

**Functions : Part 2 - Defining Functions v. Using Functions**

You will do only two activities with functions. Either you will be defining the function or it will already be defined and you will be using the function.

These are not the same activity and LiveMath does not think they are the same.



You only define a function once. If you define it a second time then it is a different function. The second function may have the same name and variable as the first, but the rule of the function has changed and so the function has changed. After all it is the instructions, recipe, or rule that really define a function.

When you define a function you signal this to LiveMath by using a function variable. Function variables are very special and reserved for the single activity of originally defining a function.



Once the function is defined and available in a notebook you do not define it again. Instead you use the existing definition.

When using a function you use regular variables and not function variables.



Here is the definition of a function:

A named water behaves as .

$\text{water}(w) = 1 + w$



Now you may wish to use this function. Suppose you want to substitute k in for w in the function $\text{water}(w)$.

$\text{water}(k)$

$\text{water}(k) = k + 1$ Substitute



If you attempt this using the function variable :

$\text{water}(k)$

$\text{water}(k) = k + 1$ Substitute



LiveMath will go along with your actions, but it now sees two definitions floating around...as opposed to one definition and one evaluation/substitution. In our simple example here it doesn't really matter. As your usage of LiveMath becomes more sophisticated and complex it may become very important....and quite difficult to decipher when things go wrong.



Something slightly more complicated

Here is a definition of the function star.

$\text{star}(x) = x + 1$



Now suppose you want to know where this function intersects the parabola $x^2 + 1$. To locate the intersection points you create an equation. If you use function variables to create this equation you get something like this.

$\text{star}(x) = x^2 + 1$



The statement immediately above is a second definition of star and not an equation to solve. We wanted to use $x + 1$ as the definition of star and find where this intersected $x^2 + 1$. However, by employing function variables we have signaled to LiveMath that we are defining a function as opposed to using one.

To use the definition of star in an equation we would use normal variables. Normal variables can be typed from the keyboard or selected from the pop-up menu in the palette.

$\text{star}(x) = x^2 + 1$



Now we can work on this equation as intended and not inadvertently redefine the function star.

Distinction: There are definitions and there are equations and they are not the same thing even though the both use equal signs.

Let's confuse the whole situation

We are about to expand on the difference between definitions and equations. In the process we may seemingly mix them up. Take a deep breath. Here we go...

Eventually, you will want to define functions based on other functions. You may want to define a function that is the sum of two existing functions.

In such a situation you would be using two existing functions but using them in a definition. It might be confusing as to which variable type to use.

All you have to do is keep the new argument in mind. Where do you want it to go?

Here are two functions:

$\text{rain}(x) = x + 1$

$\text{thunder}(x) = 2x + 4$



Now define a third function as their sum:

$$\text{cloud}(x) = \text{rain}(x) + \text{thunder}(x).$$

The x in $\text{cloud}(x)$ is definitely a function variable because a new function, cloud , is being defined.

However, $\text{rain}(x)$ and $\text{thunder}(x)$ already are defined and I am using them here. This suggests using a regular variable for them.

But, when defining the function cloud I need to point out where the argument for cloud is suppose to go. This becomes the most important consideration and takes precedent.

$$\square \text{cloud}(x) = \text{rain}(x) + \text{thunder}(x)$$



Here rain and thunder are being used in a definition and not an equation. A function variable is being used in them because the function variable of cloud is supposed to be substituted into rain and thunder .



What to keep in mind



Are you defining a function?

That is the only thing you need to keep in mind. If you are defining a function then you need to pay attention to where you want the function's argument to be placed.

If you are not defining a function and instead are creating an equation, then you want to use regular variables.



Now It's Your Turn... Follow the directions below to get hands on experience.



1.

Define a function

$$\text{car}(x) = 3x - 5$$

Evaluate $\text{car}(4)$.

Create an equation $\text{car}(x) = 3x + 1$.

Substitute the definition of $\text{car}(x)$ into this equation.



2.

Define a function

$$\text{pencil}(x) = 3x + 4$$

Create a separate definition

$$\text{pencil}(x) = -x + 3$$

Create a separate definition

$$\text{pencil}(x) = 2x - 2$$

Make one of these definitions active.

Evaluate $\text{pencil}(1)$.

Make one of the other definitions active. Look at the evaluation.

Make the third definition active. Look at the evaluation.



3.

Define four functions:

$$\text{water}(x) = 3x + 2$$

$$\text{fish}(x) = -x + 5$$

$$\text{ocean}(x) = \text{water}(x) - \text{fish}(x)$$

$$\text{boat}(x) = 3 \text{water}(x) + 4 \text{fish}(x)$$