Tertiary Students' Rankings of the Factors Behind their Choice to Study Mathematics and Computing: A Gender and Regional Study

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This paper describes an investigation into the factors which influence students in their choice of tertiary fields of study with major focus on mathematics and computing. The primary research questions were: what are the factors behind their choice, how are they ranked, and are there gender and regional differences underpinning these choices? 541 first year students were surveyed at four Queensland universities in 1998. Notable findings are reported, and the implications for promoting these disciplines are discussed.

Our student cohort is different to a decade ago (Tobias, 1990), and still changing. A sound understanding of current factors and influences underpinning students' choice has the potential to increase our understanding of our student cohort and to heighten our sensitivity to their expectations and disappointments. It has implications for the way in which degrees and courses are advertised and promoted in the community, and for the manner in which early undergraduate students are counselled. We need to be aware of changing trends in influences and aspirations, and develop sound practice based thereon.

There has always been interest in the factors that influence students entering tertiary study. Recent studies on secondary to tertiary transition difficulties (for example, Pargetter, McInnes, James, Evans, Peel, & Dobson, 1998), revealed that a factor like *strong interest in the field* is related to course satisfaction, and a factor like *parental influence* is related to first-year students' dissatisfaction with their chosen field of study. Significant attrition surveys, like that reported in Ramsay, Tranter, Sumner, & Barrett (1996), have pointed at the nature of relationships between factors of influence and persistence with, or withdrawal from, tertiary study.

There is little in recent Australian literature that focuses specifically on the factors that draw first-year students into either mathematics or computing. A recent investigation by Brinkworth and Truman (1998), in ten South Australian schools, revealed that the major influence behind scholars' choice to do Year 12 mathematics was the perception that mathematics was "*needed for further study*". A further strong influence was their "*ability to do mathematics*". Their espoused reason for not doing Year 12 mathematics was "*lack of appeal of the subject*", rather than "*inability to do it*". In the University of South Australia flexible admissions study (see Ramsay *et al.,* 1996), reasons for enrolment were sought generally. Of eight given reasons, those surveyed ranked "*to study in a field that really interests me*" the highest, followed by *"to gain entrance to an attractive career"*. "*To be with my friends*" ranked lowest.

Gender issues in mathematics and computing remain a source of concern, with enrolment in most countries indicating that fields that require a major focus of study on mathematics and computing are still male-dominated, and likely to remain so in the near future. Increasing numbers of women are entering tertiary study in Australia: females comprised 55% of commencing higher education students in Australia in 1999 (see DETYA, 1999). Yet the number of non-overseas women commencing study in non-traditional areas in Australia remains low at 20%, and 1999 figures show a rise in female enrolment in non-traditional fields of under 3% when measured against those for 1998. In 1997, the year prior to the gathering of the data for this study, females comprised 18% of commencing computing students in Queensland, and 35% of those entering mathematics.

Significant attempts have been made to identify the difficulties, and to support and encourage women. MERGA and PME Proceedings reveal many strong mathematics studies, and initiatives are well documented elsewhere too. Some Australian computing initiatives are overviewed in Craig, Fisher, Scollary, and Singh (1998), and Bae and Smith (1997) reviewed some in the US. Growth has been slow, however, and even the goals of Australian federal efforts like the *New National Agenda for Women* have not been realised.

The gender imbalance is particularly evident in regional universities, where first-year mathematics and computing classes attract very few women students. Is it possible there might be gender or regional differences in the factors that attract or influence prospective students in the choice of these disciplines? The literature offers little to illuminate regional effects on such factors. A notable 1980's longitudinal study of rural youth in Ohio (McCracken & Fails, 1991) investigated the influences on career and curriculum choices of high-school students in a range of disciplines as they matured and entered college. The influence of *self* was consistently ranked higher than that of *parents, friends* or *counsellors*. No regional comparisons were reported, however, nor any for gender. A gender study by Stables & Sian (1995) investigated career aspirations and the reasons for choosing A-level subjects, and reported that though the girls were significantly better qualified overall, than the boys, girls lacked confidence and felt the need for more advice.

