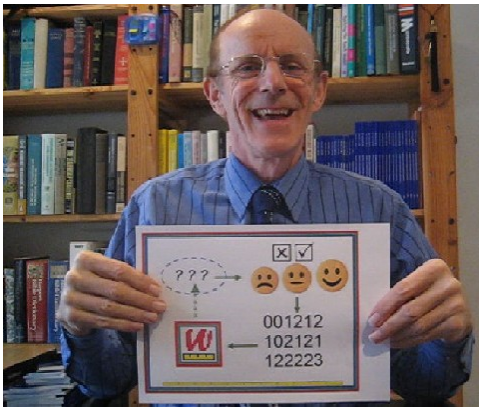
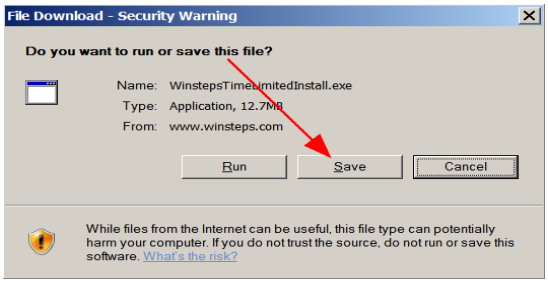
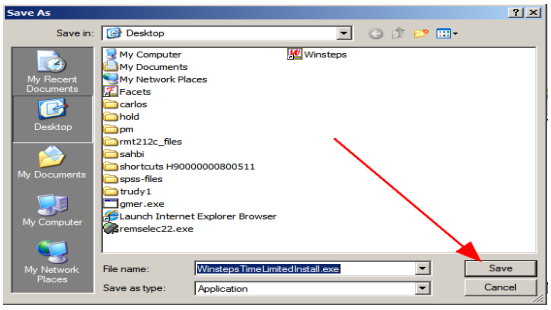
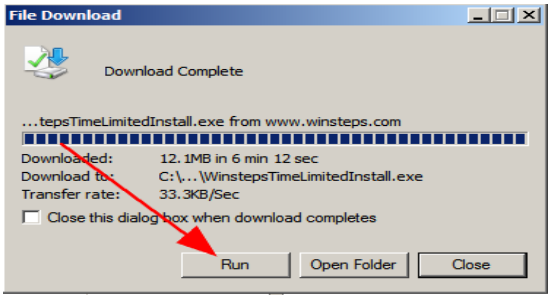
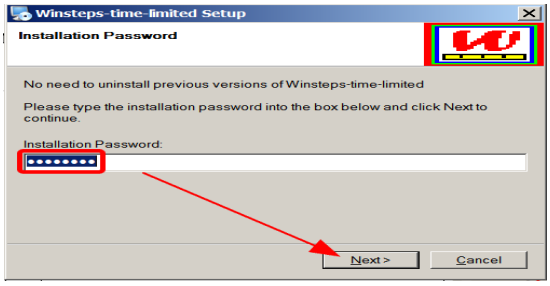
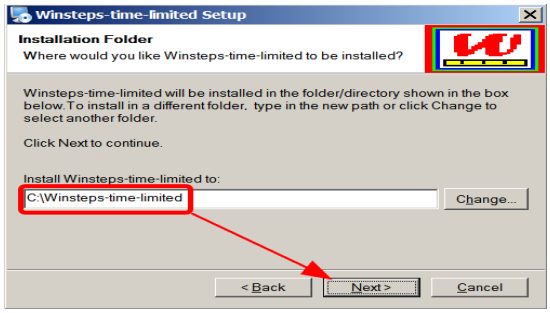
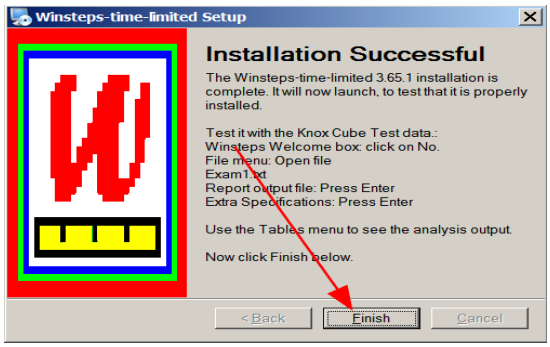
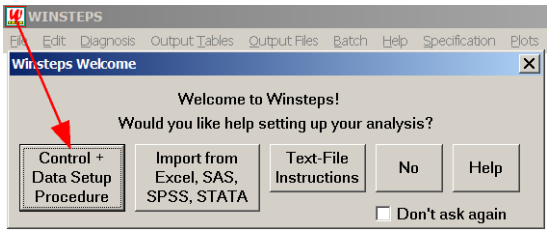
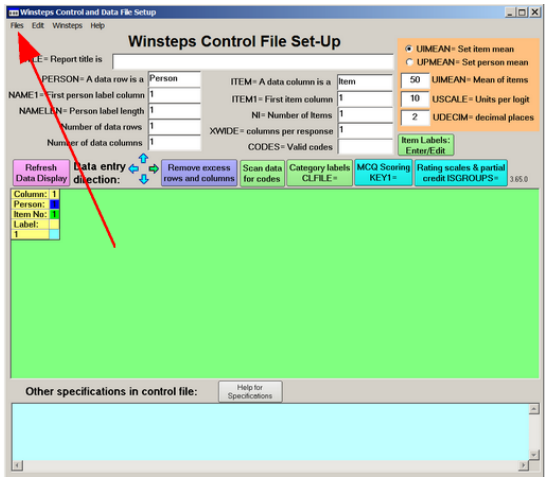
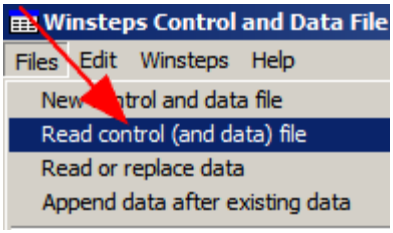
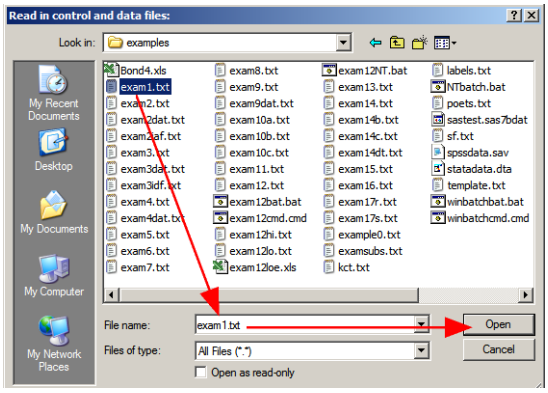
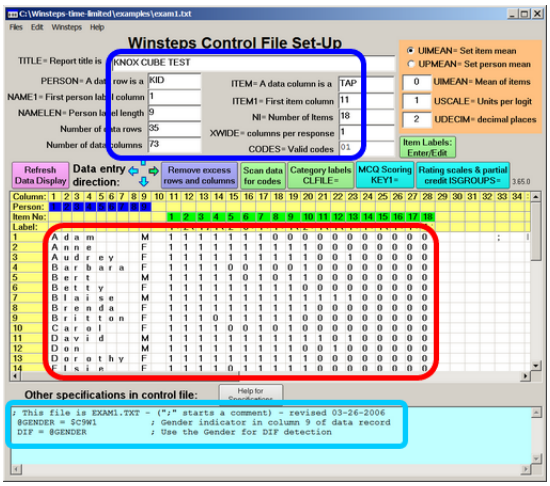
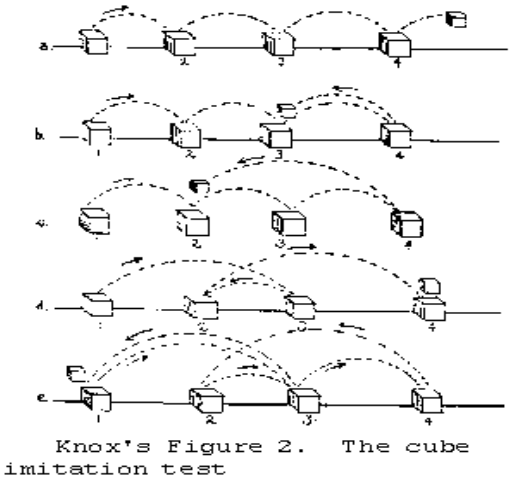
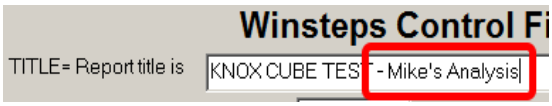
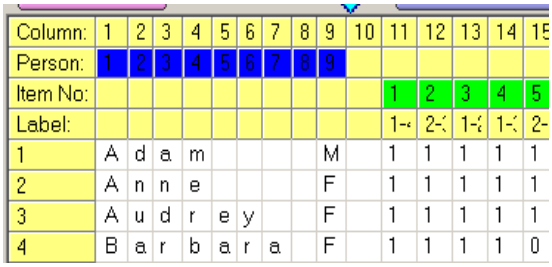
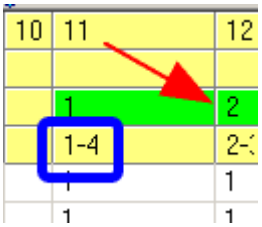
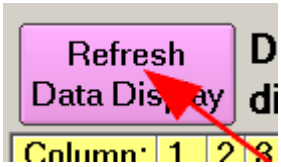
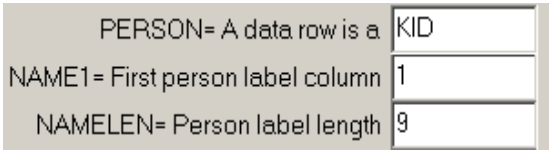
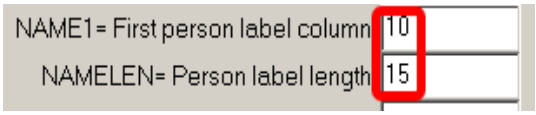
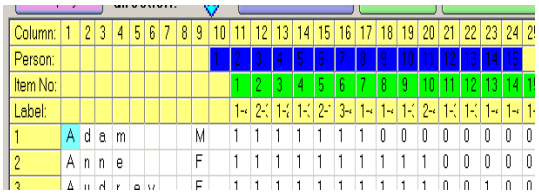
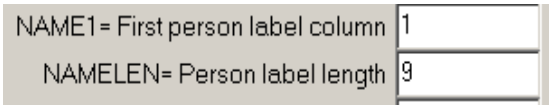
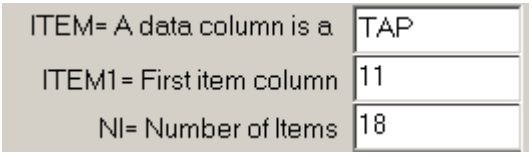
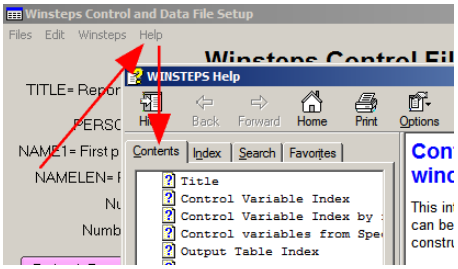
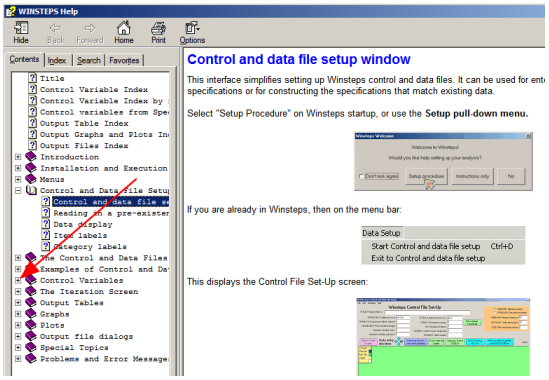
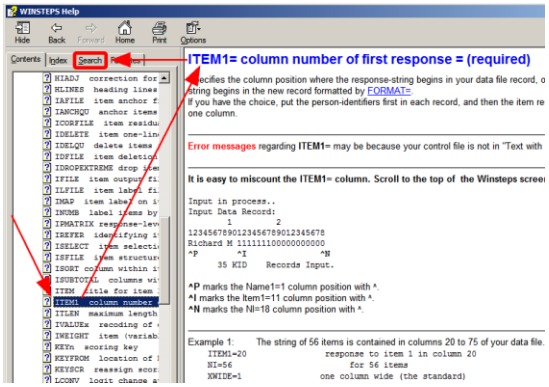
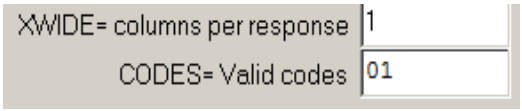
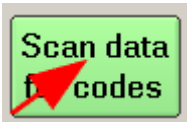
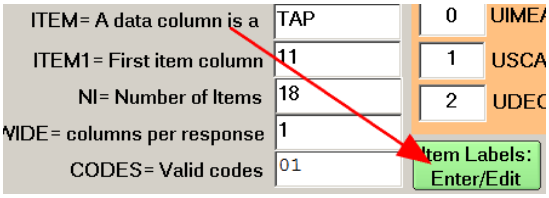
#	Winsteps Tutorial 1 Mike Linacre, instructor - June 2012
1.	**Save this PDF to your desktop to avoid re-downloading it from the Internet** **Tutorial 1. Software operation and basic concepts** ***Welcome!*** • *Winsteps* software installation and operation • Basic measurement and Rasch concepts • Simple dichotomous analysis • Constructing data files This lesson includes a quick run-through of the operation of the computer program, *Winsteps*. If you run into difficulties, **please ask questions and get guidance on the Discussion Forum**. No question is too "dumb"! http://www.winsteps.com/forum **I am also including important aspects of theory and practice, so please go through the material carefully.** *Think of yourself as the star of this movie. You are reading the script, and I am the director. I can point you in the right direction, but it is up to you to win the Oscar!* ***Unfamiliar words?*** Rasch measurement has its own technical words. Please see the explanations at http://www.winsteps.com/winman/glossary.htm You can click on the blue links to access the Internet.
2.	**A. *Introductory Video***
3.	Please view a few minutes of a movie introduction to Rasch and Winsteps by "yours truly" ... ***it is 50MB so may take a few minutes to download ...*** http://www.winsteps.com/a/intro.wmv This is a big file. Add it to your Media Player playlist. Or you may need to use a free download manager such as FDM Lite ***This movie was originally requested by the energetic Rasch folks in Hong Kong - a great idea!*** ***The movie contains slides, separately viewable at*** http://www.winsteps.com/a/slides.htm 
4.	**B. *Winsteps* Software Installation**
5.	If you have the **current version of Winsteps,** then you only need the Course data-files. Please download them from: http://www.winsteps.com/a/course-data.zip
6.	**Please download and run WinstepsPasswordInstall.exe** 

