Basic Formulas

Calling the functions

Every function in excel is "called" by starting the content of a cell with "=" followed by the function name, followed by the syntax.

Function Names

Function names are "reserved" names used to tell excel how to manage data and put it together to get the results desired. For instance, using the SUM function will tell Excel the following syntax will be added together. So far the formula will look like this: **=SUM()**

Syntax

The syntax is the "structure" or "rules" the formulas use to know the different pieces of data being referred to by the function. The syntax is structured within parenthesis that follows the function name.

The formula SUM uses the syntax of "number1, number2 ..." meaning that `=SUM(D2,E2)` would result in adding those two cells together.

Consequently, one could use mathematical symbols to do math with any formula. Meaning that `=SUM(D2+E2)` would yield the same results as the above.

A12		fx	Slogan in proper case		
A	**B**	**C**	**D**	**E**	**F**
1 Item	Quantity	Cost	Subtotal	Tax	Total
2 Book	6	55.99	=C2*B2	=D2*$F$8	=SUM(D2+E2)
3 Pencil	2	6.99	=C3*B3	=D3*$F$8	=SUM(D3+E3)
4 Ruler	5	3.99	=C4*B4	=D4*$F$8	=SUM(D4+E4)
5 Paper	1	4.99	=C5*B5	=D5*$F$8	=SUM(D5+E5)
6		thanks and have a nice day			
7 Lowest Total		=MIN(F2:F5)			
8 Highest Total		=MAX(F2:F5)		Tax Rate	0.13
9 Average Total		=AVERAGE(F2:F5)			
10 Pencil in Upper Case		=UPPER(A3)			
11 Number of items in list		=COUNTA(A2:A5)			
12 Slogan in proper case		=UPPER(A6)			
13					

Figure 1

Note:

Try creating the table in Figure 1 and analyze the results by comparing with a calculator and the knowledge gained thus far. The references to cell F8 display as $F$8, meaning that it is an absolute reference.

An absolute reference is used to "hold" the reference cell to a single location. This is useful for when cells are being copied with the "Fill Handle".

Some functions will accept cell ranges; others can only refer to a single cell. This is usually obvious, but the concept needs first to be understood for this obviousness to be prominent.

The following functions are explained in why they are able to refer to ranges:

Sum – Adds all cells within the provided range together.
Min – Finds the smallest number within a range
Max – Finds the largest number within a range
Average – Adds a range together and divides by the number of values within that range.
Count – Counts how many instances of cells contain numbers within a range.
Counta – Counts how many instances of cells contain text within a range.

There is a trend that forms here. Notice that these functions group data and provide results based on that group. Though this does not restrict them from using single cell reference, it does allow them to look at whole ranges of data.

The Following functions are explained in why they cannot refer to ranges:

Upper – Converts a cell's text content to UPPERCASE
Proper – Converts a cell's text content to Proper Case.

The trend to notice here is that a range of data is not needed, nor is it viable to be used as these functions can only display single cell values into its own cell.

If combining data was the goal, the CONCATENATE function would be used. Caution should be applied in this instance, as the CONCATENATE function does take multiple cell references and combines them, it does not however allow for ranges to be specified.

As the functions are practiced, it becomes clear what functions allow for different "reference" methods.
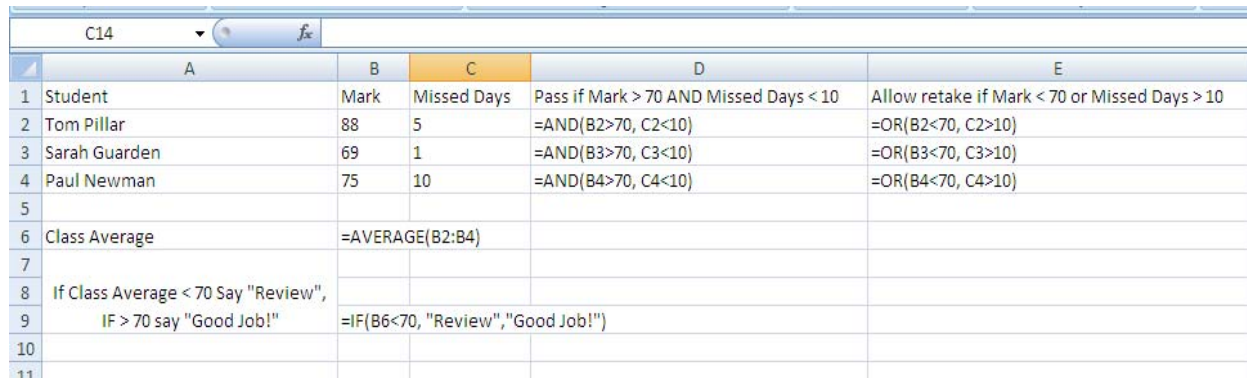
Using Mathematical Operators:

Symbols	Description	Example
+ (plus sign)	Addition	3+3
– (minus sign)	Subtraction Negation	3–1 –1
* (asterisk)	Multiplication	3*3
/ (forward slash)	Division	3/3
% (percent sign)	Percent	20%
^ (caret)	Exponentiation	3^2

Adding logic to our functions

Some functions allow for specific criteria to be looked for, then returning results based on that criteria. These logical functions differ on their provided logics. Once the basic logics used are mastered, it's easy to apply these to other related logical functions.

