Spreadsheets in a Math for Liberal Arts Course

Presentation at Joint Math Meetings, January 13, 2018

Mary Parker, Austin Community College

Challenge and Opportunity

Challenge

It’s hard to put much math modeling into an already-full math course.

Opportunity

Math for Liberal Arts has more flexibility in the choice of topics and depth of coverage than other lower-division courses.

Challenge and Opportunity

Challenge

Students in Math for Liberal Arts are, in general, not adept at algebra.

Opportunity

It is common that students feel more powerful using spreadsheets to investigate quantitative questions than they have felt in the past using algebra.

Types of spreadsheets

Most of the course:

- Rule-driven procedures.
  Make the spreadsheet just by implementing the rule and iterating.

Latter part of the course:

- Graphing formulas.
- Using a graph to estimate the best fitting formula to data.
  This gives students more skill in interpreting and understanding the parameters of the formulas.

How do we build skills?

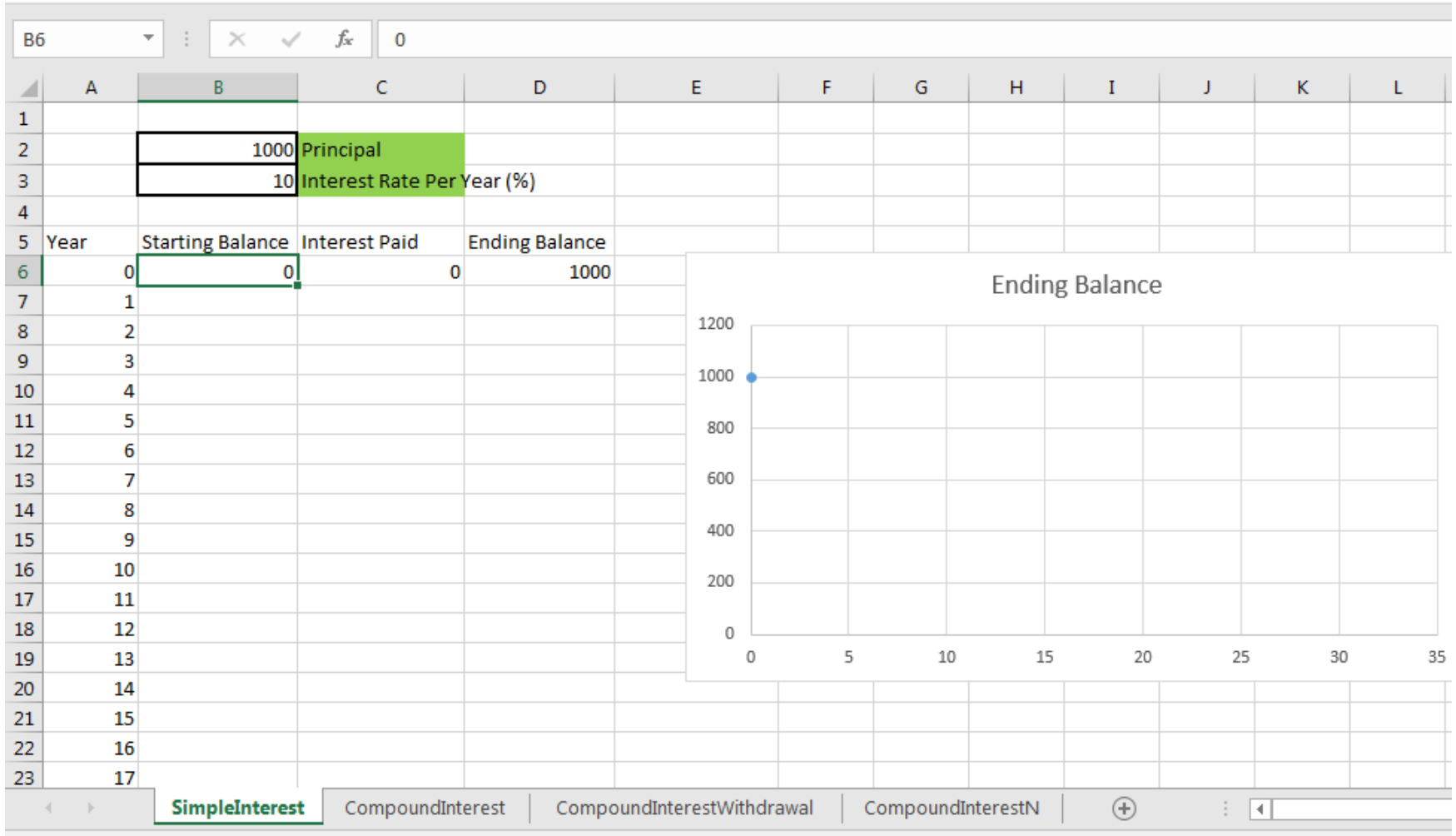
1. Start with some basic review of percentages and proportions. Using a "Problem solving" chapter from a text at this level, quickly go to more complicated problems involving these.
2. Teacher models using a spreadsheet for calculation on problems that students are using calculators for.
3. Teacher starts demonstrating cell references and pulling down formulas.
4. Students work on problems that are straightforward to do one step at a time, but tedious to fully carry out by hand.

