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AUTHOR Begg, Andy; Edwards, Roger
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ABSTRACT

This research investigated notions raised in the literature about teachers' lack of statistical background and knowledge. It focused on four assumptions: elementary school teachers have a rich source of ideas about statistics from their everyday teaching experiences; they have a greater understanding of statistics than they are often given credit for; their ideas influence their teaching; and their ideas about teaching statistics are closely influenced by their ideas about teaching mathematics. Participants were 22 practicing New Zealand elementary teachers and 12 preservice teachers. Data collection included unstructured, semi-structured, and clinical interviews, surveys, and concept maps. Results indicated that all of the respondents' initial attitudes toward statistics were negative. Very few had formal training in statistics in school and had weakly developed concepts of probability, showing reliance on prior beliefs. Over 70% of the study group participants indicated they interpreted the word "average' in a general or everyday sense. They considered graphs communicative tools. Most teachers recognized the cross-curriculum nature of statistics, though most taught it as a unit of mathematics. All teachers in the study group considered statistics important for primary school children to learn. Most teachers felt reasonably confident teaching statistics. (SM)

Teachers' Ideas About Teaching Statistics

Andy Begg and the late Roger Edwards
University of Waikato, New Zealand

Abstract

This paper presents some results from the incomplete doctorate of the late Roger Edwards that explored the notions raised in the literature concerning teachers' lack of statistical background and knowledge. This study started with four assumptions. Firstly, primary school teachers have a rich source of ideas about statistics from their everyday and teaching experiences. Secondly, they have a greater understanding of statistics than they are often credited with. Thirdly their ideas influence their teaching. Fourthly their ideas about teaching statistics are closely influenced by their ideas about teaching mathematics. In this paper some results from this study which explored these notions are presented.

Introduction

Roger Edwards was studying for his doctorate from 1994 to 1996. During that time he had collected his data and begun writing his thesis. He put it on hold in 1997 because he was starting a new job. Later that year he was diagnosed with cancer and a few months later he died. As the chief supervisor I was familiar with his work and am attempting to complete at least a partial record of his study. Roger had reported on this study while it was in progress (Edwards, 1996) and this paper is an expansion of his earlier one. This paper is concerned with four interrelated aspects—teachers' beliefs and attitudes towards statistics, their content knowledge of statistics, their beliefs and attitudes about teaching statistics, and their knowledge in terms of teaching statistics. From the review of the literature these aspects were expected to be closely linked to the teachers' attitudes and beliefs and their knowledge and understanding of mathematics and its teaching.

Framework

Through the 1994–96 period Roger showed an affinity to a 'general systems' approach where the interrelationships between the various aspects being studied were acknowledged. This approach was a variation of naturalistic inquiry from a constructivist perspective. Within the currently emerging literature it appears to fit within an enactivist framework.

Research design

Data collection involved a variety of methods. These included unstructured, semi-structured and clinical interviews; survey (Likert) scales that provided a focus for discussion; and concept maps which provided a guide with respect to the efficacy of the research. The sample comprised 22 practising primary teachers from fourteen schools and 12 pre-service primary teachers from one college of education. The sampling procedure was 'opportunity' sampling after initial efforts with a more formal approach only attracted teachers with an interest in mathematics. The sample covered teachers from a range of primary school classes and was representative of New Zealand teachers in that they were mainly females and many of them had considerable teaching experience.

Research findings

The findings generally fall into four main categories—teachers' beliefs and attitudes about statistics, their content knowledge of statistics, their beliefs and attitudes about teaching statistics, and their knowledge in relation to teaching statistics.

Teachers' beliefs and attitudes about statistics

All the initial expressions of attitude in relation to statistics were negative in orientation. Examples of words used included: *'fear, fear', 'horrors', 'uninteresting', 'I didn't understand', 'baffling', 'boring', 'horrible graphs', 'statistics is not my forte'* .

Most of the teachers saw statistics in quite a narrow sense—27 of the 34 mentioned aspects such as: graphs, tables, numbers, information and percentages. Of the remaining seven, six talked about statistics as a process and as usually being the collection and presentation of information. These six were all practising teachers.

