Two Surveys Of Talented Mathematics Students

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Abstract.

We compare some of the results of two surveys of talented mathematics students, one undertaken with Secondary School students in 1992 and the other with Intermediate School students in 1994. In both surveys (i) the mothers of the group studied were exceptionally well educated themselves, some 40% of them having first degrees; (ii) not only were the number of girls in both samples small but girls seemed to be under-represented in the families studied; and (iii) a reasonable number of the families were not 'middle class'.

Methodology

The Secondary survey

Since 1986, the New Zealand Mathematical Olympiad Committee (NZMOC) has been developing an out-of-school extension programme for talented Secondary mathematics students. Students are initially invited to join the programme on the strength of their performance on nationally available competitions which are taken by over 10,000 students in Forms 3, 4 and 5 (ages 13 to 16 approximately). Each year in December (in 1994 the schedule was put back by four months), all students thus chosen for the NZMOC list, are sent a set of problems and given a week to work on them. Around 100 students send back solutions to these problems. The problems require initiative and imagination to solve, and are not of the type found in textbooks for the normal mathematics curriculum. On the basis of the submitted solutions, approximately 20 students are chosen to attend a week long mathematics camp in May of the following year. The full details of the NZMOC programme have been described elsewhere (Holton, 1995).

At the end of 1991, questionnaires were sent to all students who had been identified by the selection processes described above and had attended a NZMOC May Camp between 1987 and 1991. Questionnaires were also sent to their parents. In the letter which accompanied the questionnaires and consent forms, parents and students were told that in this study we were hoping to obtain information on

- i how able mathematics students can be identified;
- ii how these students become interested in mathematics;
- iii how they learn mathematics;
- iv what is the best learning environment for them;
- v what motivates them;
- vi whether these students should be extended and how.

The questionnaires were sent to 71 students and their parents. Replies were received from 51 parents and 49 students. 43 of the respondent students were males and 6 were females. We received 45 responses from students and parents of the same family, 6 responses from parents but not their child, and 4 responses from the student but not the parent. Thus responses were received regarding 55 students. Parents indicated that 26 of their questionnaires had been answered by both parents working together (although the mother had been the scribe in most cases), 17 had been answered by the mothers, and 7 had been answered by the fathers. Parent responses were made on behalf of 5 daughters and 46 sons.

The survey is reported in its entirety in Curran, Holton, Daniel and Wee Haur (1992).

The Intermediate survey

A mathematics problem solving scheme, called Problem Challenge, has been offered to primary schools in New Zealand for the past 5 years. The scheme is mainly aimed at 11 and 12 year old children in Forms 1 and 2 (the last two years of New Zealand primary education) though some younger children participate. The scheme began in 1991 with 210 schools entering 5000 children and quickly grew until in 1994 some 670 schools entered 27000 children.

The scheme is similar to Mathematical Olympiads for Elementary Schools (MOES), begun some ten years earlier in the United States (described by Lenchner (1993)) and joined more recently by its Australian affiliate Mathematical Olympiads for Primary Schools (MOPS). The original aim was to foster problem solving by introducing children to interesting mathematical ideas. This was given further impetus when in 1992 a new mathematics curriculum was introduced (see Ministry of Education, 1992) which placed considerable emphasis on problem solving in teaching mathematics. The curriculum also introduced the idea of the development band to cater for able students, a role Problem Challenge could help fulfil.

The format of Problem Challenge is similar to MOES or MOPS. Entrants attempt to write answers to 5 questions (in 30 minutes) on 5 problem sets, which are sat about a month apart. Solution sheets giving answers (and various strategies for solving the problems and extension material) are supplied to teachers, who mark their pupils' efforts and return their results. At the end of the year all the results are collated, certificates presented and awards made. Those in the top 10 – 12% receive a certificate of excellence, those in the next 25 – 30% a certificate of merit and the remainder a certificate of participation. As well, awards (book tokens) are made to the top 1% or so of entrants. Further details are given elsewhere (see Curran, 1995).