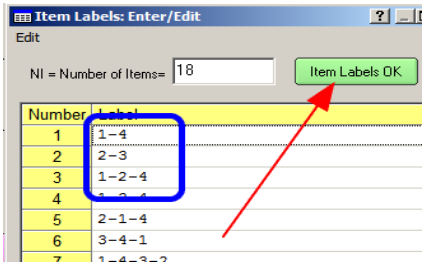
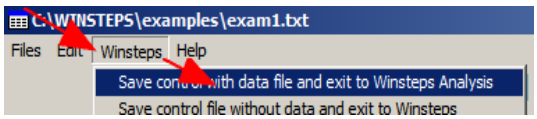
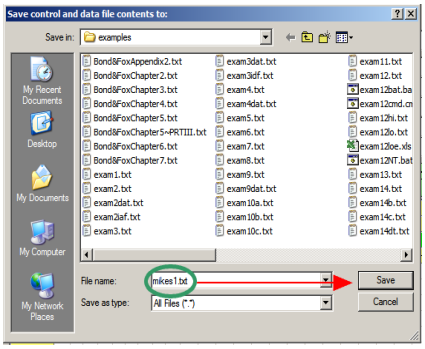
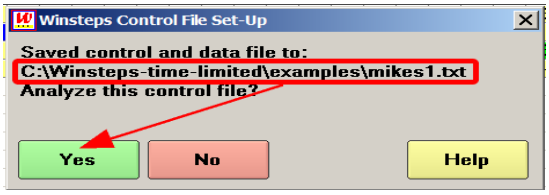
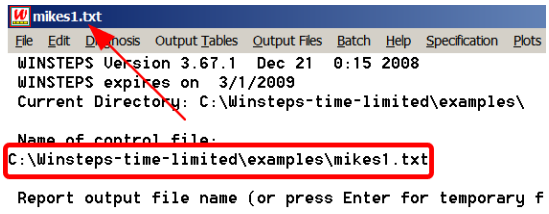
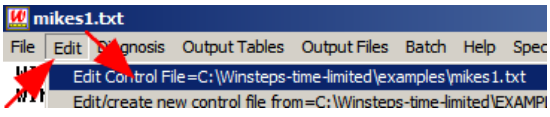
7.	Save the installation file, **WinstepsPasswordInstall.exe** to your desktop. Double-click on it if you need to re-install this software. You can delete it when you have installed *Winsteps*.	
8.	To install Winsteps, "Run" the downloaded file, or double-click on the **WinstepsPasswordInstall.exe** on your desktop.	
9.	The installation screen for *Winsteps* displays. The installation password is (copy-and-paste) in your purchase receipt: Then click on **Next**	
10.	Please install Winsteps in C:\Winsteps or the folder of your choice Then click on **Next**	
11.	Click on **Next** until the Installation is finished. Click on **Finish** to launch *Winsteps* for the first time. If you run into difficulties during the installation, please refer to http://www.winsteps.com/problems.htm	
12.	You can also launch *Winsteps* at any time by double-clicking the short-cut on your desktop. Or by dragging your control file onto the icon.	

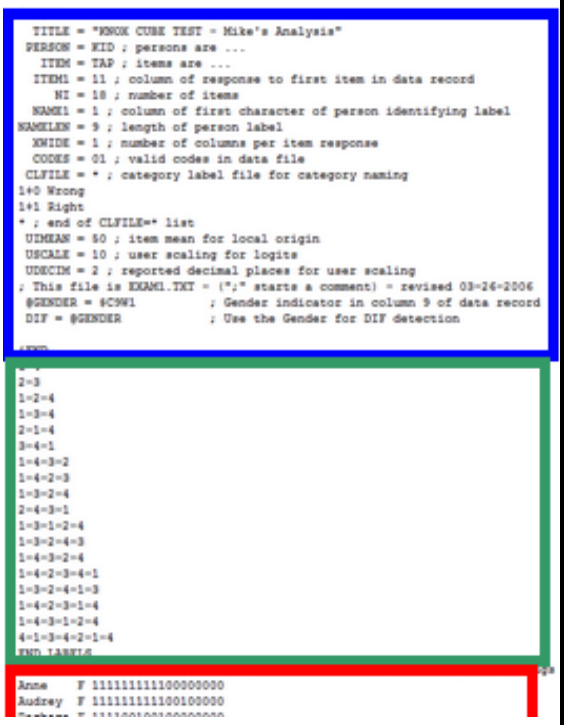
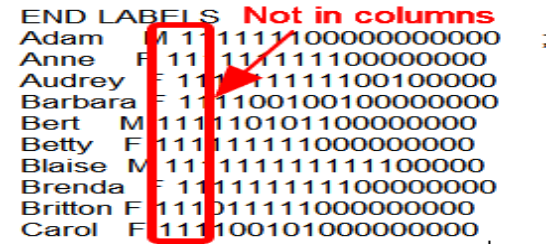
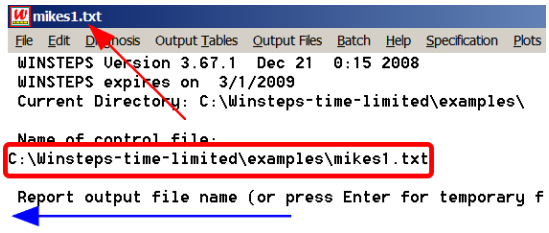
13.	**C. Running the *Winsteps* Program**	
14.	The main *Winsteps* window displays. At the top of the screen is the Winsteps menu bar. In a dialog box, Winsteps asks if we want to enter the "Setup procedure". Yes, we want to this time! So Click on **Control + Data Setup Procedure**	
15.	The Winsteps "Control File Set-Up" screen displays. This is one of the many ways of constructing your Winsteps control and data files. *We will use a different way, but this is the easiest one to get started for simple analyses.* We'll look at one of the example data files. Please click on **Files**	
16.	Click on **Read control (and data) file**	
17.	The directory listing of c:\Winsteps-time-limited\examples displays. This contains the standard Winsteps examples. They begin "exam...". The first data file is Bond4.xls. It is an example from the book by Bond & Fox "Applying the Rasch Model". They begin "Bond&Fox". ***I'll call this book B&F.*** Click on **exam1.txt** *If you only see "**exam1**", but want to see "**exam1.txt**" please tell Windows to **display suffixes**. See Error! Reference source not found.. **Appendix 1** toward the end of this document.* Click on **Open**	

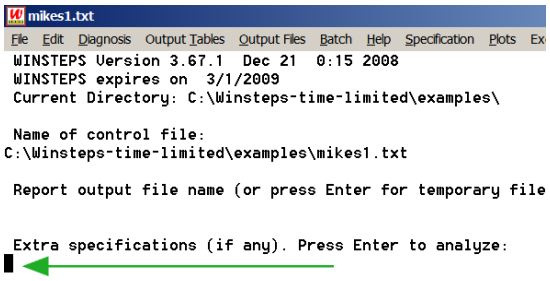
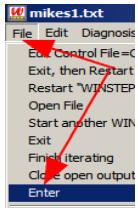
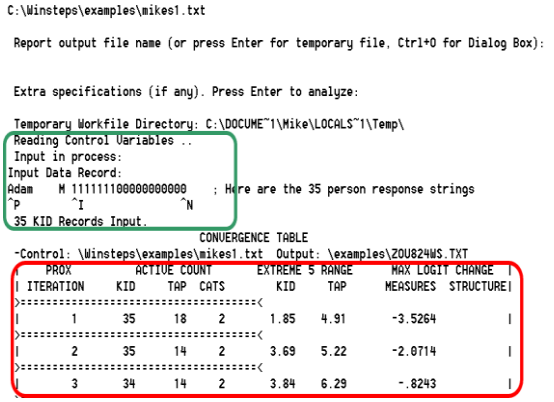
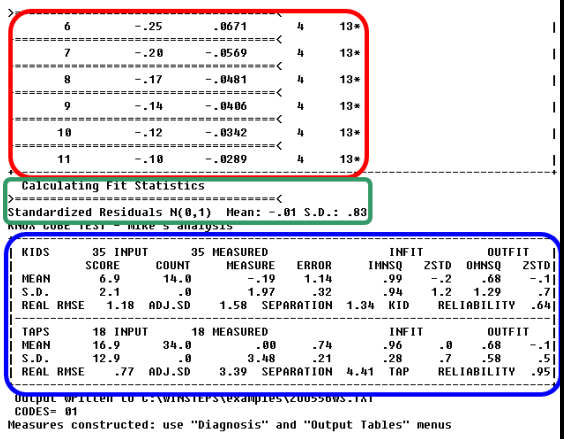
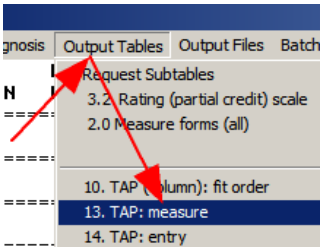
18.	The Winsteps Control File Set-Up screen displays, now populated with the information from exam1.txt The top part of the screen (inside the blue box) contains the control instructions - you can see there are 11 control variables displayed. We tell the Set-Up screen how many rows and columns there are so that the input spreadsheet is the correct size. The lower part of the screen (inside the red box) contains the person and item information and the responses. At the bottom of the screen (light blue box) are additional control variables. Winsteps has about 150 control variables. So you will often have variables to enter here.	
19.	Exam1.txt is the Knox Cube Test discussed in Wright & Stone's book "Best Test Design" (1979), available from http://www.rasch.org/btd.htm - It is a screening test designed by Dr. Howard Knox on Ellis Island in New York harbor. It assesses attention span and short-term memory. Dr. Knox tapped out patterns on 4 blocks and the newly arrived immigrants were signaled to repeat the tapping patterns. There is more information at: *Hold down shift key and please click on* www.rasch.org/rmt/rmt133j.htm - *to open the webpage in a new window. "www" hyperlinks may not always work from this PDF file. If necessary, copy-and-paste the link into your Internet browser..*	
20.	Let's see what Winsteps needs to know about your data. First off is "TITLE=". The Winsteps control variables are identified as a word followed by =. Here the "TITLE=" is "KNOX CUBE TEST". This will appear on the top line of each report output Table.	
21.	Let's personalize this a tiny bit. **Type your name into the Title box**	
22.	Look down at the data spreadsheet. The person identifying information is in columns 1 to 9. These are highlighted with the blue stripe. In column 9 is M or F. This is the person-gender indicator. The item responses are in columns 11 to 28. There are 18 items they are indicated by the green stripe. The observations are "1" for success and "0" for failure in repeating Dr. Knox's tapping pattern. "Observation" = "a response by a person to an item"	

