Teacher Attitudes Towards Chance and Data

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Seventy-two teachers from Tasmanian government primary and secondary schools were surveyed regarding (i) their agreement with statements relating to personal confidence with chance and data, (ii) their views of the importance of statistics in society, and (iii) their confidence in teaching chance and data. Differences across gender and school type were found in measures of individual items and also combined scales. These results help to specify needs for professional development.

Since the publication of *A National Statement on Mathematics for Australian Schools* (Australian Education Council, 1991), Chance and Data has been accepted as part of the 'mainstream' mathematics curriculum. There is, however, some evidence that teachers lack the essential knowledge and understanding of many chance and data concepts (e.g., Russell, 1990; Russell & Mokros, 1991; Bright, Berenson & Friel, 1993). In addition to the misconceptions held by many teachers, there is a confidence factor which may affect the effectiveness of teachers (Fischbein, 1990). This may be either a lack of confidence concerning chance and data topics, or a misplaced confidence in understanding of the concepts. Little research has been devoted to teachers' attitudes concerning the chance and data subject matter and their confidence in teaching it. Greer and Ritson (1993) studied Northern Ireland tachers' attitudes toward data handling in the school context but not in wider society, and they did not measure teachers' confidence.

This is the initial report of a study carried out as part of a research project at the University of Tasmania which commenced in 1993 to study the understanding of chance and data concepts by students and teachers. The major focus of the project is a longitudinal study of students' understanding (Watson, Collis & Moritz, 1994). The focus on teachers considers both teacher confidence and competence across a range of chance and data concepts, utilising some items from the student questionnaire, together with other general background questions and the items detailed below. In this report responses to questionnaire items are considered related to (i) agreement with statements relating to personal confidence with chance and data, (ii) agreement with the importance of statistics in society, and (iii) confidence in teaching chance and data.

Method

Sample and procedure

Schools participating in the study were chosen to provide a cross section of the types of school found in the Tasmanian government school system. Schools covering the range of grades from kindergarten to grade 10 were surveyed in each of the seven Tasmanian Education Department districts. A total of 72 teachers from 14 schools was surveyed using a structured interview format. These teachers were teaching all grades from kindergarten to grade 10. The Chance and

Data strand of the *Tasmanian Mathematics Guidelines K-8* (Department of Education and the Arts, Tasmania, 1994) had been distributed to schools but in general very little professional development in this strand had been undertaken in the schools in the sample. Mathematics curriculum officers were available in each of the seven districts.

Teachers were asked questions on a variety of topics. The interviews lasted no longer than forty-five minutes, to fit into a school timetable, and were audiotaped. The interviewer was not a teacher, was unknown to most teachers interviewed, and was younger than all teachers in the sample. Teachers did not appear to be intimidated by the interview procedure. This paper reports results from sections of the interviews titled Beliefs about Statistics and Teaching Confidence.

Instruments

The Beliefs about Statistics scale was made up of ten statements concerning attitudes or beliefs about chance and data, adapted from some developed by Gal and Wagner (1992). A continuous scale allowed teachers to indicate their levels of agreement, from strongly disagree to strongly agree, for each statement (see Figure 1). The distance along the scale from 'Strongly Disagree' (0mm) to 'Strongly Agree' (75mm) was used as a measure of the strength of the belief/attitude implicit in the statement.

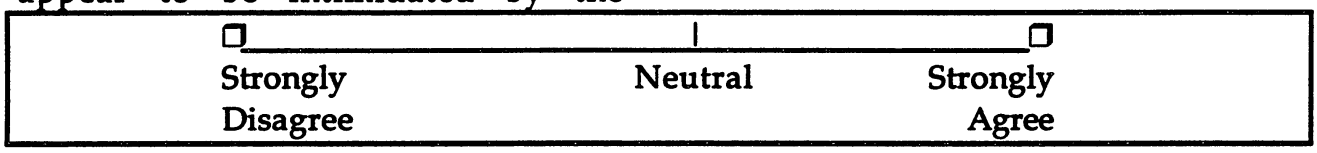

Figure 1. Beliefs about Statistics agreement scale.

The Teaching Confidence scale was based on a similar survey by Bright, *et al.* (1993). Teachers were asked to rate on a continuous scale their confidence in teaching particular topics in chance and data (see Figure 2). Because there was also an option indicating 'Would not be teaching', not every teacher completed the confidence scale for each topic. Where both the scale and the 'Would not be teaching' option were completed, the confidence measure was included. The topics included some which are commonly taught and others which are less often included in the mathematics curriculum. The complete list included Chance Language, Equally Likely Outcomes, Average, Probability Calculations, Odds, Median, Graphical Representation, Data Collection, and Sampling. As with the agreement scale, the distance along the scale from 'Low Confidence' (0mm) to 'High Confidence' (75mm) was used as a measure of the degree of confidence.

