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Essential Features of Excel

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Abstract

This article assumes that you are familiar with the GUI of a modern spreadsheet – selecting, dragging and so on. But we expect that 100% of readers are in that category – certainly most students in today's classroom are fully conversant with how such programs work. What you may not be so familiar with are the essential features of Excel that make it such a usable program. We hope that you do find some surprises in what follows and that you will make these features a regular part of the way in which you use Excel.

Essential Features of Excel

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1.   Introduction

This article assumes that you are familiar with the user interface of a modern spreadsheet[1] – selecting, dragging and so on. But we expect that 100% of readers are in that category – certainly most students in today's classroom are fully conversant with this kind of interface. What you may not be so familiar with are the certain features of Excel that we consider to be essential to its use in the educational contexts. We hope that you do find some surprises in what follows and that you will make these features a regular part of the way in which you use Excel in the classroom.

2.   The Fill Handle

Suppose we want to quickly create a 1 – 100 square or 100 board (Figure 1). A completed version of the table is given in the first worksheet of associated file Excel Essentials.xlsx.

The first step is to enter a 1 in the top left corner. Please read the following statement as "select cell B2 and type 1".

(B2) 1

Move the cursor to the small square at the bottom right corner of the cell which is called the fill handle. When you hover over the fill handle, the cursor will turn into a + sign. Press <Control> and a second, much smaller + sign appears (see Figure 2).

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[1] This paper describes the chosen features in terms of Excel 2010 and the diagrams were prepared using that version. But the features were present in earlier versions of Excel and can be implemented in very similar ways in those earlier versions.

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		1	11	21	31	41	51	61	71	81	91	
3		2	12	22	32	42	52	62	72	82	92	
4		3	13	23	33	43	53	63	73	83	93	
5		4	14	24	34	44	54	64	74	84	94	
6		5	15	25	35	45	55	65	75	85	95	
7		6	16	26	36	46	56	66	76	86	96	
8		7	17	27	37	47	57	67	77	87	97	
9		8	18	28	38	48	58	68	78	88	98	
10		9	19	29	39	49	59	69	79	89	99	
11		10	20	30	40	50	60	70	80	90	100	
12												

Figure 1: A 100-square
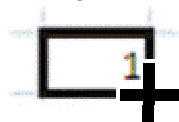
The small square on the boundary of a selected cell is called the fill handle
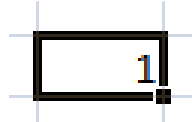
As the mouse moves over the fill handle it changes to a + sign

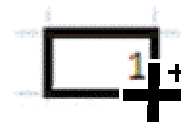Press <Control> and a second + sign appears

Figure 2: The Fill Handle

Move the mouse to the fill handle of B2 and hold down <Ctrl> while you drag down to cell B11. This action will enter the numbers 1, 2, 3, …, 10 the first column of the table. In another part of the worksheet, try this with starting cells that have values like Jan, Monday, Item 1, 1st, … and so on. This will soon give you a feel for the usefulness of the fill handle[2].

To make the rest of the table, start the next column with:

---

[2] Some of the lhe lists that the fill handle creates are contained in Custom Lists. In the File tab, choose Options and select Popular. Click the Custom Lists button to see what is available by default. This is also the place to add other lists, such as A, B, C, … that the fill handle can use subsequently.

(C2) = B2 + 10   (read this as "Select C2 and type = B2 + 10)

Drag the fill handle of C2 across to K2 in order to complete the top row of the table. You can click on some of the cells between C2 and K2 to see what the formula has been turned into by the fill handle. Finally, select K2 and double click the fill handle. The required formulas are copied down as far as the data in the adjoining column, Column B. More advanced uses of the fill handle to create data tables are given in by Abramovich and Eun [1].

Using the fill handle to extend a formula across and/or down a page and to auto-fill a formula are big time savers – well worth mastering. Here's another use.

Select the range B1:K1 and with the fill handle of K1, drag down to K12.

When you release the mouse button you have deleted the table. Don't press <Control><Z> to undo that outcome; make the table again from the start. It's good practice!

3.   Conditional formatting and much more

I will always remember the wonderment I experienced when Stephen Sugden (Bond University) showed me the following example. It refers to taxi numbers, so named by G. Hardy because of a comment made by S. Ramanujan his protégé from India. For details of the story see Abramovich and Sugden [2], where many examples of conditional formatting are described.