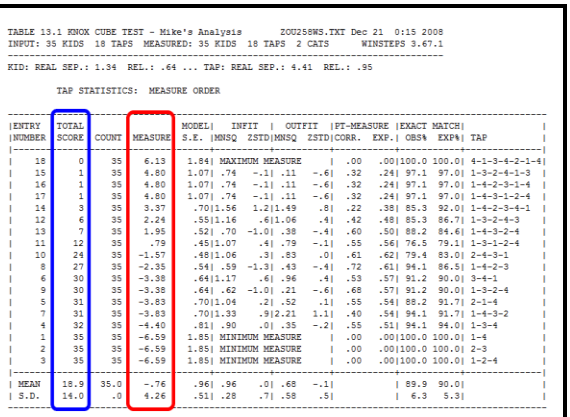
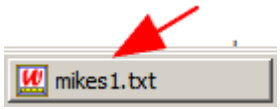
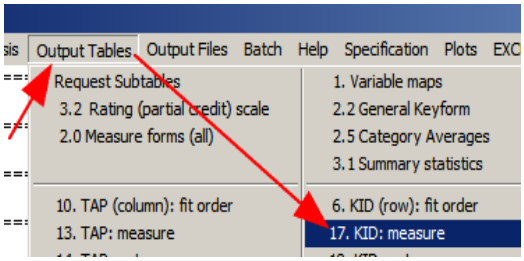
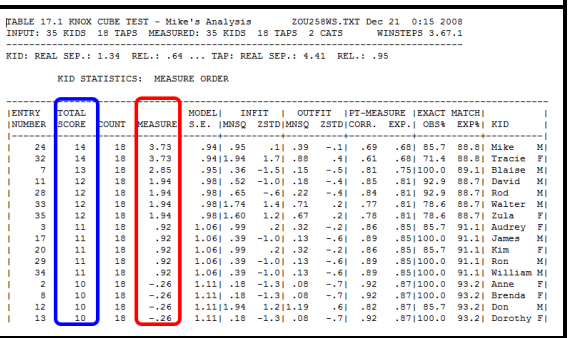
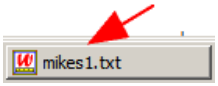
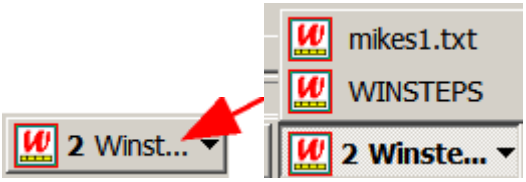
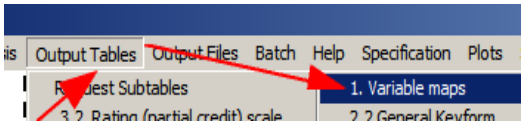
23.	To see the item label, Position the mouse pointer on the green stripe line between columns 11 and 12 Hold down the left mouse-button Drag to the right ► The label for the first item is "1-4". This means "Tap on the top of cube 1 and then tap cube 4."	
24.	To restore the look of the spreadsheet Click on "Refresh Data Display"	
25.	The members of our person sample are called "KID", meaning "child". The control variable name is PERSON=. The location of the person identifying label in the data spreadsheet is controlled by NAME1= and NAMELEN(GTH)=. Variable names can be abbreviated or lengthened and can be upper or lower or mixed case: PERSON=, PERS=, person=, Person=, etc.	
26.	Let's experiment, change NAME1= from 1 to 10 and change NAMELEN= from 9 to 15 click on "Refresh Data Display"	
27.	The blue person identifying stripe now overlaps the green item response stripe. This is valid. It can be helpful to include the responses in the person label, so that the responses always appear when the persons are reported.	
28.	Reset to the original values: change NAME1= from 10 to 1 and change NAMELEN= from 15 to 9 click on "Refresh Data Display"	
29.	The control variables for the items are ITEM= for the name give to the items ITEM1= for the first item response column in the spreadsheet NI= for the number of items in the test or instrument.	
30.	To find out more about the control variables, on the menu bar, click on **Help** when the Help screen displays, click on **Contents**	

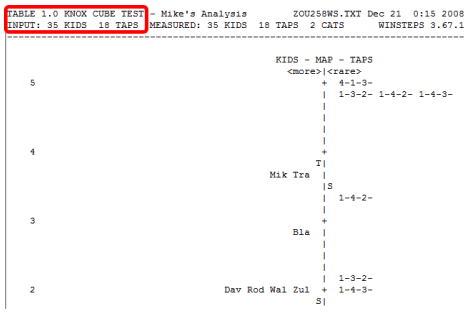
31.	Winsteps Help for the Control and data file setup window displays. Let's find out about the control variable about which we need more information. In the left-hand panel, click on "Control Variables"	
32.	Scroll down the left-hand panel Click on **ITEM1=** The Help information for ITEM1= displays. The Help information for each control variable includes a definition and examples of its use. Notice the **Search** tab in the left-hand panel. Questions and suggestions from Winsteps users are constantly improving the Winsteps Help. You will find that Help contains a wealth of information, but you may need so "search" for it. The information in the Help file is more current than in the Winsteps User Manual which you will find in c:\winsteps-time-limited\winsteps.pdf	
33.	Close Help: Click on ☒	
34.	Back on the Winsteps setup screen, XWIDE= defines how many columns there are per response. Use 1 column whenever possible as we do in exam1.txt CODES= contains the valid observations "0" and "1" for this dataset. Any other values in the data, such as "X" would be treated as missing data and ignored. If you are not sure what codes are in your data file, then click on **Scan data for codes** ***Experiment by blanking out the CODES= value and clicking on the green button.***	 
35.	Click on the green button **Item Labels Enter/Edit**	

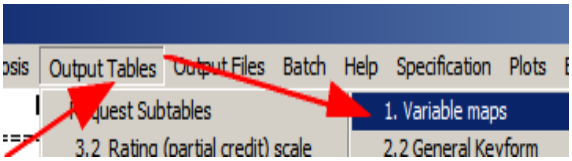
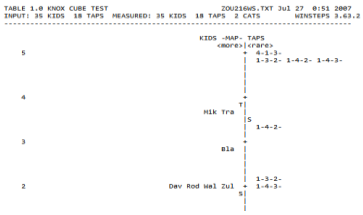
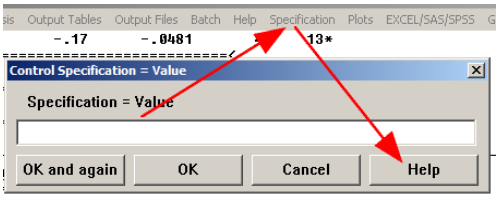
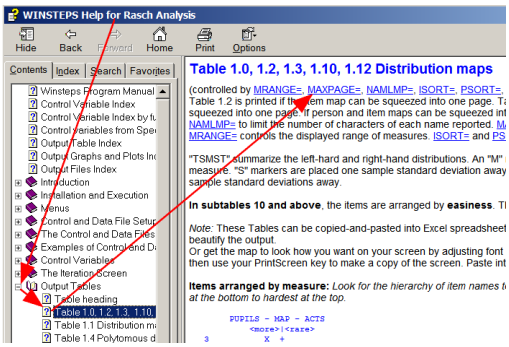
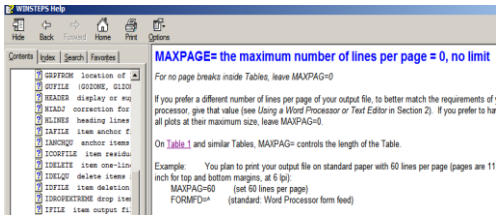
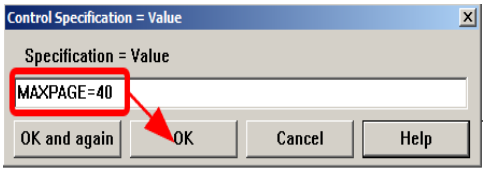
36.	This Window lets you enter the item label information. 1-4 means "tap onto cube 1 and then onto cube 4". As you look down the list you can see that the tapping patterns become longer and more complicated. Click on **Item Labels OK** to close the Window.	
37.	Let's now do a Rasch analysis. On the Setup menu bar, click on **Winsteps** *We changed the Title=, so* Click on **Save control with data file and exit to Winsteps Analysis**	
38.	On the "Save" screen, **Type in a new file name.** It can be whatever you like, I'm calling mine "**mikes1.txt**" Click on **Save** Notice that the suffix is **".txt"**. **All Winsteps control and data files are standard text files with line-feeds.** They can be edited and created with Word, NotePad, WordPad and many other programs.	
39.	The Winsteps Set-up procedure confirms that it saved your control and data file, and asks if you want to analyze these: Click on **Yes**	
40.	The Winsteps analysis screen displays again. The analysis is now identified (arrowed) as being of "mikes1.txt" (or your choice of file name). And the "Name of control file" (red box) has been set to "c:\Winsteps-time-limited\examples\mikes1.txt".	
41.	Let's see what our Control and Data file looks like internally .... Click on the Winsteps **Edit** menu, Click on **Edit Control File= ...**	

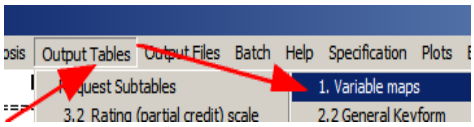
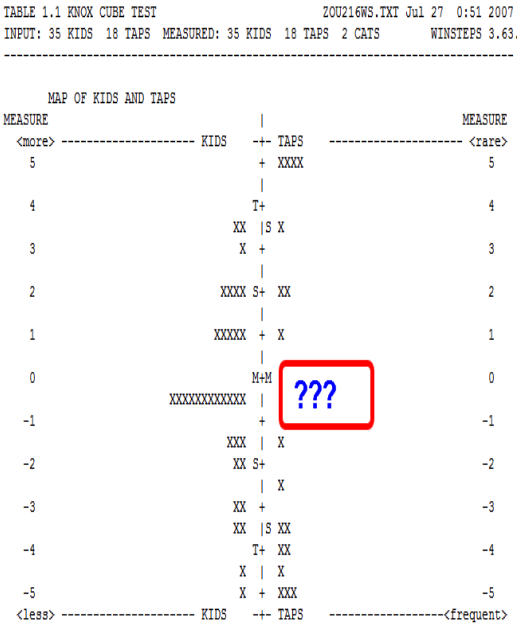
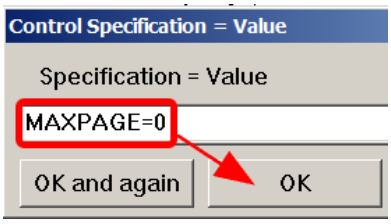
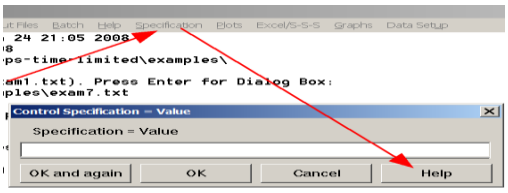
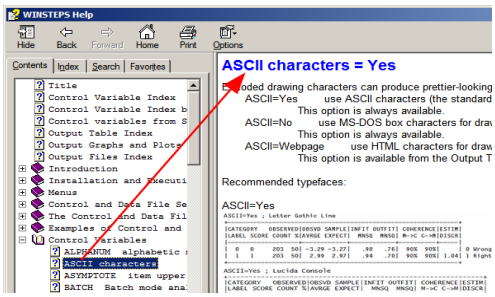
42.	The Control and Data file displays in a NotePad window. It is a text file. You can change it with WordPad, Word, etc. We need to display in Courier New, with a reasonably small font. If NotePad does not do this, see 184. Appendix 5. The top section (blue box) contains the control variables. They are "variable = value". You will recognize many of them, for instance TITLE=. The control variables end with &END - but do notice that there is no identification of the number of persons or cases. **In the Control file, you do not need to tell Winsteps how many persons there are.** Winsteps discovers that for itself! Then come the item labels (green box) with one item label per line in the same order as the columns of item responses. You will recognize that the first item is "1-4". The item labels end with END LABELS (or END NAMES) Then comes the data (red box). Each line has a person identification label, e.g., Anne, and a string of responses, "1100..."	
43.	*Oops!* If you see that the item responses don't line up neatly in columns, then please set the font to *Courier New,* with a small font-size. For assistance, see 184. Appendix 5.	
44.	That's enough for the moment, so close this NotePad window.	
45.	Back to the Winsteps analysis again. Winsteps is asking for the "Report output file name". Press **Enter** (blue arrow) for a temporary file name. You can always "Save As" temporary files to make them permanent, if you want to keep them.	

