Stem-and-Leaf Plots in the Primary Grades

KEYWORDS:
Teaching;
Data Collection;
Graphical Representation

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Summary
At first glance, the thought of primary children working with stem-and-leaf plots might seem a radical idea, since such representations are often associated with secondary school. The purpose of this paper is to show how young children can use such representations as a major tool in their educational development. However, before discussing this particular statistical technique, an overview of the role of statistics in the primary programme is included.

• INTRODUCTION •

STATISTICS is a topic that has increased in importance over the past decade. Its significance can be seen from the existence of this journal, the many articles and books on teaching statistics, and the fact that two international conferences were devoted solely to this topic. However, in spite of the significance of statistics education many teachers consider statistics a secondary school subject. For most primary teachers, statistics education consists mainly of teaching pictographs and bar charts. These graphs are drawn and discussed by the children (Pereira-Mendoza, 1986). This limited use of statistics in the primary grades seems consistent with the view that it is not considered a major component of the primary programme. Statistics appears to be on the periphery of primary education. It is the view of the authors that statistics is a central component of the primary curriculum.

There are three major components to discussing statistics in the primary grades:

Data Collection
↓
Representation
↓
Interpretation
and
Prediction

Examples that follow illustrate how stem-and-leaf plots can be used as a representation that helps in the interpretation phase of statistical education. As well as helping in these components, statistics also provides the teacher with a vehicle to integrate ideas from other parts of the curriculum. Again, this is shown in both the illustrations of how stem-and-leaf plots can be used in the development of place value and as a vehicle for discussing estimation.

It is clear that the general comments regarding the significance of statistics in the primary programme does not apply only to stem-and-leaf plots, but to any statistical aspects of the programme. Stem-and-leaf plots just constitute one aspect of statistical education in the primary grades.

● STEM-AND-LEAF PLOTS AND PLACE VALUE ●

Stem-and-leaf plots are a particular form for presenting data. The following example from Dunkels (1986), where the reader will find further details, illustrates the nature of a stem-and-leaf plot and its use in connection with place value.

Place value is something that to some children is abstract and hard to grasp. Among the standard errors we find e.g. interpreting 405 as made up of "forty" and "five", thus making "fortyfive". Working with numbers that have meaning and are important to the child promotes interest and motivation. It makes a lot of difference to work with "naked" numbers found in a book and numbers from the child's own reality, numbers that the child cares for and understands.

Every child in elementary school is interested in ages. How old are the mothers and fathers of the children in our class? Let's find out. All children promise to write down and bring the ages of their mothers and fathers tomorrow. Shall we start with the mothers or fathers? Almost everybody votes for mothers. Each child is given a rectangular piece of cardboard, 8 cm by 12 cm. The cardboard is folded in half, unfolded again, and the mother's age is written; tens digit in the left half, ones digit in the right. Then the card is cut in two pieces along the fold and the children start playing with the digits. ("Oh, gosh! My mother is 83 if I interchange the digits." — "With digits interchanged Kent's mother is 92, what is her actual age?")

Now the teacher asks all children to show their tens digits. There are twos, threes, and fours. The teacher collects one copy of each, puts them on the floor, so that one can read 2, 3, 4 going downwards, and puts a strip of paper (the left-most column of figure 1) along the column of tens digits. The children gather on the floor with their ones digits in their hands.

Without giving any details of how to do it the teacher asks the children to put down their ones digits, one child at a time. And after each digit there is time for reflection, and in fact also reading aloud in chorus. After each digit has been correctly placed the teacher and the children read all the ages so far collected. When the 9 of the first row (see figure 1), the 2, 4, 1, and 5 of the second row, and the 4 and the 0 of the third have been put down the reading goes:

> "Twenty-nine, thirty-two, thirty-four, thirty-one, thirty-five, forty-four, forty."

One child once happened to read the last entry as "forty-zero", and everybody laughed. The teacher was amazed. That child's reading is in fact more logical than saying "forty". Should we not in fact encourage "forty-zero"? Could "forty-zero" help some children to see the difference between 405 and 45? Later we have found that this is indeed the case.

Now all ones digits are on the floor; one more reading. (See figure 1.)

2	**98**
3	**2415191451**
4	**4052**

Figure 1. First one copy of each possible tens digit has been laid down. Then each child has put down his or her ones digit.

Could we improve the table? Yes, we could order the ones digits within each row. Let's do that. At the same time we could shorten the rows by splitting into two. Which ones digits are to be written in the first row? And the second? After having discussed that the teacher collected the appropriate tens digits, pinned them onto the notice board, pinned a strip of paper along the column of tens digits as the left-most column of Figure 2.

2	
2	**89**
3	**1111244**
3	**559**
4	**024**
4	**5**

Figure 2. The first step in improving the display consists of placing the tens digits, i.e. the left-most column. Here the display is completed, everything is in order, and we have obtained something between a table and a diagram.

One pupil at a time would now take that particular ones digit from the floor that was the next to put on the notice board. And soon the notice board was as shown in Figure 2.

What a good view of all the ages. How old is the oldest? The youngest? Are there any of the same age? What's the most popular age? (What's popular? Does it have anything to do with pop music?) Any ages missing? Many questions arise. But this will have to do for today. Tomorrow we will continue with the fathers.

And the day after there are two nice stem-and-leaf displays on the notice board. One gets a clear view of the ages. Still more questions arise from all these numbers that mean so much to the children.

This representation has specific advantages for the primary student. First, in appropriate situations, it reinforces the idea of place value. For example, in the age situation described previously, the stem is represented by the tens place. Through the use of such activities the *concept of place value* can be developed and reinforced. Since place value is *the key* to the curriculum (to the extent that any concept can be considered a key), the use of stem-and-leaf plots as a vehicle for place value is most attractive for a primary teacher.

Stem-and-leaf plots are useful also when introducing new ideas about numbers and not only to review or reinforce old ones. We will give an example of such a situation.

Assume that the idea of carrying has not yet been introduced, but that the class has used numbers greater than ten. Today we are going to count heart beats. You will work in pairs, and each one of you will listen to your friend's heart and count the number of beats during half a minute. Your friend will check the time, otherwise you might end up counting seconds rather than heart beats. (Small children usually have difficulties in feeling the pulse with their hands. One way of getting around these difficulties is to use yogurt tins, the big kind. After one has made a hole in the bottom the child puts the tin to the friend's chest and listens through the hole. The result is amazingly good.) In Figure 3 we show the data from

tens	**ones**
3	**9**
4	**0469**
5	**02246**
6	**0**

Figure 3. Number of heart-beats in half a minute. We cannot expect reliable results when children count heart beats for the first time. But the activity is still worthwhile.