What do students learn to do with spreadsheets in the Finance portion?

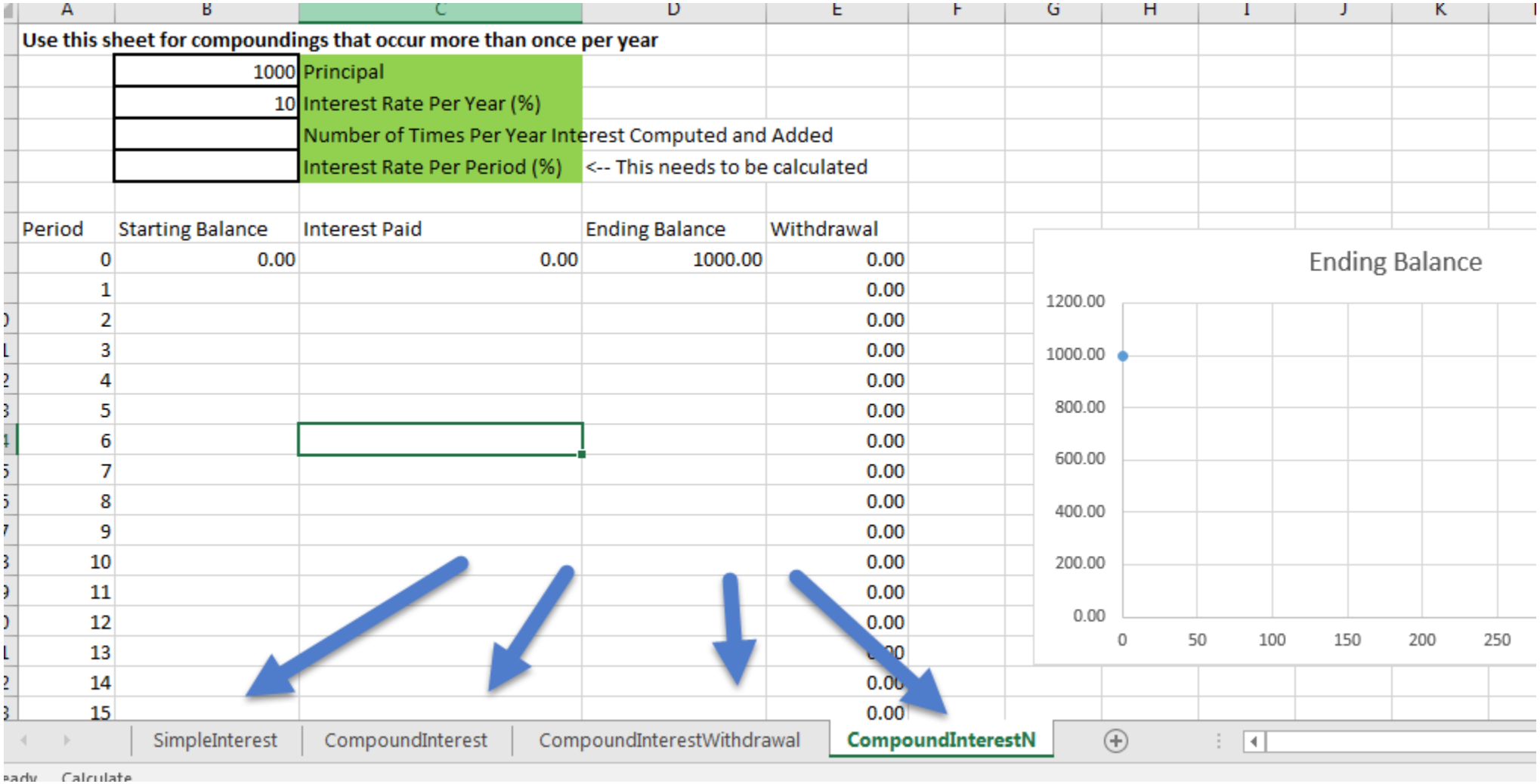
- Develop spreadsheets to compute accumulated savings with simple and compound interest.

