is very popular and a range of other science studies attract significant numbers of students.

Achievements and Interests

The Youth in Transition data enabled an examination of relationships between participation in science-oriented course types and early school achievements and interests. In general the results suggest that early school achievements and interests were strongly associated with participation in science-oriented course types, especially the physical science course type.

Achievement and Science Participation

Data relating earlier school achievement and participation in various course types are recorded in Table 2. It is evident that there was a large, and clearly significant, difference in the percentages of students from each numeracy achievement quartile who participated in a physical science course. More than one third of those from the top numeracy achievement quartile participated in this course type compared to one twentieth of those from the bottom quartile. Expressed in a different way participation rates from the top quartile of numeracy achievement were seven times the rates for those from the bottom quartile. The association of participation in a physical science course type with achievement in literacy was less regular and less pronounced. Associations between earlier school achievement and participation in the biological and other science course type was less strong (but in the same direction).

TABLE 2 Participation Rates in Science Courses by Early School Achievements

Achievement Test	Category	Physical Science	Biological Other Science
Numeracy	Top quartile	36	13
	3rd quartile	17	13
	2nd quartile	13	12
	Bottom quartile	5	9
Literacy	Top quartile	24	16
	3rd quartile	24	10
	2nd quartile	17	13
	Bottom quartile	8	8

Source: Youth in Transition Data

Interests and Participation

Scores on several of the six interest scales were clearly associated with participation in science-oriented courses at Year 12; especially the physical science course type. Relevant data for the investigative and realistic scales are recorded in Table 3. Positive associations with participation in this course type were observed for the investigative and realistic scales. The strongest positive association involved investigative interests. Some 27 per cent of those from the top, compared to seven percent from the bottom, quartile of scores on the investigative interest scale participated in a physical science course type at Year 12. Realistic interests were also positively associated with physical science participation rates; the rate for the top quartile was double that from the bottom quartile. Negative associations were observed between physical science participation and the conventional, enterprising, and artistic scales.

Participation in a biological and other science course type was also positively associated with investigative and realistic interests but the strength of the association was considerably weaker than those noted for the physical science course type.

TABLE 3 Year 12 Participation Rates in Science Courses By Early School Interests (Youth in Transition Data)

Interest Scale	Categories	Physical Science	Biological & Other Science
Investigative	Top quartile	27	15
	3rd quartile	18	14
	2nd quartile	20	10
	Bottomquartile	7	7
Realistic	Top quartile	27	14
	3rd quartile	16	12
	2nd quartile	19	12
	Bottom quartile	13	10

Source: Youth in Transition Data

Gender, Achievement and Interests in Context

Achievement and interests are not necessarily independent of student background and school characteristics. For example, many interest scores were associated with gender (eg. males expressed greater interest in realistic and investigative activities than females whereas females expressed greater interest in artistic, conventional, and social activities), achievement was positively associated with socioeconomic background, investigative interests were associated with numeracy, socioeconomic background was associated with school system, and some interest scores were associated with socioeconomic background (positively for artistic, negatively for conventional interests). In a situation such as this it was necessary to extend beyond the simple associations between each factor and science participation to explore the major influences (in a relative sense) on participation and to make allowance for interconnections between these influences.

One technique appropriate for such an investigation is discriminant function analysis. Through the application of this technique the study sought to establish the linear combination of variables which would discriminate best between two or more previously defined groups (Hair, Anderson & Tatham, 1987). The present discussion reports on the results of applying discriminant analysis separately to the differences between each of physical science and biological and other science course types and the rest of Year 12. Table 4 shows the main variables contributing to the discriminant function, the structure coefficient, and the function coefficient. Structure coefficients are the simple correlation coefficients between the variables and the discriminant functions. It is the structure coefficients which are used to interpret the discriminant function (Tatsuoka, 1988). Function coefficients are standardised regression coefficients (beta coefficients) and show the strength of the relationship, when other things are equal, between the variable and the discriminant function. When there was a difference in the magnitude of the function and structure coefficients for a variable it provided an indication that the variable was associated with one or more other variables in the discriminant function. In addition, the table provides an indication of how accurately the function would classify students into each course type; how far apart are the groups on the discriminant function and the percentage of the cases actually in the designated course type which would be correctly classified.