	A	B	C	D	E
				fx	
	C14				
1	Student	Mark	Missed Days	Pass if Mark > 70 AND Missed Days < 10	Allow retake if Mark < 70 or Missed Days > 10
2	Tom Pillar	88	5	=AND(B2>70, C2<10)	=OR(B2<70, C2>10)
3	Sarah Guarden	69	1	=AND(B3>70, C3<10)	=OR(B3<70, C3>10)
4	Paul Newman	75	10	=AND(B4>70, C4<10)	=OR(B4<70, C4>10)
5					
6	Class Average	=AVERAGE(B2:B4)			
7					
8	If Class Average < 70 Say "Review",				
9	IF > 70 say "Good Job!"	=IF(B6<70, "Review","Good Job!")			
10					
11					

Figure 2

The above logic functions work as follows:

IF - Sais that if a criteria is true, do this, if not, do the other.
AND – Asks the question "IF _____ AND _____ are true, then result is TRUE"
OR – Asks the question "If _____ OR _____ are true, then the result is TURE"

In all instances, the criteria MUST be specified as seen in Figure 2.

Using Logic Symbols:

Symbol	Description	Example
>	Greater Than	5 > 4
<	Less Than	4 < 5
=	Equal To	4 = 4
<>	Not Equal To	4 <> 5
>=	Greater Than or Equal To	4 >= 4
<=	Less Than or Equal To	4 <= 4

Using functions that combine logic with regular functions

The following functions demonstrated in figure 3 show the SUMIF, COUNTIF, and AVERAGEIF functions performing mathematical functions on one column of data provided another column contains specified criteria.

	A	B	C
	A11		f_x
	A	B	C
1	Student	Class	Mark
2	Tom Pillar	Math	70
3	Sarah Guarden	English	90
4	Paul Newman	Math	80
5	Peter Sampson	English	75
6			
7	Using SUMIF to add only MATH marks		=SUMIF(B2:B5,"Math",C2:C5)
8	Using countif to get number of ENGLISH students		=COUNTIF(B2:B5,"English")
9	Using averageif to get the MATH class average		=AVERAGEIF(B2:B5,"Math",C2:C5)
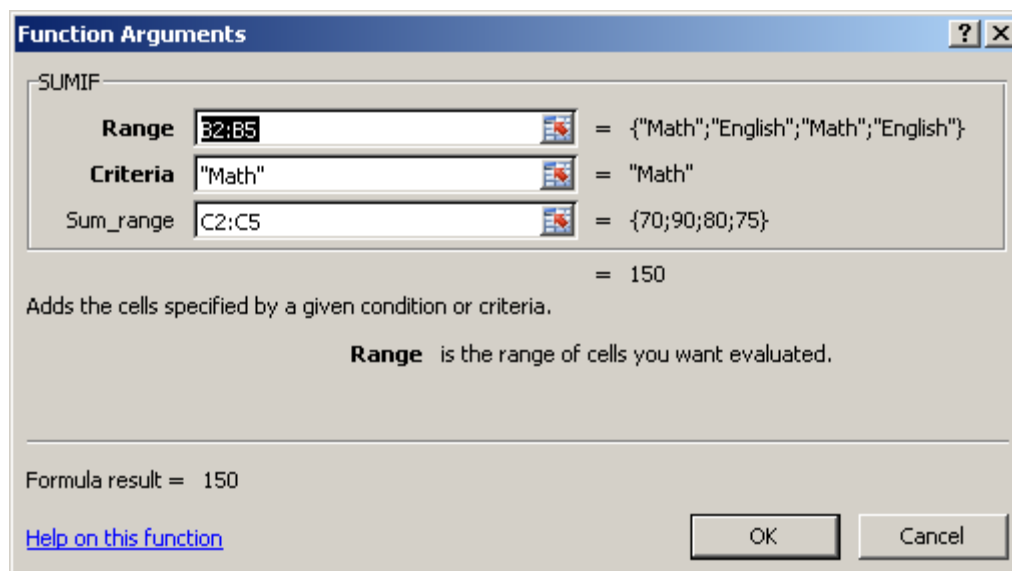
Figure 3

What the individual functions do in these examples:

SUMIF – Sums the range C2:C5 provided the cells in range B2:B5 are equal to "Math"
COUNTIF – Counts the range C2:C5 provided the cells in range B2:B5 are equal to "English"
AVERAGEIF – Averages the range C2:C5 provided the cells in range B2:B5 are equal to "Math"

Function Arguments   ?×

SUMIF

Range	B2:B5	= {"Math";"English";"Math";"English"}
Criteria	"Math"	= "Math"
Sum_range	C2:C5	= {70;90;80;75}

= 150

Adds the cells specified by a given condition or criteria.

        Range is the range of cells you want evaluated.

Formula result = 150

Help on this function   OK   Cancel

Intermediate Function Usage

To bring up a function argument box such as the one bellow, one needs to go to the "Formulas" tab and choose the "Insert Function" button. By typing in what you want to do and clicking "go", a list of functions will appear bellow. Directly underneath a description of what that function does is displayed by clicking on each function listed.

Once the proper function has been chosen, the "Function Arguments" dialogue box will assist in filling in the proper information.

