Tertiary mathematics: Perceptions of school leavers and mature-age students[1]

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As part of a study focusing on mature age students in tertiary mathematics courses, a survey was administered to a large number of first year mathematics students. Data on personal background, self-perceptions as learners of mathematics and perceptions of the tertiary learning environment were gathered. Responses from school leavers and mature age students were compared. Differences were found on several background factors and some studentsí attitudes and beliefs. Generally, the mature age students were more satisfied with the tertiary learning environment.

Introduction and Previous Research

For some time it has been recognised that participation rates in mathematical studies at all levels are not equitably distributed among groups within populations. Almost without exception females are found less likely than males to study the most demanding mathematics courses offered and to persist with mathematics to the highest degree levels (Leder, Forgasz & Solar, 1996). The identification of other disadvantaged groups appears to be context dependent and can vary from country to country. In Australia, socio-economic status and ethnicity/cultural background (often characterised as non-English speaking backgrounds [NESB]) are common grouping categories of disadvantage (see Yates & Leder, 1996).

Much of the work on factors contributing to differential participation rates in mathematics courses has centred on school-aged children. Using a variety of methods and theoretical perspectives, previous research exploring gender differences has identified a complex of contributing variables: cognitive, affective, and environmental or contextual (e.g., Burton, 1990; Fennema & Leder, 1993; Leder, Forgasz & Solar, 1996). In Australia, higher participation rates in optional school-level mathematics courses have been found for students from higher socio-economic backgrounds [SES] (Ainley, Robinson, Harvey-Beavis, Elsworth & Fleming, 1994; Teese, Davies, Charleton & Polesel, 1996). Lamb (1997) found that gender differences in participation rates were related to the interaction of SES and positive attitudes and beliefs about mathematics.

At the tertiary level, factors influencing participation rates and learning outcomes have been of increasing interest as mathematics enrolment numbers have declined in Australia as elsewhere (J•rgensen, 1997). Forgasz (1996) found that the attitudes and motivations of a small group of mature-age[1] mathematics students were more functional, (that is, more likely to lead to success and future participation) than those of their school-leaver counterparts. It was argued that more mature-age students should be accepted into tertiary mathematics courses. Perceived levels of discrimination by gender and ethnicity, Forgasz (in press) contended, had the potential to impact negatively on the decisions of some students to persist with tertiary mathematics study.

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[1] Students who have not necessarily completed the formal academic pre-requisites required generally, or for specific courses, and who are 21 or over on March 1 of the year in which tertiary entry

Mature age students and mainstream[2] tertiary mathematics courses

Various policies have been put in place to encourage young Australians to proceed to tertiary education. These changes seem to have been of particular benefit to two groups: females and older students. Females now substantially outnumber males at university (e.g., Australian Bureau of Statistics, 1996) and the greater flexibility shown by tertiary institutions has resulted in increased enrolments of mature age students. The pattern does not appear to have been uniform across different subjects or courses. While national data are difficult to extract, an exploration of the data file for Australia-wide university enrolments in 1996 revealed that 35% of all students who commenced a bachelorís degree were aged 21 or over (Leder & Forgasz, 1997). A smaller proportion of this age cohort appears to enrol in tertiary mathematics. Limited to data from three Australian universities, Forgasz (in press) found that of 1072 (58% male) undergraduate mathematics students surveyed, 11% (15% of males; 5% of females) were mature-aged.

As part of a larger study focussing on the experiences of mature-age students studying mainstream tertiary mathematics, a large scale survey was administered to first year students enrolled in mathematics courses at five Australian universities. Differences between mature-age students and school leavers were of particular interest. Within each group, the data were also examined by gender, SES, and student ethnicity. Some of the findings are reported in this paper.

The Study

The instrument and analyses

The survey instrument used was a slightly modified version of one previously administered to undergraduate mathematics students by Forgasz (in press). The modifications allowed for a sample population of first year undergraduates and for a focus on mature-age students. Items provided the following data on students:

- biographical and background information including: sex, age, ethnicity (e.g., language/s spoken at home), SES indicators (e.g., receiving financial assistance to study), school attended for grade 12 (e.g., school type)
- self-perceptions as a learner of mathematics including: enjoyment of mathematics, perceived achievement levels, confidence, attributions for success and failure
- perceptions of the learning environments: quality of teaching, course difficulty, workload, assessment, availability of help, and discrimination

Students responded to some items on 5-point Likert-type scales (1 = strongly disagree to 5 = strongly agree). For other items they selected among categories (e.g., yes/no/ sometimes). Responses were analysed using $SPSS_{WIN}$. For some variables, independent groups t-tests and chi-square tests were used to explore for differences among the various groupings of students. Statistical significance was set at the .05 level.