Since we were interested in problem solving in general and the effects of the new syllabus in particular, at the end of 1994 it was decided to profile the top achievers. Because of the selection process, we believe these students to be talented in mathematics. The Form 1 award winners were selected, because of the possibility of following up on these students again in 1995. In the survey we looked at such things as

i their family background;

ii what special aptitudes they had;

iii what their schools had done for them; and

iv why they were good at problem solving.

Complete returns were received from 9043 Form 1 students from 522 schools. Awards were made to the top 126 of these (1.4%), who had successfully answered 21 or more of the 25 problems correctly, but because of some inadequate school records 9 of these could not be completely identified. For the remaining 117 students, a three-pronged approach was adopted with students, their parents (or care givers) and their teachers all being asked to complete a questionnaire. Thus questions could be answered from the different perspectives of the child, parent and teacher. In addition, other questions were posed that particularly related to just one group, such as the parents' recollection of their child's preschool abilities, the student's recollection of their best teacher or the teacher's data on national maths and language tests .

Replies were received from 98 students and their parents (84%) and from 102 teachers (86%), with 95 in common (81%). Of the students 26 were female and 72 male, which was a slightly higher female proportion (36%) than in the original sample of 36 females from 117 (31%).

Results

A number of common features have been noted in the two surveys. The three that we mention here are family background, gender and income.

Family Background

In Table 1, we list the highest level of education reached by the parents of the students in the Secondary survey. This is followed by the corresponding statistics for the Intermediate group.

Table 1: Highest level of education of parents

	Secondary		Intermediate	
	Mother	Father	Mother	Father
Ph.D.	2	7	0	8
Master's degree	3	11	5	7
M.B., Ch.B.	2	2	0	2
Bachelor's degree	13	7	33	29
Vocational Certificate	18	11	28	27
Form 7	1	1	3	5
Form 6	2	2	10	7
Form 5	4	4	12	7
Below Form 5	5	2	0	0
No. of respondents	50	47	91	92

A remarkably high number of the parents were graduates. The New Zealand 1991 Census (Department of Statistics, 1992) recorded that 4.3% of the population aged 15 or over, had a University degree or diploma. In the Secondary survey, 57% of the fathers and 40% of the mothers were university graduates, while in the Intermediate survey, 49% of the fathers and 42% of the mothers were graduates. We were particularly interested to see the large number of graduates among the mothers, especially as they had probably been the principal care givers.

In both surveys, very few of the parents either majored in mathematics, were professional mathematicians, or had majored or were employed in a related field such as physics or computer science (see Table 2). Indeed, there were parents in both surveys who did not have high academic qualifications at all, yet seemed to have children of exceptional ability.

Table 2: Areas of study of graduate parents.

	Secondary		Intermediate	
	Mother	Father	Mother	Father
Architecture	0	1	0	1
Arts	13	7	22	10
Commerce	0	5	6	6
Law	0	0	1	1
Medicine	2	2	0	2
Music	0	0	1	0
Science	4	12	8	25
Numbers mentioning Maths in a degree	2	2	3	8
No. of respondents	19	27	38	45

Gender

We obtained information on the number of children in the family and on their gender, as well as on the position of the respondent student in the family. In Tables 3 and 4, the notation a:b indicates a family with a boys and b girls; and each asterisk indicates a daughter who was a part of the survey sample.

One of the findings of the Secondary survey was that there was not merely a larger number of males involved in the competition which was the starting point for selection for study, but that those selected were more likely to come from families with a predominance of sons. In the 52 families represented, there were 79 sons compared to 41 daughters. Although the ratio was not as high in the Intermediate survey (147:112), the respondents still seemed more likely to come from families with a predominance of sons.

The other statistic worth noting was that the girls chosen in both surveys predominantly came from families where the number of daughters exceeded the number of sons. Only 3 girls from either survey came from families where there were more sons than daughters, compared to 20 where the balance was in the other direction.

Table 3: Gender of families (Secondary).