The table in the Taxi Number worksheet is close to complete. When making it, we used:

1. The fill handle with <Control> was used to insert the numbers 1 – 30 into C2:AF2.
2. That range was copied and B3 was selected. Paste:Transpose was then used to add the same list to B3:B32.
3. Click on the number for Row 2 to see the Name Box change to x and on label for Column B see the Name Box change to y. This sets us up for the next step.
4. The formula in C3 is (C3) = x^3 + y^3 and it is this formula that was added to the rest of the cells of the table using the fill handle.
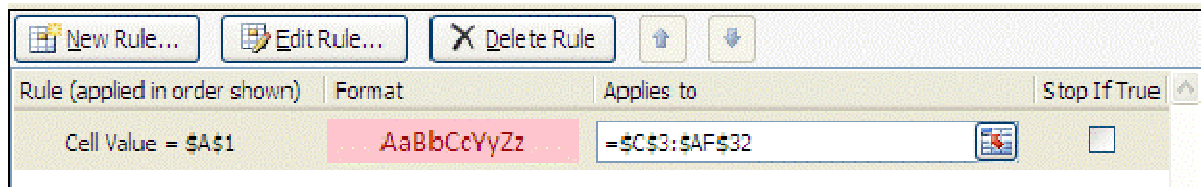
Figure 3: Applying Conditional Formatting.

As a small aside, it seems to us that one of the most useless statistical features of data that we learned at school was to find the MODE of a data set. It has little, if any, statistical significance, just one of those things we were asked to do, but with no serious rationale ever being provided. Thanks goodness that the creators of Excel chose to include it, because there are times when it is really useful – but not for statistical purposes.

5. In cell A1 the MODE function is used to find where in the table taxi numbers occur. Click on A1 to see the formula (A1) = MODE(C3:AF32).
6. We then applied conditional formatting to the table to find where those taxi numbers reside. The conditional formatting shown in Figure 3 is saying "Highlight the cell if is has the same value as the MODE function found".

As it stands, the worksheet fully justifies Ramanujan's statement that the number 1789 is indeed quite a remarkable number. It is the smallest number that can be formed as the sum of two cubes, in this case as $1^3 + 12^3$ and as $9^3 + 10^3$.

The MODE function has showed us the first number that occurs four times in the table. If you would like to find the next taxi number, simply delete one of the instances of 1789. You will find that just by making a table with numbers 1 – 30, we can find quite a few taxi numbers.

Please bear in mind that the taxi number example was no more than a vehicle for showing that:

Names can be applied to whole columns to make the formulas in a table very easy to follow.

The fill handle makes it very quick to generate a table of values.

The MODE function can be used to pick out the most frequently occurring value within a jungle of numbers. But it is most powerful when used in conjunction with Conditional Formatting.

As an extension of this, we can remove duplicates from the table by only showing $x^3 + y^3$ when $x \geq y$. We can also introduce a scrollbar that will allow

us to gradually grow the table, in this way ensuring that the lowest repeated number occurs within the table will be found. The worksheet labelled Taxi Numbers (2) has a scrollbar that controls the value of a cell called show_value and the worksheet has the following formula in C4:

(C4) =IF(AND(x >=y, x + y <= show_value), x^3 + y^3, "")

The formula in C4 has been spread across and down the full table using the fill handle. You can also change the formula in C4 to find the sum $x^2 + y^2$. What is the smallest number that can be expressed as the sum of two square numbers in two different ways, even three different ways?

The use of names, the fill handle and conditional formatting really are essential features of Excel. The other features that we want to point out are more complex in that they show how we can make Excel create two types of chart that are very popular in the school curriculum, but which Excel does not make directly.

4.   How to make a Histogram

Of all charts that we teach in schools, none is more widely used than the histogram. Indeed, from the point of view of statistics education, it would be hard to pick a chart type that is more used for univariate data. What a surprise, then, to find that Excel has no built-in histogram chart type and that the histogram add-on has severe limitations because changes to the data are not reflected in the chart. So, there is no alternative but to know how to build your own histogram.

First, let's look at some of the features of a histogram that are important (see Figure 4).

The data is counted in intervals. If the histogram add-on is used, the intervals have to be chosen before the chart is created, but the size should be chosen to make the trend of the data visible. If the interval size is too small or too large, the trend may not be visible. Ideally, once our data is given we should be able to vary the interval size[3].

