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Mathematics and statistics skills in the Social Sciences: dealing with deficits – 2007

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Outline

- Quants in the social sciences
- What's the problem?
- How it is currently supported
- The future.

Which are the Social Sciences

- ESRC covers:
- Area and Development Studies, Demography, Economic and Social History, Economics, Education, Human Geography, Science and Technology Studies, Linguistics, Management and Business Studies, Environmental Planning, Political Science and International Studies, Psychology, Social Anthropology, Social Policy, Social Work, Socio-Legal Studies, Sociology, Statistics, Methods and Computing

Benchmark documents

- Anthropology, Area Studies, General business and management, Communication, Media, Film and Cultural Studies, Criminology, Economics, Education Studies Geography, Health Studies, Hospitality, Leisure, Sport and Tourism, Linguistics, Politics and international relations, Psychology, Social Policy and Administration and Social Work, Sociology
- Main concern with numeracy and mathematics in Research Methods and Statistics.
- Show three forms of approach
  - Minimum - little mention
  - Basic research methods - the majority
  - Maximal - statistics, experimentation etc.

Minimum

- **Politics, Education, Social Anthropology, Area Studies.**
- **Little or no mention of research methods and little mention of quants**
- **Areas studies - no mention.**
- **Politics, research methods mentioned but left up to departments to decide how relevant.**
  - "Their [research methods'] weight and character cannot be prescribed except to say that these should be determined in the light of the requirements of the particular curriculum being taught."

Basic Research Methods

- **Students expected to study both quantitative and qualitative research methods with some basic statistics.**
- **Most subjects take this view - e.g. Human Geog., Sociology, Social Policy, Social Work, Biol. Anthrop., Business and Mgt., Criminology and Linguistics.**
- **Stats include descriptive and some correlation & χ^2**
  - Education - “have an ability to interpret simple graphical and tabular presentation of data and to collect and present numerical data”
  - Economics - “Numeracy, statistical and computing skills are necessary to handle this sort of information [tables, correlations, graphs]”
  - Sociology - “transferable skills in … statistical and other quantitative techniques”

Maximal

- **Psychology**
- **Modal benchmarks**
  - "Can pose, operationalise and critique research questions.
  - Can demonstrate substantial competence in research skills through practical activities.
  - Can reason statistically and use a range of statistical methods with confidence
  - Can comprehend and use numerical, statistical and other forms of data, particularly in the context of presenting and analysing complex data sets".

ESRC

- Research Methods Training Guidelines
  - All include reference to quant methods and statistics
  - Now compulsory (as MSc) for ESRC funded PhDs.
- Promotion of quantitative skills and PhDs
  - Set aside specific funding for quants PhDs
- Research Methods Programme and then Research Methods Centre and Nodes
  - To promote quant and qual methods at researcher and academic level.

What is the problem?

- Research Methods unpopular
  - However, survey at Huddersfield in 1992 showed this was found the most useful part of the degree by graduates.
- Anxiety about maths or statistics
- Lack of arithmetic ability in some (or sense of number)
- Avoiding if not compulsory
  - Choosing to do qualitative if possible
- Poor probabilistic thinking and logic
- Mulhearn and Wylie - teaching of quantitative methods is the "greatest pedagogic challenge facing UK psychology"

Numeracy in Psychology

- Mulhearn and Wylie (2005)
- Gave maths test to new students in 8 British universities.
- Found mean correct score was 13.75 out of 32 (43%)
- Some relationship between prior maths qualification and score
- Females consistently and significantly worse than males (N.B. 80% psychology students female)
- Common errors
  - Dealing with decimals
  - Algebra
  - Graphical interpretations
  - Probabilistic thinking

Dealing with Decimals

- Esp < 1
- E.g. don't know if 0.1 is bigger or smaller than 0.05
- Important for significance tests.