For this explanation, the "VLOOKUP" function will be used.
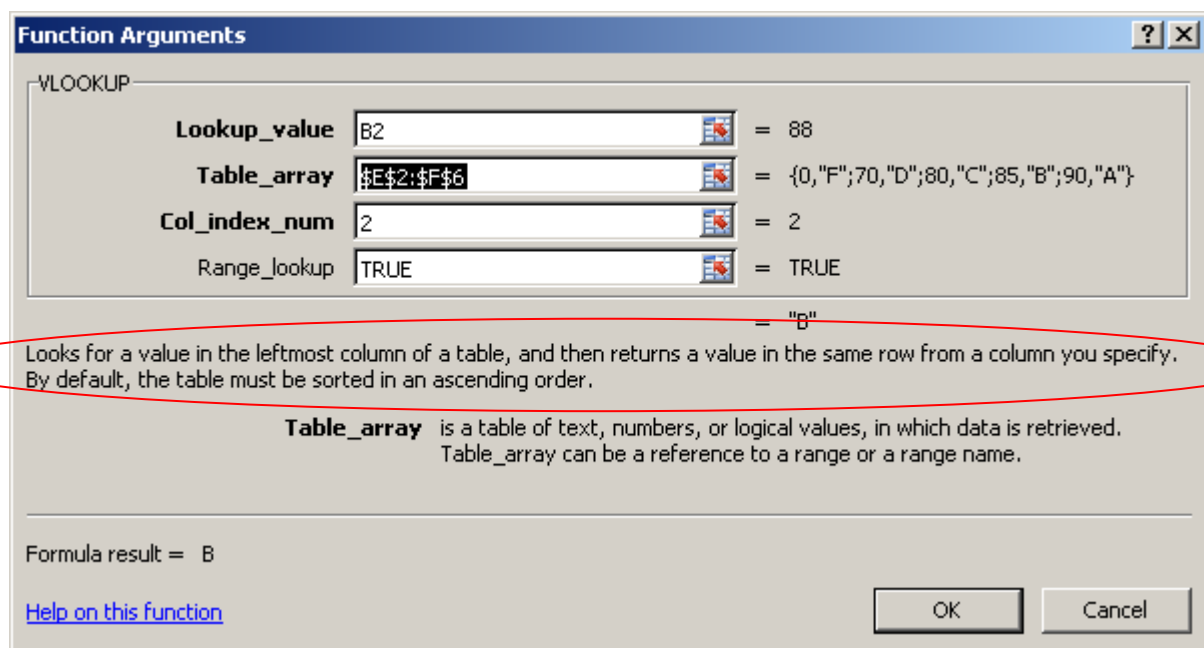
Figure 4

This function "*Looks for a value in the leftmost column of a table, and then returns a value in the same row from a column you specify*".
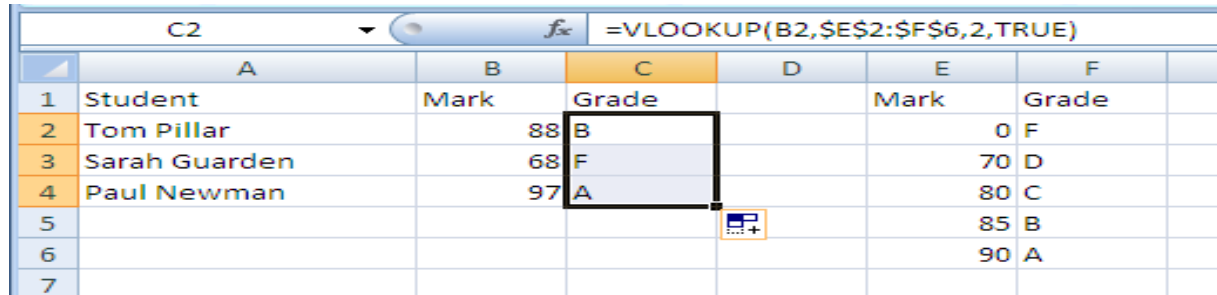
This means that a value can be "looked up" on a table and return a corresponding value to the cell containing the function.

This can be visually explained using Figure **3.**

The range A1:C4 contains a table of students and their marks. In column "C" the grade needs to be displayed, so the VLOOKUP function is used to read the value in "B2" and compare that value to the table in range E2:F6. Once the value is found, colum "2" of the results is used to be displayed.

The final value of "TRUE" is used to tell the function if it should look for a range of data or not. In other words find the closest "next" value if it's true and find the exact value only if "False".

		C2			f_x	=VLOOKUP(B2,$E$2:$F$6,2,TRUE)	
	A		B	C	D	E	F
1	Student		Mark	Grade		Mark	Grade
2	Tom Pillar		88	B		0	F
3	Sarah Guarden		68	F		70	D
4	Paul Newman		97	A		80	C
5						85	B
6						90	A
7							

Figure 5

Note:

Figure 3 shows the "Function Arguments" dialogue box filled out for cell C2. Notice the table array is set as absolute ($E$2:$F$6). This makes sure that when using the fill handle to copy the formula down through to C4 that the "table_array" does not move its range position from E2:F6.

Conclusion

Every other function can be created in a similar fashion. Search for then choose the needed function through the "Insert Function" button on the formulas tab. Once the desired function is discovered, it's a matter of filling in the options.

This may require research, assistance, or reading of the help system to discover exactly what is needed to be put into the options.

By taking the proper time needed to understand exactly what the functions are looking for greatly assists in the ability to "flex" the functions to individual needs.

