

STUDENT EXPLORATION ACTIVITIES USING MATHEMATICA

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Abstract:

Basic Mathematica concepts are described that allow the teacher to create student exploration activities. The Mathematica concepts introduced are easy to use and produce interactive activities for the students. The use of different Mathematica notebook styles is also discussed. Emphasis is on using the Manipulate command in Mathematica. Other Mathematica commands that are introduced include Plot, PlotRange, and PlotLabel.

Using the Manipulate command in Mathematica allows the teacher to create interactive activities that are easy for students to use. Students can use these activities on any computer since the activities will use the computable document format (.cdf) that allows computers without Mathematica to run interactive Mathematica notebooks. Wolfram provides a free download of the Wolfram CDF Player on their website.

Introduction

Mathematica can be used for many different applications. Several improvements in the recent version of Mathematica make it possible to create interactive applications that students can use even if the students do not have access to Mathematica itself. These improvements include the very versatile command “Manipulate” and the computable document format now available through Wolfram.

Design Principles

I used several design principles to create the activities that I used with my classes. I viewed these as goals that directed how I approached the design of the activities. I wanted the activities to be a.) simple (i.e. easy to use), b.) intuitive (no instructions necessary), c.) flexible (adaptable for many uses), and d.) aesthetic (look good and professionally designed).

Interactivity

Research indicates that a hands-on approach provides a better learning environment (Kahyeci & Imamoglu, 2007). Therefore, I wanted activities that aided visualization and demonstrated concepts (recommendation #5, CUPM report, 2004). Students’ difficulties

in understanding concepts in Mathematics can many times be traced back to a lack in the ability to visualize said concepts. My activities are designed to aid in this visualization. Since students aren't just watching, but interacting with the graphs, a deeper understanding and retention of concepts is possible (Land, 2000).

Aesthetics

Mathematica notebooks can be customized to create a visual appeal. You can add photos. These images can enhance the appeal of the notebook. I used the photos to enhance the title. You can also use the photos in more creative ways such as using it as a texture on a three dimensional image.

Another simple way to improve the aesthetics is to use style sheets and styles (figure 1). Several different style sheets are built in to Mathematica. I like to use the style sheet listed under the creative category as NaturalColor (figure 2). You can also modify a style sheet to meet your individual needs. Use the edit style sheet command to make changes to the style sheet.

