Informal Knowledge and Prior Learning: Student Strategies for Identifying and Locating Numbers on Scales

Michael Drake
Victoria University of Wellington
<michael.drake@vuw.ac.nz>

This paper reports on one aspect of a larger study into student understanding of scale. Thirteen students from Years 7 and 8 were interviewed, using a diagnostic assessment designed for the purpose, to identify how they went about locating numbers on, and reading numbers from scales. A range of student strategies were identified, most of which can be classed as informal knowledge. These strategies can be sorted into a progression that relates to the level of number thinking involved.

While learning mathematics in New Zealand, by Years 7 and 8 students are expected to develop the ability to work successfully with scales in a wide variety of contexts, including measurement, algebra, and statistics. Scales themselves, however, are not explicitly identified as something that needs teaching (Ministry of Education, 1992). Scales are also widely met in other curriculum areas (e.g., Ministry of Education, 1993, 1997), where the focus is on using them to facilitate other learning. In all of these documents, it is important to note that learning is expressed as statements of the outcomes that students should be able to achieve, and that in taking this approach they omit the *how*.

Commonly used resources that are designed to assist teachers in the delivery of the mathematics curriculum document follow this lead (e.g., Ministry of Education, 2000a, 2000b; Tipler & Catley, 1998; Wilkinson, 2002a, 2002b). They provide exposure to the sort of activity that students are expected to be able to master. Students get to read kitchen scales, draw graphs to display data they have collected, use number lines showing fractions or decimals, and interpret graphs drawn by others. In many of these activities the focus is not on the scales themselves, but the information transmitted through understanding the scales. This leaves teachers the task of realising what the potential stumbling blocks are and providing scaffolding instruction.

Unfortunately for teachers, this may not be an easy task. Research from a number of fields has shown that there are significant issues that need to be addressed as students learn about scale. In relation to linear measurement: the role of zero, the iteration of the unit, whether to count marks or spaces, and the difference between number and measurement, are all significant (see Nunes & Bryant, 1998; Outhred & McPhail, 2000; Bragg & Outhred, 2000a, 2000b; and Irwin & Ell, 2002). For the measure construct of fractions, some of these issues are also identified, as well as where fractions reside in relation to the whole numbers, the nature of the unit, how the scale is marked, and the meaning of fraction symbols (see Behr, Lesh, Post, & Silver, 1983; Lesh, Post, & Behr, 1987; Bright, Behr, Post, & Wachsmuth, 1988; Baturo & Cooper, 1999). In relation to statistical graphs, treating the horizontal axis of a histogram as a scale, scaling, and working between the gridlines have been identified as issues (see Kerslake, 1981; McGatha, Cobb, & McClain, 1998; Friel, Curcio, & Bright, 2001). Research into algebraic graphing, decimals, integers, and the use of the number line to show addition or subtraction problems, also identify issues, though space limitations preclude further development of these ideas.

Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia
J. Watson & K. Beswick (Eds), © MERGA Inc. 2007

Given the inherent problems in learning to use scales, and the lack of direction from curriculum documents and commonly used resources, this study aims to identify what understandings students have actually developed.

Methodology

This report focuses on the student interviews undertaken as part of a wider research project on student understanding of scale, and teaching strategies to improve that understanding. In total 13 students from three classes at an urban Wellington intermediate school were interviewed over 3 days. Although a larger sample had been planned, student absence and other school activities restricted the number of students available. The students were chosen by their teachers to provide a range of abilities, and a mix of gender from both Years 7 and 8.

For the research, a diagnostic assessment was developed. This included number line items as well as similar or parallel items from "familiar" mathematical contexts, as identified by the curriculum and text analyses. Questions addressed issues commonly identified in the research literature and involved whole numbers, multiples of whole numbers, fractions, decimals, and integers. The questions in the diagnostic assessment were then used in the form of a *cognitive interview* (Presser et al., 2004). This provided feedback on the assessment and the questions as well as data on how students went about answering scale related questions. These interviews were audiotaped.

Each question was provided individually in written form to the student. Once a question was answered, the student was asked "how did you work that out?" Responses were clarified and recorded by hand. Visual strategies observed by the interviewer as well as the explained strategy were recorded. Where a verbal response was not clear, the observed strategy was sometimes voiced as a clarifying question. Such an approach provided a richer record than the audiotape alone, as it allowed some access to students' initial strategies that were later rejected. However, it is acknowledged this approach is still prone to identify the method that a student considers they used to answer the question successfully, and can explain, rather than provide a record of all the thought processes attempted by the student. In a few cases students were also at a loss to explain their reasoning, and no visual cues were provided, so no strategy could be deduced.

