

EARLY GENDER DIFFERENCES

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In a longitudinal study of children in grades 0-4 gender differences are developing very early in some number domains but there do not appear to be similar differences showing in the measurement and geometry domains studied.

INTRODUCTION

Gender is still an issue in mathematics education. There has been much change, both in terms of achievement differences and in the nature of the research, since the issue became one of research interest. Many though seem to feel that the gender problem has been solved. Indeed in some circles the focus has changed as reflected in a recent report in Australia called *Boys, Getting it Right* (Commonwealth of Australia, 2002), which expressed concern about the drop out rate of boys and raised particular concerns about their language development. What is clear is that the nature of the questions in relation to gender have changed and so have the research findings.

Recent research has shown that the achievement gap has been reduced in many countries, but that there are still areas of concern. The differences are not now as straightforward as they were in the 1970s and 1980s. In the TIMMS study at middle primary school (age 9) in most countries there were no significant gender differences in performance (Mullis, Martin, Fierros, Goldberg & Stemler, 2000). In Australia and New Zealand this was also true at junior secondary school (age 13). The follow-up PISA study showed no clear gender differences, however, although not of statistical significance, it is of note that New Zealand was one of three countries where the girls out-performed the boys in mathematics (Lokan, Greenwood, & Cresswell, 2001). Other New Zealand studies show higher achievement for girls throughout the early and middle years of schooling (Flockton & Crooks, 2002). In Australia, during the primary school years (Grades 0-6), state-wide and national testing has generally found no gender differences favouring boys (Collins, Kenway & McLeod, 2000; Doig, 2001; Yates, 1999). As noted by Forgasz, Horne and Vale (in press), gender differences in achievement in mathematics continue to decline, but are not consistent across year levels societal groups and assessment instruments.

While achievement tests show no significant difference in outcomes there have been differences shown in thinking (Fennema, Carpenter, Jacobs, Franke & Levi, 1998; Horne, 2003). Both of these studies were with children in grades 1-3 and showed that in addition and subtraction, girls tended to continue using counting strategies while boys were more likely to move to more sophisticated strategies.

Gender differences have also shown in responses to some types of questions, such as the amount of interpretation of diagrammatic information (Lokan et al, 2001).

THE STUDY

The Early Numeracy Research Project (Clarke, 2001) collected data at the beginning and end of each year from over 11,000 children in Grades 0-2 from 1999-2001. Of these, 1237 children (672 boys, 565 girls) formed a longitudinal cohort who started Grade 0. A subset of 572 (295 boys, 277 girls) of these children were also assessed at the end of Grade 3 in 2002 and Grade 4 in 2003. The students were assessed individually through a task based interview of about 30-40 minutes duration near the beginning and end of each of their Grade 0-2 years and at the end of the Grade 3-4 years. This interview investigated mathematical growth in the curriculum areas of number, measurement and geometric thinking. Within number there were four separate domains: Counting; Place Value, Addition and Subtraction Strategies; and Multiplication and Division Strategies. Longitudinal data were also collected in measurement in the domains of Time and Length, and in geometry (space) in the domains of Properties of Shape and Visualisation. The geometry domains were not used until 2000 so the data for them cover one less year of development. The focus of the interview was not just on achievement but also on the strategies used. In designing the interview care was taken to have a high ceiling in each domain so that there was an appropriate challenge for each child, but in a particular domain, when the child started to be not successful the interviewer moved to another domain. This meant that the children did not attempt all questions and experienced little failure.

Figure 1 shows an example of questions from near the beginning of the Place Value domain.

11) Calculator Tasks

Get the calculator please. Have you used a calculator before? Please turn it on.

a) Type these numbers on the calculator (7, 47, 60, 15, 724, 105, 2469, 6023)
(Stop when the child is not successful. Ask the child to clear the calculator between numbers.)

b) STEP 1: Pick any number from 2 to 9, and type it on the calculator. Read the number.
(Don't clear the calculator.)

STEP 2: Type in a different number from 2 to 9 *(thus forming a 2-digit number)*. Read the number.

STEP 3: Type in a different number again from 2 to 9 *(giving a 3-digit number)*. Read the number.

[Continue to limit of correct answers: STEP 4, STEP 5, etc.]

Figure 1. Question from early part of Place Value domain

A question from the end of the Place Value domain is shown in Figure 2 to illustrate the ceiling. The full interview schedule is available (Department of Education, Employment & Training, 2001). The questions in the interview were linked to a framework of 4-6 Growth Points for each domain that reflected milestones in a common learning trajectory. For a full description of the development of the framework and the growth points see Clarke, Sullivan, Cheeseman, and Clarke (2000).