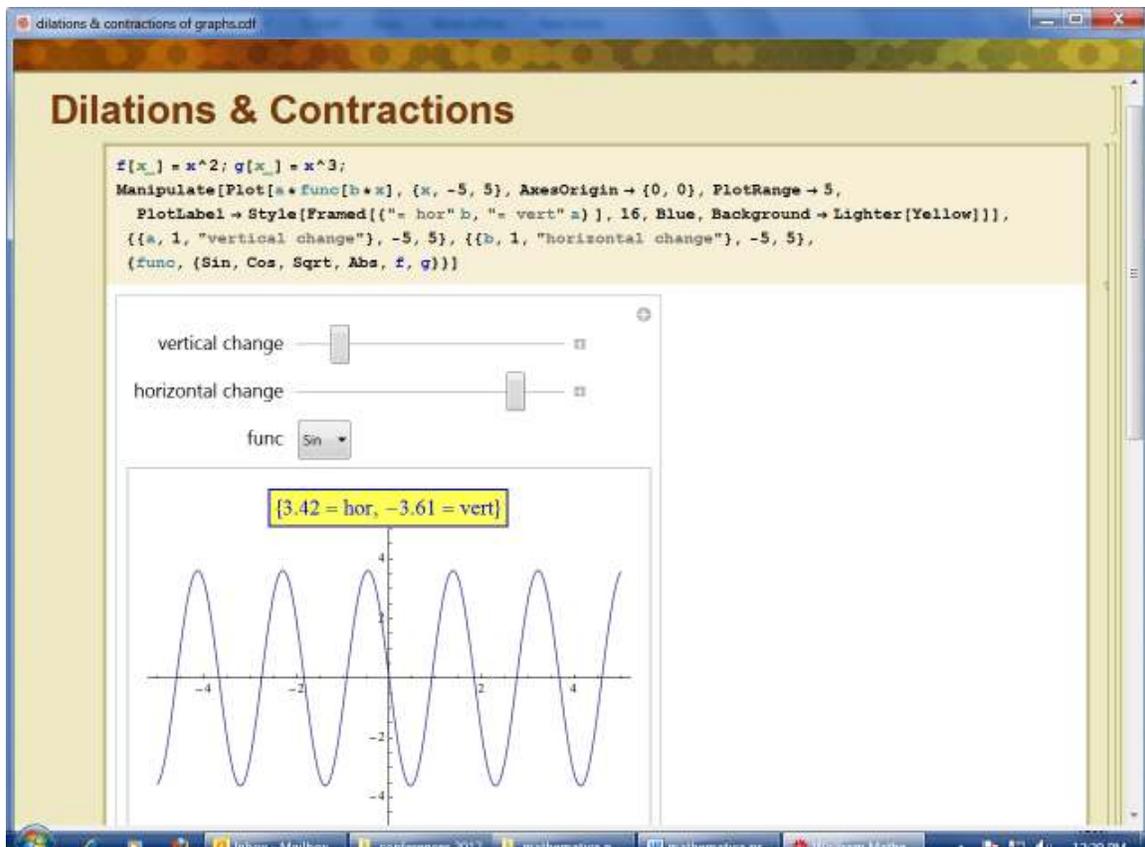


Figure 1: Notebook with use of Style Sheet

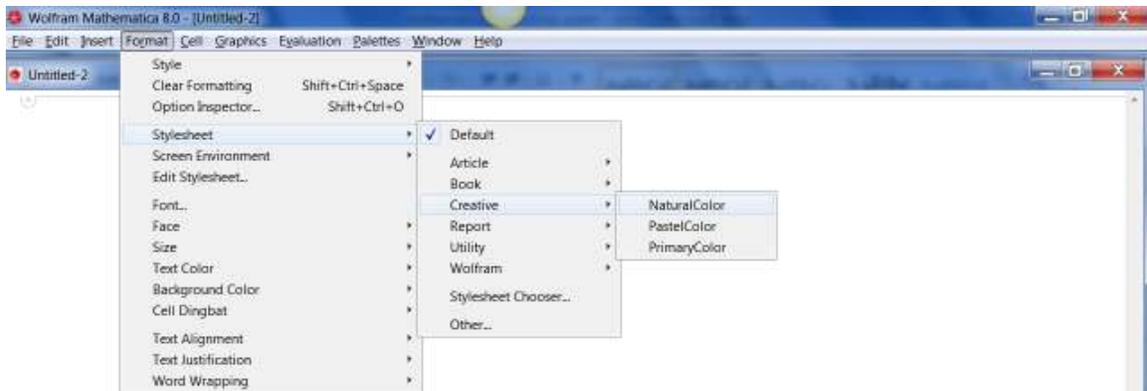


Figure 2: Using the Style Sheet NaturalColor

Manipulate

One extremely useful and easy to use command in Mathematica is the `Manipulate` command. We use it to quickly create interactive graphs. By using the `Manipulate` command, sliders are created that students can move and see what changes in the graph. We start with a simple graphing command such as `Plot` (figure 3). We then put the word `Manipulate` with a beginning square bracket in front of the graphing command in Mathematica. We then put a comma after the graphing command and add a range of values for a designated variable. We close the statement with a square bracket and execute the command. A slider is created for the designated variable and now our graph is interactive (figure 4).