Table 4

Calculate each of the following:

√ 0.09	
Answers	%
.03	43
.3	17
.81	2
Other	12
No answer	26
0.02 x 0.12	
Answers	%
.0024	28
.24	27
.024	14
.06	3
Other	12
No answer	15
40 ÷ 0.8	
Answers	%
50	43
.5	10
320	3
.1	2
Other	24
No answer	19

Note: highlighted item is the correct answer

Mulhearn and Wylie cont.

- Used standard test questions (used in 1984 study)
- Could therefore conclude that:
- “Results suggest a marked decline in standards compared to previous studies”

Quantitative Methods in Sociology

- Williams 2002 survey of *teaching staff* (via depts., BSA conference delegates and consultation days)
- Feeling that there was a crisis of number in British sociology – unenthusiastic students, barriers to effective teaching.
- All depts surveyed offered at least some quants (5-15% of degree)
- BSA survey - 75% thought students took sociology to avoid number
- Two thirds thought sociology students not numerate

Williams on sociology

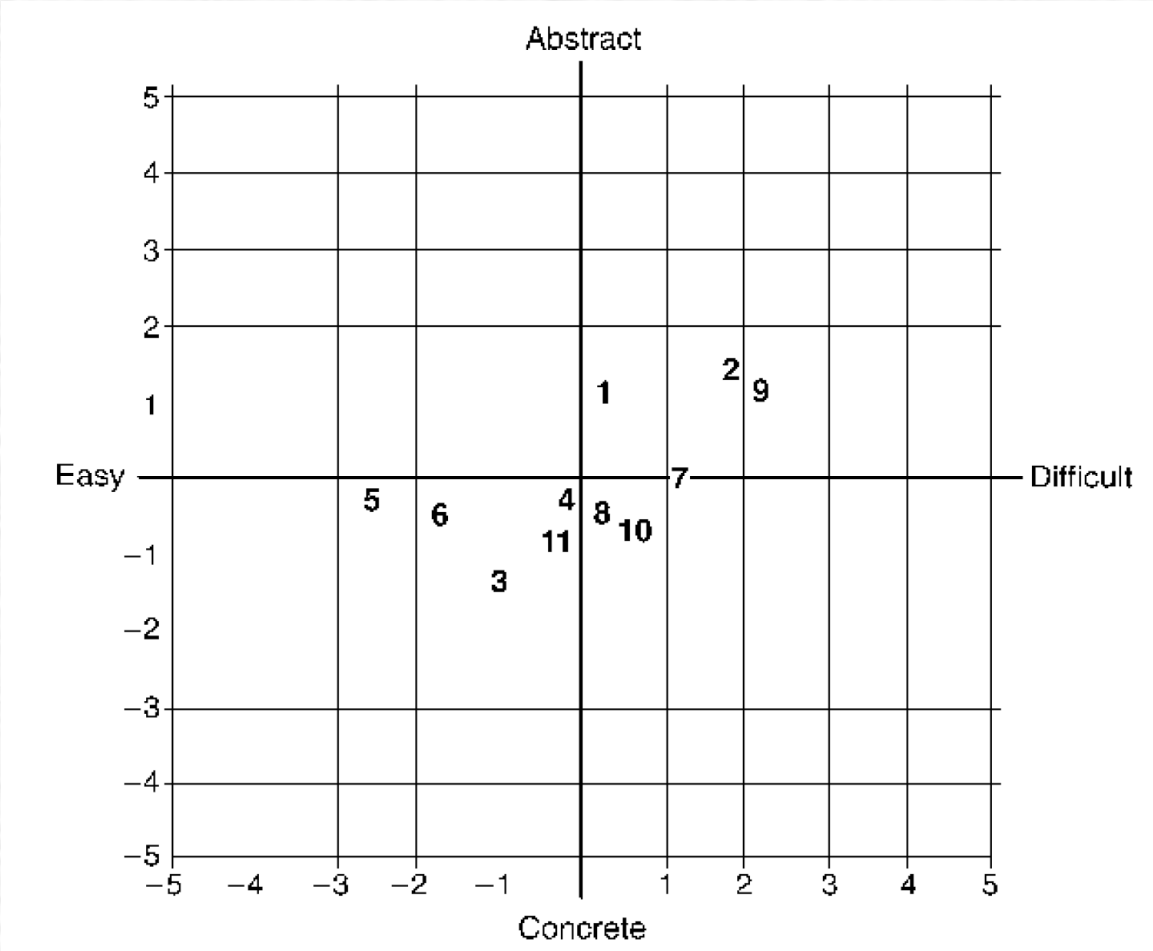
- Consultation days
  - beware bias because all were quants enthusiasts
- Students view quant research negatively
- Perceptions perpetuated by sociology lecturers
  - E.g. lecturer in qualitative methods begin with diatribe against quantitative methods.
- Students have negative view of their maths skills
- Problems include, level of language, nature of data used, shortage of qualified, motivated staff.