Next, intermediate function usage will be used, and then some advanced techniques will be applied such as embedding formulas, troubleshooting functions and database functions.
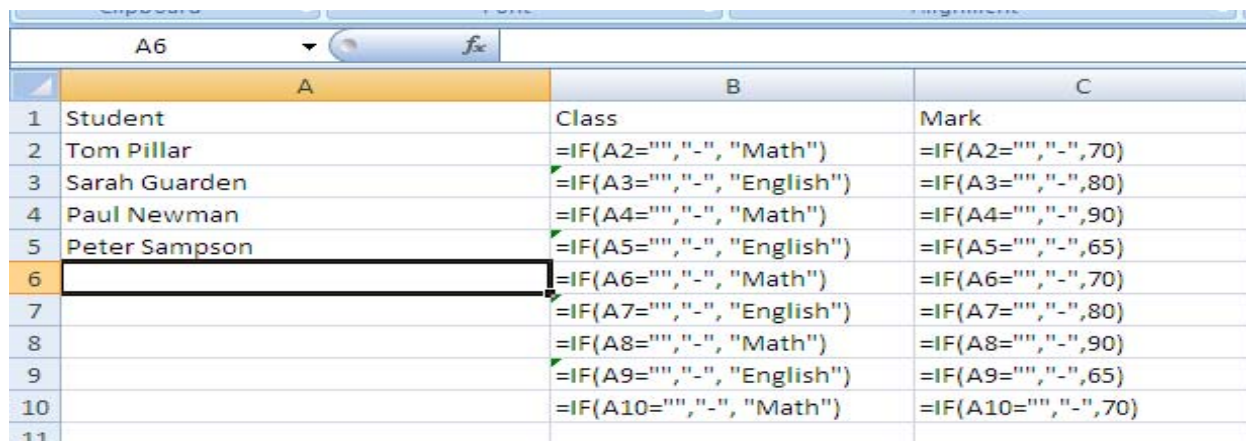
Advanced Function Usage

In this section Embedded Formulas are discussed in how they can be used to add functionality to formulas.

Embedded Formulas

Using embedded formulas allows the use of formulas to either check for logical variables or replace cell references within formulas, allowing data to be more dynamic.

The example in figure 6 shows the use of embedded formulas to check if there is a name written in column A. If there is a name listed, it outputs either "Math" or "English" depending on the "If false" part of the syntax.
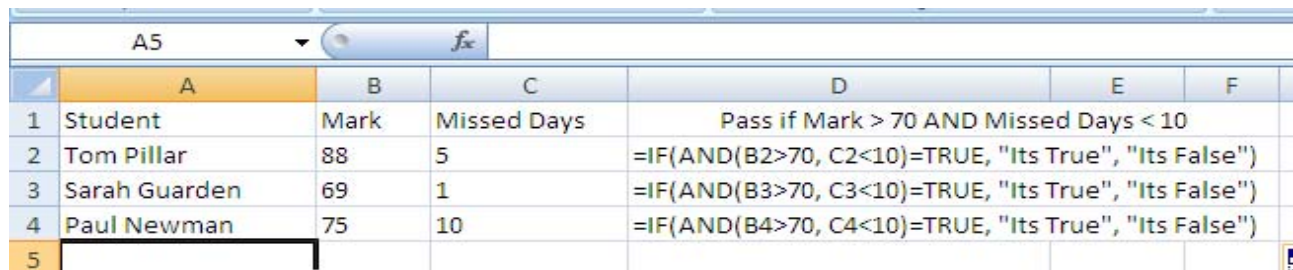
The syntax is `IF(criteria, "IF TRUE", "IF FALSE")`

	A6	fx	
	A	**B**	**C**
1	Student	Class	Mark
2	Tom Pillar	=IF(A2="","-", "Math")	=IF(A2="","-",70)
3	Sarah Guarden	=IF(A3="","-", "English")	=IF(A3="","-",80)
4	Paul Newman	=IF(A4="","-", "Math")	=IF(A4="","-",90)
5	Peter Sampson	=IF(A5="","-", "English")	=IF(A5="","-",65)
6		=IF(A6="","-", "Math")	=IF(A6="","-",70)
7		=IF(A7="","-", "English")	=IF(A7="","-",80)
8		=IF(A8="","-", "Math")	=IF(A8="","-",90)
9		=IF(A9="","-", "English")	=IF(A9="","-",65)
10		=IF(A10="","-", "Math")	=IF(A10="","-",70)
11			

Figure 6

Another method of using embedded formulas is to replace cell references with formulas.

|	A5	fx				
	A	**B**	**C**	**D**	**E**	**F**
1	Student	Mark	Missed Days	Pass if Mark > 70 AND Missed Days < 10		
2	Tom Pillar	88	5	=IF(AND(B2>70, C2<10)=TRUE, "Its True", "Its False")		
3	Sarah Guarden	69	1	=IF(AND(B3>70, C3<10)=TRUE, "Its True", "Its False")		
4	Paul Newman	75	10	=IF(AND(B4>70, C4<10)=TRUE, "Its True", "Its False")		
5						

Figure 7

Notice in the example of figure 7 the result of the AND function is used as a part of the IF function's syntax.
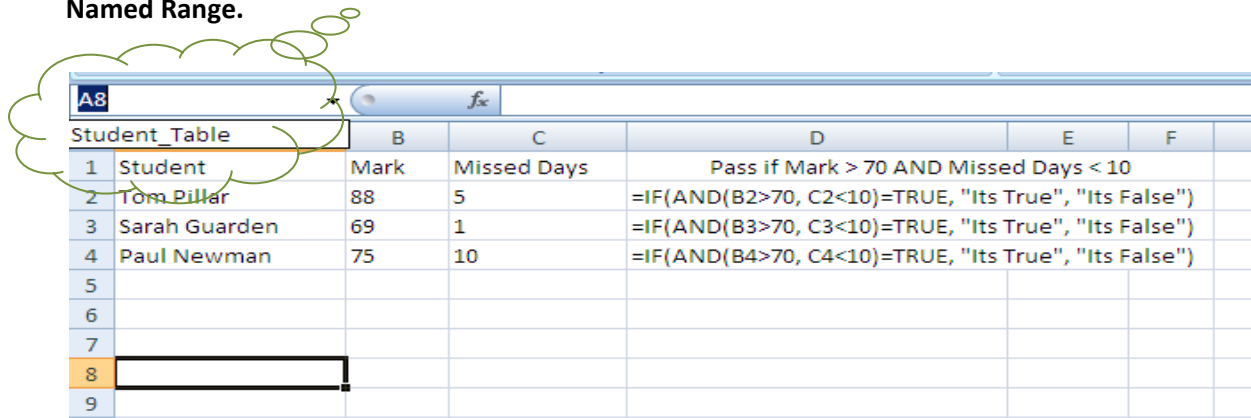
Setting your spreadsheets up for efficient use