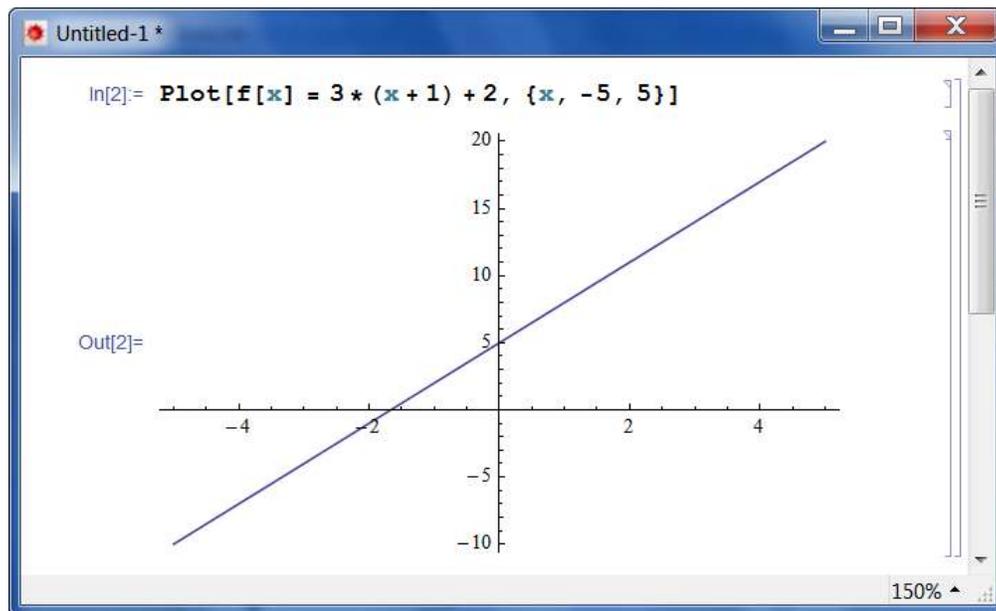


Figure 3: Example of Static Plot Command

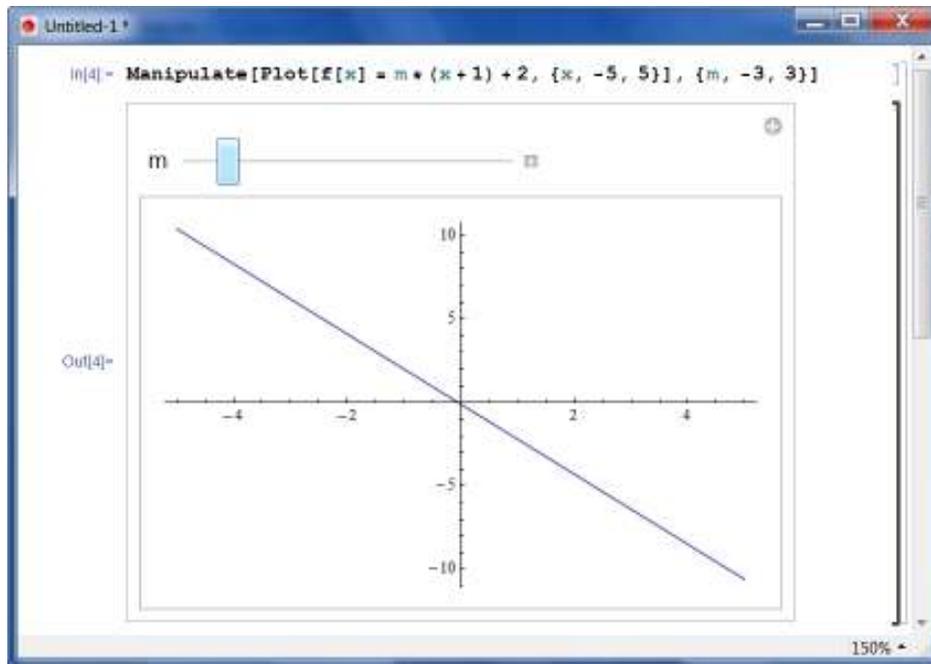


Figure 4: Example of Interactive Manipulate Command

To make the graph better, I used two other options. The first is `PlotRange` (figure 5). This keeps the y-axis from shifting and allows students to see the effect on the graph better. The second is `PlotLabel` which allows you to see the values of the variable being changed with the slider (figure 6). We again use these two options to improve the aesthetics.