TABLE 4 Discrimination Functions Distinguishing between Students in Science-oriented Course Types and Remaining Students

	Physical Science			Biological & Other Science	
Variable	Function coefficient	Structure coefficient	Variable	Function coefficient	Structure coefficient
Numeracy	.55	.56	Investigative	.64	.53
Gender	-.38	-.46	Queensland	.61	.47
Investigative	.50	.37	Realistic	.16	.33
Conventional	-.29	-.35	Socioeconomic	.26	.31
Literacy	.13	.29	West Aust	.39	.24
Social	-.06	-.27	Gender	-.23	-.08
Enterprising	.40	-.26	Literacy	.19	.20
Realistic	.06	.19	Indep. School	.19	.19

Notes: *The function coefficient is a standardised regression coefficient and the structure coefficient is a correlation coefficient between a variable and the linear discriminant function. Variables for which both the structure coefficient and the function coefficient were less than 0.20 have not been shown. Means for Physical Science group=0.94, rest=-0.22,(76% classified correctly). Means for biological science group=0.59, rest=-0.08 (71% classified correctly).*

Physical Science

The factors which distinguished students in the physical science course type from other students were high earlier school achievement in numeracy, stronger interest in investigative activities, gender (the negative sign indicates that males predominated), and lower interest in conventional activities. An examination of the function coefficients suggested that, when allowance was made for associations between the independent variables (eg. that females expressed less interest in investigative activities), the influence of gender was reduced a little but remained important. In other words the smaller percentage of females in physical science course types was not only attributable to patterns of interests expressed in early secondary school. The contribution of literacy achievement was reduced when allowance was made for numeracy achievement, with which it was correlated, and similarly the contribution of realistic interests was reduced if allowance was made for other variables such as gender and investigative interests. On the basis of this discriminant function one could correctly classify over three quarters of the students who were actually in a physical science course type.

Biological and Other Science

Interest in investigative activities was a major contributor to the discriminant function distinguishing students in biological and other science course types from their peers. There was also evidence of contributions from state influences (Queensland and Western Australia had higher participation levels due to the popularity of biology and, in Western Australia, human biology), social background (higher participation from the upper than the lower socioeconomic groups), and school system influences (independent schools had higher participation rates than government schools).

Gender Differences in Influences on Science Participation

The evidence in the preceding sections has reaffirmed the perception that gender is a powerful influence on enrolments in the science-oriented courses and that this influence remained even after allowing for the influence of other factors. It remained to investigate whether the same influences are associated with participation in the sciences for males and females. One approach was to apply discriminant function analyses, analogous to those above, separately for males and females. A second approach was to use cross tabulations to investigate the interactive effect of gender, socioeconomic background and achievement.

Discriminant Function Analyses

Results of the discriminant function analyses for males and females are reported in Table 5. From the structure coefficients for participation in the physical science course type it can be seen that although early school achievement was an important influence for both males and females it was more important for males. Interests (notably investigative and realistic) were more important for females than males, although they were important to both. Participation in physical science course types was negatively associated with conventional interests to a greater extent for males than females and enterprising interests to a greater extent for females than males. High socioeconomic status was associated with participation in physical science course types for females but the association for males was zero. In brief, participation in a physical science course type by males was strongly influenced by early school achievement, moderately influenced by interests, with almost no influence of socioeconomic status. For females the influence of achievement was important but not as strong as for males, the influence of interests was a little greater than for males, and there was an influence of socioeconomic background which was not detected for males.