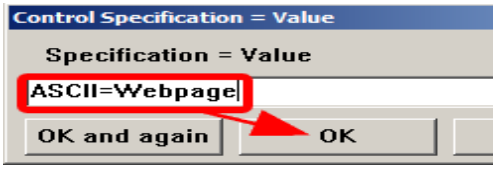
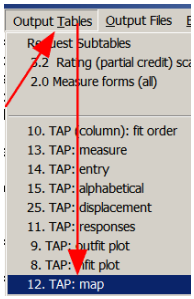
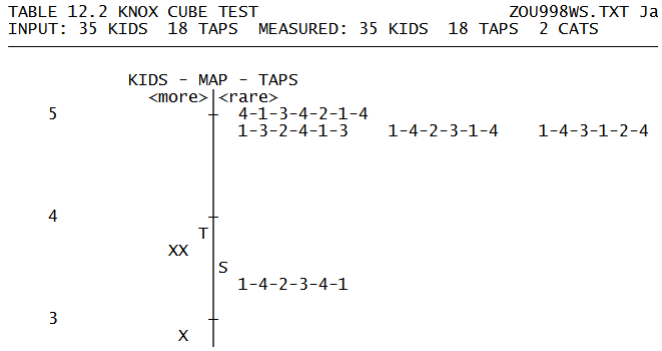
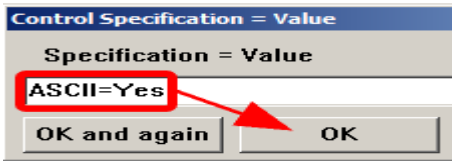
46.	Winsteps asks for "Extra specifications". These are extra control instructions. We don't have any, so Press **Enter**	
47.	If you don't want to use the Enter key, then you can click on **File** click on **Enter**	
48.	The Winsteps analysis starts. Green box: the control and data file is processed (green box). The first data record is displayed. This is useful for verifying that the data is correctly laid out. ^P = start of person label ^I = start of item responses ^N = end of item responses The number of data records is reported. Here it is "35 KID Records input." Wright & Stone called the children in their sample, "kids", and there were 35 of them. All is well. Red box: Winsteps starts making its initial estimates (red box).	
49.	The estimation process continues (red box). Each "iteration" is one pass through the data file. After each pass, the current set of Rasch measure estimates is improved. This continues until the improvement has become negligible. The estimation process has "converged". When estimation ceases, the fit statistics are computed (green boxes). The fit statistics report how well the data correspond to the measure estimates. The results of the analysis are summarized and reported in the blue box. Usually we want to see much more information than is reported here.	
50.	Of course, Winsteps outputs lots of numbers. Let's take a quick look at a couple of Tables. On the Winsteps menu bar, click on **Output Tables** **click on 13. TAP: measure**	

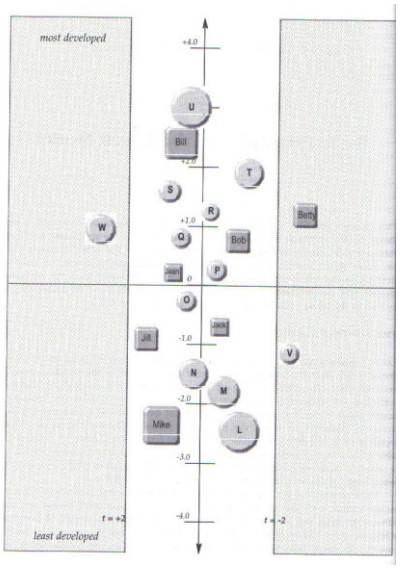
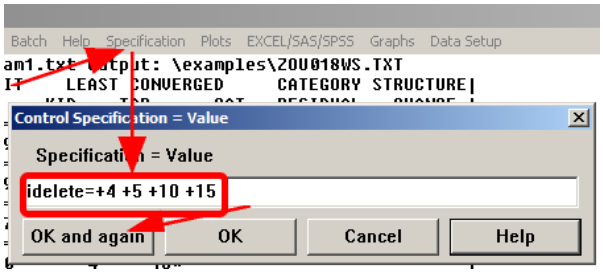
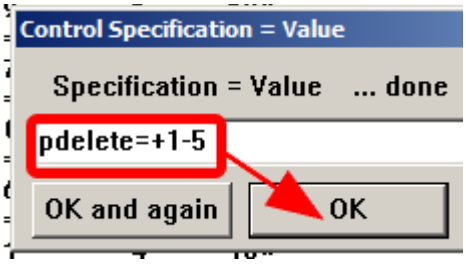
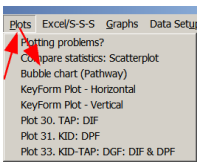
51.	Table 13 shows the "tapping" items in measure order with the most difficult at the top. They are displayed in a NotePad window. If the Table text is wrapped or ragged, please see 184. Appendix 5. If you prefer to use a different text editor, see 158. Appendix 2 of this document. The Rasch measures are in the red box, headed "MEASURE". The raw scores are in the blue box, headed "TOTAL SCORE". We'll talk more about measures in a few minutes.	
52.	On the Windows taskbar (usually on the bottom of your screen), click on "2 Winsteps" Then click on Winsteps "mikes1.txt" on the Windows task bar.	
53.	On the Winsteps menu bar, click on **Output Tables** **click on 17. KID: measure**	
54.	Winsteps Table 17, the person measure Table displays. You can see it has the same format as the item measure Table, Table 13. We know the difference between items and persons, but Rasch analysis doesn't. In Rasch analysis, persons and items are usually treated the same way. Numbers are very useful, but difficult to visualize, so let's look at a picture of these measures.	
55.	Click on Winsteps on the Windows task bar	
56.	If you see a Winsteps icon, click on it, and then on "mikes1.txt"	
57.	Let's take a look at a picture, a "map", of the measures we have estimated. On the Winsteps menu bar, click on **Output Tables** click on **1. Variable maps**	

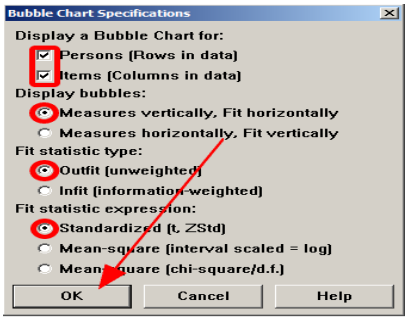
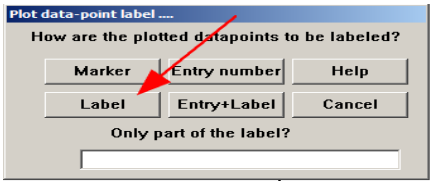
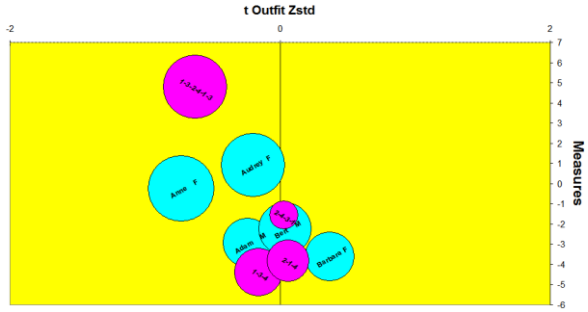
58.	Table 1.0 is a text file displayed in a NotePad window. Winsteps has 34 Tables and most of these have sub-tables. *If the Table is ragged: in NotePad, "Format", "Font", "Courier New"* The Table number is in the first line of the Table (red box). A count of persons and items is shown on the second line. If these numbers look wrong in your own analysis, then investigate your control and data files carefully.	
59.	**Ctrl+End** takes you to the bottom of this Table. **Ctrl+Home** back to the top Here is sub-table 1.0 In the blue box on the left are the linear measures - like a meter rule. We'll talk about what these are very soon. In the green box are the children located by their ability. In the red box are the items, located by their difficulty. When a child aligns with an item, then the child is predicted to have a 50% chance of succeeding (or failing) on the item. For instance, at +2, we predict child "Dav" to have a 50% chance of succeeding on item "1-4-3-". The labels "Dav" and "1-4-3-" have been abbreviated so fit this sub-Table. We could look at the data file to find out what actually happened, but the purpose of measurement is to make inferences (i.e., be useful) beyond the data. So, based on these data, we predict that children like "Dav-" have a 50% chance of success on items like "1-4-3-". We can already see improvements to make to this version of the Knox Cube Test. Children in the yellow box near 0 have no items targeted at their ability level (mauve ???). And, at +5 at the top, there are 4 very difficult items, but no children. So this version of the Knox Cube Test needs more middle difficulty items and fewer very hard items.	
60.		

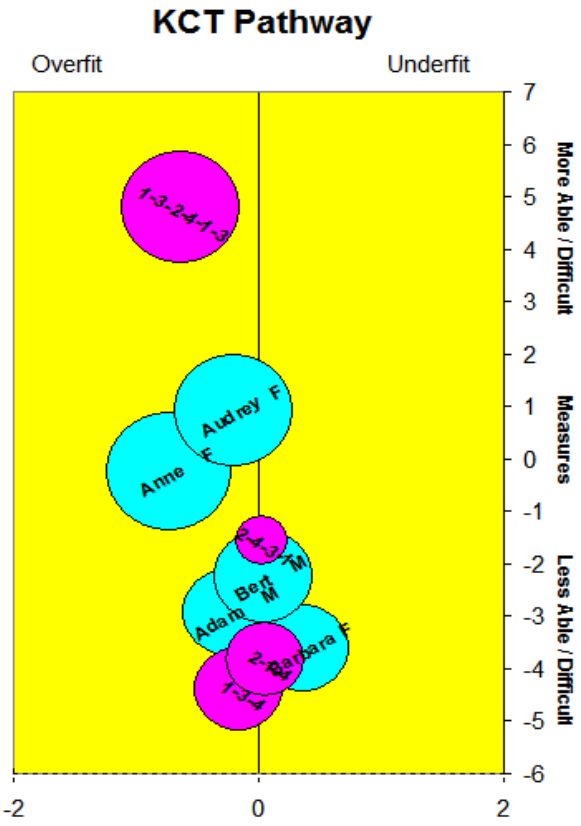
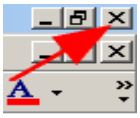
61.	**D. More Readable Output Maps**	
62.	Let's look at the variable map again ... to find out about the child-to-item targeting. Click on Winsteps menu bar Click on Output Tables Click on 1. Variable maps	
63.	Here is Table 1.0 Oops! It is too big to conveniently look at on my screen. Let's squash it (reduce its size vertically)	
64.	Winsteps menu bar Click on "Specification" In the Dialog Box, click on "Help"	
65.	I want to find out how to squash Table 1, so In the Help window In the Contents panel Click on Output Tables Click on Table 1.0 The Help entry for Table 1.0 lists a number of relevant control variables. You can click on them to find out what they are about. Click on: MAXPAGE=	
66.	MAXPAGE= (same thing as MAXPAG=, because only the first few letters are needed) sets the number of lines per page. So let's set MAXPAGE=40 The default is MAXPAGE=0 (which means Winsteps chooses the number), so we will need to remember to reset MAXPAGE=0 back to that value. Close the Help window	
67.	In the Specification box, MAXPAGE=40 Click OK	
68.	In your analysis window, the control variable is reported back to you	MAXPAGE=40

69.	Click on Winsteps menu bar Click on Output Tables Click on 1. Variable maps	
70.	The variable map ("Wright map") is now squashed ... Scroll down to Table 1.1 We can now see it clearly on our screen. The X's show the children (left-hand-side) and item (right-hand-side) distributions. Do you notice a problem with this test? There are many kids at XXXX...., one for each X, but there are few items close to them. We need items at the ???. It is an item-targeting problem. **For dichotomies: No nearby items ➔ Less precision of measurement ➔ Larger person Standard Errors** But for polytomies, this is more complicated, because rating scales have a wider operational range, equivalent to two or more dichotomies.	
71.	Let's reset MAXPAGE=0 - so that it has its standard function. Windows Menu bar Click on Specification MAXPAGE=0 Click on "OK" You can see MAXPAGE=0 on your Winsteps analysis window	 MAXPAGE=0
72.	Let's make the Winsteps Table more "publication quality". Winsteps menu bar Click on "Specification" In the Dialog Box, click on "Help"	
73.	In Help, find "ASCII=" There are three options: ASCII = Yes - this produces the Tables we have seen ASCII = No - this produces the Tables in the old MS-DOS format. It requires the "Letter Gothic Line" font (installed with Winsteps) ASCII = Webpage - this produces webpage output. Let's try the Webpage!	

74.	Winsteps Specification box, type **ASCII=Webpage** Click on OK	
75.	*Again ...* Click on Table menu Click on 12. TAP (item): map	
76.	Table 12.2 displays. It is a webpage displayed by Internet Explorer (or your web browser). Table 12 is like Table 1, but the item (TAP) labels are shown in full on the right-hand-side. The X's on the left are the person abilities. You can copy and paste this into Microsoft Word. Then highlight the text there and change the font size.	
77.	You can use the ASCII options whenever you want to, but let's return to the standard one Winsteps Specification box, type **ASCII=Yes** Click on OK	

78.	E. Pathways & Bubble Charts	
79.	Bond & Fox have popularized "pathway" charts ... There's one on the front cover of their book. Here it is. The circles are items. The squares are people. The vertical axis is the measure, the location on the latent variable. The size of the circles and squares indicates the precision (standard errors) of the measures along the vertical axis, the latent variable. The horizontal axis is the fit. Overfit on the left (the responses are too predictable), underfit on the right (the responses are too unpredictable). The fit indicates the accuracy of the measures. We will discuss this in Lesson 2. This Figure was drawn by an artist for B&F. We'll have Excel do approximately the same thing.	
80.	To keep the pathway from being too crowded, let's select a few people and items to display. Winsteps Menu Bar: Click on "Specification" In the Specification box, type (or copy-and-paste from here) idelete=+4 +5 +10 +15 Click on "OK and again"	
81.	Your Winsteps Analysis window reports that 4 items are selected 4 items for reporting: 4, 5, 10, 15	idelete=+4 +5 +10 +15 CURRENTLY REPORTABLE TAPS = 4
82.	In the Specification box, type (or copy-and-paste) pdelete=+1-5 Click on "OK"	
83.	This has selected the first 5 children: 1, 2, 3, 4, 5	pdelete=+1-5 CURRENTLY REPORTABLE KIDS = 5
84.	Winsteps Menu Bar Click on "Plots" Click on "Bubble chart (Pathway)"	

85.	Click on "Persons" and "Items" to ✓ check (or tick) them. Click on "OK"	
86.	Click on the "Label" button - we want to see the person and item labels displayed	
87.	On the Winsteps Analysis screen it tells us that Bubble Chart processing is underway	Processing Bubble Chart .... Loading winexcel.exe ... _Bubble Chart process launched
88.	After a few moments, the Bubble Chart (pathway) plot is displayed by Excel. There are many different versions and options in Excel, so your plot may not look exactly like this. You have full Excel editing capabilities for this plot. Most importantly, **Excel has a mind of its own**, and has displayed the bubbles with the **incorrect sizes**. See 177. **Appendix 4**. *"Changing the size of the bubbles"*.	