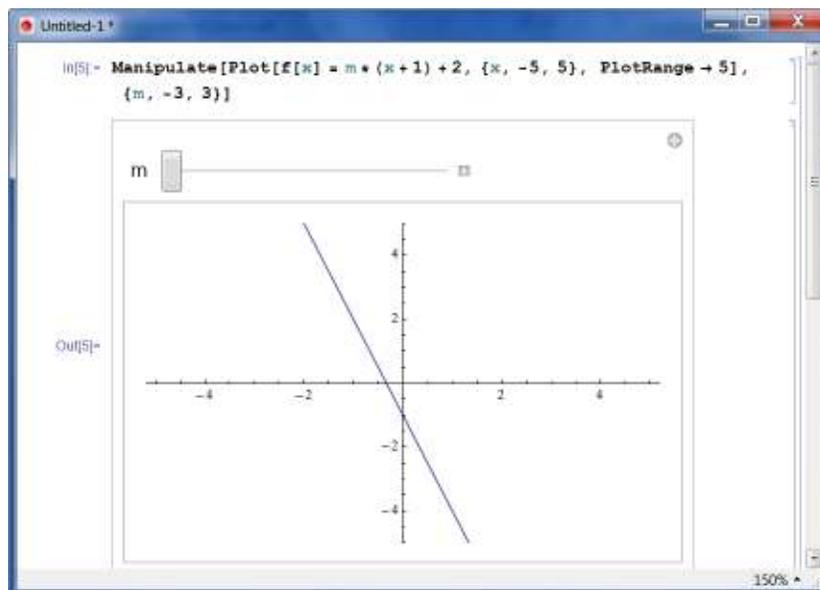


Figure 5: Example of PlotRange Command

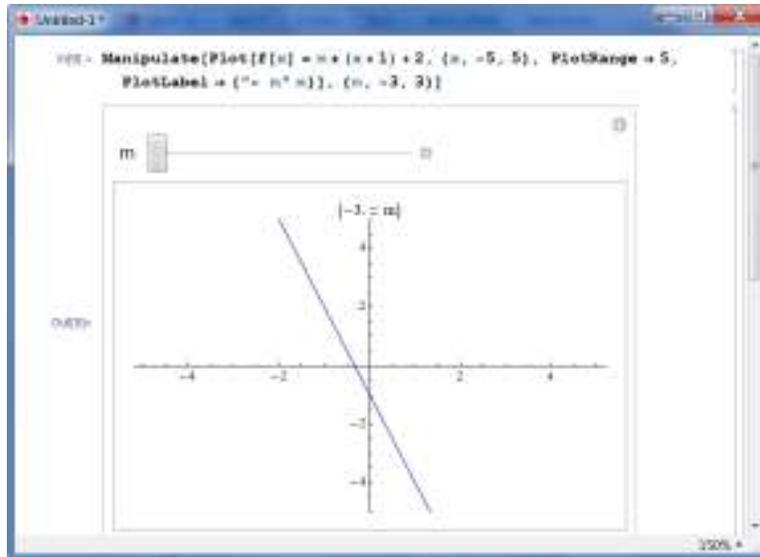


Figure 6: Example of PlotLabel Command

Creating Activities

First I chose a style sheet. I wanted consistency by class so I used the same style sheet for each activity in a given class. Then I designed the questions that I wanted students to answer. I created the executable statements. I then tested and retested the execution until I was sure that I had what I wanted. Finally I put it all together and added some pizzazz (figure 7).

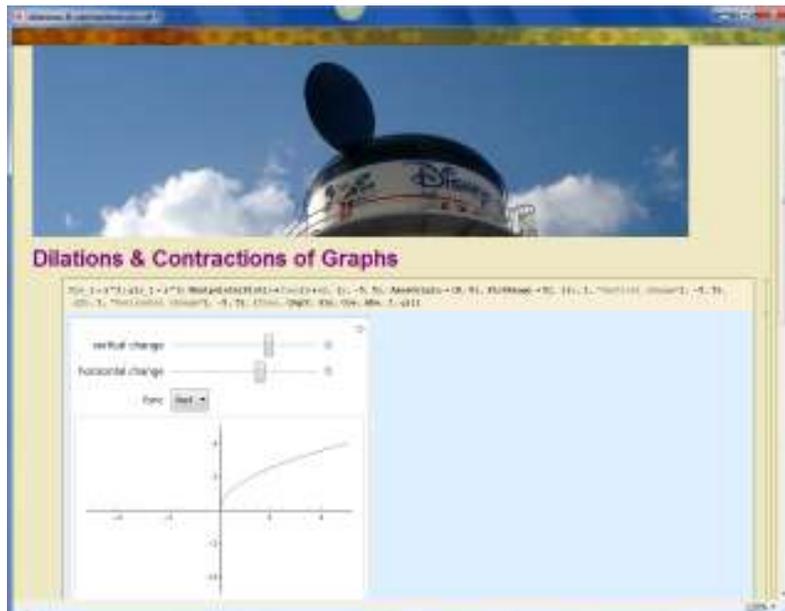


Figure 7: Completed Example with Photo

Using with Your Class

These activities can be used in many ways with your class. I used many of them as in class activities where I can direct the learning. We typically meet in a computer lab and the students are asked to interact with the activities. After students get used to working with these notebooks, I usually assign these activities as homework. They are posted to my learning management site (Moodle) so that the students can access them. I also use these activities as discovery sessions. Students can discover the properties of graphs before we cover them in class (figure 8).