After the interviews, the audiotapes were transcribed, with the transcript compared to the written notes. From this, the solution methods used for the different questions were identified, and categories of response created. This process necessarily required the coder to interpret the responses and draw inferences about the logic used to create them. Here the form of thinking used by the student provided a tool for classification, as some responses clearly relied on counting, whereas others relied on adding or multiplying.

Results and Discussion

Mental Strategies

In conducting the interviews, it quickly became clear that students had a range of mental strategies that they used when working with scale. As these strategies had been nowhere identified in the document analysis (described above) as forming part of scale-related instruction, an alternative explanation as to their existence needed to be found. Mack (1995) identifies the body of skills and understandings students have developed for themselves while working on real tasks outside the classroom as *informal knowledge*. This knowledge may or may not be correct, and can be context related. In this case, it seems that students may have developed these strategies for themselves while working with scales in classroom situations. Alternatively, they may have resulted from informal instruction while focusing on a learning task that happens to involve scales. In either case, the label informal knowledge seems appropriate as the knowledge is probably gained in an incidental fashion.

Mental Strategies as a Window into Student Thinking

In working with scale, a student's written response was not always an accurate indication of how a student obtained the answer. This was particularly true if the answer was correct. Figure 1 shows a number line on which students were first asked to write the missing numbers in the boxes, then to locate the number 11. In follow-up questioning, Student 5 was asked to identify how he worked out that the second box should have the number 42 in it. He responded that "(i)ts going up in sixes and then there's 12 so you have to put another six in there and then that's another six to make 36, and then another six to 42". Meanwhile Student 2 responded "I just counted in sixes and what I did was, there was one, two and three and so I did three times six is 18 and then for 42 I said seven times six is 42". When locating 11, Student 4 explained their strategy as "probably just before the 12, right here", whereas Student 5 explained that "you've got to get it in an even space". This student was dividing the interval into six equal spaces, then counting along five of them.

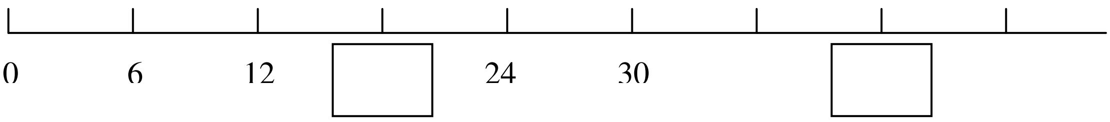

Figure 1. A number line question from the interview.

Both of these pairs of responses illustrate significant features of the identified student strategies. The first is that not all students use the same strategy on the same question, rather the strategy chosen seems to relate to their different understandings of number. For example, in the first quote Student 5 is using a skip count approach, which has links to additive thought. Meanwhile Student 2 is clearly relying on an understanding of multiplication. This provided a way to differentiate student strategies according to a level of sophistication.

The second feature relates to how students located numbers in intervals. In locating 11, Student 4 seems to be using an estimation strategy, whereas Student 2 is using partitioning. A closer look at all of the responses indicated that somewhere in the interview all 13 students used a strategy similar to that of Student 4, finding "a little bit more or a little bit less". For some problems, this strategy was used in conjunction with partitioning strategies. This suggests that finding "a little bit more" is a simple strategy accessible to all. The analysis also identified that "success" with the strategy was varied, as if the size of the "bit" chosen was arbitrary. For example, Student 7 described using both a partitioning strategy (halving) and "a little bit less" when locating 0.4cm on a ruler. His explanation for the placement being "(c)ause like zero point five would be about there [indicates where 0.8 would be], so the one before". Figure 2 below shows his response.

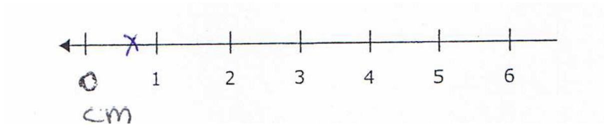

Figure 2. Work from Student 7.