There are perceived cognitive and affective associations between the disciplines of mathematics and computing. Many studies (for example Shashaani, 1995) point at links between the two, and Markert (1996) found common reasons why women do not choose careers in science, technology, engineering and mathematics. Mathematics comprises a substantial portion of the tertiary computing curriculum, and the two disciplines are often grouped in academic structuring. To investigate the field of influence specifically within the areas of mathematics and computing, therefore, and to illuminate any gender and regional trends, the primary questions posed for this investigation were:

- What factors lie behind the choice to study tertiary mathematics and computing?
- Are these factors ranked differently by first-year mathematics students and by computing students?
- Are there gender differences in these students' ranking of the factors?
- Are there differences in the rankings given by those students from homes and schools progressing from more urban areas to the more rural?

Research Design and Methodology

The decision was made to survey a large sample of first-year students at both regional and urban universities in Australia in Semester 2, 1998. Two urban and two regional universities in Queensland were targeted as appropriate, the urban universities selected so as to offer a balance of type: one traditional, the other a university of technology.

To facilitate good design of a survey instrument, ten quite different students were interviewed about the reasons for, and influences behind, their choice of studies in mathematics or computing. Their responses were synthesised into eight major factors. The three factors that surfaced as dominant in these interviews, were *strength in the subject, interest in the subject,* and *employment prospects*. A fourth factor raised often enough to be listed, was a *significant occasion or event*. The other factors that emerged reflected the influence of a significant other person: *teacher, parent, older sibling*, and *friend/other*.

Probably because the research aims were different, these eight factors classified influences on students somewhat differently to those used in some other studies. For example, Ramsay *et al.* (1996) did not specify or separate the influence of *teacher* from other "reasons for enrolment", nor distinguish between *parent* and *sibling*, listing *family* instead. Nor did that study investigate the influence of *strength* in a particular discipline.

The eight espoused factors were incorporated into a questionnaire which asked students to rate how highly each had influenced their decision to study mathematics or computing: either *strongly, moderately, weakly*, or *not at all.* Students were invited to list any other factors of influence too. They were also asked to order their top four factors of influence, to provide a different type of ranking. The rating of each factor by all or most students offered breadth of views across the cohort for that factor as an influence, whereas the ranking or ordering of the factors of major influence provided a relative measure of how strong was the perceived influence of each.

Questions also invited response on gender, location of home and school, country of origin for high schooling, type of school attended (government/non-government, single sex/mixed gender), higher education and occupation of parents, position in family, course entry (school leaver/mature-age), degree and major. To facilitate understanding of responses on employment prospects, open-ended questions on career aspirations and perceptions of future home commitments were included. The questionnaire was tested in a pilot study, minor changes made, and the refined instrument then administered to first-year, second-semester students at lectures in all of the primary mathematics and computing programs at the selected universities.

Responses were not accepted if students did not indicate significant commitment to a choice of major within the disciplines of mathematics or computing. They were also screened to remove any unreliable surveys, and to eliminate any repetition from respondents being surveyed in more than one of the classes surveyed. The data was then analysed using SPSS where appropriate.

Results

A total of 541 students' responses were accepted, the majority from the large metropolitan universities: 50% at the traditional one, and 45% at the university of technology. The representation from the two regional universities was very much lower, only 5% of the sample, but the data nevertheless revealed a good spread of home and school locations, which was important for the research (see Table 5).

General Rankings

For simplicity in this report, students' responses have been combined into those indicating relatively high levels of influence (*moderate* or *strong*) and those indicating low influence (*weak* or *not at all*). Though response rates were generally very high, close to the full group for most factors, not all respondents rated every factor. Table 1 gives the percentage of respondents on each factor, who rated it at that level.