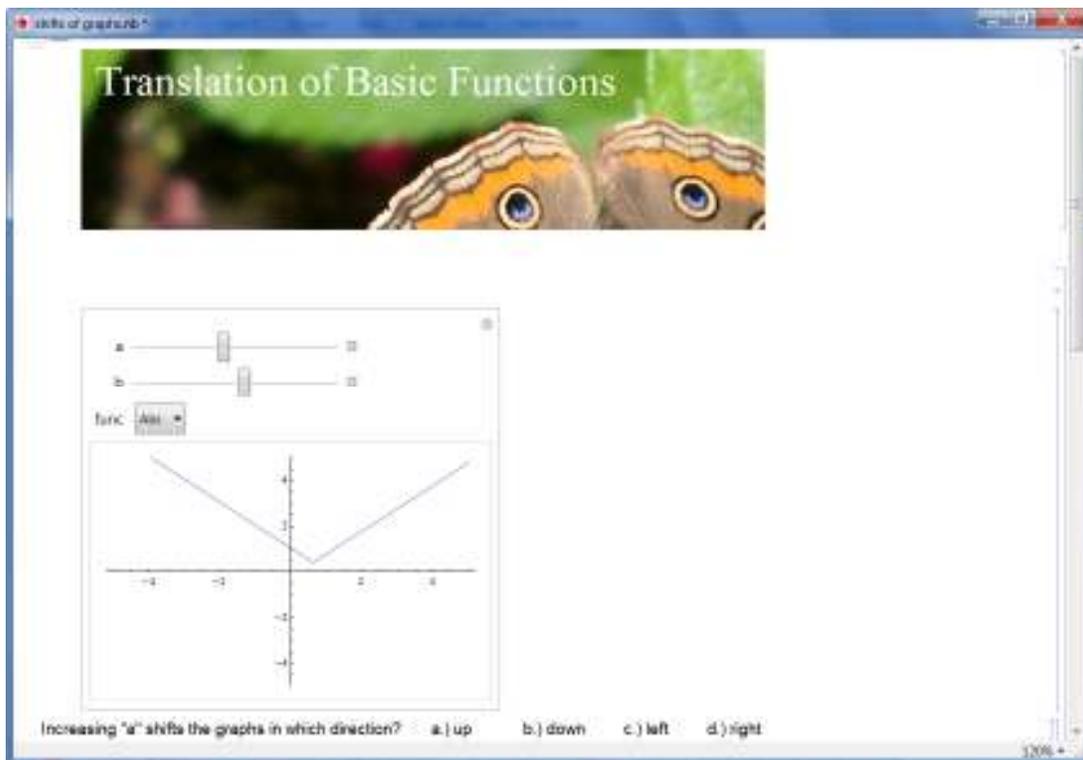


Figure 8: Example with Discovery Question

Computable Document Format

One of the new features of Mathematica is that you now have the option of saving a notebook as a cdf (computable document format) file (Figure 9). This allows the user to run and interact with the notebook without having Mathematica on their computer. The player can be downloaded for free from wolfram's web site (www.wolfram.com/cdf-player). Using the cdf format allows students to run the program directly in their browser and they can still interact with graphs. Expensive copies of Mathematica are not necessary. The only person who needs to have Mathematica is the person writing the notebooks (Instructor).

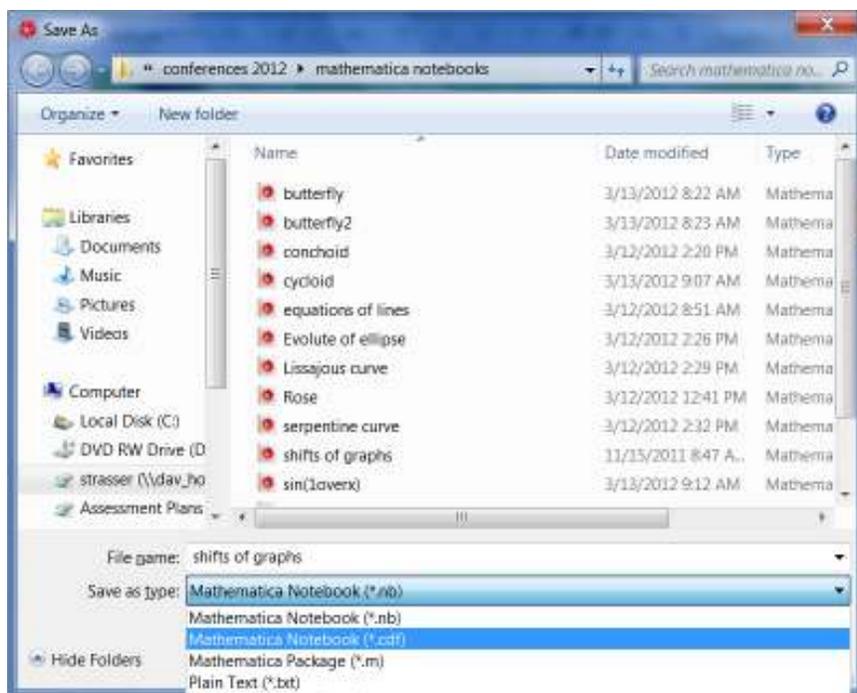


Figure 9: Saving as a cdf

Conclusion

Creating interactive activities and distributing them for student use is easy. Students find the activities intuitive and easy to use. These activities are great for demonstrating concepts and for exploring properties. Their use is also economical since the students do not need any special software to use the activities.

Bibliography:

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