Animations in Calculus with Geogebra

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Change

- Calculus is the study of change
- The ability to change a parameter and immediately see the result can demonstrate such change and how things are related during that change
- Geogebra allows for that
- I have used many of these animations in my Calculus classes.

- Secant Line as approximation to tangent line
- Derivative graphing
- Riemann sums
- Fundamental Theorem-Part 1-Accumulation Function
- Power Series
- Newton's Method, where a slight change in initial guess changes the root.

Two Purposes

- Help students visualize what happens as we change one variable
  - This used to be my only purpose
- I've come to realize a second purpose
  - Can ask a lot more "what if ... " questions
  - Demonstrate the richness of mathematics
- Sometimes even the instructor learns something new about the material
  - As I was thinking about how the definition of curvature might be illustrated, it hit me why dT/ds should be expected to be perpendicular to T.

- Makes the problem more of a "treasure hunt"
- What can be learned in this complex situation?
- Most real life problems do NOT have just one variable
- Textbook problems almost always have ONLY one variable
- Other "variables" have been arbitrarily fixed to make the problem more doable (but students don't realize this)

- Students may ask, “Who cares about this ONE problem?”
- Students can realize there are many problems associated with a particular scenerio (the textbook has decided to focus on just one)
- Allows students to get a fuller picture of what mathematics is all about
- A POWERFUL way to study complicated and interrelated patterns

Caution—Be sure of your purpose

- Just because you can do an interactive presentation, doesn’t mean that is the best way for a beginning student to grasp it.
- On the other hand, even if students don’t grasp everything, hopefully they catch the complexity of the problem and how math helps in quantifying that complexity.
- I enjoy the challenge of how to order the operations to get an animation to show the features I want to highlight.
- Let’s look at trying to put all curve sketching info in one place.

- This entire presentation, together with many geogebra files I have created (including all the ones linked to in this presentation), is zipped together at:
- https://sites.google.com/site/drhopkinsbackground/home/presentation-handouts/nctm13talk.zip?attredirects=0&d=1
- I have started to use the export feature to create interactive worksheets, such as this one.
- All my class worksheets are organized at
- https://sites.google.com/site/collegealgebraworksheets/home

- So you can see how this is done, let’s brainstorm on an animation that you think might be helpful
- Let’s see if I can make it
- In the process you’ll see more of what Geogebra can do
- I hope you see that Geogebra is not that difficult to learn
- I hope you see how to do it

- There is a Help function in Geogebra
- You could do a google search on the topic and Geogebra to see if others have posted help on your topic
- Enter in the function name only and Geogebra will tell you what form the input should be.

Others we can look at if Time

- Average velocity over smaller time intervals
- Differential vs increment
- Related Rates
- Mean Value Theorem
- Applied Max min

- Derivative of Exponential Function
- Parabola reflection properties
- Polar Areas
- Projectile motion (with drag coefficient)

Even Advanced Calculus

- Sequences (and subsequences—can find some interesting patterns in non-converging sequences)
- Blancmange Function
- Sierpinski Triangle (not typical Advanced Calculus, but does relate to recursive processes)—this one can be really slow-the spreadsheet use seems to slow it down.
- What if same process with more sides?

Geogebra

- Free, downloadable software
- http://www.geogebra.org
- Many have already contributed to http://www.geogebra.org/en/wiki/index.php/English
- Some of my ideas originated with contributions there
- They may have set them so double-click will allow you to open them in Geogebra yourself
- May give other ideas
- Is a 3D version in Beta

- http://www.mathcasts.org/ also has many Geogebra activities developed
- http://geogebrawiki.wikispaces.com/
- http://www.geogebratube.org
- http://www.geogebratube.org/student/m279 is a favorite one I discovered earlier this month.
- http://webspace.ship.edu/msrenault/GeoGebraCalculus/GeoGebraCalculusApplets.html gives a sabbatical project by Marc Renault
- http://www.math.ucr.edu/~jmccullo/geogebra.html has some applets.

- Mathematica Demonstrations in a similar vein are at http://demonstrations.wolfram.com/
- There are books using Geometer's Sketchpad (http://www.calculusinmotion.com/aim.html)- and Mathematica- (Animating Calculus- http://library.wolfram.com/infocenter/Books/2968/)
- Microsoft Math 4.0 (http://www.microsoft.com/download/en/details.aspx?id=15702) is now free to download and gives some animation features, even with 3D graphs and implicit 2-D graphs.

- http://phet.colorado.edu/en/simulations/category/math gives some math demonstrations among their other demonstrations
- Stewart has some with his Calculus book at www.stewartcalculus.com/tec (Tools for Enriching Calculus). Other Calculus books may as well.
- Now some at Illuminations: http://illuminations.nctm.org/ActivityDetail.aspx?ID=221

- New ebook http://www.pearsonhighered.com/briggscochran1einfo/detail/technology/index.html has interactive figures
- Demos at http://www.mathdemos.org/mathdemos/software.html

- I hope you have some ideas on how Calculus animations can be used to illustrate Calculus topics and further students' understanding
- I hope you have some ideas on how Geogebra can be used

- Thank you for coming