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Half of the teachers were asked how they visualized a statistician at work. Most thought of number crunching although five said it linked with collecting information. Nine of the seventeen saw it as involving computer work. Ten of them visualized a male, and four of them had him with spectacles.

The interview and Likert scale data indicated that some of the 34 teachers considered statistics important.

When asked about its usefulness the themes that emerged included:
- It helps us make sense of our world (6)
- It helps us compare and organize things, shows trends and enables us to predict (7)
- It assists in planning for the future (2)
- It helps in summarizing a lot of information (1)

One said 'it helps get one's point across', but in this regard statistics were seen as being easily manipulated to support any view, be it wrong or right. The culprits, or those who have gained notoriety in this area, were the media and politicians. Despite their concern about how statistics can be manipulated, the teachers generally disagreed with the statement "Statistics are fairly worthless, because people who have contrasting views on a certain issue can each use the same statistical finding to support their view".

Most of the teachers thought that a good understanding of mathematics was not needed to grasp basic statistical concepts such as 'average', and that statistics gives students who might have had persistent difficulties or bad experiences with mathematics another chance.

When asked to rate their own ability with statistics, they clustered their perceptions of their abilities round the centre of the scale, but they were confident about their ability to read and understand statistical terms, graphs and charts used in the media (newspaper & television).

When asked about their attitudes and beliefs about statistics they seemed related to their prior experiences with statistics. In particular their views were derived from different worlds of experience and meaning in relation to statistics. A number of the teachers held an instrumental view of statistics, and their views indicated a negative orientation towards statistics (which fitted with similar views of mathematics).

Teachers' content knowledge of statistics
Very few of the teachers had had 'formal' training in statistics during their school years or through pre-service or in-service courses. In seeking to find the teachers' knowledge of statistics three areas are reported—probability, averages, and statistical graphs.

Probability
Three questions were asked to find teachers' content knowledge about probability. The first was about lotto which was assumed to be an everyday experience. The second was a typical classroom coin-tossing question involving sub questions. The third was a more formal traditional mathematics class question on the 'law of small numbers ' involving babies being born in different hospitals.

Twenty-four of the sample indicated they had played lotto and nine others thought that they understood how it worked. These thirty-three were asked:

> If you could choose any one of the following tickets, which would you choose:
> a) 1, 2, 3, 4, 5, 6
> b) 5, 10, 15, 20, 25, 30
> c) 2, 13, 19, 27, 30, 38
> d) Use the same numbers I lost with last week
> e) Use the same numbers I won with last week
> f) No preference.

The coin tossing problem was:

> (i) You toss a fair coin five times. Which of the following sequences are most and least likely to occur?
> a) H H H T T b) T H H T H
> c) T H T T T d) H T H T H
> e) All four sequences are equally likely or unlikely.
>
> (ii) What would you expect on the 6th toss assuming choice T H T T T for the first five tosses? Explain?
>
> a) Heads b) Tails c) Equally likely d) Other.

The 'law of small numbers' problem was:

> Half of all newborns are girls and half are boys. Hospital A records an average of 50 births a day. Hospital B records an average of 10 births a day. On a particular day, which hospital is more likely to record 80% or more female births?
>
> a) Hospital A (with 50 births a day)
> b) Hospital B (with 10 births a day)

c) The two hospitals are equally likely to record such an event.

A surface analysis of responses revealed a generally weak understanding of the probability concepts being probed. Explanations revealed a greater understanding on some questions even though the answer chosen was not the 'correct' one. Notions of equally likely, independence and randomness were explored with these questions as starting points. Just over two thirds of the responses showed either a good understanding or were familiar with the concept of equally likely, about half understood randomness, and fewer understood independence. Analysis of the teachers' justifications for their choices revealed evidence of the representative heuristic of Kahneman and Tversky (1972) (that is they assumed the population to be similar to the sample) and of Konold's (1989) outcome approach (that is they predict a particular outcome rather than considerable range of possibilities).

In summary these teachers seemed to have weakly developed concepts of probability and showed a reliance on prior beliefs. They preferred the questions to do with everyday life. They tended to see things in terms of the representative heuristic. With randomness they looked for spread across a range of variables and did not seem to believe that order or pattern were likely to be associated with random events.