This data confirmed and quantified the feedback obtained from the interviews done in the preliminary stages, that the factors *interest in the subject*, *strength in the subject*, and *employment prospects* are generally most influential. Students' ranking of their major factors of influence confirmed the Table 1 order of these three factors: 46% chose *interest in subject* as the strongest influence, 18% chose *employment prospects*, 17% chose *strength in subject*.

Table 1
Percentage of Respondents on that Factor who rated it at that Level (overall N=541)

	Parent	Sibling	Teacher	Friend	Occasion	Interest	Strength	Employment
Weak or Not at all	64	79	67	69	76	5	11	18
Moderate or Strong	36	21	33	31	24	95	89	82

Though the ratings of the influence of significant people were generally lower, over 30% of students rated highly the role played by *parent, teacher* or *friend*, and 20% of students conceded that an influential role was played by an *older sibling*. Of note too, is that a significant *occasion or event* was rated strong or moderate by 24% of students.

A comparison with factors of influence ranked in other studies reveals evidence of support for some of the findings, but also some notable differences. In the Ohio rural youth study (McCracken *et al.*, 1991), *self* (without further breakdown of the influences therein) was consistently ranked highest as a source of influence, followed by *parents, friends* and *counsellors. School personnel* and *counsellors*, however, were ranked lower than *parents* and *friends*.

These results lend support to the University of South Australia attrition study (Ramsay *et al.,* 1996) where "*To study in a field that really interests me*" was rated highest out of the eight proffered reasons for enrolment, followed by "*entrance to an attractive career*". *Strength in a subject* was not specified separately there, and the reason "*To be with my friends*" rated lowest, but is different to the factor of influence of *friend* investigated here.

A Comparison of the Ratings by Mathematics and Computing Students

The degree course indicated by each respondent was used to distinguish between students studying mathematics and those studying computing, and the two groups were analysed separately. See Table 2. For simplicity, only the percentage of students that rated each factor *moderate* or *strong* is tabulated here. The percentage that rated each factor *weak* or *not at all*, simply covers all remaining respondents.

Table 2
Percentage of Respondents who rated the Factor as Strong or Moderate (overall N = 413)

	Parent	Sibling	Teacher	Friend	Occasion	Interest	Strength	Employment
Comp N=413	33	21	26	33	25	96	88	88
Maths N=101	47	19	61	23	23	92	94	66

Computing students comprised 413 out of 541 in the group, so it is not surprising that Table 2 reflected the same trends as those for the full group. Their votes for the factor of strongest influence also confirmed the top ranking of *interest in subject (*51% of all votes), and a higher ranking of *employment prospects (21%)* than *strength in subject (*11%).

Mathematics students rated *interest in subject* and *strength in subject* as most influential. *Employment prospects* were not rated nearly as strongly as by computing students. Votes for the strongest influence confirmed the relative ranking of the top factors: 32% chose *interest in subject*, and 32% chose *strength in subject*. Thereafter, 11% chose *teacher*, and only 9% chose *employment prospects*. It is notable that the influence of *teacher* on mathematics students was considerable, and that they also rated the influence of *parent* more highly than computing students did. The influence of *friend* was lower.

A Comparison of Ratings by Gender

The classes surveyed reflected an attendance of 27% females and 73% males. Women comprised 23% of those surveyed in computing courses, and 40% of those surveyed in mathematics courses, reassuringly higher than the Australia-wide figures for women commencing in non-traditional areas. For the group generally, the gender breakdown of ratings was much like that for computing students in Table 3 below, and there were statistically significant gender differences.

Males rated the factors *interest in subject* (p = 0.003, Male M = 382, Female F = 142), *employment prospects* (p = 0.019, M = 380, F = 142), and *strength in subject* more highly, on average, than did females. Both the t-test and non-parametric Mann-Whitney test gave similar p-values. Females, on average, rated the factors *parent, sibling, teacher, friend/other person* and *occasion/event* more highly, but with *sibling* (p = 0.028, M = 203, F = 84) yielding the only significant difference.