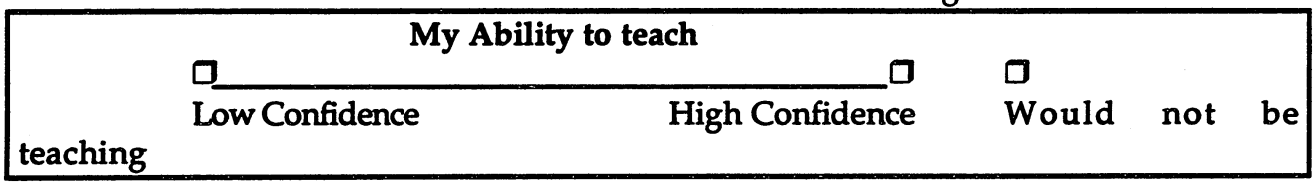

Figure 2. Confidence in ability to teach rating scale.

Variables

The independent variables used were school type (primary and secondary) and gender (although overall an increasing majority of Australian teachers is female, male teachers are still more likely to be teaching in secondary schools [Schools Council, 1990]).

Three dependent variables were defined based on the responses to the items on Beliefs about Statistics and Teaching Confidence. Two subscales were defined from the 10 items on Beliefs about Statistics (see Table 1). A subscale of Personal Confidence with statistics was based on statements 1.2, 1.4, 1.6, and 1.9, which had a definite personal focus, e.g.,

'I can easily read and understand...' (1.2); '...seem very clear to me' (1.6). Statements 1.1, 1.5, 1.8, and 1.10 constituted a subscale of Societal Importance of statistics. Calculation of scores for this subscale involved reversing scores for statements 1.8 and 1.10 to reflect their negative view in comparison to statements 1.1 and 1.5. Statements 1.3 and 1.7 were knowledge based items and are not analysed in this paper. For the Teaching Confidence scale, one variable of global Teaching Confidence was defined from the mean of the topic confidence measures available (see Table 2).

Table 1. Beliefs about Statistics items & subscales by school type and gender.

	ITEM	Prim. F	Prim. M	Sec. F	Sec. M	School Type	Gender	School *Gend
		n=15	n=10	n=7	n=10	p	p	p
1.2	I can easily read and understand graphs and charts in newspaper articles.	55.73	60.40	60.86	69.10	0.180	0.210	0.726
1.4	I can understand almost all of the statistical terms that I see in newspapers or on TV.	40.60	55.90	48.71	70.10	0.054	0.002	0.590
1.6	Statements about probability (such as the odds of winning a lottery) seem very clear to me.	42.20	54.20	54.29	66.20	0.056	0.057	0.994
1.9	I could easily explain how an opinion poll works.	41.60	49.70	38.00	58.50	0.675	0.026	0.320
	Personal Statements (1.2, 1.4, 1.6, 1.9)	45.03	55.05	50.46	65.97	0.050	0.003	0.500
1.1	You need to know something about statistics to be an intelligent consumer.	50.13	53.20	44.86	63.70	0.701	0.113	0.251
1.5	Understanding probability and statistics is becoming increasingly important in our society.	58.87	57.40	58.00	57.30	0.906	0.791	0.925
1.8	People who have contrasting views can each use the same statistical finding to support their view.	53.00	52.10	62.29	52.70	0.400	0.373	0.460
1.10	Weather forecasts about the chances of rain are wrong so often that I don't take them seriously.	25.33	36.40	38.43	24.30	0.940	0.818	0.064
	Society Statements (1.1, 1.5, 1.8, 1.10)	45.17	43.03	38.04	48.50	0.766	0.140	0.028
1.3	When buying a new car, it's better to ask a few friends about the problems with their cars than to read a car satisfaction survey in a consumer magazine.	36.00	25.80	33.71	36.65	0.517	0.582	0.322
1.7	To learn about the side effects of a drug, it's better to refer to the results of a medical study that tested it on a few people, than to talk to someone who has taken the drug.	62.93	45.00	53.14	52.80	0.878	0.165	0.181