- **Method:**
  By hand, compute the values one row at a time, for two or three rows.
  Then write formulas in the spreadsheet.

We give the framework, students enter formulas and pull down.



Students model various types of growth.

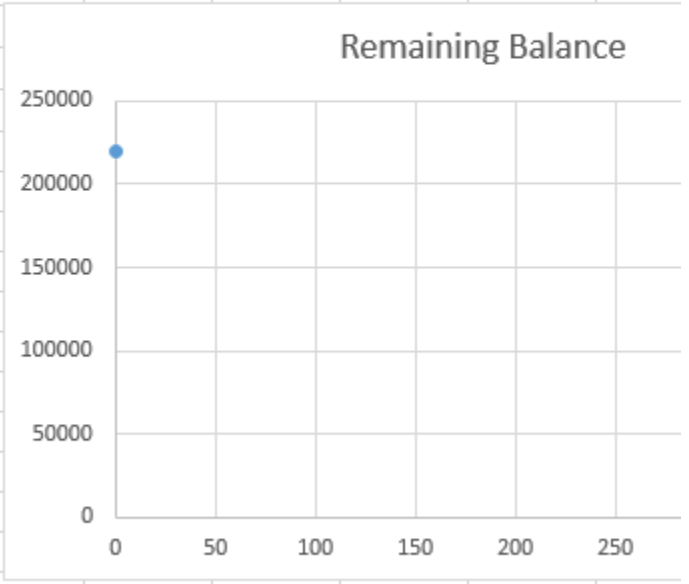


Students develop a loan amortization sheet.

Create an amortization with the option for extra payments toward the principal

220000	Principal (Loan Amount)
4	Interest Rate (%)
30	Number of Years Over Which Loan Repaid
12	Number of Payments Per Year
1050.31	Periodic Payment

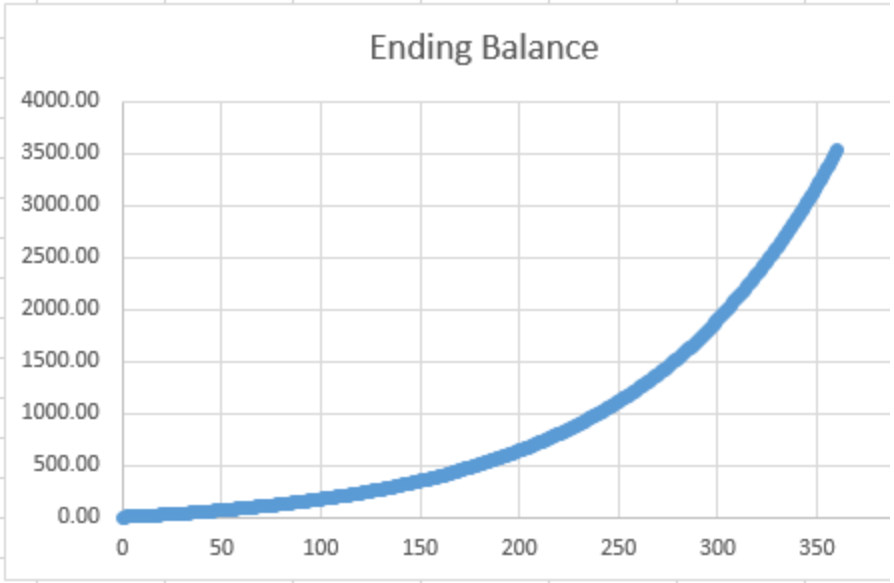
Period	Starting Balance	Interest Paid	Principal Paid	Remaining Balance	Extra Payment	Accumulated Interest
0	220000	0.00	0.00	220000	0.00	
1					0.00	
2					0.00	
3					0.00	
4					0.00	
5					0.00	
6					0.00	
7					0.00	
8					0.00	
9					0.00	
10					0.00	
11					0.00	