The sample

Sample sizes differed across universities but were representative of the relative sizes of the institutions (see Table 1). It can also be seen on Table 1 that the proportions of males, mature age students, and students of non-English speaking background [NESB] comprising each university sample varied considerably. These institutional differences are worthy of further investigation. However, for the purposes of this paper, the

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[2] ìMainstreamî does not include ëbridgingí or similar courses

university samples were combined. Table 2 shows frequencies for the entire sample by gender, age and language breakdown.

Table 1. Sample sizes by university, gender and student age.

University						
	1	2	3	4	5	Total
Total	75	94	195	201	246	811
M^1 (%)	37 (50)	86 (92)	100 (52)	121 (60)	150 (62)	494 (62)
F	37	7	91	80	94	309
SL (%)	57 (76)	66 (70)	182 (93)	175 (87)	234 (95)	714 (88)
MA	18	28	13	26	12	97
ESB (%)	55 (73)	35 (37)	128 (66)	130 (65)	157 (64)	505 (62)
NESB	20	59	67	70	88	304

It should be noted that 8 students did not identify their sex, 2 did not indicate whether they were ESB/NESB

[1] M = male, F = female; SL = School leaver, MA = Mature age; ESB = English speaking background, NESB = non-English speaking background

Table 2. Sample size by gender, age and language background

	Student Sex		Age		Language	
	M	F	SL	MA	ESB	NESB
Total N=811 (%)	494 (61)	309 (39)	714 (88)	97 (12)	505 (62)	304 (38)
Males (%)			428 (60)	66 (69)	307 (61)	186 (62)
Females (%)			280 (40)	29 (31)	193 (39)	115 (38)
School leaver (%)					455 (90)	257 (85)
Mature-age (%)					50 (10)	47 (15)

The data on Table 2 indicate that of the total sample:
- males comprised 61%
- mature-age students represented 12%
- NESB students made up 38%

Compared to their proportions in the total sample:
- there was a higher proportion of male mature age students (69%)
- mature age students comprised a slightly higher proportion of the NESB (15%) group

These data are consistent with Forgaszí (in press) sample break-up and suggest that the students surveyed were representative of the Australian tertiary mathematics cohort and that the composition of cohorts has not varied markedly over the last few years.

The composition by age of the mature age cohort was as follows: 63% were between 21 and 25 years of age when they commenced their current courses; 37% were older.

Results

There were three groups of variables on which comparisons were made between the school leavers and the mature age students:
- personal characteristics
- beliefs and attitudes
- perceptions of the learning environment

The findings for each cluster of variables are presented below.

Personal characteristics

Data were gathered on various aspects of studentsí backgrounds and personal status. A summary of selected variables on which the school leavers and mature age students appeared to differ are shown on Table 3.

Table 3.   Personal characteristics: School leavers and mature age students

Variable/Characteristic	% School leavers	% Mature Age
Full time students	99	87
Receive Austudy[3]	31	52
Never married/no permanent partner	97	73
Have children	-	16
Grade 12 in Australia	95	65
Australian-born	68	50
Single-sex school for grade 12	28	22

Personal characteristics for which it might have been expected that members of these two groups would differ appeared to be confirmed by the data shown on Table 3. Compared to the mature age students, higher proportions of school leavers were studying full-time, single and without children. Interestingly, higher proportions of mature age students than school leavers received Austudy, were not Australian born and/or completed grade 12 studies outside Australia (consistent with their higher representation among the NESB group); a lower proportion had attended single-sex schools for grade 12.

Ten per cent (69) of the school leavers and 73% (71) of the mature age students had not proceeded directly from school to their current university courses. These students were asked to indicate one or more reasons for having had this break in their studies. The data are summarised on Table 4.