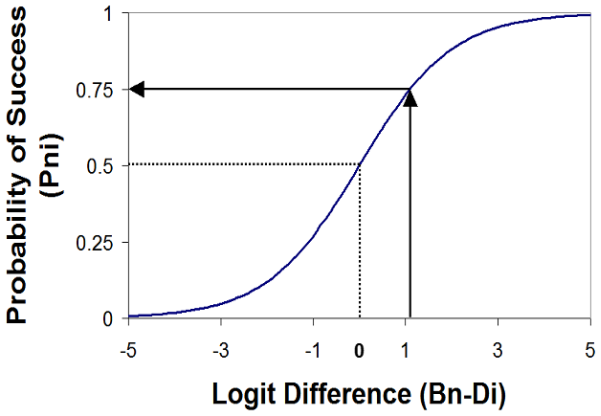
89.	***Practical Challenge:*** Here's a version of the pathway chart after some adjustments using Excel's own capabilities. ***See if you can do bette.r*** To adjust the labels in the bubbles, please install the free Excel Add-in "XY Chart Labeler" from http://www.appspro.com/Utilities/ChartLabeler.htm A huge amount of meaning is squeezed into one picture. The bubble chart shows the locations (measures) of the persons and items on the latent variable vertically. These indicate the predictive validity and the construct validity of the instrument. We talk about these in this Lesson. It shows the behavior (fit) of the persons and items horizontally. In Lesson 2, we talk about fit. It shows the certainty (precision, standard error of measurement) of the persons and items by the size of the bubble. In Lesson 3 we talk about *precision.*	 How about trying differently shaped bubbles? In Excel 2007 and later, www.winsteps.com/winman/bubblecharts.htm section Autoshapes - also in Winsteps Help
90.	Close the Excel window	

91.	F. Practical Additive Measurement: Norman Campbell and the Social Scientists
92.	There was a big argument back in the 1930s. The question being debated was "Is psychological measurement possible?" The hard scientists, the physicists, led by Norman Campbell said "No, measurement requires a **deliberate action**, a concatenation (such as putting sticks end-to-end to measure length, or piling bricks one on top of another to measure weight), and you can't concatenate people's heads!". The soft scientists, the social scientists led by Stanley Stevens, could not answer that, so they devised their own definition for a new kind of "measurement": "**Measurement** is the **assignment** of numbers to objects or events according to rule" (Stevens, S. S. 1946. "On the theory of scales of measurement." *Science,* 103, 677-680). The social scientists call "measures" whatever numbers they happen to have acquired. This has caused confusion ever since. For social scientists, any number is a measurement, provided you can imagine some rule that it follows. For everyone else, measures have to conform to strict objective criteria. But Georg Rasch solved the problem. He showed how the strict criteria of the physical scientists can be applied to social science by means of Rasch models, which Georg Rasch called **"Models for Measurement."**
93.	Let's go back to the debate with Norman Campbell. He laid out the philosophy underlying physics in his book *"Physics: The Elements"*. Measurement is central to physics, and Norman Campbell, a practical man, took an operational view of additive measurement. To paraphrase, **"Measurement means that adding one more unit adds the same amount extra, no matter how much there is already."** "Adding one more unit" means the simple addition of 1 to the measurement number. But "adds the same amount" is more complicated. It means defining an operation that increases the amount we have by a certain, constant amount. With weight the constant amount is one gram or one pound, and the operation is "piling up". With length, the constant amount is one meter or one foot, and the operation is "putting end to end" (technically "concatenation"). With temperature the constant amount is one degree, and the operation is "heating". Norman Campbell could not imagine how we could define a unit of attitude and then construct a process that would increase an attitude by a known amount. Nor could the social scientists of the 1930s, so they gave up .....
94.	*Campbell: "*measurement requires a deliberate action, a concatenation". Measurement requires deliberate construction. *Stevens:*"Measurement is the assignment of numbers according to rule ..." The social scientists call "measures" whatever numbers they happen to have acquired. *Example:* 3 minutes on the clock is a *Campbell* measurement. The clock is deliberately constructed to concatenate equal-units of time. A score of 3 on a Math test is a *Stevens* "measurement". The Math test is an accidental collection of items. There is no deliberate concatenation of equal-units of item difficulty.

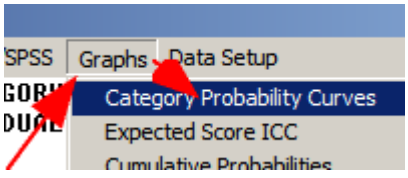
95.	**Georg Rasch (1900-1980)**
96.	Georg Rasch was a poorly-paid mathematics instructor in Denmark who consulted in statistics in order to support himself. He didn't know that social-science measurement is impossible. Instead, he was faced with the practical problems of his clients, problems that needed practical solutions. The Danish Department of Defense had a particular problem with their educational tests. Rasch came up with a practical solution based on log-odds transformations. It worked well, but the social scientists found it too complicated (as many still do) and the mathematical statisticians found it too simplistic (as many still do). So Georg Rasch made little progress with his measurement ideas until he was invited to present a course of lectures at the University of Chicago in 1960. Only one person attended all the lectures and that was Benjamin D. Wright, and even he had more pressing things to do for the next several years. Then, in 1964, Ben had some data analysis problems of his own, and he thought that perhaps Georg Rasch would have some ideas about how to solve them, and, besides, a trip to Denmark would be fun. This got Ben interested again and ... but you can read the story at www.rasch.org/rmt/rmt0.htm - and it was Ben Wright who spread the Rasch model around the world ...
97.	So, what had Georg Rasch discovered, invented, constructed, that was able to overcome Norman Campbell's objections? Georg Rasch didn't put it this way himself, but we can now say that Georg Rasch devised a way of "concatenating heads" in a psychological way that parallels Campbell's way of "concatenating rods" in a physical way. Rasch implements "additive" measurement: **Adding one more unit means the same amount extra, no matter how much there is already.** If you want to read about how this is done, and also obtain some other insights into what "measurement" really means, please read my paper *"Measurement, Meaning and Morality"* www.rasch.org/memo71.pdf - The linearity (= additivity) that the Rasch model *constructs* differs from the *assumed* linearity of Classical Test Theory and much of Item Response Theory (IRT). For more about IRT, see http://en.wikipedia.org/wiki/Item_response_theory Read more about the *asserted* (rather than *constructed)* linearity of the widely-adopted "interval measurement" classification of S.S. Stevens in www.rasch.org/rmt/rmt111n.htm *"Stevens Revisited".*
98.	You may be wondering: "I signed up to learn a statistical method, why are we wasting time with history and philosophy?" Let Lord Acton (1832-1902) answer: *"The knowledge of the past, the record of truths revealed by experience, is eminently practical, is an instrument of action, and a power that goes to the making of the future."* Especially in the area of social-science measurement, the misconceptions of days gone by continually dog our steps, and we find ourselves in disputes that should have been resolved long ago. Indeed, you will undoubtedly encounter sceptics who will tell you "the Rasch model is wrong!" or "the Rasch model doesn't work!" Make a note of www.rasch.org/rmt/rmt103e.htm "The Rasch Model Cannot Be Disproved" as a resource for such occasions.
99.	

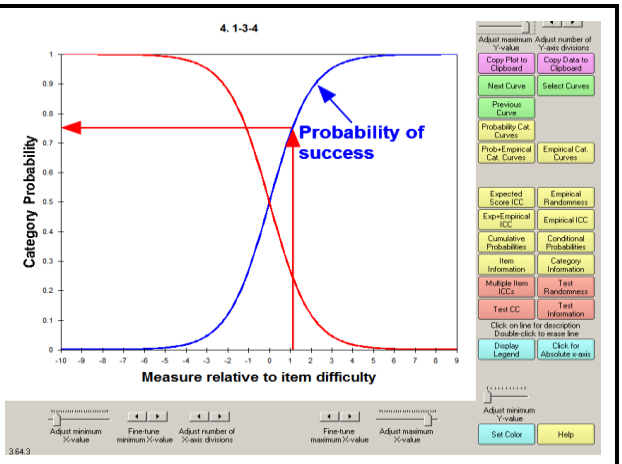
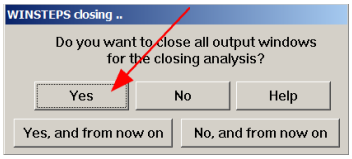
100.	**G. The Rasch Dichotomous Model**	
101.	Georg Rasch presents several mathematical models in his book "Probabilistic Models for Some Intelligence and Attainment Tests" (Chicago, 1980). His model for dichotomous (right/wrong, yes/no, present/absent) responses by persons to items has become known as "***the*** Rasch model". This is our starting point, and is the model that we used to analyze *exam1.txt,* the Knox Cube Test. Georg Rasch wrote his model in multiplicative form using Greek letters. Later authors wrote it in exponential form also using Greek letters. But both of these obscure the essential additive process, so I prefer to write the model in log-odds form using the more familiar Latin (Roman) letters.	Georg Rasch writes his model: $$\theta_{vi} = \frac{\xi_v}{\xi_v + \delta_i}$$ Wikipedia writes his model: $$\Pr\{X_{ni} = 1\} = \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}}$$
102.	The **Rasch dichotomous model** specifies the probability, P, that person *n* of ability B_n succeeds on item *i* of difficulty D_i. "Success" means "exhibits more of our intended latent variable." "Failure" means "exhibits less of our intended variable". So we must score the observations in accordance with this intention, no matter what values are assigned to the observations during data collection.	$$\log_e\left(\frac{P_{ni}}{1-P_{ni}}\right) = B_n - D_i$$ Log-odds of person n succeeding on item i = Ability of person n - Difficulty of item i
103.	**$\log_e$** is the "natural" logarithm: if you would like a quick refresher about logarithms, please study 161. Appendix 3 of this document.	
104.	**Probability:** I think of this in frequentist terms. The probability of an event is the proportion of times the event would happen if we could repeat the operation a great many times. A probability is always between 0 (never happen) and 1 (always happen). P is the probability of success, and 1-P is the probability of failure. Since either success or failure must always happen, when we add their probabilities they must sum to 1: (Probability it happens) + (Probability it doesn't happen) = (P) + (1-P) = 1	
105.	**Probabilities, Logarithms and the Rasch Model**	
106.	To help with our understanding of Rasch models, let's be explicit that success is a score of "1", and failure is a score of "0" on an item. Then the **Rasch dichotomous model** specifies the probability, P_{ni1}, that person *n* of ability B_n scores 1 on item *i* of difficulty D_i and P_{ni0} is the probability of scoring 0. "Ability" is what we are looking for in the people. In your situation, you can use other words "Proclivity", "Motivation", "Health status", "Disability". "Difficulty" is what we identify in the items. In your situation, you can use other words, "Challenge", "Impediment"	$\log_e(P_{ni1} / P_{ni0}) = B_n - D_i$ $P_{ni1} + P_{ni0} = 1$

