Investigation of Gender Differences Among Year 6 Students when Estimating Measurements

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This paper describes a study which sought to understand more fully the thought processes of year 6 students when they estimate measurements and to determine possible gender differences in such thinking. After completing 14 untimed multiple-choice estimation of measurement questions, 100 year 6 students were asked to explain to an interviewer how they had obtained their responses for each question. In general, no significant gender differences were found for performance on specific estimation of measurement questions. Year 6 boys and girls reported using similar strategies.

Both the National Statement on Mathematics for Australian Schools (Australian Education Council, 1991) and the Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics, 1989) emphasise that high priority should be given to developing students' skills of estimation of measurement. However, research into students' thought processes when they estimate measurements has been sparse. Whitin (1994), shows how estimation may be explored through children's literature.

Lindquist (1987) describes strategies used by good estimators: comparing to a referent, chunking (breaking the object into subparts and estimating each part) and unitizing (dividing the object into equal parts and estimating one part).

Using data for year 6 students from the Australian Primary Schools Mathematics Competition for the years 1990 to 1992, Leeson (in press) found that boys performed significantly better than girls on items involving estimation of measurement. However, as noted by Leder (1990, p. 21), "the issue of gender differences in mathematics learning is complex". Perhaps the differences noted by Leeson might be attributable more to the style of testing than to ability. Indeed, it has been suggested that multiple-choice questions tend to favour boys (Willis, 1989) and that the reason for this may be that girls are disadvantaged by any form of assessment carried out under 'exam conditions' (Open University, 1986). A study by Bishop and Clements (1994) found that, despite a decade of interest in gender differences, researchers and teachers are still unable to reliably predict whether pencil-and-paper multiple-choice items will yield gender-related performance differences.

The aims of the study reported in this paper were to understand more fully the thought processes of year 6 students when they estimate measurements (length, mass, capacity, area and temperature) and to determine possible gender differences in such thinking. The study also sought to determine if gender-related performance differences in estimation of measurement were evident when multiple-choice items were used in a non-exam-like situation and when open-ended questioning occurred.

Method

As a pilot study, 12 multiple-choice questions, involving estimations of measurement, were devised and these were administered at a local primary school to 98 year 6 students, comprising 55 females and 43 males. Selected students were then interviewed, one-at-a-time, to determine reasons for their responses.

On the basis of this pilot study, a "Measurement Quiz" comprising 14 multiple-choice questions was finally prepared. Students were asked to select,

from a set of four, the best response for each of:

1 the height of a normal door
2 the capacity of a household bucket
3 something with a length closest to 2 metres
4 the size of a drawn angle
5 the capacity of a medium saucepan
6 he temperature of an air conditioned room
7 the length of an ordinary table knife
8 something with a capacity of 60 litres
9 the mass of a bucketful of potatoes
10 the temperature of a healthy child
11 the unit used to measure the mass of a dog
12 the area of a slice of bread
13 something with a mass of 160 grams
14 something with an area of 6 cm^2.

The "Measurement Quiz" was given to 244 year 6 students, comprising 120 females and 124 males from three local primary schools. No time limit was prescribed, so that pressure on students might be diminished. After the responses had been assessed, a representative group of 100 of these students, comprising 50 females and 50 males, were chosen for individual interview. These students were asked to explain why/how they had obtained their responses for each of the 14 items of the Quiz. All interviews were recorded on audio-tape. Later, as these were analysed, students' responses were categorised according to common elements which emerged (random guesses, estimation, elimination, real-life experiences).

In an endeavour to determine whether boys and girls focus on different aspects of real-life experiences, students were also asked to state those aspects of their favourite sport which interests them (e.g. speed, distances, skill, uniforms).

Results

The numbers of correct responses for each of the 14 items according to gender are given in Table 1.

Table 1 Correct Responses

Item	Females (n=120)		Males (n=124)		Total (n=244)
1	111	(92.5%)	118	(95.2%)	229
2	72	(60.0%) **	97	(78.2%) **	169
3	00	(83.3%)	100	(80.6%)	200
4	60	(50.0%)	74	(59.7%)	134
5	48	(40.0%)	58	(46.8%)	106
6	66	(55.0%) *	85	(68.5%) *	151
7	65	(54.2%)	68	(54.8%)	133
8	60	(50.0%)	72	(58.1%)	132
9	61	(50.8%)	57	(46.0%)	118
10	71	(59.2%)	74	(59.7%)	145
11	84	(70.0%)	98	(79.0%)	182
12	5	(4.2%)	9	(7.3%)	14
13	47	(39.2%)	62	(50.0%)	109
14	31	(25.8%)	38	(30.6%)	69

(* differences significant at $p < 0.05$ ** differences significant at $p < 0.01$)

The number of questions correctly answered ranged from 1 to 13 for females and 3 to 14 for males, with mean scores of 7.84 for females and 8.15 for males.

Reasons advanced by students for their responses to each of the questions of the Quiz were categorised according to whether they reported that they had made a random guess, estimated, eliminated the more unlikely items or relied on past experiences. These are given for females in Table 2 and for males in Table 3.