Education and Sociology

- Students in many disciplines dread stats courses
- There is much anxiety about stats.
- Murtonen and Lehtinen 2003 survey of education and sociology students in Finland. Small scale, n=34
- Stats and quant experienced as more difficult than other topics (e.g. main subject, language)
- Students see topics as hard and soft and see stats as hard

Murtonen and Lehtinen

1. Maths general
2. Stats general
3. Language
4. Res meths
5. Subject intro
6. Subject w'out methods
7. Stats s/w
8. Descript stats
9. Stats sig test
10. Quants methods
11. Qual methods



Murtonen and Lehtinen cont.

- Students unfamiliar with concepts and contents
  - E.g. difficulty of seeing that means and SD pictures a population
- Negative attitudes
  - Saw themselves as non-mathematical and not the kind of person who is good at stats.
- Students blamed:
  - Superficial teaching
  - Poor link of theory and practice
  - Unfamiliar and difficult concepts
  - Fragmented presentation of methods
  - Negative attitudes

Response: Different approaches to statistics

- Both in teaching and in textbooks
- How much calculation, arithmetic to expect
- Use algebraic fomulae or not.
- The “Black Box” approach - use statistics software (usually SPSS) to do calculation, focus teaching on its appropriate use and interpretation.

Textbooks

- The traditional approach
- Formulae and hand calculation
  - E.g. Howitt, D and Cramer, D (2005) *Introduction to Statistics in Psychology*. Harlow: Pearson. 3rd Ed.

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Calculation 5.1 continued

Table 5.1 Steps in the calculation of the standard deviation

Scores (X) (age in years)	Scores squared (X^2)
20	400
25	625
19	361
35	1225
19	361
17	289
15	225
30	900
27	729
$\Sigma X = 207$	$\Sigma X^2 = 5115$

Table 5.1 lists the ages of nine students (N = number of scores = 9) and shows steps in calculating the standard deviation. Substituting these values in the standard deviation formula:

$$\text{standard deviation} = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}}$$

$$= \sqrt{\frac{5115 - \frac{(207)^2}{9}}{9}}$$

$$= \sqrt{\frac{5115 - 4761}{9}}$$

$$= \sqrt{\frac{354}{9}}$$

$$= \sqrt{39.333}$$

$$= 6.27 \text{ years}$$

(You may have spotted that the standard deviation is simply the square root of the variance.)

In between

- Step by step calculations.
  - E.g. Robson,C (1994) *Experiment, Design and Statistics in Psychology*. Harmondsworth: Penguin. 3rd Ed.
  - Actually does have formulae, but includes them on the facing page.