Averages

The teachers' initial responses to the term 'average' were explored through the questions 'what is average?', 'what comes to mind when you think of average?' and 'is there a distinction between how *average* is used in everyday life and in mathematics?' Most noticeable about the responses was the variety of terms and ideas used when discussing 'average'. These included; *mean, median, middle, middle-ish, middle of the road, in between, overall balance, typical, normal, ordinary, moderate,* and *representative value.*

Over seventy percent of the group indicated they interpreted average in a general or everyday sense. In addition, over sixty percent of them indicated that notions of 'in-between, normal or middle-ish' were central to their everyday views of average.

Half of the teachers referred to different kinds of averages—mathematical and everyday averages. The difference between them appeared to be related to accuracy and preciseness. Mathematical averages were based on algorithms while everyday averages were noted for their vagueness and were considered more like estimates. While these people distinguished between mathematical and everyday notions of average some saw the distinction in terms of the different measures of central tendency. For example, one said, *mathematically speaking the average is the mean* but in an everyday sense it is *more about the mode* and another said, in teaching mathematics *average is more the mean* but in everyday life it is *roughly the middle of the bunch .*

As the everyday notion of the term average was in evidence it was decided to explore this by asking teachers to comment on how an Australian newspaper statement used the terms average and median. The statement read,

> *Hobart defies homes trend .* AGAINST a national trend, Hobart's median house price rose to $88,200 in the March quarter—but, Australia wide, the average wage earner finally can afford to buy the average home after almost two years of mortgage pain.

The responses to this indicated a great variety of terms and ideas in use to describe what 'average' and 'median' mean in this article. For example terms such as mean, middle, middle class, normal, middle group, and in between were used to describe average. Average was used for mean (6), middle (5), middle bracket (8), generalization (6) normal (3), and most (2). Median on the other hand was used mainly to refer to notions of middle—17 made reference to the median as the middle price or middle housing bracket. Among the remaining people three indicated it referred to normal 'middle class' housing and one said it meant what most people could afford. Approximately half of the group who answered the question thought that the terms average and median were being used interchangeably in the article. For example, four thought both terms were being used to indicate what was 'normal' or 'middle class' where as one thought both terms were being used to refer to the most common wage or house price. Several referred to the incorrect use of the terms by the journalists who wrote the article. For example one said, *that's misinformation, the median is the middle and the average could be higher or lower* , and another said *It's funny they have used both here. It suggests it's hog wash. The median can be above the average, Are they throwing in those terms loosely?* Among the other half who considered the terms were being used differently, the largest sub group (5) saw average used as mean and median as middle. Two others used average for what was normal or typical and median as middle, while two others referred to average as a broad term and the median as more specific or precise. Only a small number of the teachers talked about the median's properties as to why it was used in the article. Their comments included: *It's the middle price. That's the stats they have. It would usually be the average in the media. So that the price isn't dragged up by outliers if using the mean.*

The results suggest a general lack of familiarity with the terms mean, median and mode. Table 1 shows the percentage of teachers who correctly recognized and interpreted each term when asked to review student work on these terms.

Term/Concept	Practising Teachers	Pre-service Teachers

Mean	55%	67%
Median	33%	83%
Mode	37%	75%
All three terms correct	21%	58%
One or more terms correct	58%	92%

Table 1: *Correct interpretation of 'averages'*

The table shows that only 21% of the practising teachers and 58% of the pre-service teachers correctly recognized and interpreted each of the three terms indicating a lack of familiarity or understanding of these terms. While the results suggest that pre-service teachers are more familiar with these terms than practising teachers this may not be so as many of the pre-service group were in the process of covering statistics in their course.

Further analysis showed that many teachers recognized the terms but said they could not remember them sufficiently to be able to use them—*I can't remember what 'mean' is to tell the truth . I am just learning them all again myself* and *I need to get out my maths book and have a look. I can't recall* . Others reported they were unfamiliar with the terms or were unsure about their understanding.