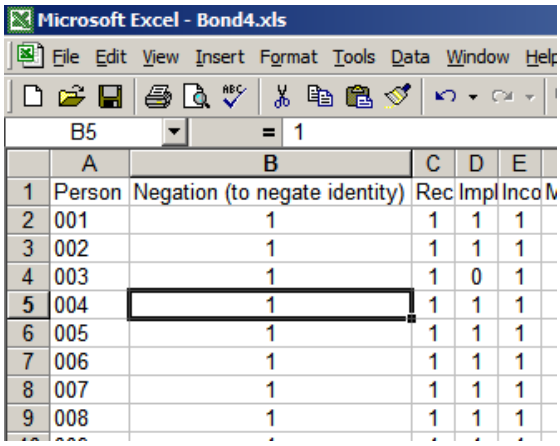
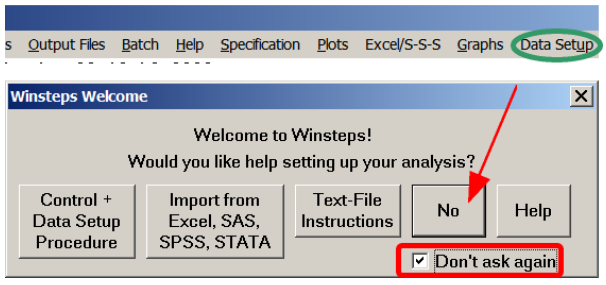
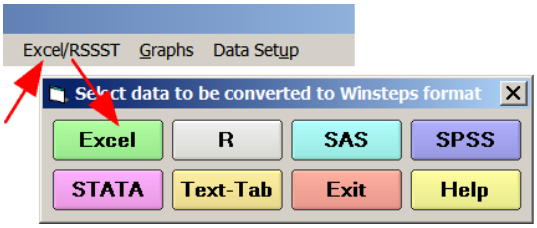
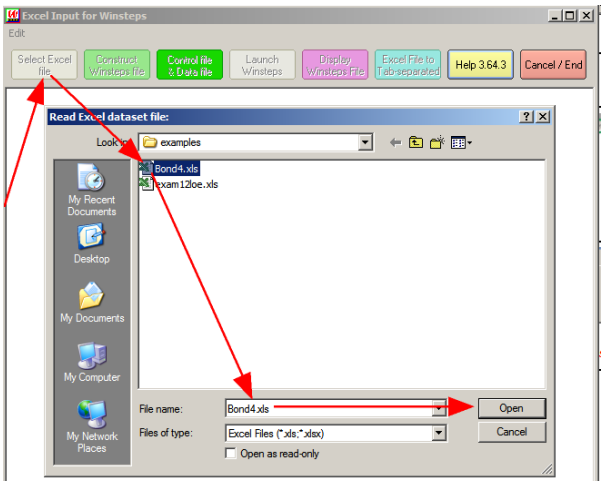
107.	*An essential concept:* **"qualitatively-ordered data":** "qualitative ordering" is "good, better, best" "Success" means "more of what we are looking for" "Failure" means "less of what we are looking for" The difference between "Success" and "Failure" is *qualitative.* The qualitative ordering of these different qualities is shown by scoring them "1" and "0". "1" means "indicating more of the latent variable". "0" means "indicating less of the latent variable". **Rasch models analyze qualitatively-ordered data.** These data can be found everywhere.	**Standard Rasch item-scoring:** Success = 1 = more of what we seek Failure = 0 = less of what we seek "what we seek" is the "latent variable"
108.	**B_n** and **D_i** are distances in **logits** along the **latent variable** relative to the **local origin** A "**latent variable**" is something which we can have more or less of, but which we cannot measure directly. It is a variable such as "mathematics ability" or "patient quality of life". We conceptualize it to be a straight line marked out in equal-interval units. This line is infinitely long. We can always imagine something (or someone) with more of the attribute than anything (or anyone) we have encountered so far, and also something (or someone) with less of the attribute. We conceptualize each observation in the data to indicate "less" or "more" of this latent variable.	
109.	"**Logits**" are "log-odds units". Look at the Rasch equations: $\log_e(P_{ni}/(1-P_{ni})) = B_n - D_i$ On the left is "$\log_e$", this means the "natural logarithm". If you don't know about logarithms, please look at 161. Appendix 3 to this document. The logarithm is of P_{ni1} divided by P_{ni0} which is the ratio of two probabilities. A ratio of probabilities is called the "odds". So, on the left-side of the equation we have log(odds). These provide the units for the right-side of the equation, so B_n and D_i are measured in "log-odds units", "logits" - pronounced *low-jits.* In Table 1.0 above, the logit values have been linearly rescaled (multiplied by a constant and then had another constant added) to produce numbers that are easier for most people to think with. This is like going from Celsius to Fahrenheit on a temperature scale. The meaning hasn't changed only the numbering. The "**local origin**" is the place we are measuring from. In physical measurement: for length, it is one end of a tape measure. For mountains, 0 is at sea level. For temperature, it is 0° on a thermometer. In Rasch measurement, 0 is usually in the center of the range of item difficulties, but it can be wherever we prefer it to be - as long as we make it clear to ourselves and everyone else where that 0 point is.	
110.	What if the probability of success is the same as the probability of failure? Then both probabilities are 0.5. The odds of success are 0.5/0.5 = 1, and the logarithm of the odds is log(1) = zero. So the ability and the difficulty are the same. Exactly what we expect! When I encounter an item of exactly the same difficulty as my ability, I can't predict whether I'm going to succeed of fail. My prediction would be like tossing a coin ... *Heads or Tails?*	$P_{ni1} + P_{ni0} = 1$ $P_{ni1} = P_{ni0} = 0.5$ $\log_e(P_{ni1} / P_{ni0}) = \log_e(0.5 / 0.5) =$ $\log_e(1) = 0 = B_n - D_i$ $B_n = D_i$

111.	If I'm sure to succeed, then my probability of success is 1 and my probability of failure is zero. My logit ability will be plus-infinity relative to any item of finite difficulty.	$P_{ni1} + P_{ni0} = 1$ $P_{ni1} = 1, P_{ni0} = 0$ $\log_e(P_{ni1} / P_{ni0}) = \log_e(1 / 0) =$ $\log_e(\infty) = \infty = B_n - D_i$ $B_n = \infty$
112.	If I'm sure to fail, then my probability of success is 0 and my probability of failure is one. My logit ability will be minus-infinity relative to any item of finite difficulty.	$P_{ni1} + P_{ni0} = 1$ $P_{ni1} = 0, P_{ni0} = 1$ $\log_e(P_{ni1} / P_{ni0}) = \log_e(0 / 1) =$ $\log_e(0) = -\infty = B_n - D_i$ $B_n = -\infty$
113.	Suppose that I generally succeed 3 times out of 4 in hitting a target with an arrow. Then my probability of success is P = 3/4 = 0.75. And my probability of failure is 1-P = 1/4 = 0.25. Then my odds of success is P / (1-P) = 0.75 / 0.25 = 3. And my ability is $\log_e(3) = 1.1$ logits more than the target is difficult.	$P_{ni1} = 0.75$ $P_{ni0} = 0.25$ $P_{ni1} / P_{ni0} = 3$ $\log_e(P_{ni1} / P_{ni0}) = \log_e(3) = 1.1$ $1.1 = B_n - D_i = 1.1$
114.	Extending this idea, we can draw a picture of the relationship between ability (relative to an item) and probability-of-success. the relationship is called a **"logistic ogive".** You can see on the plot that a zero logit difference (dotted line) corresponds to a 0.5 probability of success. An ability advantage of 1.1 logits (arrowed) is equivalent to a probability of success of 0.75. This curve is *"monotonic ascending"* - the probability of success always increases with increasing measure difference, monotonously.	
115.	Table of logits to probability Notice that the range 0-100% approximates 10 logits.	

Logit Difference	Probability of Success	Logit Difference	Probability of Success
5.0	99%	-5.0	1%
4.6	99%	-4.6	1%
4.0	98%	-4.0	2%
3.0	95%	-3.0	5%
2.2	90%	-2.2	10%
2.0	88%	-2.0	12%
1.4	80%	-1.4	20%
1.1	75%	-1.1	25%
1.0	73%	-1.0	27%
0.8	70%	-0.8	30%
0.5	62%	-0.5	38%
0.4	60%	-0.4	40%
0.2	55%	-0.2	45%
0.1	52%	-0.1	48%
0.0	50%	-0.0	50%

116.	Let's see this curve for exam1.txt. On the Winsteps menu, click on **Graphs** Click on **Category Probability Curves**	

117.	The probability curves for categories 0 and 1 display. These are for item 4. "1-3-4" but they look the same for all dichotomous (right-wrong) items. The x-axis is in logits relative to the difficulty of item 4. It has an infinite range from -∞ to +∞ The y-axis is the probability. This always has the range 0 to 1. The red arrows show that 1.1 logits above the item difficulty corresponds to 75% chance of success on the item.	
118.	There's much, much more to see ... but let's make it easier for you to set up your own data for Winsteps. So **close all windows**	
119.	You may see the "WINSTEPS closing" dialog. This is because you are closing the Winsteps analysis window while Tables are displaying. Click **Yes** because we want to close everything.	
120.		

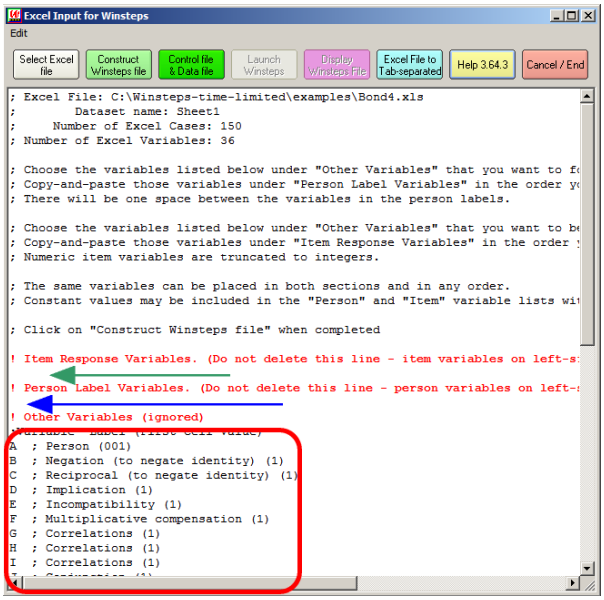
121.	**H. Winsteps Control and Data Setup with Excel, R, SAS, SPSS and STATA**	
122.	It really simplifies Winsteps control+data-file set-up if you already have the response-level data on your disk in a convenient form. Let's start with an **Excel** spreadsheet. Here is the layout: **One row for each person.** **One column for each person identifying variable.** **One column per item.** **The first row has the identifying labels** Here's an Excel spreadsheet for B&F Chapter 4. It has one person identifying column A, and 35 items columns, B - AJ	
123.	Double-click on the Winsteps icon on your desktop	
124.	We don't need to see the "Welcome" dialog every time, Click on **"Don't ask again"** If we need the Data Setup screen, we can launch it from "Data Setup" (green ellipse) Now click **No**	
125.	On the Winsteps menu, Click on **EXCEL/RSSST** Click on **EXCEL** *R statistics, SAS, SPSS, STATA: Your procedure is the same as Excel. Your variable names are not in row 1, but the usual ones.*	
126.	When the Excel dialog box displays, Click on **Select Excel file** In the file dialog box, Click on **Bond4.xls** Click on **Open** *There are also datasets in the other formats for you to experiment with.*	

127. After a few moments, the labels in the first row of the Excel spreadsheet display. Scroll up and down to see them. They are shown here in the red box.
Sorry, if you don't have Excel on your computer, this won't happen!

Look down the list of column labels. Some are person variables. For instance, column A. Some are item labels. We need to tell Winsteps which are which.

We do this by copying-and-pasting the column information into the correct place in this control dialog. The person variable columns go under "Person Label Variables" (blue arrow) and the item columns go under "Item Response Variables" (green arrow)

Do not change anything else



128. OK - so go ahead and copy-and-paste.
This is what happens when I do it ....

Item 1 is in column B of the Excel spreadsheet. It is "Negation". I pasted in Excel B - K as the Item Response Variables.

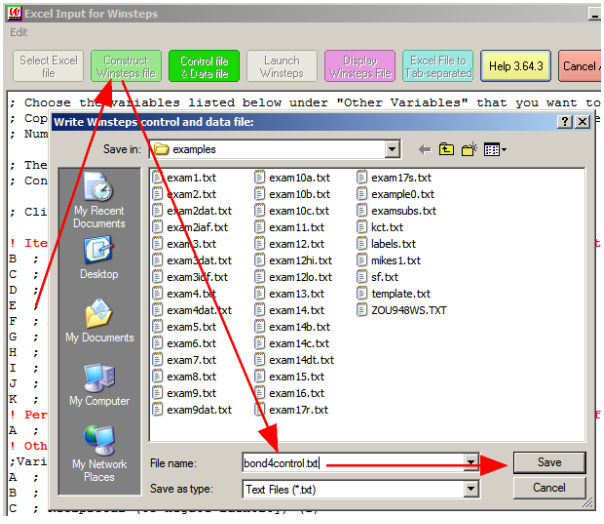
Column A of the Excel spreadsheet in the person number. I pasted it in as the Person Label Variable.