The bars of the chart should touch, and in Excel Column Charts, the bars are by default separated. Also, it would be good if the labels changed with interval size.

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[3] We do seem to remember a time when the intervals of a histogram were allowed to be of different sizes and the area of the bar showed the information, not its height. It seems that we can only work with intervals of a fixed size but that is probably a good thing.
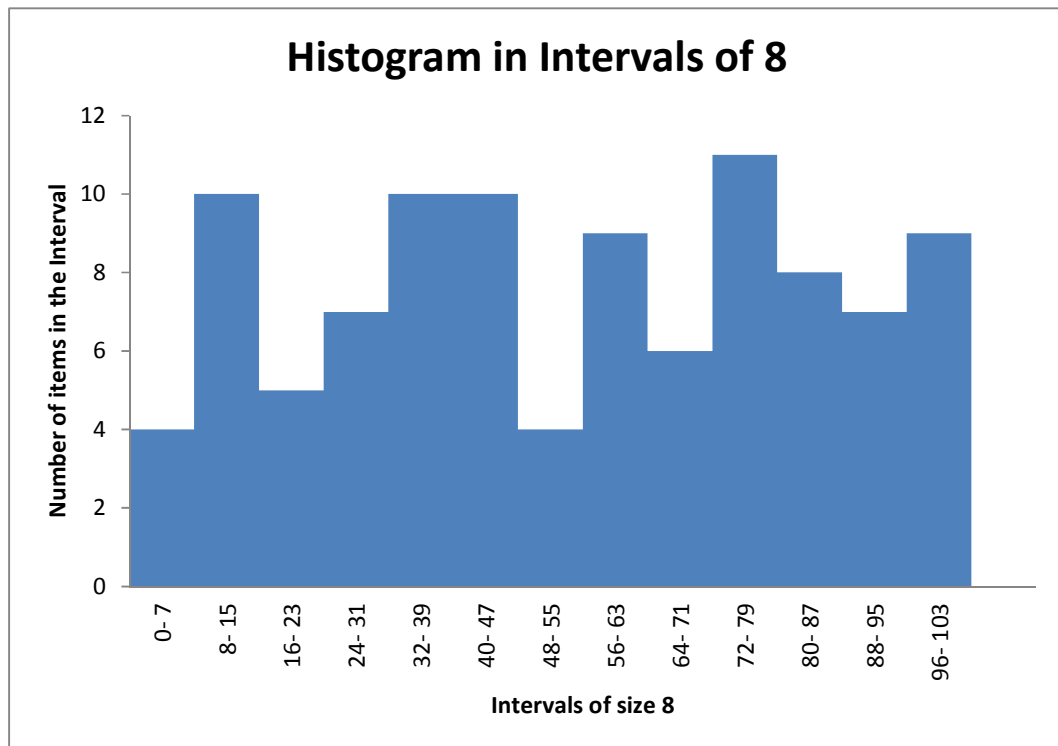
Histogram in Intervals of 8

Figure 4: A typical histogram

These are just some of the features that Excel does not do, unless, that is, you show it how.

Using Names

To make Excel create a histogram it is good to build on its strengths. We will suppose that the data that we want to chart (say 100 data points) is held in a 10 by 10 array of cells. The first thing to do is to name that array as data. Our data is in B3:J12, so we selected that range, clicked in the Name Box and typed data followed by the <Enter> key (see Figure 5).

Adding a Scrollbar

We need to be able to experiment with the interval size to find which one is the most appropriate. As the diagram below shows, we highlighted D14 and attached a scrollbar (Form Control[4]) to change its value. Although it doesn't show, we have also named D14 as size (see Figure 6).

---

[4] There are two types of scrollbar but the one that we find useful is the Form Control not the ActiveX Control. To set the properties of the latter, you need to be familiar with VBA and not many students will have met VBA yet.