All the teachers showed some understanding and recognition of the mean algorithm but either only partly understood it or did not notice the incorrect application of the algorithm in the student work that they reviewed. Two other aspects emerged. Firstly teachers of junior classes seemed to be less familiar with the terms than others which may be because this is not in the curriculum they teach. Secondly, the two Pacific Island teachers who had done their own schooling in their home islands before coming to New Zealand revealed very little knowledge of any of the terms suggesting that statistics may not have been included in their school mathematics.

In summary, the teachers saw average as an everyday notion rather than an algorithm. Average was seen as being 'around the middle', and although many were aware of the mathematical meanings, they were not able to use them correctly. They lacked familiarity with the terms and were unsure about when it was appropriate to use them. The mean was better understood than the mode and median although most teachers showed an intuitive grasp of these concepts. Generally these teachers did not have a good grasp of the measures of central tendency and were likely to rely on intuitive everyday notions of average.

Statistical graphs

The first question on graphing sought to explore teachers ideas about the value of graphs in a general rather than school context. Virtually all of the teachers said they saw the value of graphs as communicative but only six (of 31) referred to them as data exploration tools. Their perceptions of the main values of graphs are summarized in table 2.

Value of graphs	Practising	Pre-service
Visual/pictorial nature	51%	54%
Easy clear to see/read/understand/interpret	56%	100%
Quick/efficient as in time	26%	27%
See patterns/trends	5%	36%
Getting message across	5%	9%

Table 2: *The main values of graphs*

Other values were: *it makes it interesting, it is a different way of showing something, easy to remember, a way of organizing information, assist in finding out something, and helps with logical thinking, prediction, biases and practicality.*

The typical teacher focussed on the gross features of the graphs, relied on overall impressions, and did not appear to consider the whole data set or examine the detail in a graph. Further evidence of this lack of attention to detail came from several other sources. Firstly only five of the practising teachers and three of the pre-service teachers noted an inconsistency between the percentages and sizes of the picture figures on one graph. In addition several teachers did not notice the graph heading until they were asked about it.

Another response from three of the group indicated that they thought one graph was not a 'true graph' as it didn't have the usual axes. Under this view graphs have certain features like axes and titles which make them graphs. This suggests that teachers have predetermined notions about what graphs or school graphs should look like. This was also evident with a line plot as several, when asked what they would do with the information, responded that they would use it to draw a graph, meaning a more conventional primary school graph such as a bar graph or pie graph. There was also a suggestion that for some teachers pictographs are not really graphs either but are the precursors to real school graphs.

The teachers were asked how they would display some simple category variables related to swimming club ability groupings. The teachers showed a preference for bar graphs (15) and pictographs (12) with bar graphs being the most common choice of pre-service teachers (7) and pictographs (10) and bar graphs (8) for practising teachers. This may reflect their experiences. Three of the practising teachers questioned whether it was worth displaying the data, showing perhaps that they were more likely to question the data.

Percentages were placed alongside the numerical data and the teachers asked if this would influence how they would graph the data. Over half the practising teachers and all but one of the pre-service teachers moved to using a pie graph. This suggested that teachers knowledge of graphs is fairly predictable and they operate with predetermined scripts regardless of other features of the data—percentages means pie graphs, numbers means bar and pictographs.

In summary, graphs were seen as communicative tools. Teachers seemed to have 'scripts' for responding to them regardless of the data. Bar graphs and pictographs were the preferred choice of a good number of the teachers for displaying simple category type data. In addition, the data suggested that pre-service teachers were slightly more likely to choose bar graphs while practising teachers were more interested in pictographs than pre-service teachers.

Teachers beliefs and attitudes about teaching statistics
The first question in this part of the research sought the participants' views on how they felt about teaching in general. Nearly all indicated that they found teaching a very enjoyable and satisfying career, although three said they were planning to get out of teaching as it was not rewarding enough financially. In terms of teaching mathematics they all thought that a key responsibility in teaching was to encourage children to explore their own mathematical ideas rather than for them as teachers to communicate their own understandings.