Table 5 Discriminant Functions For Male and Female Participation in Physical science and Other Science Course Types

	Physical Science		Other Science	
	Female	Males	Female	Males
Achievements				
Numeracy	**.50**	**.70**	.15	.00
Literacy	**.28**	**.41**	**.23**	.09
Interests				
Realistic	.17	.03	**.25**	.18
Investigative	**.46**	**.33**	**.40**	**.40**
Artistic	.01	-.01	.17	-.05
Social	**-.25**	-.07	-.04	**.24**
Enterprising	**-.45**	-.13	-.18	.09
Conventional	-.19	-.18	**-.33**	**.35**
Student Background				
Socioeconomic	**.20**	-.05	**.23**	**.24**
Non-English Background	.09	.13	**-.30**	.16
Location	-.08	-.08	-.10	-.01
School Type				
Catholic School	.02	-.18	.10	-.08
Independent School	.05	-.05	-.11	**.44**
State				
Victoria	.00	-.11	-.03	-.02
Queensland	-.01	-.06	**.23**	**.48**
South Aust	-.13	.02	-.13	.13
Western Aust	.16	.02	**.42**	-.11
Tasmania	-.07	-.09	-.15	-.05
NT	-.06	.01	.02	-.09
ACT	.05	.04	-.04	.02

Notes: Structure coefficients (ie. correlation coefficients between the variable and the linear discriminant function) are shown and coefficients greater than 0.20 are shown in ***bold****. School type is a set of dummy variables relative to government schools. State is a set of dummy variables relative to New South Wales.*

There was also a difference between males and females in discriminant functions for the biological and other science course type. Female participants in the biological and other sciences were characterised by attending school in Western Australia (and to a lesser extent Queensland), having stronger than average investigative interests, less strong conventional interests, and being of Australian or other English speaking background. Participation in these courses also was associated with higher levels of achievement for females but not for males. Among males participation was associated with investigative and conventional interests, living in Queensland, attending an independent school, and being from a higher socioeconomic background.

Interactive Influences of Gender Achievement and Social background

There was evidence of an interactive influence of numeracy achievement, gender and socioeconomic background on participation in a physical science course type. Table 6 records participation rates for students in each of four possible combinations of numeracy achievement and socioeconomic background separately for males and females.

TABLE 6 Interactive Influences of Achievement and Socioeconomic Background on Participation in Physical Science Courses for Male and Female Year 12 Students

Socioeconomic Background	Numeracy Achievement								
	Persons			Males			Females		
	Low	High	Total	Low	High	Total	Low	High	Total
Low	10.4	22.3	16.6	14.5	38.8	27.2	7.7	8.7	8.2
High	9.5	26.3	19.8	16.6	36.9	28.0	3.4	17.7	11.7
All	9.4	25.3		15.4	37.7		5.0	14.9	

Source Youth in Transition data. The figures shown are perceptions of students in each cell whose course was characterised as a physical science type.

The results for all students confirm the strong association between participation in a physical science course type and both achievement and gender with a weaker association between participation in this course type and socioeconomic background.

For male students the results show a strong influence of achievement and almost no influence of socioeconomic background on participation in this course type. For females there was evidence of an overall effect of both achievement and socioeconomic background. Of even greater interest was evidence of an interactive influence of achievement and socioeconomic background on participation. There was a strong influence of socioeconomic background on participation in this course type among girls of high numeracy achievement but none (in fact a small reversal) among girls of low numeracy achievement. An alternative way of expressing this result would be to say that among girls of high socioeconomic background higher achievement levels were associated with participation in physical science course types, but among girls of low socioeconomic background no association was observed.

Coeducational Schools and Science

Using the Subject Choice Data it was possible to investigate the proposition that the coeducational status of a school influences the propensity of females to undertake studies in the sciences. Many studies of subject choice by females in coeducational and single sex schools have involved only small samples in local areas. The Subject Choice Data offered the opportunity to investigate this issue on a larger scale. The analyses involved 214 schools of which 159 were coeducational, 33 were girls schools, and 22 were boys schools. In this analysis the course types are defined slightly differently (mathematics-science, rather than physical science, and biological science) but the difference in practice was trivial. Table 7 records participation rates for three science oriented course types.

The first part of the table shows participation rates for all students. It clearly shows that the participation rate in a mathematics-science course type was greatest in all boys schools and least in all girls schools; a direct consequence of the different participation rates for males and females. There was no corresponding trend was evident for the "other science" course type, even a slight trend in the reverse direction.