Named Ranges

Named Ranges can be used to simplify selecting ranges and making referring to ranges easy. To create a name range, simply click on the "Formulas" tab and click the "Name Manager" button. From this dialogue box, named ranges can be created, editing, and deleted.
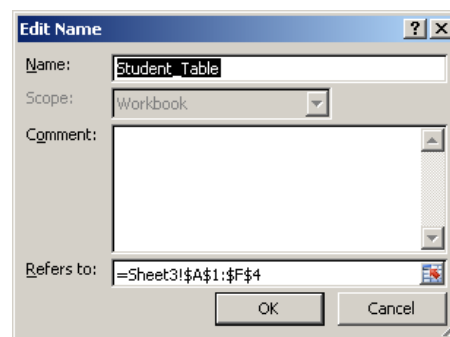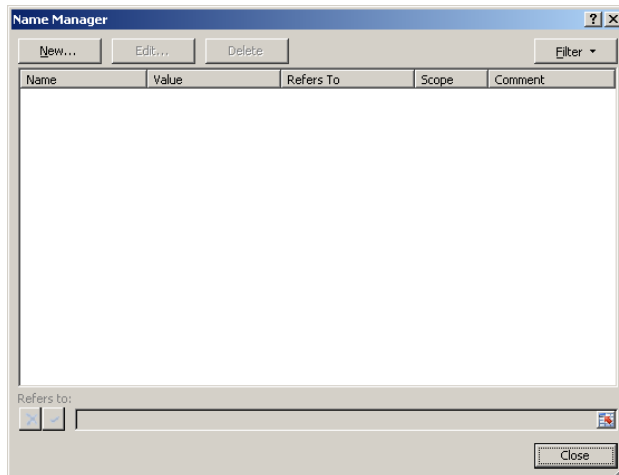
Once the name range has been created, click the drop down in the Name Box and choose the created Named Range.

	Student	Mark	Missed Days	Pass if Mark > 70 AND Missed Days < 10		
1	Student	Mark	Missed Days	Pass if Mark > 70 AND Missed Days < 10		
2	Tom Pillar	88	5	=IF(AND(B2>70, C2<10)=TRUE, "Its True", "Its False")		
3	Sarah Guarden	69	1	=IF(AND(B3>70, C3<10)=TRUE, "Its True", "Its False")		
4	Paul Newman	75	10	=IF(AND(B4>70, C4<10)=TRUE, "Its True", "Its False")		

Data Validation

Data validation can be used for many types of data control within a cell. It is worth the time to investigate the different controls, as it creates stored knowledge that can be applied to other scenarios.

Where to find it: (Data Tab --> Data Validation --> Data Validation
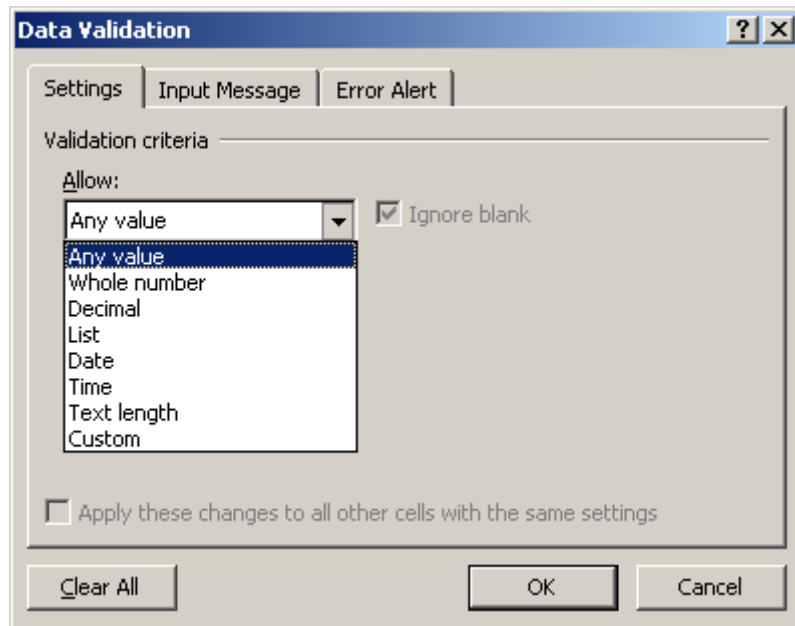
Figure 8

Any Value is default - All cells have this set by default. It allows any value within the cell.

Whole Number – Allows ONLY whole numbers to be entered into a cell (No decimals)
- Sub-Options allow a range of numbers to be defined that are allowed. These can also be cell references or formulas.
- Formulas do not function if they result in invalid data

Decimal – Allows for decimal number to be entered along with whole numbers

- Both the "Whole Number" and Decimal options provide the same sub-options, the following examples apply to both.
- If any chance of decimal numbers exists, use this option

The "**Input Message**" Tab allows for the creation of an input message when the cell is selected.