Teaching statistics
Although most of the teachers recognized the cross-curricula nature of statistics, the majority reported teaching it as a unit (or units) of mathematics. Slightly less than half of the practising teachers reported teaching it as 1 block of about 5 weeks duration once a year, a quarter reported teaching it twice a year in 3-week blocks, and two reported teaching it three times a year in 2-week blocks. One followed a specific course and was not aware of how statistics was covered, one had done it once a week but had shifted focus due to the children's weak numeracy skills, and two were using a thematic approach. Lower in the school statistics was taught in shorter bursts.

When asked about what they taught, virtually all the teachers mentioned graphing and data collection. Interpretation and posing questions were prominent but less often mentioned.
The next three areas mentioned were measures of centre, communication, and discussion.

In seeking to find how statistics was taught it was thought useful to find teachers' views of teaching statistics in relation to teaching mathematics. The majority of the practising teachers saw teaching statistics as the same as teaching mathematics, while those from the
pre-service group were not so sure of this. Comments included: *it's part of maths, we know it's a maths thing.*

When asked whether they used group activities frequently (more than in other areas) when teaching statistics all but one responded positively and thirty of them were very positive.

Importance of statistics
Analysis of the teachers' responses to the question 'how important is statistics for primary school children?' showed that they all considered it important. In terms of the strength of importance, only a quarter thought it 'really' important or 'one of the most important' areas. The reasons given for its importance for primary children were based on its utilitarian value in terms of functioning in all areas of life, interpreting media, because of technology, in future jobs, and because of its links with mathematics and mathematical thinking. Those who indicated that it enhanced the teaching of mathematics said such things as *it gives purpose to mathematics* , *makes it real, it helps motivate* , and *it's fun* . When asked whether they agreed or disagreed (on a Likert scale) *that 'much of statistics could be omitted from the curriculum without doing any real harm'* there was general disagreement.

When asked about its importance within the strands of the curriculum the responses were varied and are summarized in table 3.

Relative importance of statistics	Practising	Pre-service
All of equal importance	14%	16%
Number then others of equal importance	42%	33%
Number (statistics 3rd or 4th important)	40%	33%
Mathematical processes first	5%	—

Unaccounted — 16%

Table 3: *Relative Importance of Statistics*

Those who thought the strands were of equal importance said: *The curriculum is the reason for them being equal. We have just two weeks on each, each term. They all are equal as they can all be worked together.* Most thought that the number strand was the most important, their reasons included: *Number was basic or a prerequisite to understanding other areas. Number is such a big area. Children have more understanding to bring to number. It's school policy.* One 'unaccounted' pre-service teachers indicated that statistics was more important than many other areas but left his answer general, the other indicated that the relative importance of the strands changed according to level. She said, *they all have their importance at different levels. Mathematical processes is really important at the basic level as it gives a basic grounding. Measurement is not so important at the intermediate level. Statistics is as important as the rest at the new entrant level. Statistics has the ability to be taken at any level whereas measurement and things like that tend to die a little bit.*

Big ideas of statistics

To find what teachers regarded as the big ideas of primary school statistics teachers were first asked to draw concept maps that showed the topic categories from statistics. From the analysis of these only three categories were included in more than 50% of the concept maps, these were 'collect data', 'interpret data' and 'probability'. Three others were in the 39-50% range—'graphs', 'communication' and 'context'. For further analysis the concept map categories were regrouped into four much broader categories—these were posing questions (52%), collecting data (94%), analyzing data (85%) mainly by using graphs, and interpreting data (85%). The percentage figures here indicated the number of concept maps that included one or more of the sub-categories under each of the four headings.

Teacher confidence

In an attempt to find out about teachers' confidence they were asked to rank themselves on three scales regarding:

- Generally I feel secure about the idea of teaching statistics.
- The thought of teaching statistics makes me feel nervous
- I would find it difficult to explain to someone what an average is.

Over 80% of the teachers rated themselves as feeling reasonably secure when teaching statistics, and the same number were not nervous at the thought of teaching statistics. Only 25% felt it would be quite difficult to explain to someone what an average was. A further indication of their confidence with teaching statistics came from the priority they would give to professional development work in statistics when compared to the other strands in the curriculum. Even though most had had little (pre- or in-service) education in statistics, three quarters said it would either not be a priority or would only be of low priority.