In this question Student 7 did not manage to divide the interval into two equal pieces when halving, so in considering the possibility that students were estimating when using "a little bit more/a little bit less", this perspective was explored. For estimation to be used successfully, it needs to be relational with the "bit" being in proportion to the size of the interval. Given that Student 7 did not halve an interval accurately, it seems to be very bold to suggest that he can work with space proportionally. For this example, better explanations are either that this student is used to working with rulers and "knows" how big a millimetre is, and uses this knowledge, or the piece chosen *was* arbitrary, with a small partition "close to" being taken.

Other questions in the test seemed to access a student's informal knowledge specifically – or rather their assumed understanding of a situation. Figure 3 shows a response from Student 9, who, when asked how she got that answer, did not seem to imagine that a thermometer could have anything other than a unit scale: " 'cause there's ten, that would be twelve". However, on a similar item involving a number line she correctly identified that the scale went up in twos, suggesting her response to the thermometer question was prompted by the context. In other questions, Student 9 showed she had access to a number of different strategies, though not to any that involved the use of multiplication, suggesting she did not have access to multiplicative thinking.

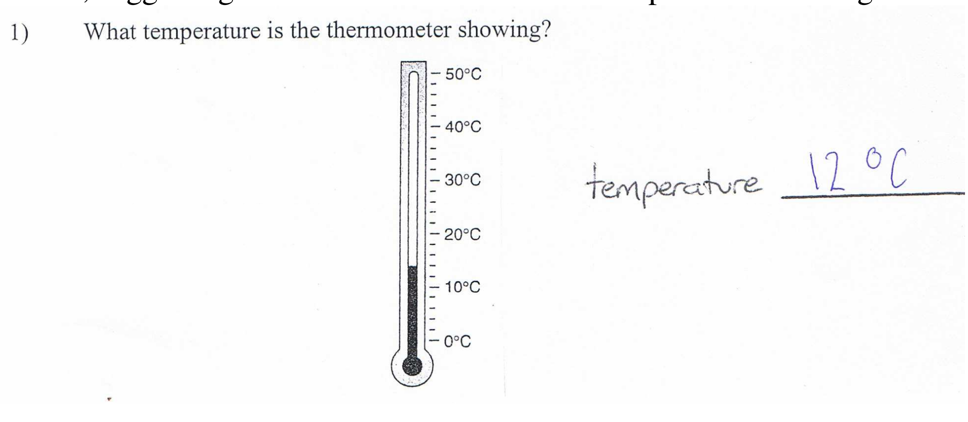

Figure 3. Unit scale thinking.

Error Patterns as a Window to Student Understanding

In explaining her reasoning for her answers to the questions in Figure 4, Student 9 indicated that she was unclear about whether or not she had them correct. For question 3a her logic was " 'cause the one's on zero so it might be like zero point", for 3b "point nought two, or one". To interpret this error pattern, research into measurement understanding seems to offer a better insight into the thinking that Student 9 is applying than fraction based research. For example, Nunes and Bryant (1998) suggest that several problems exist for students when learning to use rulers. One is the issue of counting and measuring, where counting never starts at zero. Another is whether or not to count the gaps or the lines. A third is that "children can conceivably be taught to follow a procedure for reading measurements on a ruler and still have little understanding of the logic of measurement" (p. 86). Student 9 seems to be clearly counting the marks, but uses one as her start point, a counting-measurement confusion. She also seems to be "counting in points", that is counting each mark between the whole numbers as a tenth, regardless of how many there are. Thus this question has opened a valuable window into the understanding that Student 9 has of scales, and suggests several avenues for new teaching.

