School Mathematical Achievement as a Predictor of Success in a First Year University Mathematics Foundations Unit

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This research examines the relationship between the mathematical background of approximately 300 first year B. Ed (primary) students entering the education faculty and their achievement in the first year mathematics foundations unit at Queensland University of Technology (QUT). Students' mathematical backgrounds were divided into five categories according to level of achievement at high school ranging from success at advanced level mathematics to having done no recent mathematics at all. The performance of each group was compared for overall achievement in the Mathematics Foundations unit. In addition the results in the Foundations Unit were correlated with the results in the Mathematics Curriculum unit and two other core units taken by all students. The paper draws some implications regarding the selection of students for the course and their mathematical needs.

At QUT, as at many other tertiary institutions in Australia, there are no subject prerequisites for entry into the B. Ed (primary) and entry from Year 12 is based on an overall placement (OP) score. Thus, pre-service primary teacher education students enter university with greatly differing backgrounds in mathematics. Some have little formal school education in mathematics. Others have studied advanced mathematics at year 12. In recent years, as the number of applicants has increased, the required OP score has also increased. There is evidence, both anecdotal and research, that many students begin teacher education displaying negative attitudes towards mathematics and apprehension of the subject (see, for example, Grootenboer & Lowrie, 2002). Most pre-service primary teacher education programs in Australia are able to allow only a limited time for the teaching of mathematical content even though the mathematical content knowledge of pre-service primary teachers has been an area of concern for some time now (See, for example, Ball, 1990; Peard, 1998; Peard, 2001; Relich & Way, 1992). It is therefore important to make the most efficient use of the limited time available to improve the general mathematical competencies of pre-service primary teachers. In reviewing and planning the unit content, the author must take into account the wide range of mathematical knowledge that the students bring with them in order to plan an efficient unit. Some possibilities that have been considered include exempting those with a strong background from the Foundations unit, offering different content to different groups, integrating content units, and making Year 12 Mathematics a prerequisite subject. The current research will provide important data on which to base such decisions and to help make the most efficient use of the limited time available.

The Issue of Validity

The author has expressed concern with the face validity of much of the current Year 12 Mathematics B (academic) assessment in Queensland (Peard, 2002) and the present research will add data to the study of its predictive validity. Furthermore, concern has been expressed recently (both at the State and National levels) about the declining number of students enrolling in academic and advanced mathematics courses. The present study included a comparison of the achievement of those students who had completed an

advanced mathematics course at high school in order to add data to the debate about this issue. Finally, the study subsequently examined the relationship between success in the unit and achievement in three other compulsory tertiary units one of which was Mathematics Curriculum, in order to determine the predictive validity of the unit.

Aims

The primary aim of the study was to determine whether or not there are noticeable differences in achievement in the first year Mathematics Foundations unit between students of differing mathematical backgrounds and with differing achievements in school mathematics, and whether achievement in this unit is a valid predictor of achievement in the subsequent Mathematics Curriculum unit, in order to answer the following research questions:

- Do students who take academic mathematics subjects in Year 12 perform better in the Foundations unit than those who take a non academic subject?
- Is achievement in an academic or non academic mathematics subject in Year 12 a valid predictor of success in the Foundations unit?
- Is the achievement in the Foundations unit of students with no Year 12 mathematics significantly different from the others?
- Is achievement level in school mathematics a valid predictor of success in the Foundations unit?
- Does the Foundations unit provide a useful background for the Curriculum unit?

Methodology

The unit consisted of a series of lectures and workshops. Assessment consisted of a reflective journal for which entries were made for each workshop (50%) and a final exam (50%). The group of 310 students who completed MDB386, Mathematics Foundations, in Semester 2, 2002 formed the study group. As part of the journal entry for the first week students were asked to write answers to the questions:

What was the last mathematics subject you did at high school?

What grade or final result did you achieve?

How did you feel about this subject?

The majority of the students (about 2/3) had completed Year 12 in the State of Queensland where there are three levels of mathematics: Mathematics A, a general course, Mathematics B, an academic course and Mathematics C, an advanced course which includes Mathematics B. In addition a small number of students came from other States (where options are generally similar), a few from overseas, and a significant number (about one quarter) from other courses or the work force (mature entry).

Mathematical Background

Responses to the question "What was the last mathematical subject that you did in school" were categorized into five distinct categories:

Category 1. An advanced academic Year 12 mathematics subject at an Australian high school.

Category 2. An academic Year 12 mathematics subject at an Australian high school.

Category 3. A non-academic (general, social, or vocational) Year 12 mathematics subject at an Australian high school.

Category 4. No year 12 mathematics but a Year 10 or 11 mathematics subject at an Australian high school.

Category 5. Other. These included those with overseas qualifications and those who either could not remember or did not respond.