Stack Plot: Breakdown of Monthy Pa

Students use an annuity calculator to explore the effects of various interest rates and various choices.

	A	B	C	D	E	F
1	**Use this calculator for fixed deposits.**					
2		0	St… g Balance			
3		1	Pc… e Deposit			
4		1	N… er of Deposits Per Year			
5		1	A… as a %)			
6						
7	Deposit Number	Starting Balance	Deposit	Interest	Ending Balance	Withdrawal
8	0	0.00	0.00	0.00	0.00	0.00
9	1	0.00	1.00	0.01	1.01	0.00
10	2	1.01	1.00	0.02	2.03	0.00
11	3	2.03	1.00	0.03	3.06	0.00
12	4	3.06	1.00	0.04	4.10	0.00
13	5	4.10	1.00	0.05	5.15	0.00
14	6	5.15	1.00	0.06	6.21	0.00
15	7	6.21	1.00	0.07	7.29	0.00
16	8	7.29	1.00	0.08	8.37	0.00
17	9	8.37	1.00	0.09	9.46	0.00
18	10	9.46	1.00	0.10	10.57	0.00
19	11	10.57	1.00	0.12	11.68	0.00
20	12	11.68	1.00	0.13	12.81	0.00
21	13	12.81	1.00	0.14	13.95	0.00
22	14	13.95	1.00	0.15	15.10	0.00
23	15	15.10	1.00	0.16	16.26	0.00