Table 3 offers a comparison of male and female computing students. Male computing students rated the factors *strength in subject* (not significant), *interest in subject* (p = 0.000, M = 312, F = 89) and *employment prospects* (n s), more highly than did females.

Table 3

Percentage of Computing Male/Female Respondents who rated the Factor as Strong or Moderate (Male Computing = 318, Female Computing = 95)

	Parent	Sibling	Teacher	Friend	Occasion	Interest	Strength	Employment
Male Comp	30	15	25	32	25	97	88	89
Female Comp	42	38	27	35	26	93	87	87

Females rated all the factors *parent, sibling, teacher, friend/other person* and *occasion/event* more highly than did males, but with only one significant difference, that of *sibling* (p = 0.001, M = 165, F = 58). (On average, however, both males and females judged *sibling* influence quite low.) Though similar percentages of males and females (97% of males, 93% of females) gave moderate/strong ratings of the factor *interest in subject*, the statistically significant difference between males and females is a result of the degree of positive influence. 68% of males chose strong, rather than moderate, compared with only 44% of females. More males (56%) voted *interest* as the strongest influence than did females (35%). There were no statistically significant differences, on average, between male and female mathematics students' ratings, but Table 4 shows interesting results.

Table 4

Percentage of Mathematics Male/Female Respondents who rated the Factor as Strong or Moderate (Male Maths = 60, Female Math s= 41)

	Parent	Sibling	Teacher	Friend	Occasion	Interest	Strength	Employment
Males Maths	50	21	63	18	25	86	93	62
Female Maths	42	14	59	30	21	100	95	73

A Comparison of Ratings by Regions

The data offered a good spread of urban and regional home and school locations: see Table 5. Because there was little difference between the distributions of the respondents' home and school locations for the majority of their high school years, results will be reported on home location. Differences for school location were minor.

Table 5

Distribution (in %) of Home and High School Locations
Missing data accounts for discrepancies from a total of 100%.

	major city	large inland town	large coastal town	small inland town	small coastal town	rural property
Home	58	10	9	9	7	4
School	59	11	9	9	5	1

Students' ratings of the factors of influence were analysed first in two groups: the *urban* group: students from cities and large towns (77% of respondents) and the *country district* group: those from rural areas and small towns (20%). *Teacher* influence was rated more highly, on average, by students from country districts (p = 0.009) for home location, and p = 0.041 for school location). There were no significant differences noted for ratings on any of the other factors.

Urban students rated *interest in subject* as the strongest influence, with a vote of 46%. *Employment prospects* were chosen by 20%, and *strength in subject* by 17%. Country district students rated *employment prospects* (11%) lower than *strength in subject* (18%), but still rated *interest in subject* highest (49%).

For greater clarity, respondents were divided further, into *three* regional groups: *major city, large town,* and *small town/rural.* Table 6 gives the regional breakdown of ratings for the whole group, which were similar to those for the computing group alone.

Table 6

Percentage of Major City, Large town and Smalltown/Rural Respondents who rated the Factor as Strong or Moderate (City = 314, Large = 106, Small = 107)

	Parent	Sibling	Teacher	Friend	Occasion	Interest	Strength	Employment
city/ large /small	34 / 38 / 35	23 / 17 / 20	30 / 33 / 42	28 / 48 / 27	24 / 30 / 21	95 / 92 / 98	89 / 88 / 93	81 / 86 / 82

Mathematics students, however, rated the influence of *teacher* highly, and more so in smaller regions. See Table 7. Computing students may not have had a specific teacher in mind: their ratings of *teacher* were lower, and progressed from city to rural as follows: 25%, 24%, 31%. In the large town group, generally, *friend* had a surprisingly strong rating, 48% of all students admitting to moderate or strong influence.