Table 4.   Reasons for not proceeding directly from school to current university course: Percentages (and frequencies)

Reason	% School leavers	% Mature Age students
had not decided on career	12 (8)[1]	23 (16)
wanted to travel	20 (14)	13 (9)
wanted a break from study	28 (19)	27 (19)
wanted outside experience	19 (13)	14 (10)
family influence	9 (6)	6 (4)
no intention to go to university	1 (1)	7 (5)
not academically qualified	-	3 (2)
studied at another tertiary institution	41 (28)	45 (32)
had to work to support family	-	10 (7)
had to work to support self	9 (6)	32 (23)
other reasons	25 (17)	10 (7)

[1]   Frequencies shown in brackets

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[3]   Australian government financial support for students. Stringent eligibility criteria apply, including age and parental means-testing.

Again, as may have been anticipated, the school leavers and mature age students differed in the extent to which particular factors might contribute to a time lapse between their attendance at school and for their current courses at university. The mature age students were more likely than the school leavers not to have decided on a career path, to have had to support themselves and/or their families, and/or not intended to pursue tertiary study. The school leavers were more likely than the mature age students to have wanted to travel and/or gain experience outside educational institutions.

Beliefs and attitudes

In several places on the survey questionnaire, items were included which reflected studentsí attitudes and beliefs about themselves as mathematics students. Many similarities were found for the two groups of students. On average, there was no statistically significant difference in their beliefs about:

- potential levels of success in tertiary mathematics that year (SL=3.36; MA=3.5)
- the extent to which likely success in tertiary mathematics was attributed to ability (SL=4.11; MA=4.19), task difficulty (SL=3.11; MA=3.08) and luck/environment (SL=2.55; MA=2.51)
- the extent to which possible failure in tertiary mathematics was attributed to ability (SL=2.84; MA=2.95), effort (SL=4.13; MA=3.93), task (SL=3.43; MA=3.44) and luck/environment (SL=2.37; MA=2.44)

For two of the affective items, statistically significant differences were found:

- A higher proportion of school leavers (33%) than mature age students (17%) indicated that they were studying mathematics because they believed they were good at it (p<.01)
- Mature age students (4.43) scored higher than school leavers (4.06) on attributing likely success at university mathematics to *hard work* (p<.001).

The students were asked if they were required to use (a) computers and (b) scientific calculators in their courses. Among those who said ëyesí, it was surprising to find that there were no differences among the two groups in perceived levels of competence with either technological instrument. It may have been expected that school leavers might feel more competent, particularly with the use of computers. As may have been predicted, students believed they were more competent with scientific calculators (N=533, mean = 4.16) than with computers (N= 342, mean = 3.60).

Enjoyment of mathematics at school and at university

Students were also asked whether they had enjoyed mathematics at school (yes / no/ sometimes) and if they were enjoying mathematics at university. The results for the two groups of students are shown on Table 5.

Table 5. Enjoyment of mathematics at school and university: Percentages of school leavers and mature age students

Enjoyment of mathematics	School Leavers			Mature Age		
	Yes	No	Sítimes	Yes	No	Sítimes
School	57	9	34	53	16	32
University *	35	19	46	48	15	38

* p<.05

The distribution of responses for the enjoyment of mathematics at school was similar for the two groups of students. However, there was a statistically significant difference (x^2=5.86, p<.05) for responses to the enjoyment of mathematics at the university level. The mature age students were more likely than the school leavers to enjoy their tertiary studies. Overall, there were fewer students who enjoyed tertiary mathematics than school mathematics, but the decrease in enjoyment levels was greater among the school leavers. Compared to their responses about school mathematics, there was also an increase in the number of school leavers who did not enjoy mathematics at the tertiary level; this trend was not evident among the mature age students.

Perceptions of the tertiary learning environment

The school leavers and mature age students differed significantly on several items aimed at gathering impressions of the tertiary learning environment. Students were asked to indicate the extent to which they agreed (strongly disagree = 1 to strongly agree = 5) with each item about ìuniversity mathematicsî. The results are shown on Table 6.