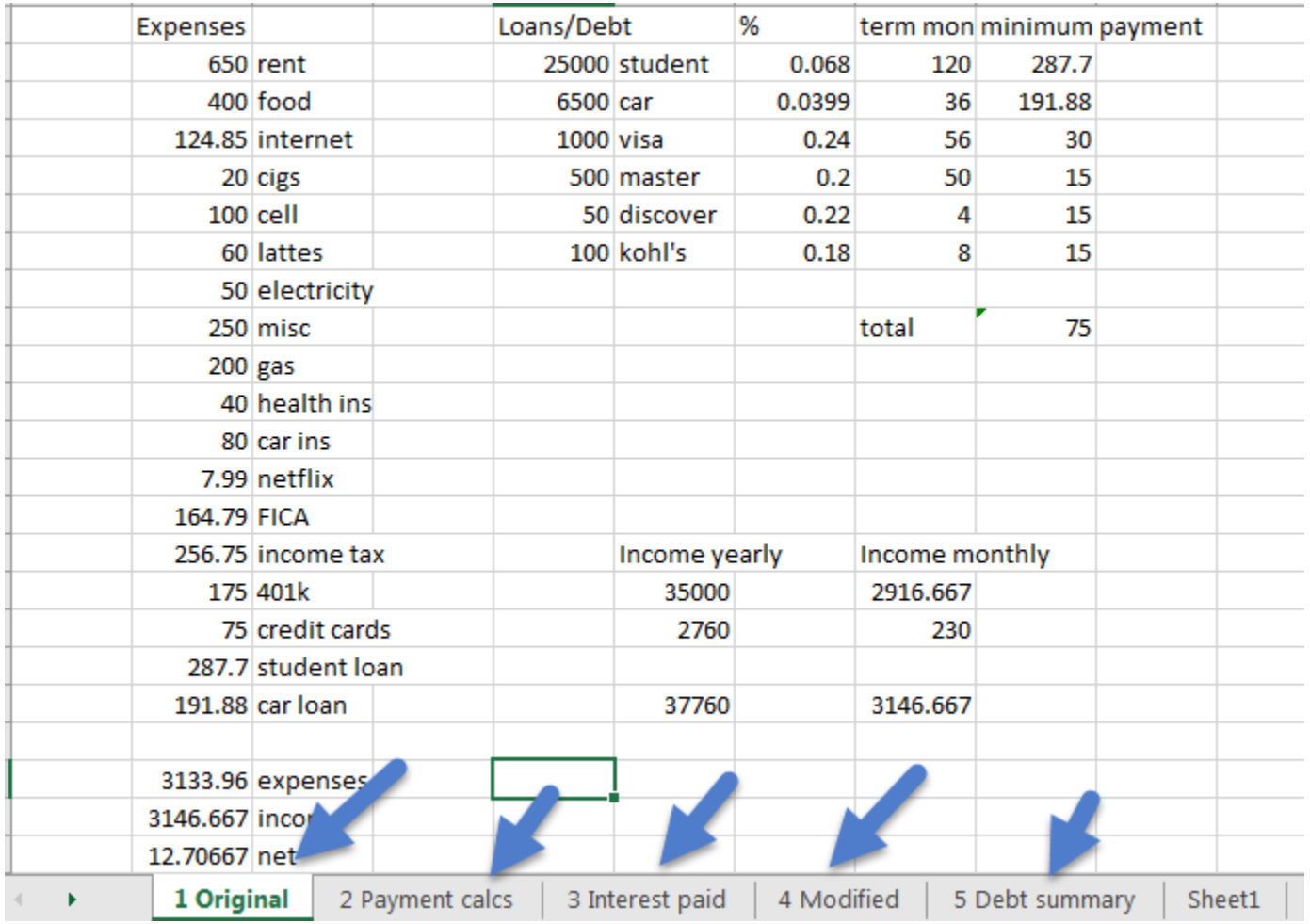


AnnuityCalculatorFixedDeposits | AnnuityCalcVariableDeposits

Financial Advice Project (in Groups)

- Students are given Joe's income, monthly spending pattern, and debts and asked to give him advice. (Three different scenarios per group.)
- They are expected to use an online debt-reduction calculator to compute his optimal loan payment strategy, including choosing which method to use to decide how much to pay on each loan and when (snowball, avalanche, etc.)
- They are also expected to use a spreadsheet to summarize all of this.
- On the final exam in the course, they are expected to use their spreadsheet to make some additional adjustments and give the resulting values.

One student's workbook



Expenses		Loans/Debt		%	term mon	minimum payment
650	rent	25000	student	0.068	120	287.7
400	food	6500	car	0.0399	36	191.88
124.85	internet	1000	visa	0.24	56	30
20	cigs	500	master	0.2	50	15
100	cell	50	discover	0.22	4	15
60	lattes	100	kohl's	0.18	8	15
50	electricity					
250	misc				total	75
200	gas					
40	health ins					
80	car ins					
7.99	netflix					
164.79	FICA					
256.75	income tax		Income yearly		Income monthly	
175	401k		35000		2916.667	
75	credit cards		2760		230	
287.7	student loan					
191.88	car loan		37760		3146.667	
3133.96	expenses					
3146.667	inco					
12.70667	net					

1 Original | 2 Payment calcs | 3 Interest paid | 4 Modified | 5 Debt summary | Sheet1

Her revised budget for Joe

A	B	C	D	E	F	G	H	I
	150	misc	subtracted 100 by getting rid of unneccessary misc payments					
	100	gas	subtracted 100 by using public transportation					
	40	health ins						
	80	car ins						
	164.79	FICA						
	256.75	income tax						
	175	401k						
	$ 836.90	Loans/credit cards		edited loan payments to decrease amount of interest pa				
						Income yearly		Income monthl
						35000		2916.667
						2760		230
						37760		3146.667
	$2,526.43	expenses						
	$3,146.67	income				Savings account		
	$ 620.24	net						
						Monthly deposit		Interest rate
						$ 620.24		0.01
				started a savings account with investing his monthly cash				

