

one group of children after the ones digits have been ordered.

Now the children are asked to make another stem-and-leaf display which is to be based on the half a minute one. That display is to show the number of heart beats in one minute. This is of course no easy task for a child who has never been exposed to carrying. It introduces the idea in a natural way, and the child has to think about carrying in order to produce the display of Figure 4.

tens	ones
7	8
8	08
9	28
10	0448
11	2
12	0

**Figure 4.** Number of heart-beats in a minute. Stem-and-leaf plot obtained from the corresponding plot for half a minute.

## ● AN EXAMPLE OF DATA COLLECTION ●

A second, and obvious advantage of introducing stem-and-leaf plots, is that it constitutes another form of graphically representing data. A variety in the presentation of concepts will help students internalise the ideas into their schemas. Furthermore, this particular form of graph displays all the data in an "original form" in such a manner that specific data can be read directly from the graph.

Stem-and-leaf plots are ideal for collecting data from estimation tasks. We would like to give an example of this from an inservice meeting with two groups of elementary teachers of grades 1–6. The task was to estimate the weight of a box containing some rocks. The box was closed and sealed and so the contents could not be seen.

When we presented the task to the first group we tried the box in our hands and said, "Well, with this weight it seems reasonable that you give the estimates in hectograms to one decimal place."

It should be mentioned that the participants were used to hectograms ( $1 \text{ hg} = 100 \text{ g} = 0.1 \text{ kg}$ ), since the inservice meeting was in Sweden, where the metric system has been in use for a very long time. Hectograms are used quite a lot in actual practice. Certain food products are usually thought of by Swedes in hectograms, like minced meat, sliced roast beef, potato salad, cheese, sausage, grapes. We mention this so that it is clear that the people who were to estimate the weight of our box were used to thinking in terms of hectograms, and so the difficulty was not at all in the preception of the unit of measurement. Our suggestion to give the estimates in hectograms to one decimal place really made sense. Figure 5 shows the result of the first group. We give only the ordered version of the stem-and-leaf plot here. It has of course been preceded by an unordered one, which emerged when the estimates were collected as each participant called out his or her estimate loud.

The median is 7.7 hg. The quartiles are 6.5 hg and 9.1 hg, and so we find that the middle half of the estimates lies between these two bounds. We can use the difference as a measure of the spread of the estimates, 2.6 hg. The full range is considerable, all the way from

hg	
units	tenths
4	8 (1)
5	45778 (5)
6	2559 (4)
7	22233678 (8)
8	355677 (6)
9	168 (3)
10	4499 (1)
11	1 (1)
12	5 (1)
(33)	

**Figure 5.** Stem-and-leaf plot of estimates of the weight of a closed box containing some rocks.

4.8 hg to 12.5 hg, i.e. from less than half a kilo to more than a kilo. We conclude that estimating weights around 7–8 hectograms is not easy.

The same box was used with the second group of teachers of exactly the same category. The second group was of course not informed about the result of the first group. Furthermore the instructions were slightly altered. This time the estimates were to be given in kilograms to two decimal places. The result of the second group is given in Figure 6.

kg	
tenths	hundredths
5	2 (1)
6	357 (3)
7	255 (3)
8	258 (3)
9	0248 (4)
10	
11	0 (1)
12	04589 (5)
13	577 (3)
14	
15	058 (3)
16	2478 (4)
17	4568 (4)
18	45678 (5)
19	
20	
21	
22	
23	
24	
25	0 (1)
(40)	

**Figure 6.** Estimates, to be given in kilos to two decimal places, of a closed box containing some rocks. The estimates are recorded here so that the leaves represent the same weight as in Figure 5.

The median is now 1.32 kg, i.e. higher than the highest estimate of the first group. The quartiles are 0.785 kg and 1.76 kg, almost a kilo apart, so the spread is greater than for the first group. The range is greater too, almost 2 kilos, from 0.52 kg to 2.50 kg.