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		51	38	98	6	62	72	6	36	27	18	
3		60	48	37	12	29	83	38	68	72	73	
4		32	39	76	45	89	14	97	26	25	75	
5		8	5	15	65	93	83	15	76	89	93	
6		97	57	16	44	21	8	30	68	42	30	
7		44	98	10	66	62	40	28	41	33	98	
8		69	99	46	78	87	82	82	84	56	84	
9		59	46	75	60	99	88	75	42	90	52	
10		15	53	72	81	96	65	39	38	13	79	
11		5	95	56	8	22	35	97	47	20	61	
12												

Figure 5: Data to be shown in a histogram

9		59	46	75	60	99	88	75	42	90	52
10		15	53	72	81	96	65	39	38	13	79
11		5	95	56	8	22	35	97	47	20	61
12											
13		Interval Size		8		◄		▯		►	
14											
15		48	32	96	0	56	72	0	32	24	16
16		56	48	32	8	24	80	32	64	72	72
17		32	32	72	40	88	8	96	24	24	72

Figure 6: Creating the Interval Data

Because we use the scrollbar so frequently (see also Staples [xx]), we add the scrollbar icon to the Quick Access section of the screen. This is the part above the File tab and you can customise it by choosing Options in the File tab menu. It is fiddly, but once done, it doesn't need to be redone. Learning how to set the parameters of the scrollbar is important too and once mastered, we find that students really appreciate being able to make their spreadsheets interactive by controlling cell values with it.

Using the INT function

There are a few functions in Excel that we find very useful, even though we have never used them in other contexts, and the INT function is one. To find the interval into which each data item should be put, we use the formula:

```
(B16) = size*INT(B2/size)
```

This formula, which can be applied equally well to non-integer data, can be spread over the range B16:K25 in order to generate a table in which the end-point of the interval in which each of our data points will lie. To do this efficiently, means that you should use the fill handle to drag the formula across from B16 to K16 and then down to K25. It is also a good idea to name the B16:K25 range; we chose interval_data. You can experiment by changing the scrollbar that controls size and see how the numbers in the interval_data cells change accordingly.

Using the COUNTIF function

We are now ready to create the data for the histogram. One of the Excel functions that we use perhaps as often as any other is COUNTIF, and it makes it easy to generate the data needed for the histogram. The data will start in M3 and continue down column M. The formulae at first are:

    (M3) = 0
    (M4) = M3 + size

Drag this formula down to M22 and name the range M3:M22 as intervals. Now go to N3 and enter the formula:

    (N3) = COUNTIF(interval_data, intervals)

Double click the fill handle to fill this formula down to N22.

By taking the range of intervals down to M22 we have catered for the case when the interval size is at its minimum of 5. But when the size is set to, say, 10, much of the range is filled with interval numbers that are out of the range of the data. Our work-around for this involved not filling cells that are not needed. We made the following changes to M4 and N4 and filled down.

    (M4) = IF(M3 < 100, M3 + size, "")
    (N4) = IF(M4 <> "",COUNTIF(interval_data,intervals),"")

As before, change the scrollbar to see how the information in M3:N22 changes accordingly.

Making the Histogram

The following steps will make the histogram in a reasonably efficient way – there are many different ways in which to do this but this one uses some important features.

Select only the data in column N (N3:N22) and in the Insert Tab, choose the first Column Chart option. Select the Design Tab and from the Chart Layouts

menu choose Layout 8. This is the one that most readily represents a histogram because the Gap Width has been set to 0.

The axis labels need to be made to match the information in column M. Right click the chart and choose Select Data … This allows you to Edit the Horizontal (Category) Axis Labels. Click the Edit button and drag over M3:M22 to select the axis labels.

We also need to put meaningful information into the chart title and axis titles. Here is a way of making these titles change as the scrollbar changes `size`. For example, to link the Chart Title to the value of a cell, add the following formula to cell P3.

(P3) = "Histogram in Intervals of "& size

Now click on the Chart Title to select it and in the formula bar add:

= P3

The axis titles can be linked to P4 and P5 in the same way.

You can also create your own interval labels in Column O with a formula such as:

(O3) =IF(M3 <> "", M2 & "- "& (M3- 1), "")

To add these labels to the chart, right click the chart, choose Select Data … and edit the Horizontal (Category) Axis Labels.

Finally, have a go and experiment with the scrollbar to find an appropriate size for the histogram intervals. Do you agree with us that an interval size of 14 gives quite a meaningful shape – it also accords with some advice we seem to remember that there should be about 7 intervals in a histogram.