Modeling data with formulas

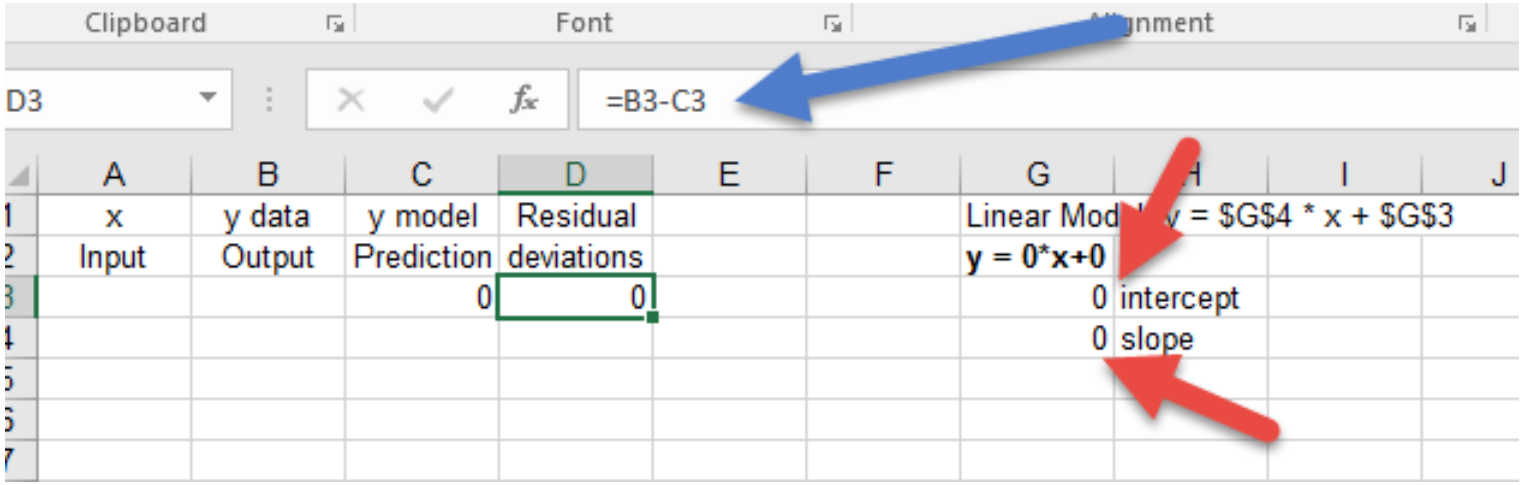
Linear $y = mx + b$

Quadratic $y = a(x - h)^2 + k$

Exponential $y = a(1 + r)^x$

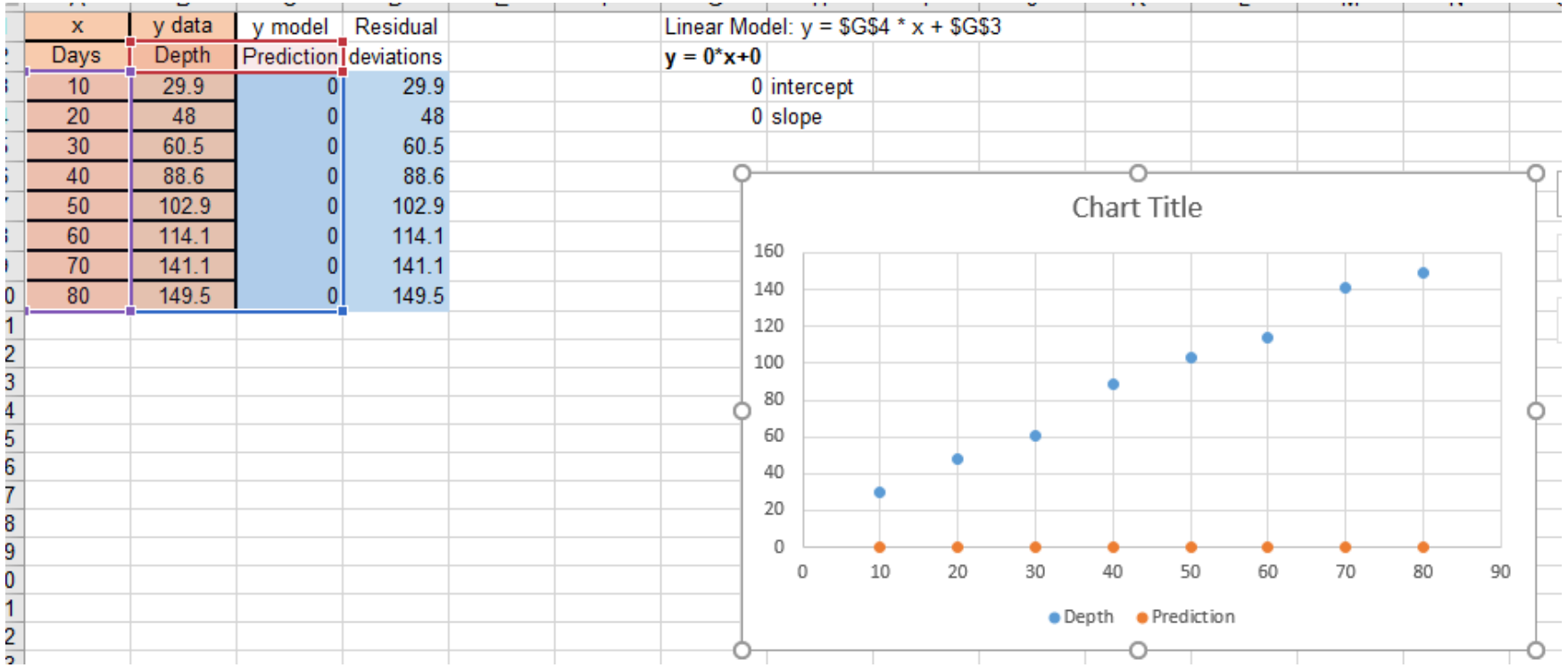
These forms were chosen (for quadratic and exponential) because the parameters are easy to interpret.

Page 3 of the workbook, as provided to students



- The labels of the columns
- The formulas
- The places to enter the parameter values (Red arrows here)
- Labels in cells G1 and G2 that are more elaborate than we will expect students to do, but useful in the beginning.