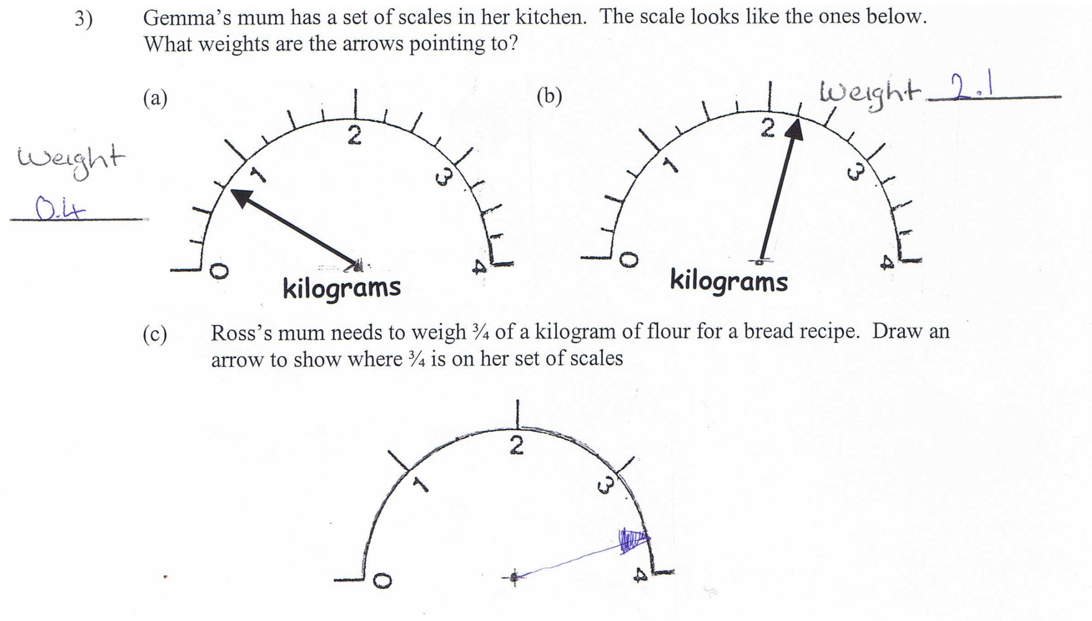

Figure 4. Other examples of thinking from Student 9.

Question 3c adds another perspective to Student 9's understanding. Her logic for placement is " 'cause like, the three then mark quarters, like a little bit away from four". Here fraction knowledge seems to be accessed, though there is confusion as to the meaning of the symbol ¾, apparently confusing ¾ with 3¾. Baturo and Cooper (1999) also found such confusion. One possible explanation is that this could be tied to a developed understanding of fractions like ¾ as "three pizzas, each cut into four slices" in which the three is the number of wholes. This interpretation can be used successfully when sharing (e.g., dividing three pizzas between four people) or when answering questions involving the quotient sub-construct of fractions, but suggests a limited understanding of fraction symbols, and a poor knowledge of the continuity of fractions – that is, where they can be found in relation to the whole numbers.

In the follow-up interview Student 9 indicated that she had met these sorts of problem before, and did not find them difficult. However, her observed strategies indicate significant misconceptions that need to be addressed. How did these arise? Some strategies appear to be the result of specific instruction, and appear to be strategies that have been developed uncritically and have been overgeneralised. (We can almost hear a teacher say to the class learning about the ruler that "each of these little marks between the numbers is a tenth, so its point one, point two, point three…"). Such strategies can be described as *prior learning*. Others appear self-developed and are better described as informal knowledge. For example, ¾ as "three pizzas each cut into four pieces" was not a common approach to the teaching of fraction symbols found in the reviewed texts.

Table 1
Typical Student Strategies for Partitioning Unmarked Intervals

Thinking type.	Strategy name.	Example of strategy.	Useful with…
Counting based.	A little bit more, a little bit less.	Make a mark "a bit" to the left or right.	Locating numbers "just next to" other numbers.
	Halving.	"Eying up" exactly where the middle of an interval is using the point of the pen as a marker.	Can be used repeatedly (to find quarters etc).
Addition based.	*n* equal spaces	Draw in marks for each unit, counting along in ones "to fill in the gap".	Scales involving whole number multiples. Can be successfully transferred to decimals or fractions.
	Mixed methods.	Repeated halving or combining the use of halving and "a little bit more, a little bit less" or "counting in ones".	
Multiplication based.	2, 3, 5 method.	Students know how to accurately partition an interval into 2, 3, and 5 pieces.	
	Mixed methods.	Locating 11 on a scale using multiples of 6 by finding ½ way, and cutting the remaining interval into 3 equal pieces…	Subdividing most intervals into the commonly used number of pieces.

Student 9's answers were typical of the pattern of responses found in the interviews. Students had a range of strategies that they used selectively to answer questions. Overall a finite set of solution strategies was identified and student success with these was influenced not only by the appropriateness of the strategy to the situation, but also by a series of other understandings, for example, whether or not to count the marks or the spaces (and how to do this), whether to start the count at zero or one, and the ability to create intervals of equal size. Table 1 summarises and names the strategies identified as being used by students when answering problems involving partitioning unmarked intervals on scales. In some cases where the type of thought was not obvious, these strategies have been allocated to a stage based on the frequency of their use. For example, halving was used by 12 of the 13 students, though not by one who answered all questions correctly, so has been placed in the counting category. Hart (1981) also talks of one half as an honorary whole number suggesting that students find working with one half easy.