Worked example

Standard deviation: method 1

Observations	Step 3 differences	Step 4 squared differences
4·5	−2·32	5·3824
6·0	−0·82	0·6724
7·4	+0·58	0·3364
8·2	+1·38	1·9044
2·1	−4·72	22·2784
6·5	−0·32	0·1024
5·4	−1·42	2·0164
9·3	+2·48	6·1504
10·8	+3·98	15·8404
8·0	+1·18	1·3924
Step 1 total = 68·2	**Step 5** sum of squared differences	= 56·0760

Step 2 mean $= \frac{68{\cdot}2}{10} = 6{\cdot}82$

Step 6 variance $= \frac{56{\cdot}0760}{(10-1)} = \frac{56{\cdot}0760}{9} = 6{\cdot}23$

Step 7 standard deviation $= \sqrt{6{\cdot}23} = 2{\cdot}5$

Stats without maths

- Actually means without arithmetic and algebraic formulae
  - E.g. Dancey, C.P. and Reidy, J (2004) *Statistics Without Maths for Psychology*. Harlow: Pearson. 3rd Ed.

The 'group' row is the between-groups statistics, and is the row of interest. Our analysis shows us $F(2,33) = 9.92$, $p < 0.001$. Remember in Chapter 5 we explained that a correlation coefficient could be squared in order to show the percentage of variation in scores on *y* accounted for by scores on *x*? Well, partial η^2 is a correlation coefficient that has already been squared. So in this case, we can simply read the number in the 'eta squared' column. The interpretation in the case of partial η^2 in this ANOVA is to say that 37.5% of the variation in driving ability is accounted for by which alcohol condition the participants were in

Tests of Between-Subjects Effects
Dependent Variable: driving ability score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
Corrected Model	145.167[a]	2	72.583	9.915	.000	.375
Intercept	1980.250	1	1980.250	270.500	.000	.891
GROUP	**145.167**	**2**	**72.583**	**9.915**	**.000**	**.375**
Error	**241.583**	**33**	7.321			
Total	2367.000	36				
Corrected Total	386.750	35				

a. R Squared = .375 (Adjusted R Squared = .337).

The 'error' row contains the figures relating to the within-participants variation

Levene's Test of Equality of Error Variances[a]
Dependent Variable: driving ability score

F	df1	df2	Sig.
.215	2	33	.808

Shows that the variances of the three groups are not significantly different from each other, therefore we have met the assumption of homogeneity of variance

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept+GROUP

Maths skills in the social sciences

Actually different kinds of skills

1. Symbolism and algebra
   - incl. number substitution
2. Numeracy
   - incl. calculation and sense of scale
3. Logic
   - e.g. probabilistic thinking, syllogisms, and Mill's agreement and difference.

2 and 3 are the most important for the social sciences.

Forms of support

- Use the ‘Black box’ method and deal with anxiety. Focus on interpretation, meaning and limits.
- Tutorial sessions - needs specific problems (otherwise no work because of anxiety)
- Central support or decentralised - Huddersfield has School learning support officers
- Students need re-assurance. Can do it and end course with confidence in ability.

The Future

- More quantitative and more popular
- A retreat from quants
- Dealing with the deficits
- E-learning

The ESRC wins

- More academics trained in and use quants
- Modern techniques (e.g. log linear analysis) used at undergrad level
- All social sciences as popular as psychology and can ask for maths on entry.
- Some hope with growth in interest in Mixed Methods Research
- Gorard - prob theory (hypothesis testing) not so impt. for much Soc. Sci. Instead, a relatively simple use of number in research.

Retreat from quants

- Growth in qualitative - “Turn to language”
- Means lack of quants skills in posgrads and hence new teachers, stats not taught or not compulsory
- Wider range of standards in the social sciences
- School syllabus changes to reflect this.