Putting the plots back-to-back (Figure 7) shows the difference between the two groups in an efficient way. The two groups were comparable, they consisted of exactly the same kinds of teachers. Obviously the instructions influenced the participants quite a lot.

In this particular case we have access to the correct

answer, and the reader is invited to guess the actual weight of the box before reading further.

We had just taken a random heap of reasonably sized rocks and put them in the box. It came as a surprise to us when the digital balance we used for checking displayed exactly 1.00 kg.

There were a couple of things to be learnt here and the stem-and-leaf plot turned out to be an efficient tool. For a further discussion of matters related to estimation exercises (see Dunkels, 1987).

	hg	tenths	units	tenths	
		4	8		(1)
(1)	2	5	45778		(5)
(3)	753	6	2559		(4)
(3)	552	7	22233678		(8)
(3)	852	8	355677		(6)
(4)	8420	9	168		(3)
		10	4499		(4)
(1)	0	11	1		(1)
(5)	98540	12	5		(1)
(3)	755	13			
		14			
(3)	850	15			
(4)	8742	16			
(4)	8654	17			
(5)	87654	18			
		19			
		20			
		21			
		22			
		23			
		24			
(1)	0	25			

(40)

(33)

**Figure 7.** Comparison between two groups that were given the task of estimating the weight of the same box with different instructions as to how the recording was to be given. The group to the left was asked to give the estimates in kilograms to two decimal places, the group to the right in hectograms to one decimal place.

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#### MÅNDAG – FREDAG

0 05



5 23 41 59

6 01 19 37 55

7 08 19 29 40 50

8 01 11 22 32 43 53

9 04 20 36 52

10 08 24 39 57

11 13 24 33 42 51

12 00 09 18 27 36 45 54

13 03 12 21 30 39 48 57

14 06 15 24 33 42 51

15 00 09 18 27 36 45 53

16 02 12 21 31 40 50 59

17 10 20 31 42 53

18 09 25 43

19 00 15 30

20 }  
21 } 00 30  
22 }  
23 }

**Figure 8.** Part of a bus schedule from Stockholm. The design is exactly that of a stem-and-leaf plot. Here we have two-digit leaves separated by spaces.

## OTHER USES

In Sweden there are certain cities where the time tables for buses are nothing but stem-and-leaf displays of the departure times, see Figure 8. If learning about stem-and-leaves at school in connection with mathematics can promote the reading of time tables for buses then we have really succeeded in relating teaching to day-to-day life.

Another use of stem-and-leaf plots is when displaying the dates of birth of all the pupils in a class. This is something that is done in some way or the other in most classrooms that we have visited. In Figure 9 we give an example of what it can be like. The display of Figure 9 is also useful when treating the old birthday chestnut: Are there two people in this group with their birthdays on the same date?

<b>JANUARY</b>	03, 12, 22,
<b>FEBRUARY</b>	01, 27,
<b>MARCH</b>	04, 04, 05, 11, 15,
<b>APRIL</b>	12, 14, 28,
<b>MAY</b>	
<b>JUNE</b>	13, 15, 20, 26,
<b>JULY</b>	01,
<b>AUGUST</b>	
<b>SEPTEMBER</b>	08, 09, 24, 30, 30,
<b>OCTOBER</b>	02,
<b>NOVEMBER</b>	14, 18, 30,
<b>DECEMBER</b>	24,

**Figure 9.** Birth dates of a group of people presented as a stem-and-leaf display with two-digit leaves. Here we have chosen to use a comma to separate the leaves. A space could equally well have been used.

## CONCLUSIONS

Stem-and-leaf plots provide a valuable tool for the primary teacher. They are not the only statistical technique available for the primary teacher. Pictographs, bar charts and tables, to name a few, are still extremely valuable components of the primary statistics programme. However, they provide an additional element to the primary teachers' arsenal, which not only expands the representational models available in a manner consistent with the ideas of Dienes. In addition to providing an additional representation, stem-and-leaf plots provide a model in topics such as place value that are not available through the utilisation of other statistical techniques.

#### References

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