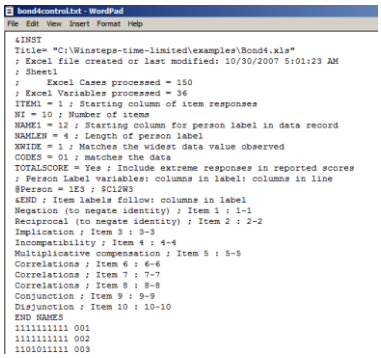
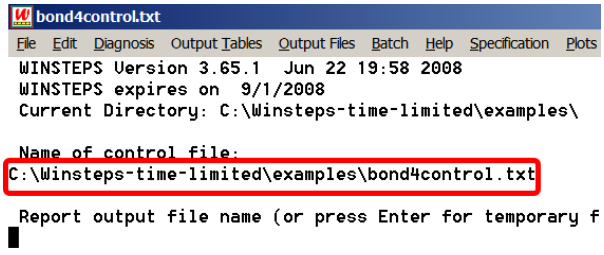
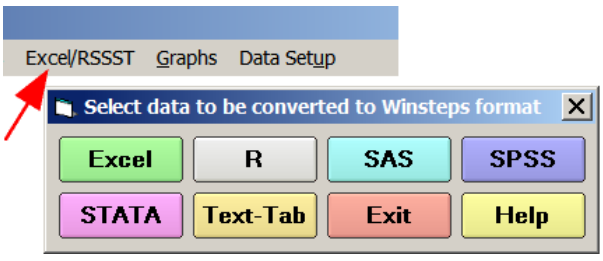
You don't have to use all the Excel columns. You can change their order and you can also use the same column in both the person and item variable list.

```
! Item Response Variables. (Do not delete this line - item vari
B  ; Negation (to negate identity) (1)
C  ; Reciprocal (to negate identity) (1)
D  ; Implication (1)
E  ; Incompatibility (1)
F  ; Multiplicative compensation (1)
G  ; Correlations (1)
H  ; Correlations (1)
I  ; Correlations (1)
J  ; Conjunction (1)
K  ; Disjunction (1)
! Person Label Variables. (Do not delete this line - person var
A  ; Person (001)
! Other Variables (ignored)
;Variable  Label (First Cell Value)
A  ; Person (001)
B  ; Negation (to negate identity) (1)
C  ; Reciprocal (to negate identity) (1)
```

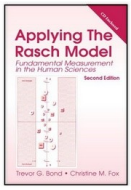
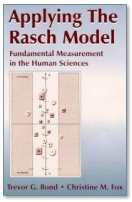
129. To construct the Winsteps control and data file:
Click on **Construct Winsteps File**
Enter the **name of a new output file** to be the Winsteps control and data file. My name is **bond4control.txt**
Click on **Save**

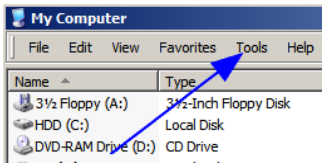
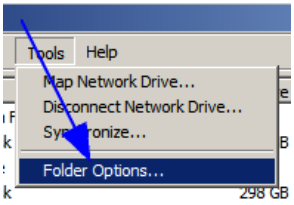
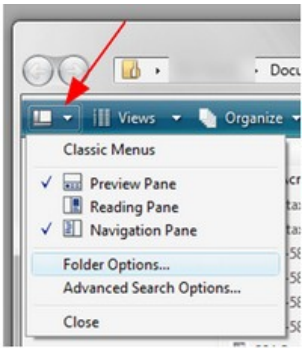
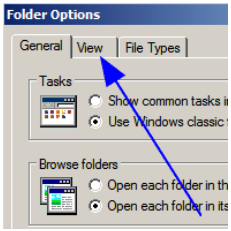
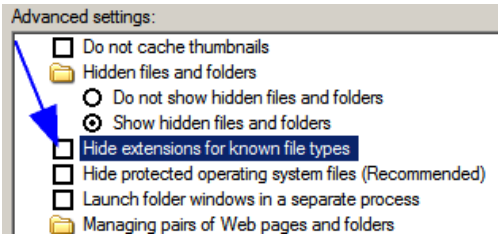
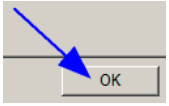
The Excel interface starts processing. This can be slow, because Winsteps is communicating with Excel through Windows.

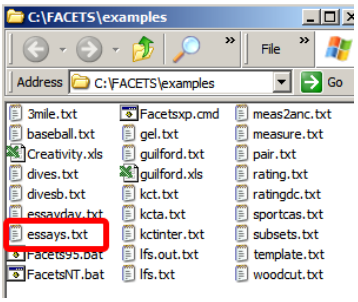


130.	Then the Winsteps control and data file displays. It is a text file in the familiar format. You can edit it if you want.	
131.	**Close** the **bond4control.txt** window	
132.	Let's analyze the file we have just created .... On the Excel Processing for Winsteps Click on **Launch Winsteps**	
133.	The usual Winsteps analysis screen displays with the control file already active. We don't want to perform this analysis right now so ...	
134.	Close all windows	
135.	**You can experiment** doing the same procedure for SPSS ".sav" files, SAS ".sas7bdat" files and STATA ".dta" files and R ".rda" or ".rdata" files using datasets in the Examples folder. SPSS, STATA and R should work for everyone.	
136.	SAS: If this fails, you probably need the "SAS Local Data Provider" free (with free registration) from http://www.sas.com/apps/demosdownloads/92_SDL_sysdep.jsp?packageID=000608	
137.		

138.	**I. *More to think about ....***	
139.	It is now time to hear from that long-time advocate of Rasch measurement, Ben Wright. Unfortunately he was incapacitated by a stroke in October 2001 and is struggling to do any productive work. Read the document listed here that matches your interests, but everyone glance at the first one - it has a typical picture of Ben in action *"proclaiming useful measuring"*.	• Fundamental Measurement in Social Science and Education http://www.rasch.org/memo33a.htm • Fundamental Measurement for Psychology http://www.rasch.org/memo64.htm • Fundamental Measurement for Outcome Evaluation http://www.rasch.org/memo66.htm
140.	In the literature you will find that the "Rasch Dichotomous model" is sometimes called the "**1-PL IRT (One-Parameter Item Response Theory) model**". This is because these models have a superficial mathematical similarity, but they also have a fundamental conceptual difference: the Rasch model deliberately implements the properties of additive measurement. The data must conform to the Rasch model if they are to support additivity. The 1-PL IRT model of Frederic Lord is a "hoped-for" description of a set of data. If the data don't fit it, then another model is tried. http://www.rasch.org/rmt/rmt193h.htm See also http://www.rasch.org/rmt/rmt61a.htm	**Rasch Dichotomous Model vs. One-parameter Logistic Model** *Aspect* / Rasch Dichotomous Model / Item Response Theory: One-Parameter Logistic Model *Abbreviation* / Rasch / 1-PL IRT, also 1PL *Motivation* / Prescriptive: Distribution-free person ability estimates and distribution-free item difficulty estimates on a linear latent variable / Descriptive: Computationally simpler approximation to the Normal Ogive Model of L.L. Thurstone, D.N. Lawley, F.M. Lord *Persons, objects, subjects, cases, etc.* / Person *n* of ability B_n, or Person *v* (Greek *nu*) of ability β_n in logits / Normally-distributed person sample of ability distribution θ, conceptualized as N(0,1), in probits: incidental parameters *Items, agents, prompts, probes, multiple-choice* / Item *i* of difficulty D_i, or Item *ι* (Greek *iota*) of difficulty δ_i in / Item *i* of difficulty b_i (the "one
141.	That's the end of the Lesson. Well done!	

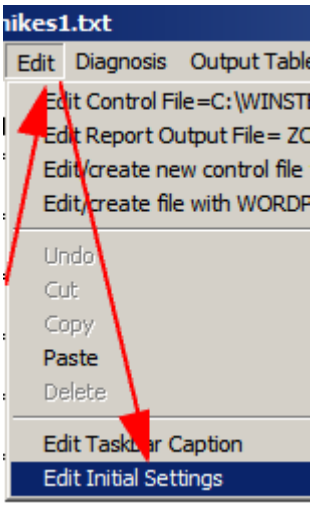
142.	**J. Supplemental Readings on Rasch Measurement**	
143.	In B&F, 2nd Edn, Chapters 1 and 2 correspond to what we have looked at so far. All questions are based on the Lessons or free downloaded documents. The books are for those who wish to do additional study on their own.	
144.	In B&F, 1st Edn, Chapters 1 and 2 and sections of the Preface correspond to what we have looked at so far.	
145.	In Best Test Design (Wright & Stone), chapter 1 is the place, but it is much more mathematical than our discussion here.	
146.	**Free PDF:** Wu, M. & Adams, R. (2007). Applying the Rasch model to psycho-social measurement: A practical approach. Educational Measurement Solutions, Melbourne. www.edmeasurement.com.au/Learning.html	
147.	**Free PDF:** Wright, B.D. & Stone M.H. (1999) Measurement Essentials. www.rasch.org/memos.htm - measess	

148.	**Appendix 1. Displaying file name suffixes**	
149.	On your desktop, click on **My Computer** or any folder	
150.	XP: Click on **Tools**	
151.	XP: Click on **Folder Options**	
152.	Vista: 1. Click the Layout button (to the left of the Views button) 2. Click Folder Options	
153.	Click on **View**	
154.	Un-check **"Hide extensions for known file types"**	
155.	Click on **OK**	
156.	**Close** unwanted windows	

157	Suffixes will now display in folder file lists	

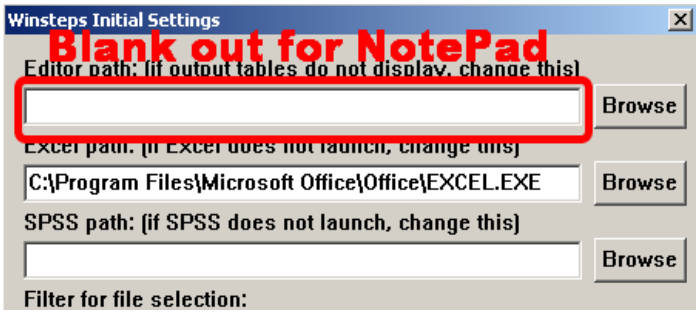
158 Appendix 2. Changing the text-editor used by *Winsteps*

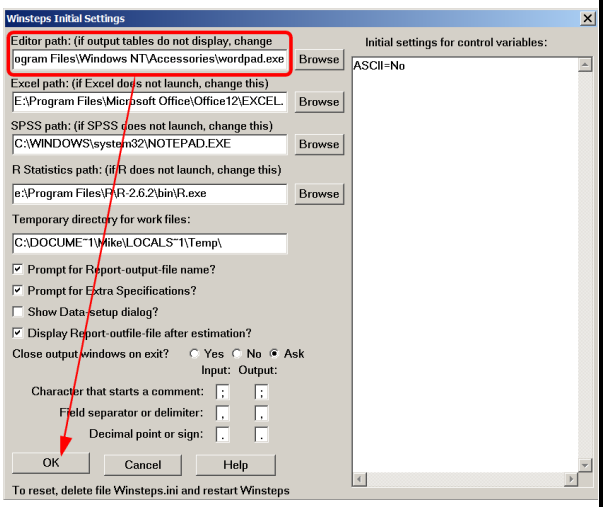
159 In the *Winsteps* main window,
Click on **"Edit"**
Then
Click on **"Edit initial settings"**



160 In the top box, type in the path to your preferred text editor, or use the Browse button to locate it.
I've entered the path to Wordpad.
Then click **OK** to save this setting.

For NotePad please blank out the Editor box:



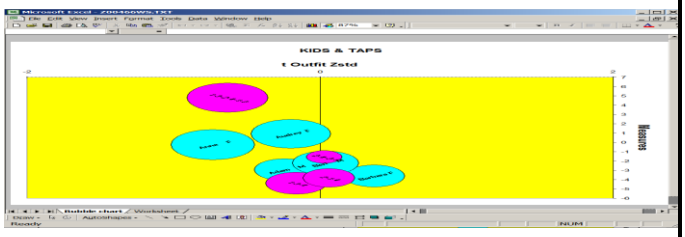


161.	**Appendix 3. What are Logarithms?** PPT: http://teachers.henrico.k12.va.us/math/HCPSAlgebra2/Documents/10-2/2006_10_2.ppt Video: http://www.youtube.com/watch?v=mQTWzLpCcW0	
	Much of what we do during this Course is based on logarithms. One reason is because logarithms transform multiplication into addition:	$100 * 1000 = 10^2 * 10^3 = 10^5 = 100000$ this is the same as: $\log(100) + \log(1000) = \log(100000)$
162.	Let's start with squares, 2 x 2 = 4 and cubes, 2 x 2 x 2 = 8 We can see that it takes two 2's to make 4 so let's write them 2^2 and it takes three 2's to make 8 so let's write them 2^3. Then what about $2^{2+3} = 2^5$?	$2^2 = 2 \times 2 = 4$ $2^3 = 2 \times 2 \times 2 = 8$ $2^{2+3} = 2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32 = 4 \times 8 = 2^2 \times 2^3$
163.	The superscripts ^{2} and ^{3} are called "powers", and we've discovered that multiplying numbers is the same as adding powers. We can do this with non-integers:	$1.4142 \times 1.4142 = 2 = 2^1 = 2^{1/2} * 2^{1/2}$ $1.4142 = 2^{1/2}$ = square-root(2)
164.	And powers work for negative numbers	$2^1 = 2 = 4 / 2 = 2^2 / 2^1 = 2^2 * 2^{-1} = 2^{2-1}$
165.	So, we have the general rule of powers of 2:	$2^{x+y} = 2^x * 2^y$
166.	This works exactly the same way if we change the "base" value from 2 to 10.	$X = 10^x$ $Y = 10^y$ $X * Y = 10^{x+y}$ $10^{x+y} = 10^x * 10^y$
167.	Now x and y are called "exponents" and "10" the base. So this is an "exponential" form.	$X * Y = 10^x * 10^y = 10^{x+y}$
168.	We can rewrite this "exponential" form into "logarithmic" form. "Log" is short for "Logarithm".	$\log_{10}(X) = \log_{10}(10^x) = x$ $\log_{10}(Y) = \log_{10}(10^y) = y$ $\log_{10}(X*Y) = \log_{10}(10^{x+y}) = x+y$
169.	This is very useful. We can transform a multiplication X*Y into and addition log(X) + log(Y). This saves a huge amount of effort when the multiplication is done by hand, and was why logarithms were invented around 1617.	$\log_{10}(10^x) + \log_{10}(10^y) = x+y = \log_{10}(10^{x+y})$ $\log_{10}(X) + \log_{10}(Y) = x+y = \log_{10}(X*Y)$
170.	In Rasch work, we use a special base, called "e". This has the value 2.718.... And the logarithms are then called "natural" or "Napierian" logarithms.	$2.3026 * \log_{10}(X) = \mathbf{\log_e(X)}$ $\log_{10}(X) = 0.4343 * \mathbf{\log_e(X)}$
171.	Once we alert the reader what base we are using, "e" from here on, we can omit it.	$\log(X) + \log(Y) = \log(X*Y)$
172.	Here are some important facts about logarithms: the logarithm of 1 is zero	$\log(1) + \log(1) = \log(1*1) = \log(1)$ so $\log(1) = 0$ this is the same as saying $x^0 = 1$

173.	the logarithm of plus infinity is infinity	$\log(\infty) = \infty$
174.	the logarithm of zero is minus infinity	$\log(0) = -\infty$
175.	the logarithm to the base "e" of "e" is 1	$\log_e(e) = 1$
176.	the logarithms of negative numbers don't exist	log (-1) = Oops!