Figure 9 is a view of the "Input Message" tab.
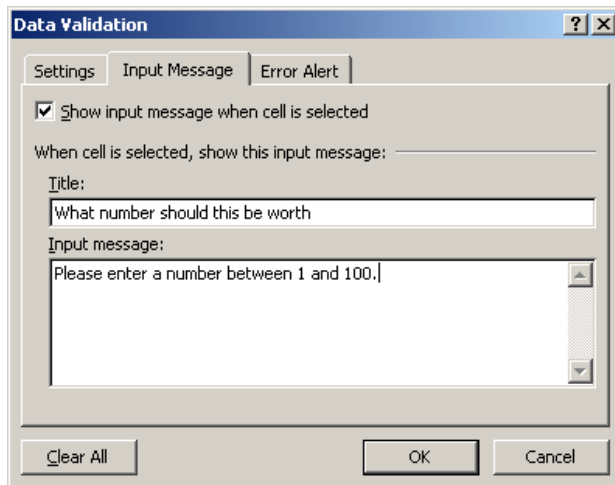
Figure 9

**Figure 10** shows the input message that displays when the cell is selected.
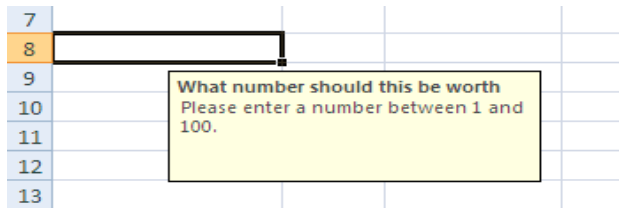
Figure 10

Note:

✓ Ensure the "Show input message when cell is selected" check box is selected.
✓ The title will be bold and represent the direction of thought, the "Input Message" should be descriptive and direct.
✓ Use the "Clear All button to quickly remove all typing
✓ If you lose track of exactly how the cell will be affected, click cancel and start over.
✓ One can enjoy their own custom error messages

Figure 11 Shows the creation of custom error messages within the "Error Alert" tab.
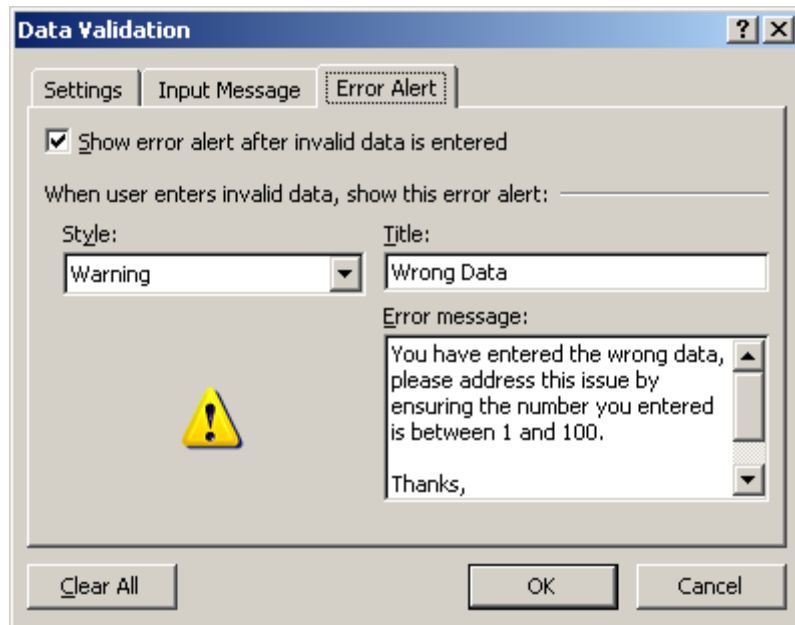
Figure 11

The style is what type of error dialogue box will be displayed. The Warning message is the yellow exclamation mark, the Stop message is a red ball with a white X; the information dialogue box is a question mark.

Once the Whole number or Decimal has been completed, test out the cell by entering invalid data, then valid data.   Test both the high and low barriers, just be sure.

Figure 11 shows the custom error message created through the "Error Alert" tab.
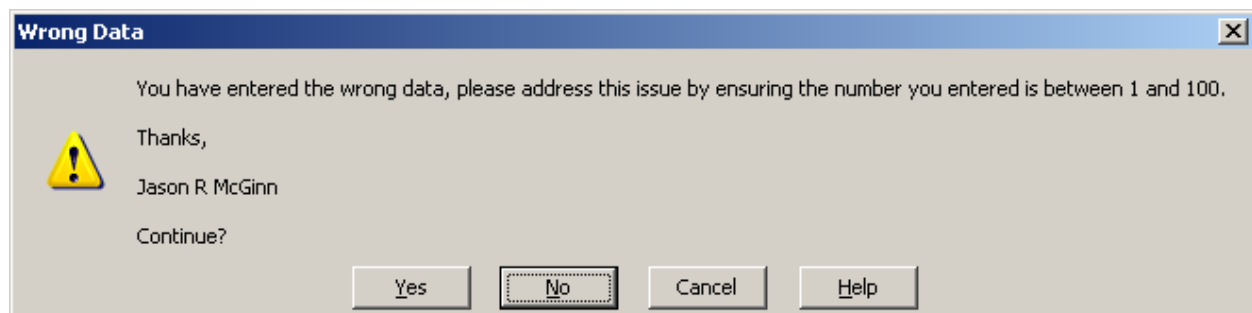
Figure 12

List Boxes

By choosing "**List**" for the allowed criteria, "**In-Cell dropdown**" appears along with "**source**"

The source is a range of cells containing the data allowed within the cell.