Table 6.   Perceptions of the tertiary learning environment: Mean scores for school leavers and mature age students

University mathematics	School leavers	Mature age	Significance levels
easy	2.73	2.67	
enjoyable	3.05	3.38	t=2.90, df=779, p<.01
challenging	3.91	4.13	t=2.47, df=777, p<.05
interesting	3.23	3.64	t=3.56, df=778, p<.001
useless	2.24	1.88	t=-3.36, df=772, p<.001
well taught	3.27	3.66	t=3.52, df=763, p<.001
understand work	3.50	3.62	
lectures boring	3.44	2.65	t=-6.53, df=769, p<.001
lecturers approachable	3.50	3.87	t=3.43, df=772, p<.001
tutors helpful	3.91	4.09	
enough personal help	3.21	3.41	
tutorials useful	3.84	4.00	
assessment fair	3.82	3.87	
too much work	2.85	2.51	t=-3.04, df=770, p<.01
confident of passing	3.73	3.76	

The data on Table 6 indicate that compared to the school leavers, the mature age students found university mathematics to be more enjoyable, challenging, interesting and well-taught. They also considered lectures less boring and lecturers more approachable. Compared to the mature age students, the school leavers thought mathematics was less useful and that there was too much work.

Discussion

The data presented in this paper suggest that mature age students and school leavers constitute distinct cohorts along a number of dimensions. Their age differences alone revealed differences in life experiences. The mature age students, for example, were more likely than the school leavers to have family responsibilities and to come from

NESB backgrounds. Given the large proportion of Australians now undertaking tertiary studies, the higher proportion of mature age students than school leavers who did not proceed directly from school to university because they had to support themselves or their families suggests that they may be from lower socio-economic circumstances than their school leaver counterparts. That a higher proportion of mature age students was also in receipt of Austudy appears to support this inference. On the other hand, it may reflect their high levels of motivation in that they are prepared to make financial sacrifices in order to return to study.

The data also revealed many similarities but also some important differences in the two groupsí attitudes and beliefs about themselves as learners of mathematics. There were no differences in the two groupsí beliefs about their likely performance levels for the year or their perceived competence levels with scientific calculators and computers. The findings with respect to technology were somewhat surprising. Considering the relatively recent and increasing exposure to technology for mathematics learning now experienced by school students, it was anticipated that mature age students would feel less certain about using the equipment.

Compared to the school leavers, fewer mature age students indicated that they were studying mathematics because they believed they were good at it. This seems consistent with the slightly higher proportion of mature age students who said they had not enjoyed mathematics at school and with the groupís higher mean score for attributing success to effort. Yet, the mature age students indicated that they were enjoying tertiary mathematics to a greater extent than the school leavers. Forgasz (1966) noted that mature age mathematics students were more highly motivated than their school leaver counterparts. Despite the longer time period since the mature age students last studied mathematics and their poorer experiences at school with mathematics, perhaps their higher motivation and their greater likelihood to be studying tertiary mathematics by choice partially explain the differences in the two groupsí self-perceptions.

There were also differences between the two groups of students in their perceptions of the tertiary learning environment Overall, the mature age students were more positive than the school leavers. They were less critical of the quality of teaching, of access to staff and of the availability of assistance, and seemed more stimulated by the mathematical content and its worth. These findings may be related to their greater motivation and maturity and/or their life and work experiences prior to commencing their present tertiary courses. This is not to say, however, that the mature age students were fully satisfied with their tertiary mathematics programs. There would still appear to be room for improvement.

The greater dissatisfaction with the tertiary mathematics learning environment evident among the school leavers should be of concern to tertiary mathematics educators. As they constitute the majority of the cohort, tertiary mathematics departments would be ill-advised to ignore the concerns expressed. It should also be noted that the overall decline in the enjoyment of mathematics from school to the tertiary environment replicated earlier findings (see Forgasz, in press). Perhaps students are responding to the different teaching and learning styles they have experienced at school and in the tertiary setting. The data appear to support contemporary efforts for all tertiary teaching to take greater cognisance of educational theories on effective student learning. There were several aspects of the tertiary mathematics learning environments in particular about which students were either ambivalent or fairly negative. The

studentsí sentiments may be taken as indicators of areas within mathematics departments that invite closer examination.

Final Words

Previous large scale research on mature age students in Australia has focussed on students enrolled in Arts and Education faculties (e.g., Hore & West, 1980). As a group mature age students have been found to be successful and highly motivated. From interviews with 23 tertiary mathematics students, of whom 13 were mature age, Forgasz (1996) made similar conclusions. The data from the large scale survey reported in this paper appear to corroborate these earlier findings.

The next stage of the present study will explore in greater depth the experiences of mature age students of mathematics and will make comparisons with those of school leavers. The findings may provide answers to the issues raised by the large scale survey data reported in this paper.

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