The set of strategies identified allows a "multiplicative" student to partition intervals into the most commonly used number of subdivisions. Strategies used to partition intervals into sevenths, elevenths, thirteenths and the like were not investigated.

Student Responses to Items Involving a Scale where some Marks are not Numbered

The thermometer in Figure 3 and the scales from questions 3a and 3b in Figure 4 are all examples of scales where not all marks are numbered. Students used a different set of mental strategies to those in Table 1 when working with this sort of scale. These are shown in Table 2. As examples of these strategies, when dealing with the fractional question A5 (Figure 5), Student 1 used a "counting in tenths" strategy, referencing the nearest whole number rather than "counting up from the number on the left": "'(C)ause it's zero there [points to zero] and zero point nine, one is after zero point nine … and one point one is after one." Student 5 on the other hand converted the problem to whole numbers, then reconverted to answer the question, a strategy that relies on an understanding of multiplication: "Well, you can't get 4 into 10 so I worked to 100 and stuff." Student 7 meanwhile ignored some of the scaffolding on the problem (the zero at the start of the scale) to turn the problem into one he could understand and solve: "I knew that one before zero is zero and one after one is two."

Table 2
Typical Student Strategies for Numbering a Marked Scale

Thinking type.	Strategy name.	Example of strategy.	Useful with…
Counting based.	Thinking in ones.	Each mark shows one more, as all scales go up in ones…	Unit scales.
	Trial and error.	Students count along in ones and if that doesn't work try twos…	Scales marked in multiples of a number. Can be adapted for decimals.
	Counting in tenths.	If there are marks between the (counting) numbers, count 0.1, 0.2, 0.3, … . Some students also count back in points from the nearest whole number.	Scales marked in tenths.
Addition based.	Skip counting.	A development of the trial and error strategy – using skip counts. For example – "that's a big gap/number to fit on, lets try tens…"	For interpolating and creating a scale. For extrapolating, this just requires a continuation of the scale with the correct "skip".
	Fitting tenths	For example, a scale marked in quarters "that would be 0.3, that o.5 then o.6 0r o.7 then 1"	Scales marked in tenths.
	Bits and "ths".	There are 5 bits (spaces), so each is a fifth.	Fractional and decimal scales.
	Whole number conversion	For example, treating the entire number line as the whole '¼ is 1, ½ is 2, ¾ is 3 and 1 is 4' or reunitising tenths as whole numbers.	Not useful for fractional scales. Decimal version works on scales in tenths.
Multiplication based.	Marks and interval method.	There are 5 marks, the interval is 10, so each mark is 2.	Any non-unit scale. Also useful for decimals.
	Whole number conversion.	A development of the "marks and interval" method. For example, 4 pieces, ¼ of 100 is 25 so ¾ is 75, so its 0.75.	Decimal and fractional scales.
	Treating the fraction as an operator	Treating the entire number line as the unit. For example, 6 is ¾ of 8	Not particularly useful.

With some of these strategies, it is possible that they are simply reconceptualisations of an earlier strategy with a higher level of number understanding. For example, it seems likely that unit counting (thinking in ones) precedes all other strategies, and that "trial and error" relies on the development of the ability to skip count – and the realisation that not all scales go up in ones. "Counting in tenths" likewise appears to be linked to learning that there are numbers *between* the whole numbers. All of this may well be the case, but is likely to need a study of student understanding over Years 1 to 6 to determine a thorough developmental progression.

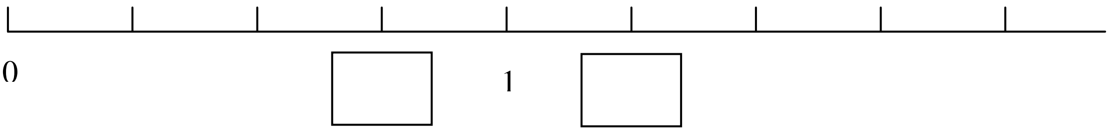

Figure 5. Number line item mathematically similar to questions 3a and b from Figure 4.