- ✓ Each cell is considered an option within the list, so with A1:A4 selected, each name is what is allowed within the cell. (**See Figure 14**)
- ✓ In-Cell dropdown option provides a drop down box to the user to choose the option of text to be entered into the cell. (**See Figure 14**)
- ✓ The source list COULD be a range of formulas, providing a dynamic dropdown box.

Figure 13

Figure 14

Date, Time, and Text Length all contain the same options as whole number and decimal. The "custom" option allows for a formula to be entered. This does not change the fact that you can have a dynamic list by choosing a range of cells with pre-defined formulas.

Paste Special Options

Accessed by clicking on the "Home" tab, the down arrow on the paste button and "Paste Special"

Paste Options allow a variable of different types of pasting control.

- ✓ Pasting just formulas can be useful to setting up "Testing" tables or just simply a good way to copy formulas!
- ✓ Pasting the values is good practice for calculating out a range, then copy and pasting its value to another location.
- ✓ Pasting formats can be useful for copying table formats and applying it to similar tables. This may be useful for organization colours
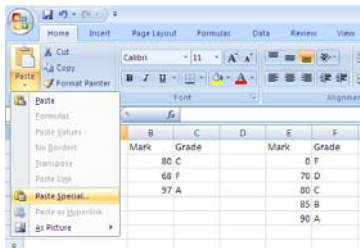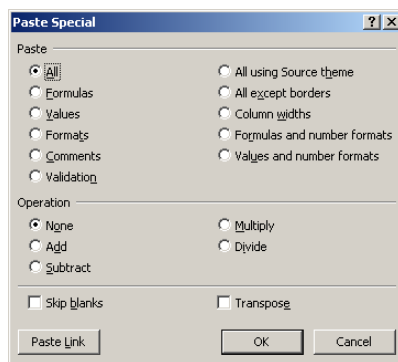

Figure 15

Figure 16

- ✓ The rest of the options can be learned though testing them out.
- ✓ Use "**Paste Link**" to paste a link to the data you copied.

Filters and Sorts

Once the filter is applied (by selecting a table, clicking on the data tab, then clicking Filter), drop down menus appear on each column header. This dropdown allows for "Fine tuning" the content via check boxes and/or Text and Number Filters.
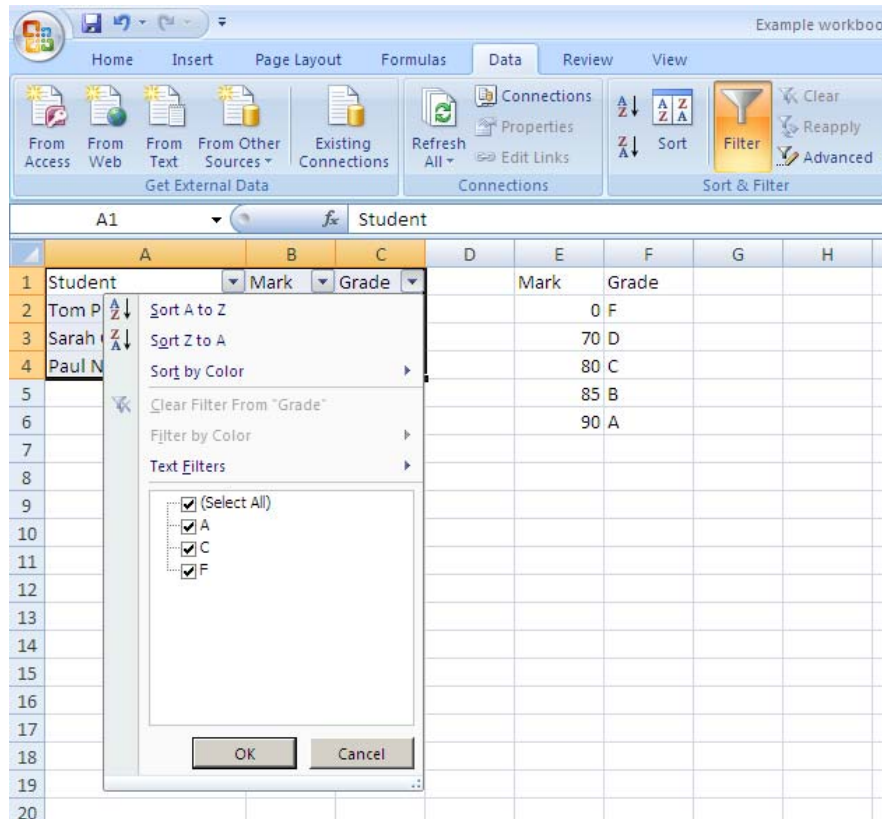
Figure 17

Had there been numerical values in the grade column, "Number Filters" would be displaying on the menu as opposed to "Text Filters"

- ✓ Sorting options can be chosen from this menu, unless multiple levels of sorting is required.
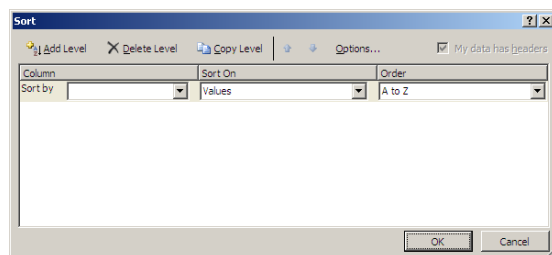- ✓ Text and Number filters are used for fine tuned filtering

Figure 18

The sorting dialogue box allows for controlled sorting. Things can be organized by Mark, then Grade if needed.