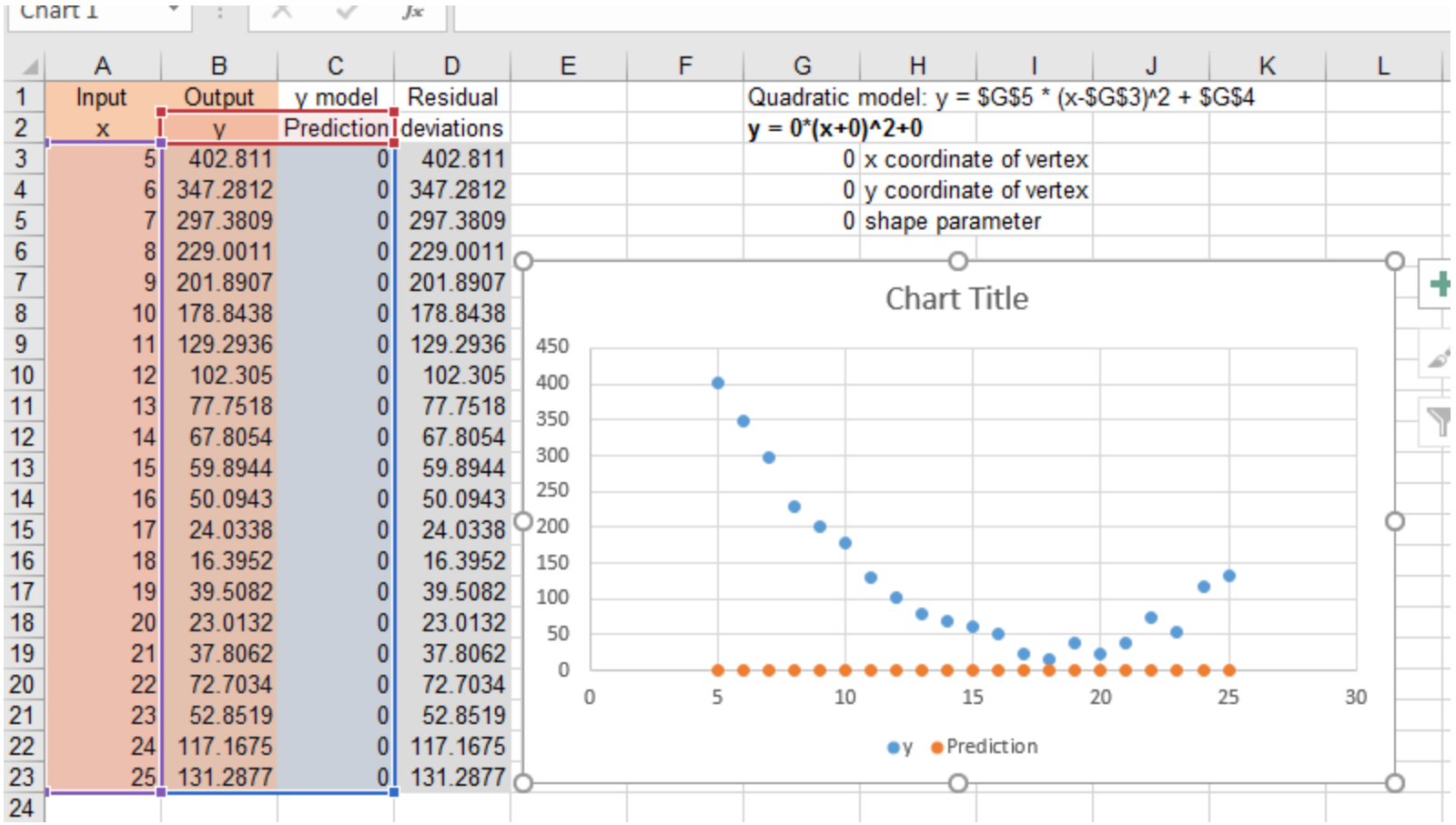
Page 2 of workbook, as students started



x	y data	y model	Residual
Days	Depth	Prediction	deviations
10	29.9	0	29.9
20	48	0	48
30	60.5	0	60.5
40	88.6	0	88.6
50	102.9	0	102.9
60	114.1	0	114.1
70	141.1	0	141.1
80	149.5	0	149.5

- They copied data to the sheet
- They “pulled down” the formulas for the prediction and the deviations
- They made a graph
- Then they estimated the slope and intercept

Page 5 of workbook. Note the parameterization of the quadratic model.



	A	B	C	D
1	Input	Output	y model	Residual
2	x	y	Prediction	deviations
3	5	402.811	0	402.811
4	6	347.2812	0	347.2812
5	7	297.3809	0	297.3809
6	8	229.0011	0	229.0011
7	9	201.8907	0	201.8907
8	10	178.8438	0	178.8438
9	11	129.2936	0	129.2936
10	12	102.305	0	102.305
11	13	77.7518	0	77.7518
12	14	67.8054	0	67.8054
13	15	59.8944	0	59.8944
14	16	50.0943	0	50.0943
15	17	24.0338	0	24.0338
16	18	16.3952	0	16.3952
17	19	39.5082	0	39.5082
18	20	23.0132	0	23.0132
19	21	37.8062	0	37.8062
20	22	72.7034	0	72.7034
21	23	52.8519	0	52.8519
22	24	117.1675	0	117.1675
23	25	131.2877	0	131.2877
24				

Quadratic model: y = G5 * (x-G3)^2 + G4

y = 0*(x+0)^2+0

0 x coordinate of vertex

0 y coordinate of vertex

0 shape parameter

Why spreadsheets?

- Requires active participation.
- Different type of engagement in this from working with algebra (symbolic manipulation.) Usually students have a better attitude about trying to make it make sense.
- Generally speaking, everyone's product looks good – considerably more so than when doing work by hand.

Why spreadsheets?

- Making successive adjustments to improve their estimates and their solutions shows students a different (and useful) aspect of quantitative thinking than in previous math courses.

- Students successfully do considerably more complex problems than they expect to be able to do.

See
http://www.austincc.edu/mparker/talks/
or mparker@austincc.edu

Includes these slides, a longer set of slides with more details, and links to some materials.