Other concerns held by teachers with respect to confidence in teaching statistics related to their lack of familiarity with statistical concepts and terms. Nearly all of the teachers were unfamiliar with one or more of the terms taken from the curriculum. Teacher confidence was lowest on the newer ideas in the statistics curriculum (stem and leaf graphs and probability). Not surprisingly, teacher confidence was highest on the 'older' more familiar statistics curriculum topics (data collection, bar graphs and pictographs).

Use of calculators and computers

Calculator and computer use in primary school statistics was not extensive. In the teachers' accounts of teaching episodes that went quite well two teachers mentioned using calculators and two mentioned computers. A later question asked specifically about the use of calculators and computers in statistics, four teachers mentioned using calculators and five using computers in statistics, and five more had used calculators in other areas of mathematics. Of the five who mentioned using computers within a statistical context the following uses were given: getting information from a CD ROM, word processing and drawing, graphing (2), and for exposure to statistics vocabulary. Those that used calculators used it for operations such as adding scores (3), finding percentages, and calculating means. While the teachers did not think computers were essential, analysis of the many comments revealed that they were regarded as helpful and that they may be increasingly so.

Teachers knowledge in terms of teaching statistics

Knowledge Essential for Teaching

Some of the anomalies between teachers' perceptions of their statistical abilities (or lack of) and their high teaching confidence are illumined when one looks at their views about whether statistical knowledge is essential for teaching. The literature on teachers and statistics education points to concerns regarding teachers' *preparedness* for teaching statistics (eg. Greer & Ritson, 1994) and this is linked with their lack of statistical education. As was noted in the teacher confidence section, the teachers themselves do not necessarily see their lack of statistical education as a problem for their teaching. The results in this study suggest that while teachers acknowledge the value of statistical knowledge, they are somewhat ambivalent, as a group, about how important it actually is. The teachers appear more concerned about the 'how' of teaching

and consequently place more emphasis on finding appropriate ideas and activities than in gaining more statistical training. The following response patterns are indicative of these trends. The teachers generally agreed (average 3 on a 1 to 7 scale) that a good understanding and knowledge of statistics is essential for teaching statistics. At the same time, when asked whether statistics knowledge is more important than knowing how to provide appropriate statistical activities for pupils, they generally disagreed (average 5.5 on a 1 to 7 scale). This emphasis on appropriate activities was reinforced by interview data. When the teachers were asked about what they would want in in-service courses on statistics nearly all said they would want more ideas and activities for use in their classrooms. Only two said they would want further work on statistics itself.

Curriculum knowledge

A significant number of the teachers were unfamiliar with the curriculum document with a number of them saying 'said they hadn't used it yet'. As one said 'I am not familiar with the new curriculum. I got my first look after finally getting a document from another teacher, it had been stored in a cupboard for a year'. This was also evident with their lack of familiarity with statistical terms and concepts from the new curriculum. Nearly all of the teachers were unfamiliar with one or more of the terms taken from the curriculum. In their concept maps only seven (of the thirty-four) made reference to statistical investigations as a major sub-strand within the curriculum. Of these seven, some were from the pre-service group indicating the emphasis on statistical investigations by practicing teachers is actually lower.

Sixteen of the teachers who had taught using the current curriculum (1992) and the older version (1987) were shown both and asked to comment on how they differed. Nine said that there was little difference in substance between the two. One said, *they haven't really changed that too much have they. It's still there. It's not new. The curriculum says it's new. It's not.* Another's opinion (similar to that of three others) was, *I understand the old one 10 times more than I understand this new one. I am doing the old one. I think I am doing the new one but it's all disguised by new jargon. It's just the same with names changed.*

In putting together the differences attributed to the curriculum documents the following pictures emerged. The old curriculum was described as being: more specific (3), easier to follow (1), text based (2), arbitrary (2), hierarchical (1), teacher directed (1), and based on numbers (1) and graphs (1). The new curriculum was described as being more general and vague (3), more difficult to read (1), formalizes what teachers are doing anyway, is less prescriptive, gives more prominence to statistics (1), pushes statistics lower down in the junior school (4), is more child-centred (3), emphasizes thinking and processes more (2), is less hierarchical (1), and more integrated and inclusive (1). Concerns related to the new curriculum were concerned with its readability (1) and that it might water statistics down (1). In terms of whether the teachers were happy with where they saw statistics education going, most indicated that they thought things were about right. Many of them mentioned its cross-curricula characteristics and saw this as positive.