School Achievement

The responses to this question were recorded for Categories 1 to 3 as:
Level 1. High or very high, A or B grade, or any equivalent response.
Level 2. Sound, Satisfactory, C grade, Pass, or any equivalent response.
Level 3. Low or very low, D grade, fail, or any equivalent response.
School achievement was not reported for Categories 4 or 5.

Tertiary Achievement

Achievement in the first year Foundations unit at the end of 2002 was recorded as final percent mark in the unit (50% journal mark and 50% final exam) for all categories.

At the end of 2003 the results of the students in Mathematics Curriculum Studies MDB373 were recorded and correlated with the results in the Foundations unit. The coefficient of correlation is a measure of the predictive validity of the foundations unit of success in the Mathematics Curriculum unit.

As we would expect performance in all tertiary units to correlate positively to some extent, a cross correlation with achievement in two other core units using the university records scale of 1 to 7 (7 high) was also performed. These were, CLB 376 (Studies of Society Curriculum) and CLB369 (Social and Environmental Foundations). This was done to give a measure of whether the Foundations unit correlated more highly with the curriculum unit than the other two. Any student who did not complete all four units was omitted from this part of the study.

Recording of Results

All results were recorded by the author on Microsoft Excel. Statistical tests for significance (of difference of means) were performed in those situations where it was required using the Excel functions. The Pearson product-moment coefficient of correlation was used.

Results and Analysis

Student Background

The distribution of the group is illustrated in Table 1 where it can be seen that the modal category was a non-academic Year 12 subject. The majority (about 80%) of students were female, but no separation of results on the basis of gender was made. Queensland Year 12 results in Mathematics A and B show no significant differences in achievement by gender.

Table 1
Mathematical Background of the Study Group

Category	1	2	3	4	5
n	7	92	125	24	62

Achievement in the Foundations Unit

The distribution of the achievement of the whole group of 310 students is shown as a Box plot in figure 1.

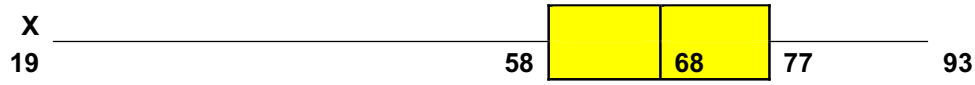


Figure 1. Overall achievement in Foundations unit.

Achievement According to Background

A comparison of student achievement according to mathematical background category is shown in Table 2 and Figure 2. Owing to the very small number of students in Category 1, this category is not shown in Figure 2. The lowest achieving group was Category 5. As noted, this group came from a variable background and no inferences will be made from their responses. Consequently this group also is not shown in Figure 2.

Table 2
Summary of Tertiary Achievement (%) by School Background Category

Category	1	2	3	4	5
n	7	92	125	24	62
Mean	68	72.3	65.3	65.9	58.9
Median	NA	74	67	66	62
Q1	NA	65	58	55	42
Q2	NA	80	72	73	72

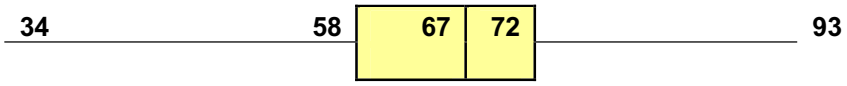
Analysis. As expected, those students who had done an academic mathematics subject achieved higher in the tertiary unit than those who had done a non-academic subject. What is surprising, however, is that although the difference in mean achievement is clearly statistically significant ($p<0.01$), it is not great (means 72.3 and 65.3). In Queensland, and in other States, higher achieving students are encouraged to take the academic option while lower achieving students are encouraged to take the non-academic option. Pupils who do not perform well in the academic subject are often moved to the non-academic. Given these circumstances, one might expect the samples from two distinctly different populations to show considerable difference in the distribution of achievement with little overlap. However, this was not observed in the present study and, as can be seen from Figure 2, there is considerable overlap of the distributions. The upper two quartiles (upper 50%) of Category 3 are greater than the 1st quartile (lower 25%) of Category 2.

Furthermore, those students who had done only Year 10 or 11 mathematics (Category 4) achieved little differently from those who had done the non- academic subject in Year 12, although this was a smaller group (n=24) and contained a high proportion of mature age students.

Another surprising result was the performance of the Category 1 students. There were only seven students in this group whose mean score was 68. This is higher than Categories 3 and 4 but lower than Category 2, though with only seven students this difference is not statistically significant. Nevertheless, it can be said of this group that they did not perform better than those of Category 2.

Category 2 (n = 92)

Category 3 (n = 125)



Category 4 (n = 24)

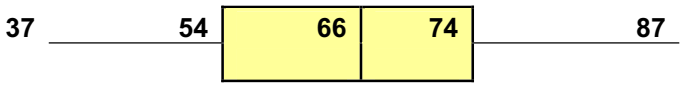


Figure 2. Distribution of Results of Categories 2, 3 and 4.