5.   How to make EDA-type charts

The Box and Whisker Chart

This is probably not the place to argue against the introduction of EDA, exploratory data analysis, techniques to the school curriculum, see [4], [5] and [6]. Rarely do we see EDA techniques finding application outside the classroom, but they have nevertheless been embraced by the educational community as being a good way to engage students with statistical information. Perhaps because so few

people use the techniques outside the education sector, there is no Box and Whisker option in Excel, but it does have a chart type that comes close enough.
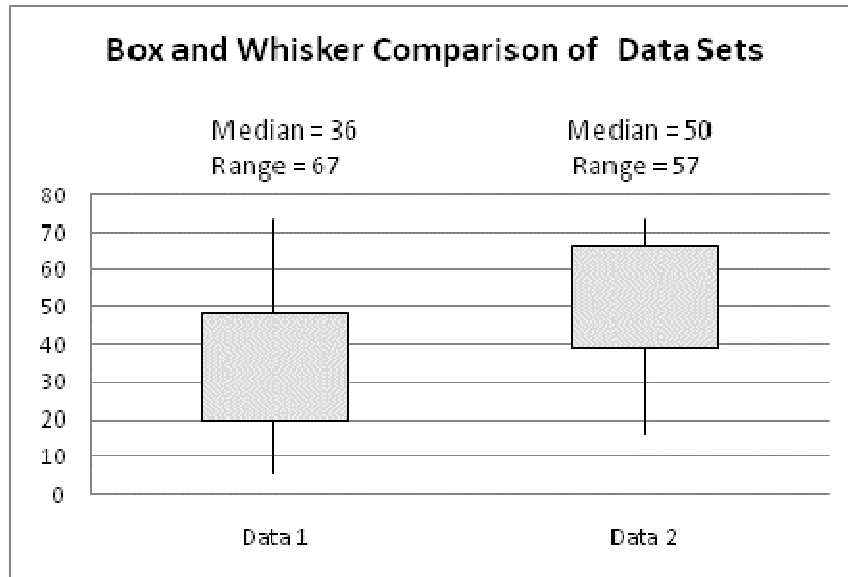
In the Other Charts option, the second Stock option is the one used for the above chart.

Random data generated using the RANDBETWEEN (bottom, top) function has been placed in columns B and C and the ranges labeled as data1 and data2. While creating what follows, we copied and used Paste:Values to stop the data from changing on us all the time. The last step in completing the worksheet was to restore the RANDBETWEEN function so that the F9 (calculate now) feature could be used to see the chart in action.

To create a box and whisker chart, you have to divide the data into four quartiles, which, when working by hand, means that the data first has to be sorted before you can locate these values. With Excel, no sorting is needed. And the MEDIAN function is really quite versatile when it comes to finding the quartile values. The first step is to find the medians of the data sets.

(J6) = MEDIAN(data1)

(J7) = MEDIAN(data2)

We then need to find the maximum and minimum values for each data set (see the formulas in G6:H7). To find the first and third quartile numbers requires the use of an array function, and that in turn requires that you know how to enter formulas that refer to ranges of cells. It is done by holding down <Control> and

<Shift> while you press <Enter>. With that in mind, we can find the Q1 value by finding the median of all those values that are less than or equal to the dataset median.

(F6) =MEDIAN(IF(data1<=$J$6,data1,"")) and <Control><Shift><Enter>

(F7) =MEDIAN(IF(data2<=$J$76,data2,"")) and <Control><Shift><Enter>

The formulas in I6 and I7 are very similar with the <= replaced by >=.

If you are wondering why the information in F5:I7 has been set out in that way, it is because the Stock Chart requires that you position the data in the order Open-Hi-Lo-Close. It is those values are used to create the boxes and whiskers of the resulting chart.

To make the chart, select the range F5:I7 and insert the Other Charts:Stock chart. Much of the work is now complete, but we felt that it would be good to add in the other important information about the data sets. In N5 we created the sentence:

(N5) = "Median = " & J6

The cells below that hold the other sentences that we would like to add to the chart. Using the Insert:Shapes:Text Box, we made sure that the empty text box was selected and then, in the Formula Bar, we add the reference:

= $J$6

In this way, we can control the content of a text box to match the current values in the worksheet. Our last step was to return the data set to use the RANDBETWEEN function and now the chart reacts to each press of the F9 key.

It appears that the Stock graph will not allow you to swap the x- and y-axes in order to display the box and whisker diagrams in the usual orientation. Is that such a loss? We think not.