Consistency in Student Response Strategies

In designing the diagnostic assessment, one consideration was whether or not students found number lines easier or harder to work with than scales found in “familiar” situations. One measure of this was created by considering the strategies used by a student in the pairs of supposedly similar questions. Students’ responses were analysed to see whether or not they had used their strategies for answering the number line question on the contextual question. A “mark” was given if they did. This analysis thus gave a *consistency rating* for a question. Questions with a consistency rating of 13/13 were questions where every student transferred the strategy they used on the number line item to the contextual item. Table 3 shows the results of this analysis.

Table 3
Consistency in Strategy use when Dealing with a Number Line Problem and a Similar Item Presented in a Familiar Context.

Item type	Consistency rating	Percentage
Scales involving multiples of whole numbers	13/13	100
	10/13	77
	10/13	77
Decimal scales	11/13	85
Fractional scales	9/13	69
	3/13	23
Conventions of scales	3/13	23

Most students answered similar questions involving whole numbers and decimals by using the same mental strategy, and gave similar explanations when asked to explain their reasoning. Only in two situations were there significant inconsistencies, in that most of the students changed their mental strategy when answering the “contextual” item. In one case this involved showing understanding of the conventions of a number line, and creating a horizontal axis for a bar graph. Here the issue identified by McGatha et al. (1998) relating to students treating the numbers on the horizontal axis of a bar graph as individual data points or categories can be identified in the students’ responses to the question.

The other case involved fractional number lines with marks. The two contextual items involved are shown in Figure 4 (Questions 3a and 3b), whereas Figure 5 shows the similar number line items. Note that although the questions required students to find the similar numbers, the visual cues were different in that the number line item did not go up to four. This may have caused some students to respond differently.

Several patterns were of note when considering student responses to these items. Firstly, in answering the number line question in Figure 5, only three of the 13 students answered correctly and these students were successful with both the number line and the contextual items. Secondly, each of these students identified the missing numbers as 0.75 and 1.25, using a "whole number conversion" approach (see Table 2). Fractional strategies were not found to be used by any of the 13 students for these four fraction questions.

Overall, analysis identified that of the students who answered *any* contextual question incorrectly, in 30 out of 40 instances (75%), the students had changed their response strategies from the equivalent number line question. This suggests that strategy use is unstable in situations where a student is unsure of the mathematics in the situation.

Conclusions and Implications

In the absence of formal guidance from curriculum documents and commonly used resources, these New Zealand students seem to have developed their own understanding of scale. This consists of informal knowledge and prior learning of varying levels of sophistication that students apply to situations in an attempt to make sense of them. In many cases, this understanding was used consistently, in that mathematically similar items utilising a number line and a "familiar" context evoked the same solution strategy. However, this was not always found to be the case. Fraction questions caused students to change their strategy. Also, with the bar graph, most students did not treat the horizontal axis as a scale, instead bringing to the question a particular understanding of the context. Here it can be said that using such a graph as a context for developing an understanding of scale has introduced an element of *contextual pollution*; that is it has introduced context situated knowledge that interferes with the intended learning about another topic. In this particular case the contextual pollution was the common misconception that the horizontal axis of a bar graph is not a scale so, for example, ordinal data recorded on this axis do not need to be placed in order of size. In another situation quoted, a thermometer invoked a unit scale response from a student who could use appropriate mathematics on the similar number line item. The concept of contextual pollution suggests that teachers need to be aware that contexts may not always be helpful and that they need to be alert for signs that students are operating from a different conceptual base to them. In terms of scale, the consistency analysis has suggested that number lines invoked similar strategies from students, so may be a better initial tool for developing students' understanding.

In conclusion, scale is one of the big ideas in mathematics. It underpins significant learning in number, measurement, algebra, and statistics. Scales are met not only in mathematics but also in other curriculum areas. It comes as a surprise that even by Years 7 and 8, not all these students have learned that there are numbers between the whole numbers, and that some students cannot recognise when an interval on a number line (or a weighing scale) has been divided into quarters. This small study has shown that many of these New Zealand students have a lot to learn if they are to become successful users of scale, that an understanding of scale cannot be assumed by teachers, and that more research into this area would be of value. It also suggests that it may be time to reconsider how students are expected to develop their understanding of scale, as current approaches seem to be leaving a great deal to chance.

References

Baturo, A., & Cooper T. (1999). Fractions, reunitisation and the number line representation. In O. Zaslavsky (Ed.), *Proceedings of the 23rd conference of the International Group for the Psychology of Mathematics*

Education volume 2. (pp 81-88) Rehovot: Department of Science Teaching, The Weizmann Institute of Science.