Males predominate (M:F)	Total families	Equal numbers (M:F)	Total families	Females predominate (M:F)	Total families
1:0	2	1:1*	14	0:1*	1
2:0	9			0:2***	3
3:0	0			0:3	0
2:1	14	2:2	1	0:4	0
3:1	2			1:2	3
3:2	1			1:3	1
4:2	0			1:4	0
		3:3	1	2:3	0
Totals	28		16		8

Table 4: Gender of families (Intermediate).

Males predominate (M:F)	Total families	Equal numbers (M:F)	Total families	Females predominate (M:F)	Total families
1:0	2	1:1******	21	0:1*	1
2:0	18			0:2******	6
3:0	6			0:3***	3
2:1*	10	2:2*	5	0:4*	1
3:1**	5			1:2**	9
3:2	2			1:3**	3
4:2	1			1:4*	1
				2:3	1
Totals	44		26		25

Income

Although the figures in the tables below indicated that most of the parents would qualify for the label of 'middle class', this was not exclusively the case.

Notes. One of the Medical Practitioners listed here has a Ph.D. as his highest qualification.

Not all of the mothers who are listed as being in paid employment, worked full-time.

Table 5 Present employment status of parents (Secondary).

	Mother	Father
Home Duties	13	0
Technician/Clerk	9	4
Teacher	7	5
Admin/Management	1	10
Academic	1	6
Doctor	2	3
Engineer	0	6
Unemployed	2	2
Business person	0	3
Trades person	0	2
Other professional	4	4
No. of respondents	42	49

If these parents were judged on the basis of the Elley-Irving Socio-Economic Index, revised after the New Zealand 1981 Census, then all of the employed fathers came within the top three of the five groupings of the Index. These three groupings represent 42% of the male labour force in New Zealand, when it is calculated on the basis of the median educational and income levels for males aged 25-44 years (Elley and Irving, 1985).

In the Intermediate questionnaire, respondents were given the choice of grading themselves on a five point scale and were told the amount, in dollar terms, which had been the average income in 1992/93. It was notable that not all of the above average or high income earners had any tertiary qualifications, and that not all of the graduates were above average or high in income.

Table 6: Family income (Intermediate).

Low	5
Below average	12
Average	20
Above average	41
High	16
No. of respondents	93

Concluding Comments

In both surveys, the number of parents with degrees, and especially the number of mothers with degrees, was well above the national average. There were few parents whose major was in mathematics. Among mothers with degrees, the predominant degree obtained was an Arts degree. This may reflect the social pressure or mores of the time when these degrees were being undertaken. However, it may also be that the Arts training of the principal care giver had an influence on the upbringing of children which aided mathematical development. We speculate that in such a household, there would most likely be continual debate and discussion. This would help to foster talented mathematical students. First, it would help them to develop a strong vocabulary and an understanding of the nuance of language, a skill which greatly assists in the understanding of mathematical problems. Second, it would help develop the student's general knowledge and logical thinking. Certainly the latter of these is essential in mathematics. Romberg (1992) recognised these kinds of attitudes as being a crucial part of the process of developing the ability to understand and solve complex problems. On the other hand, it is likely that the advantages alluded to above, would not alone be sufficient to maintain the student's interest in mathematics.

It is significant that the students in our studies came from a variety of socio-economic backgrounds. Apparently, mathematical talent does not require a middle class family in which to develop. While it was clear that the majority of our students were reared by well-educated parents who had the socio-economic ability to provide good stimulation for their children, there were also some notable exceptions. Hence it is not possible to conclude that it is these factors alone which created the environment that nurture the able mathematician.

One could postulate that mathematical ability is equally spread through the community and that it is only lack of opportunity, rather than lack of talent, that sees it more manifest among the middle class. This is an area in which more work needs to be done despite the longstanding nurture-nature debate.

Finally, we note the predominance of males in the families studied. We are unable to offer any explanation for this. Although the number of daughters in the Intermediate survey is relatively higher than that in the Secondary survey, it is possible that their numbers may decline by the time they reach the age of the students in the Secondary survey. We plan to follow this cohort to see if this is indeed the case. It is, however, of interest that more girls came from families where daughters predominate. This adds another dimension to the current research on gender issues in mathematics.

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