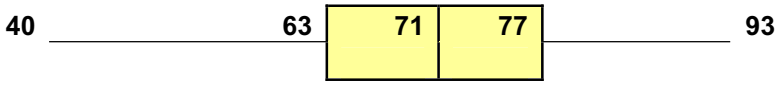
Achievement of Category 3, Level 1 Students

Comparing the achievement of those Category 3 students who did well in Year 12 (Grade of "A/B", High or very high achievement) with all those of Category 2 (total), it can be seen that the differences in tertiary achievement are now very small (Table 3, Figure 3). Again the difference in means of 68.8 and 72.3 is statistically significant but relatively small. Furthermore the bottom quartile of each group achieved very similarly.

Table 3
Summary of achievement (%) of Categories 3 (High achievement) and Category 2

Category	2	3
n	92	62
Mean	72.3	68.8
Median	74	71
Q1	65	63
Q3	80	77

Category 3 (high achievers) (n = 62)



Category 2 (n = 92)

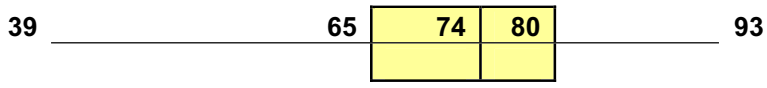


Figure 3. Distribution of results for Category 2 and Category3 (high achievement).

A Comparison of School and Tertiary Achievements

For Categories 1, 2 and 3, a comparison of tertiary achievement and school achievement irrespective of course is shown. The mean tertiary score for those students who reported a school achievement of Level 1 was compared with that for those who reported a school achievement of Level 2 and Level 3 (Table 4). We again see a clear relationship between the two, but again these differences may not be as great as one might expect with those reporting a Level 1 achievement achieving only 6.8% above those of Level 2.

Table 4
Tertiary achievement (%) and school achievement level

Level	Level 1	Level 2	Level 3
n	96	123	13
Mean	70.8	64	58

Achievement in Other Tertiary Units

Table 5 shows the correlations between the units. We see that, as one would expect, achievement in all units correlate positively. However the coefficient between the Foundations unit and the Curriculum unit is noticeably higher than any of the others.

Table 5
Coefficients of correlation between units

	MDB386	CLB376	MDB373
CLB376	0.295		
MDB373	**0.687**	0.337	
CLB369	0.375	0.238	0.244

Conclusions and Implications

From the analysis of the above results, four main implications are drawn.

Implications for the Mathematical Content of the Unit

Although there are noticeable differences of achievement between the five categories, these are not sufficiently great as to warrant the need to offer different content to different groups. It can be seen that there is considerable overlap in the distribution of achievements in all five categories. For example, approximately one quarter of those in the lowest achieving group (Category 5, 3rd quartile, 72) achieved better than the bottom half of the highest achieving group (Category 2, median 74).

Implications for Entry into the Course

The results clearly show that there was no significant difference in achievement between those students with no Year 12 mathematics (Category 4) and those with a non academic Year 12 background (Category 3). Again, it can be seen that there is considerable overlap in the distribution of achievements of Categories 2, 3 and 4 with approximately one quarter of those in Category 4 (3rd quartile, 74) achieving better than the bottom half of the highest achieving group (Category 2, median 74). Although this former group was much smaller in number (n=24), the results nevertheless show that there could be no

justification for denying entry to the course for this group based on their lack of Year 12 mathematics.

Implications for Year 12 Mathematics

It can be concluded from the results that the variables affecting tertiary achievement are both the nature of the course (academic and non academic) and level of school achievement. However, it has been noted that these differences are not as great as might be expected. It can therefore be concluded that the selection of an academic course in Year 12 does not in itself mean a greater chances of success at the tertiary level, at least in primary teacher education. Of course, whether or not this conclusion can be applied to other courses or in general would require much further research. Furthermore, the performance of the students who had done an advanced Year 12 mathematics (Category 1) was not statistically significantly different from those of Category 2. Although the number in this category was very small (n = 7) this conclusion would imply that there is little point in encouraging high school students to select advanced courses when they may not be suited to them.

Implications for Achievement in the Unit

It can be concluded from the correlation coefficients that the Foundations unit is a better predictor of success in Curriculum than the other two core units. It would be reasonable to infer that the Foundations unit does in fact provide a foundation for curriculum.

Conclusion

Despite recent concern about the proportion of students enrolling in academic and advanced mathematics courses in Year 12, the results of the present study show that the better predictor of success in the Mathematics Foundations unit of the B.Ed. (primary) at QUT is success at school mathematics irrespective of whether the course is advanced, academic or non academic. Furthermore, this success is only a weak predictor of future mathematical performance in this situation. Further research would be necessary to determine whether or not this pattern of response would be observed among mathematics students in other faculties. In regard to the Faculty of Education, the results suggest that there is no evidence to support offering different tertiary courses based on school mathematics background, or indeed to make Year 12 mathematics a prerequisite to entry. The results provide evidence for the retention of a Foundations unit as a prerequisite for the Curriculum unit in any future revisions of the program.

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