Table 2: Basis of Responses by Females(n=50)

Item	Correct	Guess	Estimation	Elimination	Experience
1	46	1	30	11	4
2	26	4	1	15	6
3	40	1	14	21	4
4	19	4	2	6	
5	17	4	10	2	
6	24	5	0	15	4
7	29	3	16	9	1
8	24	3	0	13	8
9	26	3	5	4	4
10	25	6	0	9	10
11	34	3	0	24	7
12	3	1	2	0	0
13	18	0	0	15	3
14	11	1	1	9	0
		1.4%	22.5%	48.8%	17.3%

Table 3 Basis of Responses by Males (n=50)

Item	Correct	Guess	Estimation	Elimination	Experience
1	5	0	29	12	4
2	32	1	1	19	11
3	41	1	18	20	2
4	22	5	6	6	5
5	22	2	1	17	2
6	30	1	1	24	4
7	28	2	10	15	1
8	24	1	0	13	10
9	30	3	0	21	6
10	26	5	0	7	14
11	37	1	0	32	4
12	0	1	0	0	
13	19	0	0	17	2
14	16	2	4	9	1
		6.4%	19.0%	56.8%	17.7%

Elimination, i.e. rejecting the unlikely choices, was reported as the most common basis whereby students selected correct responses for most questions. However, for the three items involving length of objects (questions 1, 3 and 7) and the item involving angle measure (question 4) students also reported a high incidence of estimation. Females reported a higher incidence of guessing than did males (11.4% and 6.4% respectively).

Students, who stated that they made an estimate, reported doing so by either using various referents as indicated in Table 4 or by unitizing as indicated in Table 5.

Table 4 Numbers of students reporting use of particular referents

Item	Referent	Females (n=50)	Males (n=50)
1	own or another's height	5	4
2	arm lengths	1	0
3.	a door	3	5
	own or another's height	5	3
4	right angle	4	6
6	outside temperature (30^0)	0	1
7	a handspan	1	0

Table 5 Numbers of students who reported unitizing

Item	Unit	Females (n=50)	Males (n=50)
1	metre rule	24	25
2	a litre container	1	1
3	metre rule	4	4
5	a 1 litre milk container	1	0

Some students reported that they chose a particular response on the basis of real-life experiences which they were able to recall. These are given in Table 6.

Table 6 Numbers of students reporting responses selected on the basis of real-life experiences

Item	Experience	Females (n=50)	Males (n=50)
2	use of 9 litre bucket at home	6	10
5	home experience (involving saucepans)	1	2
6	knowledge of air-conditioning at home or at parent's workplace	3	4
8	observation of filling of petrol tank of family car	7	5
	general knowledge of cars	1	5
9	shopping experience	3	6
10	knowledge of own or another's temperature	7	12
11	weighing dog at home	5	4
13	shopping experience	3	2

Table 7 shows those aspects of their favourite sport which interested each of the 100 students. Some students gave more than one response.

Table 7 Aspects of favourite sports which interest students

	Females (n=50)	Males (n=50)
Skill	37	41
Speed	14	15
Distance	12	12
Uniforms	3	3
Enjoyment/excitement	3	9

There were no significant gender differences for any of these aspects.

Discussion

In general, gender differences for achievement on specific items of the "Measurement Quiz" were not significant, except for item 2 (the capacity of a household bucket) and for item 6 (the temperature of an air-conditioned room), where for both items males achieved significantly better than females, though no clear reason emerged for these differences. This overall result differed from that for the Australian Primary Schools Competition, for which there were significant gender differences for each of the first five items of the Quiz (which were common to both Competition and Quiz). The lower incidence of gender differences for the Quiz may indicate that females achieve better on multiple choice items when they are not pressured by a time constraint. It might also indicate that strategies for improving

females' performance in mathematics are beginning to take effect and that gender differences in mathematics may be decreasing, as noted by Fennema (1994).

As a follow-up to this study, 84 year 6 students, comprising 48 females and 36 males, from one of the three participating schools, were each given four pencil-and-paper multiple-choice questions relating to speeds, distances and time in an endeavour to determine if gender differences existed among these students for this aspect of mathematics; however, no significant differences were found. In an attempt to determine whether the form of question had an affect on gender differences, these 84 students were also given five open-ended items involving estimation of length, mass, capacity, area and temperature of common objects; again, no significant gender differences emerged.

The study found that year 6 males and females reported using similar strategies for finding responses to pencil-and-paper multiple-choice items involving estimation of measurements. Further, it revealed that a common strategy is elimination of unlikely responses. When making an estimate, pupils reported using either a referent or comparing against a unit. Males and females reported basing some of their estimations on similar real-life experiences. The study also found that the strategies reported by higher achievers did not differ significantly from those reported by lower achievers. No consistent pattern for the use of strategies emerged; indeed, some higher achievers reported largely using elimination, while others reported a mixture.

Not surprisingly, it was found that students achieved highest for estimation of length and lowest for estimation of areas; in fact, they often confused area with length.

In an attempt to determine those aspects of real-life experiences on which students focus, students were aked to nominate aspects of their favourite sport which interested them. Results indicated that there was little difference in the preferences of males and females.

Conclusion

This study found that, in general, for year 6 students, there were no significant gender differences in their ability to estimate measurements nor in the strategies which they employed. Further, females and males appear to have similar measurement real-life experiences and, in relation to these, exhibit similar interests.

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