17) Interpreting the Number Line

Show the child the orange page of number lines. Point to the first one, pointing to the relevant numbers as you read the question.

[at any stage]: K → C

- a) The numbers on this line go from 0 to one 100. . . . (pointing to the little mark) Round about what number would this be? (acceptable range: 55 to 75).
- b) The numbers on this line go from 0 to 2000. . . . (pointing to the little mark) Round about what number would this be? (acceptable range: 400 to 600).
- c) The numbers on this line go from 39 to 172. . . . (pointing to the little mark) Round about what number would this be? (acceptable range: 65 to 95).
- d) The numbers on this line go from zero to one million. . . . (pointing to the little mark) Round about what number would this be? (acceptable range: 700 000 to 800 000).

Figure 2. Sample questions from the end of the Place Value domain.

ANALYSES, RESULTS AND DISCUSSION

Following the interview, trained personnel assigned each child a growth point for each domain. These growth points did not form an interval scale. Horne and Rowley (2001) describe a statistical approach that was used to create an interval scale from the growth points in each domain. These interval scales are close to the growth points and were set to cover the same range but they allow statistical comparisons to be more easily made as parametric statistics can be used to identify differences.

For each of the eight domains mentioned above, means and standard deviations were calculated separately for the male and female students from the longitudinal cohort for their entry into the project at the beginning of Grade 0, then at the end of that and each subsequent year until the end of Grade 4.

Domain	First three years			Five years		
	df	F	p.	df	F	p.
Counting	1/1235	46.09	0.000	1/570	19.38	0.000
Place Value	1/1235	9.30	0.002	1/570	1.316	0.252
Addition & Subtraction	1/1235	18.83	0.000	1/570	16.172	0.000
Multiplication & Division	1/1234	9.01	0.003	1/570	12.691	0.000
Time	1/1177	0.13	0.721	1/570	1.835	0.176
Length	1/1179	1.30	0.254	1/570	.162	0.688
Properties of Shape	1/2433*	4.58	0.033	1/570	1.352	0.245
Visualisation	1/2449*	1.19	0.277	1/570	.301	0.584

* Since this was only a two year period there was a larger cohort.

Table 1. Analysis of variance for change by gender

An analysis of variance of the growth in each domain (See Table 1) shows that over the first three years, significant differences developed in each of the number domains ($p < .01$) but generally not in either the measurement or geometry domains. Over the

five years with the reduced cohort all the number domains but Place Value showed significant differences ($p < 0.01$) for gender and again measurement and geometry domains showed no differences. The growth points for the domains for Addition and Subtraction Strategies and for Multiplication and Division Strategies are linked to strategies students use in achieving a correct solution to the task. However the domains for Counting and Place Value are not as closely linked to strategies. While clearly solving any problem requires strategies the actual assignment of Growth Points for the number domains using the word “strategies” were directly linked to the nature of the strategies used.

This growing separation of the genders is shown more clearly in the graph in Figure 3 for the counting domain. The two central lines show the means for the boys (squares) and girls (triangles) from the beginning of their Grade 0 year until the end of their Grade 4 year. It illustrates that there were no differences on arrival at school but that there were differences which developed and continued throughout the five years. The other lines on the graph illustrate the spread of the data by showing the boundaries of the band representing 90% of the children. The assessment was specifically designed for Grades 0-2. The ceiling for these grades was high, and because of this it was used at grades 3 and 4 though it is clear that by grade 4 a number of children have reached the ceiling.

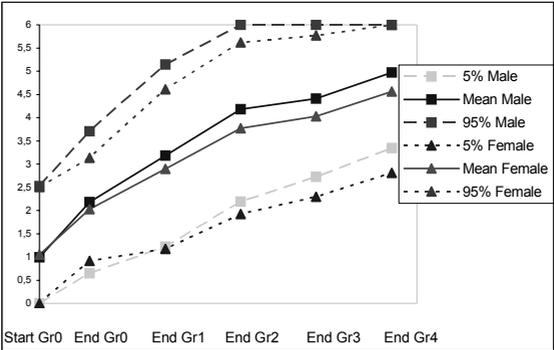


Figure 3. Gender differences in growth in the Counting domain

Figure 4 shows the patterns of growing separation of the genders for the other number domains and the similarity between them. The shape and separation of the two central lines representing the means is the critical aspect of the graphs. The legend and horizontal scale are the same for each of the graphs.