Behr, M., Lesh, R., Post, T., & Silver, E. (1983). Rational number concepts. In R. Lesh & M. Landau, (Eds.), *Acquisition of mathematics concepts and processes* (pp. 92-127). New York: Academic Press.

Bragg, P., & Outhred, L. (2000a). What is taught versus what is learned: the case for linear measurement. *Mathematics education beyond 2000*. (Proceedings of the 23rd annual conference of the Mathematics Education Research Group of Australasia, Freemantle, Western Australia (pp 112-118)). Perth: MERGA.

Bragg, P., & Outhred, L. (2000b). Students' knowledge of length units: do they know more than rules about rulers? In T. Nakahara & M. Koyama (Eds.), *Proceedings of the 24th conference of the International Group for the Psychology of Mathematics Education* (pp. 97-104). Hiroshima: Hiroshima University.

Bright, G., Behr, M., Post, T., & Wachsmuth, I. (1988). Identifying fractions on number lines. *Journal for Research in Mathematics Education*, 19, pp. 215-232.

Friel, S., Curcio, F., & Bright, G. (2001). Making sense of graphs: Critical factors influencing comprehension and instructional implications. *Journal for Research in Mathematics Education, 23,* pp. 124-158.

Hart, K. (1981). *Children's understanding of mathematics: 11-16.* Newcastle upon Tyne: Athenaeum Press Ltd.

Irwin, K., & Ell, F. (2002). Visualising and the Move from Informal to Formal Linear Measurement. In B. Barton, K. Irwin, M. Pfannkuch & M. Thomas (Eds.). *Mathematics Education in the South Pacific* (Proceedings of the 25th annual conference of the Mathematics Education Research Group of Australasia, Auckland, pp. 358-365). Sydney, MERGA.

Kerslake, D. (1981). Graphs. In K. Hart (Ed.), *Children's understanding of mathematics.* pp. 11-16., Newcastle upon Tyne: Athenaeum Press Ltd..

Lesh, R., Post, T., & Behr, M. (1987). Representations and translations among representations in mathematics learning and problem solving. In C. Janvier (Ed.), *Problems of representation in the teaching and learning of mathematics* (pp 33-40) Hillsdale, NJ: Lawrence Erlbaum Associates.

McGatha, M., Cobb, P., & McClain, K. (1998, April). *An analysis of students' statistical understandings.* Paper presented to the annual meeting of the American Educational Research Association, San Diego, California.

Mack, N. (1995). Confounding whole-number and fraction concepts when building on informal knowledge. *Journal for Research in Mathematics Education, 26,* 422-441.

Ministry of Education. (1992). *Mathematics in the New Zealand curriculum.* Wellington: Learning Media Limited.

Ministry of Education. (1993). *Science in the New Zealand curriculum.* Wellington: Learning Media Limited.

Ministry of Education, (1997). *Social Studies in the New Zealand curriculum.* Wellington: Learning Media Limited.

Ministry of Education. (2000a). *Figure It Out measurement level 3.* Wellington: Learning Media Limited.

Ministry of Education. (2000b). *Figure It Out measurement level 3 answers and teachers' notes.* Wellington: Learning Media Limited.

Nunes, T., and Bryant, P. (1998). *Children doing mathematics.* Malden, MA: Blackwell Publishers.

Outhred, L., & McPhail, D. (2000). A framework for teaching early measurement. *Mathematics education beyond 2000.* (Proceedings of the 23rd annual conference of the Mathematics Education Research Group of Australasia, Freemantle, Western Australia (pp 487-494)). Perth: MERGA.

Presser, S., Couper, M., Lessler, J., Martin, E., Martin, J., Rothgeb, J., & Singer, E. (eds.). (2004). *Methods for testing and evaluating survey questionnaires.* Hoboken, NJ: John Wiley & Sons.

Tipler, M., & Catley, K. (1998). *National curriculum mathematics level 3 book 1.* Christchurch: Caxton Educational Ltd.

Wilkinson, C. (2002a). *Pearson primary maths 3b.* Auckland: Pearson Education New Zealand Ltd.

Wilkinson, C. (2002b). *Pearson primary maths book 3b teachers guide.* Auckland: Pearson Education New Zealand Ltd.