Tables (Pivot Tables & Charts)

Creating Pivot tables are simple. To create one:

- ✓ **Select the table of data wanted within the pivot table.**
- ✓ **Click the Insert tab, click pivot table (or chart if only chart is desired)**
- ✓ **Confirm the selected range with the "Select table or range" option**
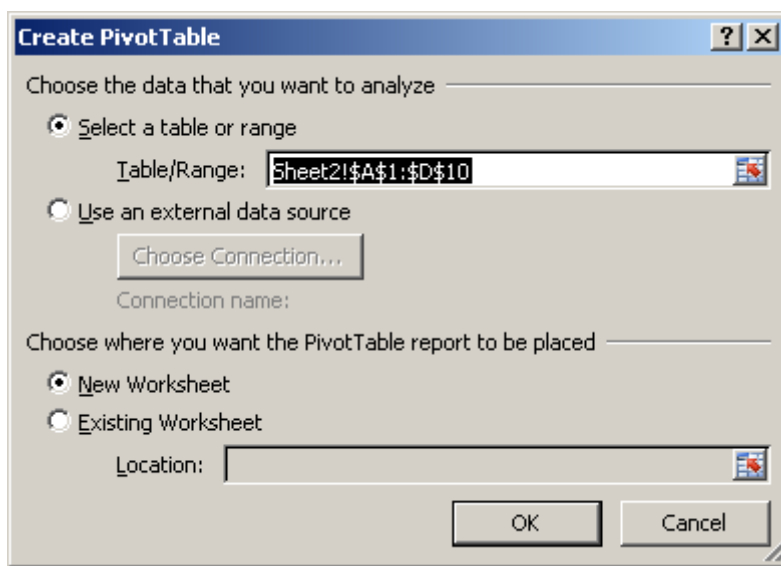   - o **Other options are available for different data locations**

Once "OK" has been clicked, a blank pivot table appears until data to be included is checked off in the list on the right. The labels that appear bellow it can be dragged to different "Fields" changing the appearance of the table.

- ✓ Basic options such as naming the table and Field Settings can be found on the PivotTable Tools options tab. (Circled in figure 20)
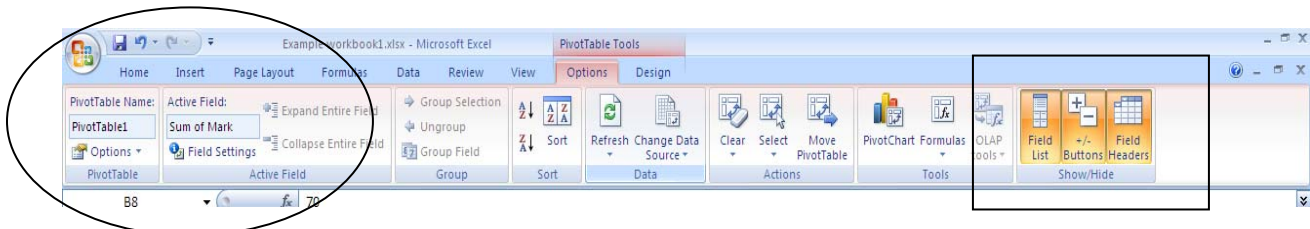

Figure 20

✓ If the field list dialogue box is accidently closed, use the Show/Hide options to bring them back.
✓ Depending on the order within the fields along the bottom, controls the order of the data to be displayed. For example, in figure 21 for details.
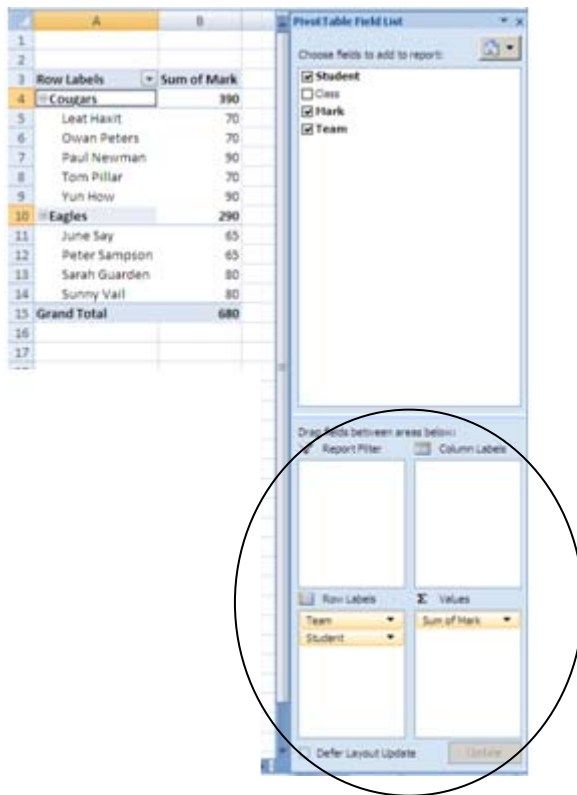

Figure 21

A personal note from the author:

Excel has many features beyond the obvious tools to use. Once familiar with each of the tools, more functionality becomes apparent. It's the combination of tools that begin to allow the creation of many great spreadsheets and workbooks.

Beyond the data structuring Excel provides, there are many capabilities held within the combining not only of the Excel tools, but with other Office products and Software integrating together.

These documents can go so far as to communicate with other networked databases, the operating system itself (Windows XP, Vista), and countless other technologies.

The more you learn, the more you unlock.

- *Jason R. McGinn (2009)*