Activities and contexts

Analysis of activities and contexts revealed both a range of ideas in use and a common core. In collecting data the core of activities used by half the teachers included surveying colours or types of cars, students favourite foods, TV programmes, sports, or aspects to do with the students such as their hair, eye colour, shoe type, and clothes colours. The underlying objective seemed to be to determine the most or least of something. The main concern was to identify things that were close to the students. The overriding impression was that the teachers had similar views and approaches which were so close that one would have thought they might have all been taught the same approach. Previously available resources may have influenced this. The similarities between the activities and contexts reinforced the notion of primary teachers as a community of practice with shared experiences.

Teachers' ideas change

The teachers' responses to the statement 'my understanding of mathematics has been transformed in the process of teaching' averaged 2.5 on a Likert 1 to 7 scale. This was reinforced by the interview data and reasons given for changing included, *new textbooks, a new curriculum, a new person with different ideas coming along, identifying different needs with different groups of children, improved confidence as a teacher,* and *responding to children being bored.* Only a few had remained 'on the same track'. The two practising teachers who did not indicate they had changed were the two youngest practising teachers surveyed with one being in his first year teaching and the other being in her second year.

Discussion

There was a real diversity in the views expressed. The differences between the individuals' views were much greater than the differences between the subgroups.

The distinctions between beliefs and attitudes towards statistics and towards teaching statistics were not always clear. This was because it was not possible to know what teachers were reacting to when talking about their attitudes and because the teachers tended to see these two aspects as inextricably linked. This suggests a minor flaw in the initial framework.

Images of statistics

A number of the teachers reported having bad images of statistics. These included the younger pre-service teachers which suggested that teaching approaches to statistics in senior high schools and tertiary institutions have changed little—presumably meaningful contexts are not used and that the emphasis remains on techniques and formulas. In identifying the teachers' views about statistics, it was found that a formula-number version of mathematics (and statistics) remains in evidence which suggests much still needs to be done in regard to the curriculum reforms. Such a limited view of statistics (and mathematics) means that teachers may find it difficult to enable their student to take possession of the content if they have not previously taken possession of the content themselves.

Teachers' backgrounds

The notion of teachers' inconsistencies reflecting incomplete knowledge or a swing from an outcome approach (Konold, 1989) to a representativeness approach (Kahneman & Tversky, 1972) is not necessarily true, it may relate to the different knowledge bases or worlds of meaning being accessed. Teachers access what is relevant to them in a particular situation, not just what is relevant in terms of a particular statistical model. However, comments about always using pie charts for %'s did suggest the development of patterns of thinking leading to scripts which may be hard to break away from and are inconsistent with approaches that encourage developing a feel for the data.

Progression

While the notion of progression is logical, its application may require more thought. In particular when it is interpreted with respect to a topic such as graphing and the view is that graphing at first only involves displaying data rather than understanding the data.

Confidence with respect to teaching statistics :

Nearly all the teachers said they were confident or felt secure when teaching statistics. Analysis showed that their confidence was high when they were working at their usual class teaching level. The view that they may be reluctant to teach statistics because of a lack of confidence (Gal, 1992) gained only minimal support in this study. A pattern of confidence emerged in terms of familiarity with statistical concepts and terms even though to the researcher this familiarity seemed to be based on somewhat limited knowledge.

Conclusion

The inclusion of data handling as a major component of the curriculum was a progressive step, but a curriculum cannot be considered without regard for those who implement it.
It seems debatable whether the teachers in this study had access to the necessary support in terms of resources and the opportunity to gain a better understanding of concepts and how to teach them.

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Author(s): Andy BEGG and (the late) Roger EDWARDS	
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