Table 7 Participation Rates in Science Courses at Year 12 by Co-educational Status of School

	Coeducational Status			
	Girls School	Coed School	Boys School	All
All Students				
Maths-Science	11.7	15.6	24.1	15.9
Other Science	9.6	7.5	7.0	7.7
Female Students				
Maths-Science	11.8	8.4	---	9.1
Other Science	9.6	7.6	---	8.0
Male Students				
Maths-Science	---	24.1	24.1	24.1
Other Science	---	7.5	7.0	7.4

Source: *Subject Choice Data. Table does not include data from government schools in Western Australia.*

The second part of the table shows participation rates for female students by the coeducational status of the school which they attend. Those data show that the participation rate in a mathematics-science course type for females from all girls schools was a little greater (about 3.4 percentage points) than for those from coeducational schools. However, although there was a detectable difference it was small. It was far less than the difference between males and females in general (about 15 percentage points - see Table 1) and was one of the smaller differences bewteen groups in the data.The third part of Table 7 shows the participation rates for males by the coeducational status of the school which they attend. Those data show that there was almost no difference in participation rates for males in all boys schools or coeducational schools.

The data in Table 7 make no allowance for the influence of concomitant factors such as school type, socioeconomic background, or achievement. The mean socioeconomic level for students in single sex schools was significantly higher than for those in coeducational schools; and a higher percentage of Catholic (48 per cent) and independent schools (24 per cent) than government schools (5 per cent) were single sex. When a statistical allowance was made for these influences, and ethnic background, the difference in the female participation rate in a mathematics-science course type attributable to the coeducational status of the school was reduced (from 3.4 to 2.5 percentage points). It was not possible to allow for differences in early school achievement.

IN CONCLUSION

Two main science-oriented course types were identified in the subject combinations of senior secondary students in Australia; a physical science course type, and a biological and other science course type. There were differences between groups of students in their participation in these course types; especially in the physical science course type which involves the concurrent study of both chemistry and physics. Quite large differences were evident in the patterns of participation in this course type between males and females. There were also differences in the participation patterns between socioeconomic groups but only small differences between different types of school and between city and rural areas. As a generalisation participation in a physical-science course type is most strongly shaped by gender, earlier achievement in numeracy, and interest patterns. In comparison, participation in a biological and other science course type is most strongly shaped by investigative interests, social, and curriculum influences (as represented by systemic variables).

The analyses also show some complexity in the differences in participation between males and females. Among males the influence of earlier achievement on physical science participation is independent of, and much stronger than, socioeconomic status. Among females earlier achievement influences participation for those of higher socioeconomic background but not for those of lower socioeconomic background. This suggests that differences in social processes are operating and that conventional expectations regarding women in science still limit some females in senior secondary school. The issue which remains is whether those influences can be addressed through school programs or whether they are best addressed through community programs.

Even though the largest differences in the patterns of subject choice are between different levels of early school achievement and different patterns of interests which emerge in early secondary school, programs directed to those ends seem unlikely to change the relative poor science participation rates of females from lower socioeconomic backgrounds. It may be that policies to increase student participation in physical science courses need to be directed at early school experiences, but special attention needs to be given to females from low socioeconomic background. In addition initiatives directed to improving the science participation of females overall need to take account of the circumstances of those from low socioeconomic background.

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Correspondence: Dr John Ainley,
Principal Research Fellow,
Australian Council for Educational Research,
Private Bag 55
Camberwell Vic 3124
AUSTRALIA

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Signature: J. G. Ainley	Position: PRINCIPAL RESEARCH FELLOW
Printed Name: JOHN G. AINLEY	Organization: AUSTRALIAN COUNCIL FOR EDUCATIONAL RESEARCH
Address: AUSTRALIAN COUNCIL FOR EDUCATIONAL RESEARCH, 7, PRIVATE BAG 55, CAMBERWELL VIC 3124, AUSTRALIA	Telephone Number: +61 (3) 277 5500
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