Results

Beliefs about Statistics

The results for each of the 10 statements on Beliefs about Statistics grouped by gender and school type are summarised in Table 1 with items grouped by their

subscales. The scale was completed by 25 primary and 17 secondary teachers. In considering the items individually, a 2x2 ANOVA (gender by school type) was performed for each item and the associated p-values for school type, gender and the interaction are also given in Table 1. Only two significant differences were found ($p < .05$). Both of these were for gender (1.4 and 1.9), indicating greater male confidence in understanding and explaining statistical terms. The subscale of Personal Confidence with statistics displayed differences associated with both gender and school type, males (secondary and primary) and secondary teachers (male and female) being significantly more confident. For the subscale of Societal Importance of statistics, neither gender nor school type was a significant factor, however there was an interaction effect. This is illustrated graphically in Figure 3 which indicates a similar mean for male and female primary teachers but a lower mean for female secondary teachers compared to their male counterparts, in fact the lowest mean value obtained.

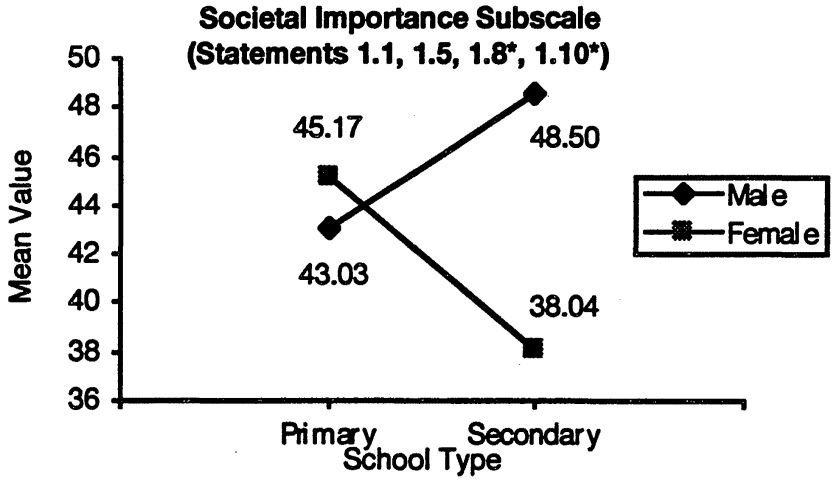

Figure 3. Societal Importance subscale by gender and school type.

Teaching Confidence

A total of 37 primary and 34 secondary school teachers completed the Teaching Confidence scale. The results for individual items of Teaching Confidence are summarised in Table 2. The only topic showing a significant difference for gender was Odds, with males more confident. Secondary school teachers were significantly more likely to be confident about their ability to teach Average, Probability Calculations, Odds, Median, and Sampling ($p < .05$). Differences for Equally Likely Outcomes, Graphical Representation, and Data Collection were also approaching significance at the .05-level, secondary school teachers tending to be more confident. The results for Median were particularly striking, only 19 primary teachers indicating any level of confidence, with the others choosing the 'not teaching' option.

Table 2 Teaching Confidence items and subscale by school type and gender.

Topic Confidence	Primary Female		Primary Male		Secondary Female		Secondary Male		School Type	Gender	School* Gender
	Mean	n	Mean	n	Mean	n	Mean	n	p	p	p
Chance Language	50.39	23	47.29	14	42.46	13	58.43	21	0.755	0.214	0.067
Equally Likely Outcomes	45.43	23	45.64	14	49.42	12	60.43	21	0.051	0.240	0.258
Average	53.32	19	60.93	14	67.57	14	67.57	21	0.002	0.252	0.252
Probability Calculations	38.12	17	38.92	13	42.64	11	59.38	21	0.024	0.109	0.145
Odds	34.45	20	41.50	14	46.55	11	62.48	21	0.001	0.020	0.360
Median	33.60	10	39.89	9	65.67	12	67.86	21	0.000	0.362	0.659
Graphical Representation	66.13	23	62.64	14	70.07	14	68.81	21	0.059	0.369	0.673
Data Collection	62.22	23	61.50	14	67.57	14	68.19	21	0.066	0.988	0.836
Sampling	44.71	21	48.23	13	62.77	13	62.14	21	0.001	0.751	0.649
Teaching Confidence	50.34	23	50.02	14	58.26	14	63.92	21	0.001	0.389	0.334

Subscale correlations

The Teaching Confidence subscale was significantly correlated with both Personal Confidence ($r_{40} = 0.450$, $p < .01$) and Societal Importance subscales ($r_{40} = 0.307$, $p < .05$). The correlation of Personal Confidence with Societal Importance, however, was not significant ($r_{40} = 0.241$, ns).