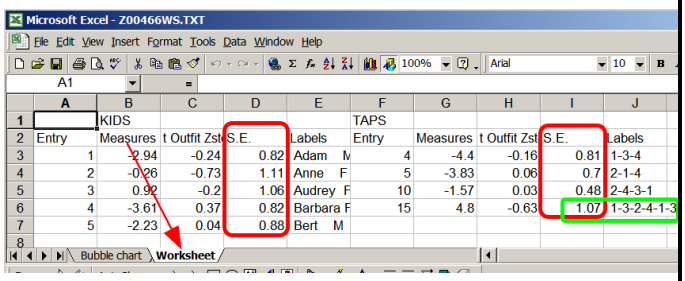
177 Appendix 4. Changing the size of Bubbles in Excel Bubble Charts (Pathway maps)

178 *This section is tricky ...*
The Excel plot displays. The bubbles are located vertically by measure and horizontally by fit. Their diameters are supposed to be twice their Standard Errors of measurement. But Excel has chosen its own bubble-sizing.



179 Click on the "Worksheet" Tab below the plot. The standard errors are in Column D for the persons and Column I for the items.

Look at the biggest bubble, item "1-3-2-4-1-3". Its "Model S.E." is 1.07, so that the bubble diameter = 2*S.E. = should be 2.14.



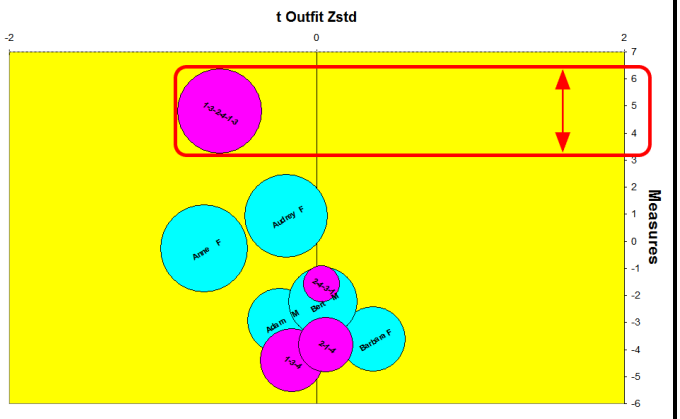
180 Click on the "Bubble Chart" Tab.

Look at the biggest bubble. Its diameter is currently about 3.1 on the vertical axis on my screen. That may be different on yours.

The bubbles is too large, 3.1 on the vertical axis instead of 2.1. This is because Excel plots relative, not absolute, sizes.

Let's use the Excel functions to correct the plot.

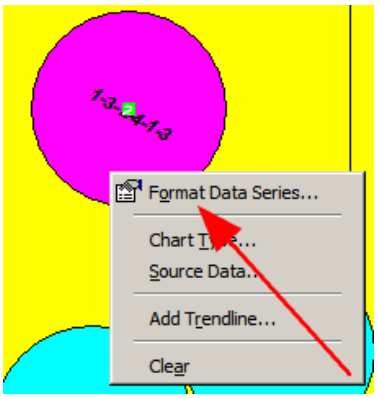
If you are familiar with Excel, turning on "Gridlines" helps with this.

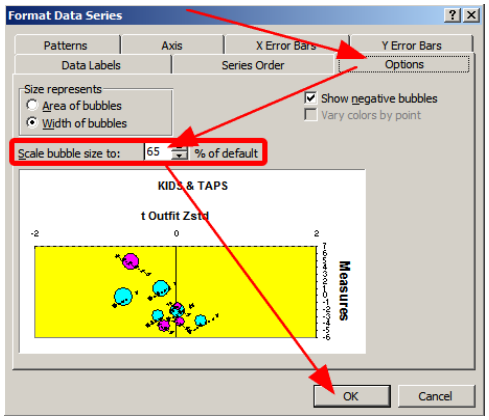
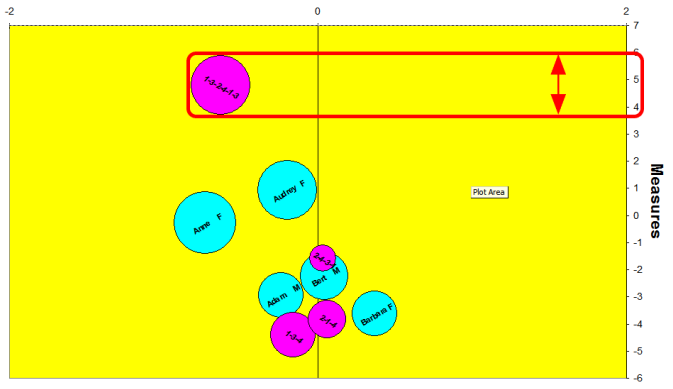


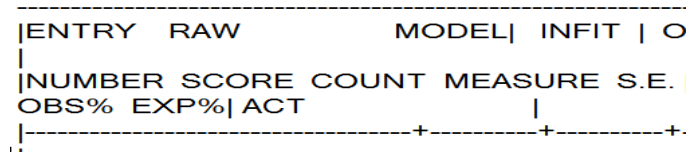
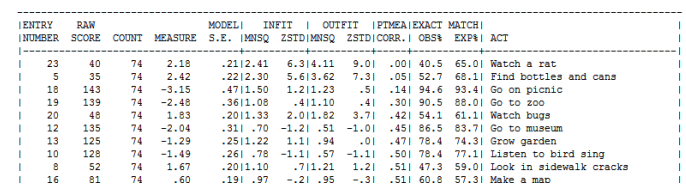
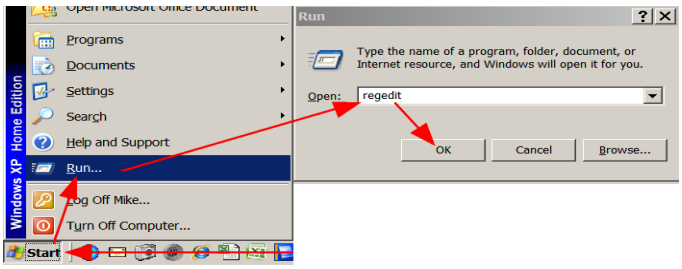
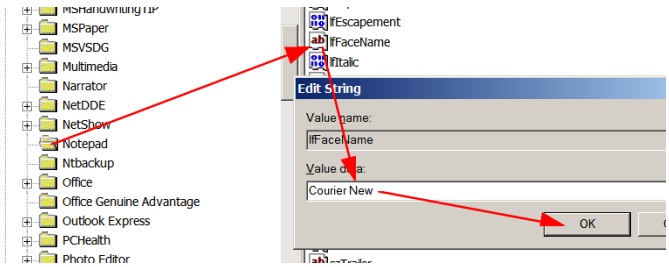
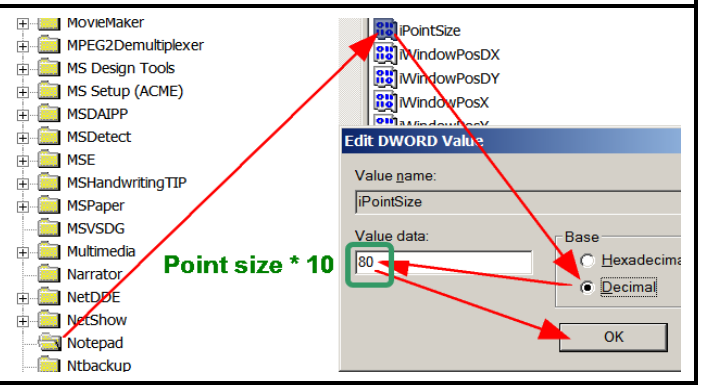
181 Right-click on the bubble.

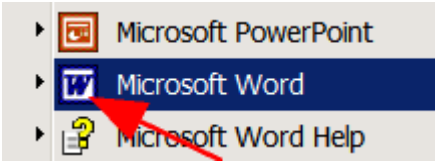
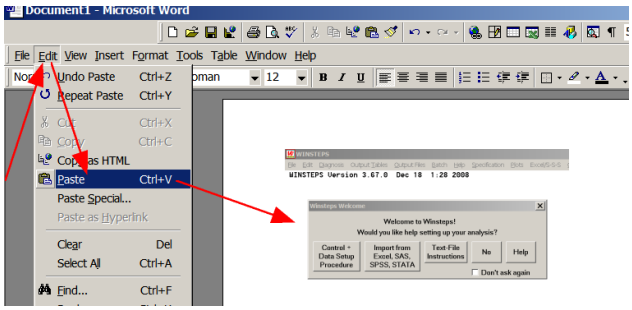
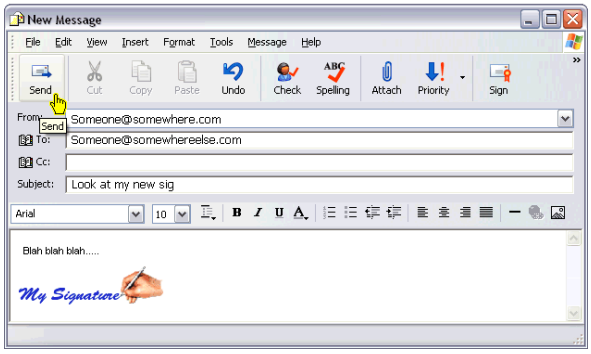
Click on "Format Data Series" (not "Format Data Labels" or "Format Data Points").

If "Format Data Series" does not display, move the mouse-pointer a little lower down in the bubble and right-click again.



182.	Click on "Options" tab "Scale bubble size to:" Type in a value to reduce the bubble size, such as "65" Click on "OK" All the bubbles change size. Excel rescales all bubbles by the same amount both when it originally displays the bubbles and when you rescale them.	
183.	And we see a much better looking pathway. The diameter of the biggest bubble is about 2.2 logits (vertically). *You may need to go back-and-forth several times adjusting the bubble size to get it to look right.* This is now your plot. You can beautify the plot using other Excel functions for coloration, layout, etc. See Bond & Fox Chapter 3 for a further explanation of this pathway.	

184.	**Appendix 5. Changing the text appearance in NotePad**	
185.	Oops! A Table may display too big or ragged or wrapped. We need to display this text in a fixed-space font, such as Courier New, and also a smaller font so everything fits in the window.	
186.	On the NotePad menu bar, Alt+O or click on Format pull-down menu Alt+F to change the Font Font: Courier New Font style: Regular Font size: 7 (You can type in values not listed) Click on OK	
187.	The Table now displays neatly *Alter the Font size if the Table is too big or too small.*	
188.	**To make permanent (default) changes in NotePad font face and/or size:**	
189.	Windows "Start" Click on "Run" Type in "regedit" Click on "OK"	
190.	Registry Editor: Click on the + in front of "HKEY_CURRENT_USER" Click on the + in front of "Software" Click on the + in front of "Microsoft" Click on "Notepad" For the type face: Double-click on "IfFaceName" Type in "Courier New" (or "Letter Gothic Line") Click on "OK"	
191.	For the font size: Double-click on "iPointSize" Click on "Decimal" Type in 80 (for point-size 8 multiplied by 10) Click on "OK" Close registry Click on top right ☒	

192.	**Appendix 6. Print-Screen, then email - in case of problems**	
193.	If you have a problem, and need to send me a picture of what is on your screen. Press the PrintScreen key on your keyboard This copies a picture of your screen on to the Windows clipboard	
194.	Open a new Word document	
195.	Then Paste (Ctrl+v) the clipboard into the document	
196.	Save the document Attach it to an email to me Be sure to tell me the exact section # in the Tutorial where the problem happens.