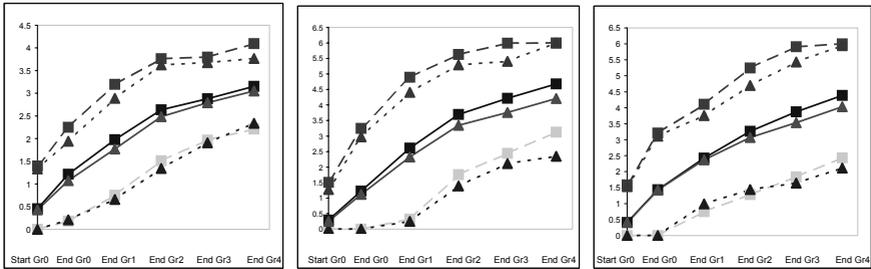


Figure 4. Gender differences in growth in the domains of Place Value, Addition and Subtraction Strategies, and Multiplication and Division Strategies

Of the four domains in Measurement and Geometry there appeared to be the greatest differences in growth in the Properties of Shape domain (Figure 5). This domain was not assessed for the longitudinal cohort when they were in Grade 0 so the data are shown here from the start of Grade 1 to the end of Grade 4. While at the start of Grade 1 the girls were ahead of the boys this was not significant. There were slight differences developed during the four years but the separation did not continue to grow and the change was not significant by the end of grade 4.

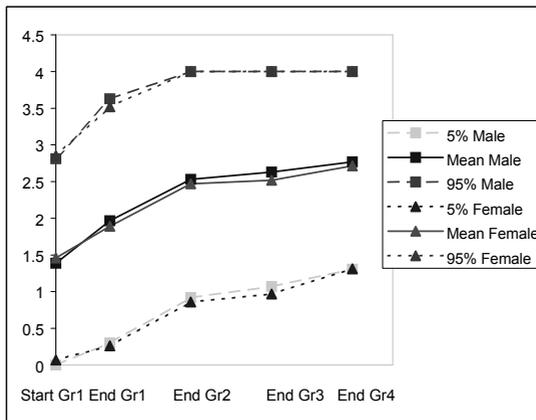


Figure 5. Gender differences in growth in the Properties of Shape domain

What is of interest is that the other measurement and geometry domains show a similar pattern of little to no gender difference, in contrast to the number domains where most of the differences were significant and continued to increase during the five year period. Figure 6 shows the growth graphs of the remaining three domains.

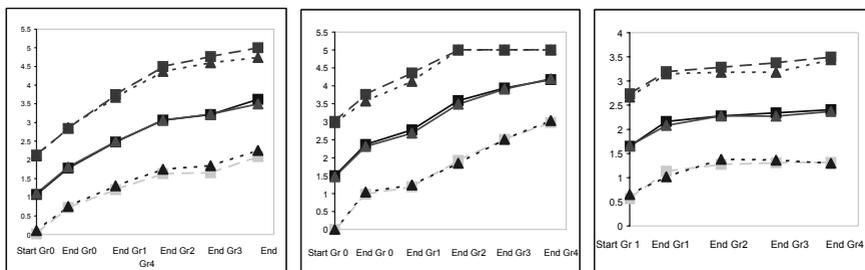


Figure 6. Gender differences in growth in the domains of Time, Length and Visualisation.

Horne (2003) raised the concern that the gender gap in the Addition and Subtraction Strategies domain was increasing as the children became older. It is of concern that other number domains are showing similar patterns of increasing separation. Fennema et al. (1998) also focused particularly on addition and subtraction. The differences showing here in other number areas need to be replicated.

In contrast, the lack of gender difference in measurement and geometry is of interest and supports the general findings on achievement tests in middle primary schools. Owens (1996), commenting on gender and spatial differences, indicated that differences seemed to show in favour of boys when three dimensions were involved. The lack of differences here may be related to the fact that both the geometry domains focused on two dimensions. There has been very little written about gender differences in the area of measurement in recent years. The choice of other domains, such as Area and Volume, may have lead to different results just as the choice of three dimensional examples may have lead to different results in geometry.

Hyde and Jaffee (1998), in reacting to the findings of differences in strategies in addition and subtraction suggest that one explanation could be the stereotyping, either by the teachers or the children themselves, of girls as compliant and boys as resistant to rules and as risk-takers. It could be that in the interview situation the girls, more than the boys, are trying to give the teacher the responses that they perceive the teacher is seeking. There is clearly a need for a closer look at gender differences in approaches in all areas of mathematics at the earliest levels of schooling.

Analysis of data like this raises more questions than it answers. Why are the differences showing in number and not in measurement and geometry? How might the classroom culture and the teacher affect this? Would the same differences show in strategy use between boys and girls in other mathematical areas? Gender is still an important area of research and there are still many unanswered questions.

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