Back to Back Plots

In contrast to the histogram and box and whisker charts, Excel does generate one of the EDA basics, the stem and leaf plots, without any help from you. They are standard bar charts. Excel also makes back-to-back plots easy to generate.
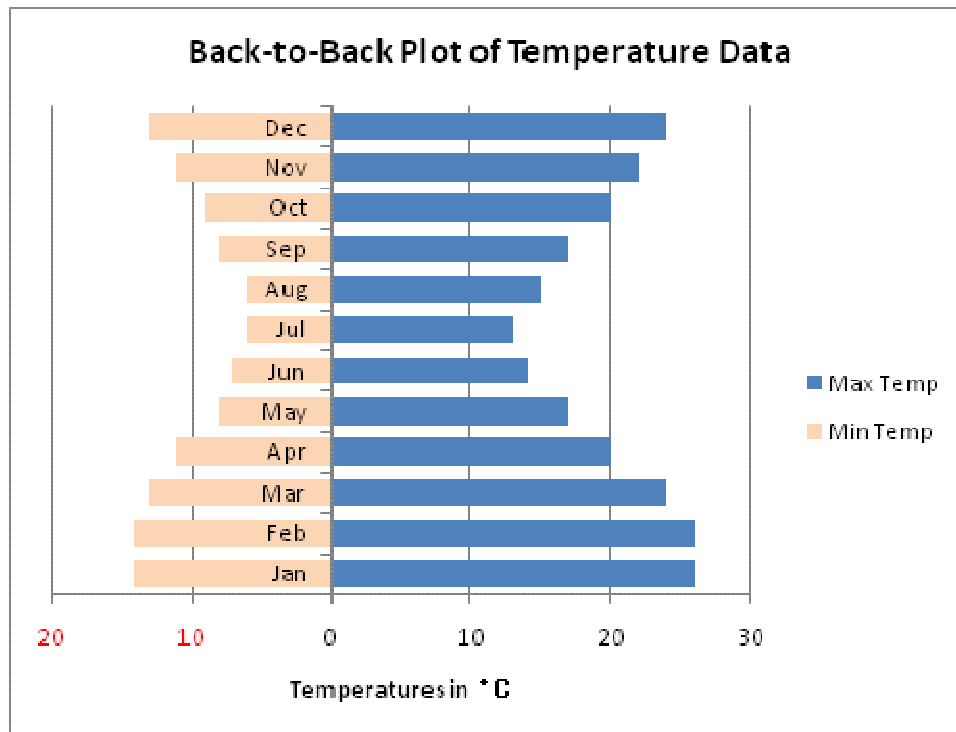
In the example above, monthly Max and Min temperature data has been plotted as a 2-D Stacked bar, but the Min temperatures were converted to negative numbers before plotting. By changing the Number Format of the horizontal axis to show negative numbers in red, the horizontal axis labels do not display an accompanying – sign, and the change in colour is hardly noticeable.

6.   In Conclusion

While we might want to spend time showing students how to navigate a spreadsheet and enter numbers into cells, those are skills that we believe cause no difficulties. But to release them to become skilled spreadsheet users, we need to look beyond the basics and to share some of the features of Excel that are essential to making use of its power. We have chosen the fill handle, conditional formatting, the use of names and scrollbars as being the most important. We have also included the INT, COUNTIF and MODE functions as having valuable uses and we have shown how to make the two types of chart that are most frequently in

educational contexts. By introducing the scrollbar (Form Control) and a method of making chart titles and text boxes respond to worksheet changes, we have pointed to two very useful devices for making spreadsheets interactive. By touching on the need to use <Control><Shift><Enter> with array formulas we may have stepped slightly outside the junior-high school boundaries. But it is a feature that is essential in many applications and we are comfortable about including it. It is our opinion that these features are not 'icing on the cake', rather they are essential to the effective use of Excel.

Acknowledgements

We are most grateful to one of our reviewers for the comments made and hope that we have been successful in responding to the suggestions made.

References

1. Abramovich, S & Eun, K. C. (2008) *Mathematical Problem Posing by Elementary Pre-teachers: The Case of Spreadsheets*, (eJSiE Vol 4)

2. Abramovich, S. & Sugden, S.J., (2004) *Spreadsheet Conditional Formatting: An Untapped Resource for Mathematics Education* eJSiE, Vol 2

3. Staples, E. (2004) *Scrollbar Examples*, (eJSiE, Vol 2)

4. Tukey, John Wilder (1977). Exploratory Data Analysis. Addison-Wesley.

5. Velleman, P F & Hoaglin, D C (1981) *Applications, Basics and Computing of Exploratory Data Analysis*

6. Young, F. W. Valero-Mora, P. and Friendly M. (2006) Visual Statistics: Seeing your data with Dynamic Interactive Graphics. Wiley