Discussion

The sample in this study is relatively small and hence there is a need for further research in this area. Both Personal Confidence and Teaching Confidence for topics in the chance and data strand were higher for secondary than primary teachers. This might be expected, as primary teachers cover a range of subjects, while secondary teachers are likely to spend more of their time involved in teaching mathematics, increasing their confidence in dealing with statistics as a part of that subject.

Female teachers had lower Personal Confidence with statistics, while there were no significant gender effects for Teaching Confidence items, except for the topic of Odds. In a professional context it seems females are equally confident in teaching chance and data topics, however they are less confident with statistics in daily life. This may be related to a perceived difference in the two contexts: in the mathematics class statistics may be seen as algorithmic and nonthreatening, while in society it requires interpretation and may be seen as more nebulous and threatening. Whether this interpretation is related to the reported lack of confidence of younger female students in mathematics generally (e.g., Fennema & Sherman, 1978; Meyer & Koehler, 1993) would require much further investigation.

Neither school type nor gender was a significant main effect for the Societal Importance subscale, however there was an interaction effect, with a similar mean for male and female primary teachers but a lower mean for female secondary teachers compared to their male counterparts (see Figure 3). Reasons for this can only be conjectured. Recall, however, that gender generally was not associated with differences in teaching confidence.

The non-significant correlation between the Belief in Statistics subscales indicates that they are probably measuring, as intended, different aspects of the teachers' beliefs about statistics. The higher positive correlation between Personal Confidence and Teaching Confidence is not surprising since teachers

confident about personal involvement with statistics could well be expected to feel confident in their ability to teach particular topics. Confident teachers may also be likely to see statistical ideas as important to society (the second highest correlation).

Teaching Implications

The responses to two of the individual topics on the Teaching Confidence scale, Graphical Representation and Median, deserve further comment because of the findings of other research. All teachers regardless of school type or gender indicated high levels of confidence in their ability to teach Graphical Representation. Research by Bright, *et al.* (1993) indicates that primary teachers tend to 'fixate' on particular features of a graph in order to explain ideas such as 'typical' or 'middle of the data' rather than concentrating on the entire data set. There is also some tentative evidence that primary and secondary school teachers may use unconventional strategies when faced with a problem using data in a graphical form (Callingham, 1993). It may be that the apparent confidence of teachers in their ability to teach graphing is misplaced, at least when it comes to interpretation. Further light may be shed on this topic when responses to other parts of the survey are analysed.

The results related to Median need to be seen in the light of recent increased use of the concept in society. The Australian Bureau of Statistics (1995) reports that the median is used more often as a measure in statistical surveys because of its robustness. Given this exposure, the low number of responses to this item by primary teachers (19/37) and their low confidence when they did respond is anomalous in the light of the fact that all teachers should have encountered the median in their own schooling.

The results of other research also inform discussion of the median. Although usually having a good informal sense of 'middle' when asked to find a median, both children and teachers are apt to define the middle as the centre of the range or the middle point on the x-axis of their graphs (Russell, 1990; Berenson, Friel & Bright, 1993). Research by Mokros and Russell (1995) indicates the importance of developing notions of representative measures of data, building on intuitive understanding, including a sense of the middle. This process needs to be developed gradually over time and, they state, should culminate in developing the concept of the mean, rather than teaching this as an isolated algorithm at a relatively early stage. In this survey, primary teachers were less confident about their ability to teach 'average' than secondary school teachers, but almost all (33/37) responded with some measure of confidence. It is of course impossible to know whether the confidence is based on knowledge of the formula or the concept. Compared with the teaching of the mean it would appear that primary teachers either avoid developing ideas about 'middle' or do not recognise the term 'median'. The responses displayed here warrant further investigation. It may be that neither teachers, nor the curriculum, have caught up with the research findings and the trend to increased use of the median. This will have implications for pre-service instruction and in-service professional development.

If teachers lack the understanding of, or confidence in teaching, chance and data, then students are less likely to receive adequate grounding in the area. If students entering pre-service courses have inadequate grounding, then they will also need to address this strand of the mathematics curriculum explicitly in their courses, to improve their knowledge, understanding and thus their confidence. In-service courses also are needed not only about how to teach these concepts, but also about the concepts themselves, particularly for primary

school teachers. Fischbein (1990) would suggest that both types of course need to be practical in approach, with a significant component of 'hands-on' experience.

Given the increasingly widespread use of inferential statistics in decision making at all levels of society, if we are to have a statistically literate society, then there are many issues relating to the pre- and in-service training of teachers to teach statistics that still need to be addressed. There are also many research questions raised by these data in relation to teachers' confidence and their subject matter knowledge. Some will be considered in later reports from the larger study from which these data came.

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