Table 7

Percentage of Major City, Large town, and Smalltown/Rural Mathematics Respondents who rated the Factor as Strong or Moderate (City =51, Large = 20, Small = 27)

	Parent	Sibling	Teacher	Friend	Occasion	Interest	Strength	Employment
city/ large /small	44 / 38 /56	40 / 31 / 63	55 / 62 / 70	19/ 46 / 16	20 / 40 / 19	94 / 81 / 94	94 / 95 / 96	59 / 71 /74

Mathematics students from major cities voted for the strongest influence as follows: 35% chose *interest in subject*, 28% chose *strength in subject.* Only 12% chose *employment prospects,* and 10% chose *teacher.* Small town and rural mathematics students voted as follows: 48% chose *strength in subject*, 19% chose *interest in subject* 11% chose *teacher*, and 11% chose *employment prospects*.

Computing students ranked their strongest influences differently: those from major cities voted as follows: 48% chose *interest in subject*, 24% chose *employment prospects*, and 12% chose *strength in subject.* Only 11% of computing students from small towns and rural regions rated *employment prospects* as their greatest influence: 62% chose *interest in subject.* Influence of *friend* followed with 9%, a much bigger vote than *parent* or *teacher.*

Summary and Discussion

The investigation revealed that the factors *interest in subject, strength in subject* and *employment prospects,* are most widely felt by first-year students to be the strongest influences underpinning their choice to study mathematics and computing. Considerable numbers of students also rated *parent, teacher, friend* and *sibling* as moderate to strong influences, and some admitted to the strong influence of a significant *occasion or event.* Interview data validated and illuminated these findings.

Interest in subject is easily the most influential factor for computing students, followed by *strength in subject* and *employment prospects*, which rate similarly, and much higher than all other factors. Mathematics students rate *strength* and *interest in subject* equally strongly, but they rate *employment prospects* a bit lower, roughly on a par with the influence of *teacher. Parents*, too, are conceded to have considerable influence, nearly half the mathematics students admitting to strong/moderate influence. Results also indicate that *friends* exert a lesser influence on mathematics students than on computing students.

Gender differences revealed that males rated the factors *interest in subject*, *employment prospects*, and *strength in subject,* significantly more highly than did females. Females generally rated the influence of *significant people* in their lives more highly than did males, supporting claims in the literature that socialisation experience (Reinen & Plomp, 1997) is a more dominant influence in the lives and choices of females. It is important also to note that 17% of computing females ranked *strength in subject* as their strongest influence. Are there signs, at last, that women are beginning to bury the widely acknowledged “we can, I can’t” paradox? Is pervading technology itself the catalyst for that?

Many of the regional differences were slight, which is reassuring considering the perceived disadvantage of fewer opportunities for scholars. Is this a result of access to technology bringing information to the more remote areas? Even if this is the case, one very important finding of this study is that the personal influence of *teacher* is espoused by mathematics students to be felt strongly, and increases towards more rural areas.

Comparisons with ratings given by computing students clearly indicate that mathematics students, especially those away from the cities, should have more information on prospects for employment. While it may be the case that some students are drawn to the study of mathematics without the additional motivation of career prospects, ways should also be sought to make this information more accessible to parents and teachers, whose influence should not be underestimated. Current efforts are commendable, but professional mathematicians should increase their efforts to advertise career opportunities.

There is evidence in the data also, of the positive influence of *occasions or events* like mathematics camps, competitions, and career expos. These are some of the activities listed by students when asked to specify the nature of that influence. Clearly these results offer support for the promotion of such activities, and for increased efforts to create more opportunities of that kind.

These findings have valuable implications for educators, and for those who promote the study of mathematics and computing, or support and counsel students. Mathematics teachers and educators in particular, should be aware of the influence they have on the career and study decisions students make, especially in more isolated areas. They should build a knowledge base that supports this appropriately, and should be involved in the planning and organising of information sessions and activities for scholars.

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