Creating Interactive Excel Templates for Concept Demonstration

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Capabilities of Spreadsheet Technology

With the spreadsheet, the teacher is able to

- Illustrate, demonstrate concepts
- Facilitate discovery
- Enable problem solving
- Ease homework "pain"
Discovery and Demonstration

- Manipulate coefficients
  \[ R = A \cdot \cos(B \cdot \theta + C) \]
- Make predictions
- Verify with spreadsheet
Problem Solving and Homework

- Find simultaneous solution
- Use the spreadsheet
- Enter the coefficients
- Note the results

\[ y = 3x - 2 \]
\[ y = \frac{4}{5} + 6 \]
Some History

- 1978 Harvard MBA student Dan Bricklin
- Collaborated with Bob Frankston
- Ran on an Apple [ ]
- Mainframe implementation in early 60's
Some History

• 1981 – Grace Murray Hopper Award
• Sold millions of Apple computers.

• "Without the invention of this software category, spreadsheets, the impact of the personal computer might have been delayed for years." (R.S. Houghton)
Advantages of Electronic Spreadsheets

• Introduce basic concepts
  – Teach details afterwards

• Allows multiple representations
  – Formula
  – Graph
  – Table of values
Advantages of Electronic Spreadsheets

- Experiment with values
  - View results
  - Study "what if"
  - Foster higher-order thinking

- Easily acquired software
  - Use in school labs
  - Available for home computers
  - Learning curve short
Disadvantages of Spreadsheets

- Must have computer
  - Budget issues
  - No home computer?
- On tests
  - Need a lab full
- Unavailable on "high stakes" tests
Interactive Excel Spreadsheets

• "Excelets"
• Change value in one cell
• Changes spreadsheet display
  – numerical
  – graphical
  – symbolic
• Done without …
  – programming
  – macros
  – Visual Basic

A "Javaless" applet
Interactive Spreadsheets

x values input

Adjustable variables

a = ?
b = ?
c = ?

y values output

Graph output
Template Methods

- Enter a value
  - Evaluate the expression
  - **Example** – Visual Basic macro used

- Sliders manipulate value(s)
  - **This example** classic min/max problems
Template Methods

- Example which shows values of several related quantities – Rectilinear motion
  - Time, Position
  - Velocity
- Slider used to advance time, $t$
  - Linear visual for time, distance
  - Speedometer visual for velocity
  - Note how distance "catches up" as velocity increases
Style Issues

• Create a title page
  – Sets the scene,
  – describes the problem
• Give instructions

\[ f(x) = 2x - 5 \]

\[ f(0.1) = 4.8 \]

Velocity and Acceleration

• For \( s(t) = 3t^2 + 2t - 5 \)
• Velocity \( v(t) = s'(t) = 6t + 2 \) ft/sec
• Acceleration \( \dot{v}(t) = 6 \) ft/sec^2

Demonstrate in data matrix
• Column 1 has values 1 – 10
• Column 2 has \( s(1) \)
• Column 3 has \( d(s(x),x) | x=1 \)
• Column 4 has \( d(s(x),x,2) | x=1 \)

Click Comparison tab. Control value of time with slider ... view position & velocity.
Style Issues

• Use appropriate colors
  – Note counter example
  – Students like to abuse
Style Issues

• Nice sometimes to eliminate grid

• Decide whether to show numbers which provide points for graph
Style Issues

- Design with the goal of representing relationships in multiple ways

Table of values

Highlight solution value of $x$

Plot point of current result. View when it reaches relative min.

Graph representation of physical situation

Display solution numerically

Graph of solution function
Resources

- "A Developer's Guide to Excelets".
  - Examples, links, tutorials.
- "Interactive MS Excel Workbooks".
  - Includes PDF tutorial on creating an interactive tangent line graphing tool.
- "Chemistry Excelets".
  - Over 20 interactive chem spreadsheets.
- "Microsoft Excel Modules".
  - Lots of info, tutorials
- "Hacking Excel"
- Speedometer charts, another source
Resources

- "Excel 2000 Teaching Modules".
  - Includes tutorials for interactive spreadsheets
- "The Excelets Page".
  - Examples from economics
- "The ABC's to Excel".
  - Tutorials, includes interactive features

References, thanks to David Young
http://plaza.ufl.edu/youngdj/index.htm
Demonstration

• We will create a spreadsheet which illustrates the concept of a tangent to a curve

\[ m = \lim_{\Delta x \to 0} \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x} \]
Tasks for Showing Tangent

• Generate x values in 1st column
• Generate y values using $f(x) = x^2$
• Plot points, adjust axes, scale
• Specify two points $(A, f(A)), (B, f(B))$
  – draw secant
• Determine line through points
  $y = mx + b$

\[
m = \frac{f(A) - f(B)}{A - B} \quad b = F(A) - m \cdot A
\]
Tasks for Showing Tangent

- Include $y = mx + b$ in graph
- Manipulate A, B values – entering manually
  - They change → line changes
  - Deal with situation $A = B$
- Create slider(s) control A, B, values
- Clean things up
- Display slope as value
Evaluating Data

• Next slide shows how LEGO NXT Mindstorms robot was used to gather data
• Shows program
• We are turning the robot in a circle and recording the sound level
• Then we will upload the data
Rotate the Robot

- Rotate motor B 170 degrees (rotates the whole robot about 15 degrees)
- Do this 12 times. This causes the robot to completely turn around in a circle (360 degrees), recording 12 ordered pairs (count, sound level)
Analyzing the Data

- Now let's go to Excel to graph the data
Brainstorm Additional Ideas

What ideas do you have about things to add or alter? What other kinds of interactive spreadsheets occur to you after seeing these? Questions? Comments?

- area under the curve
- left/right sums
-
URLs for Previous Links

- http://academic.pgcc.edu/~ssinex/excelets/
- http://www.framingham.edu/faculty/smabrouk/Interactive/index.htm
- http://academic.pgcc.edu/~ssinex/excelets/chemistry_excelets.htm
- http://aitt.acadiau.ca/nstpd/excel00.htm
URLs for Previous Links

• http://guava.cites.uiuc.edu/l-arvan/ExceletsWeb/Modules.htm
• http://www.forsyth.k12.ga.us/kadkins/abc.htm
• http://www.windowsdevcenter.com/pub/a/windows/excerpt/excelhacks_chap05
• http://peltiertech.com/Excel/Charts/Speedometer.html
• http://www.andypope.info/charts/gauge.htm