Dealing with deficits

- Support Centres
- More use of the ‘Black box’ approach
- Better stats software design and use of AI-based help systems
  - Appropriate tests selected and proper interpretations offered to users

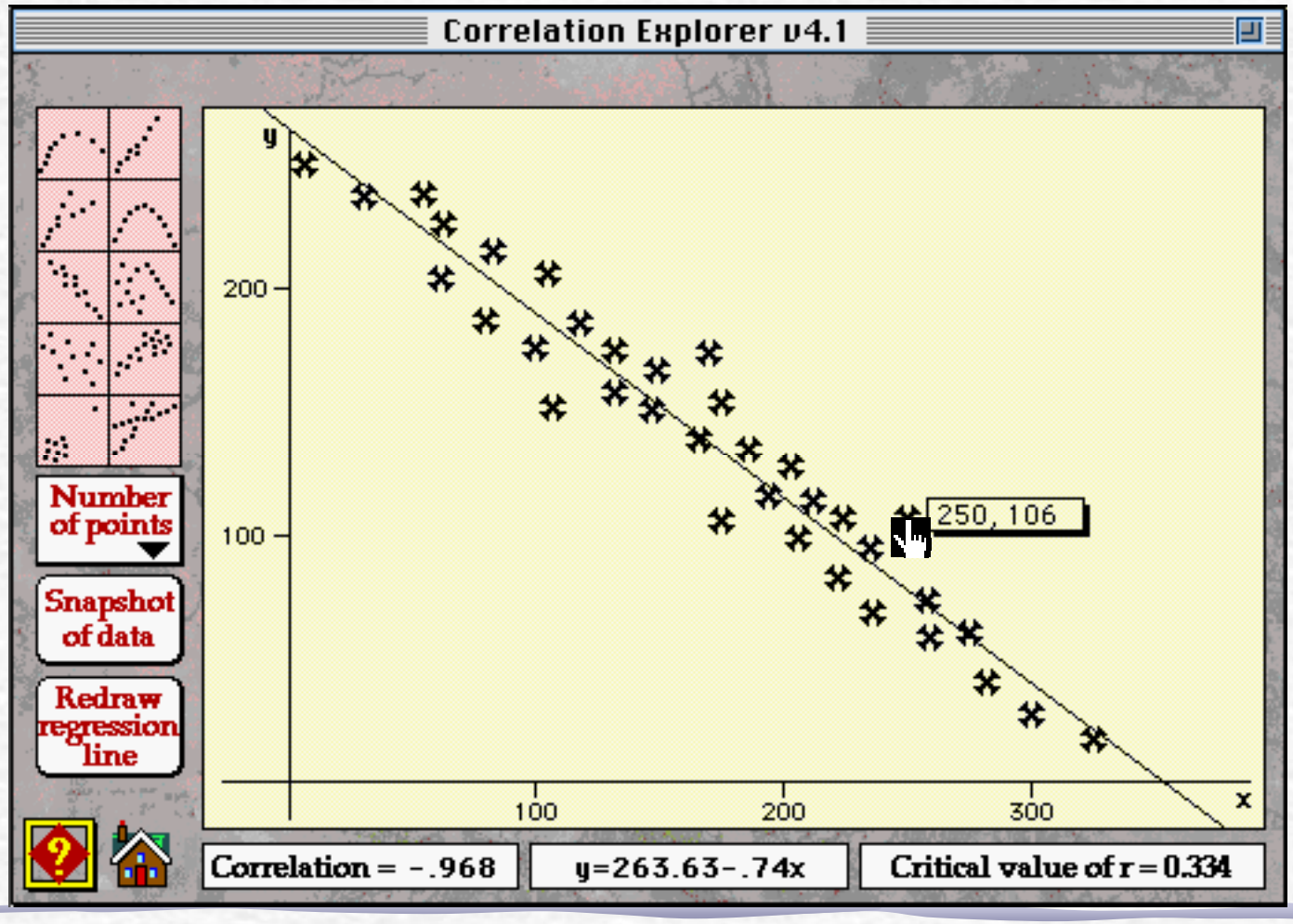
Better e-learning

- ESDS examples
  - But need to address undergrad learners rather than researchers.
- METAL, STARS, SIMPLE etc
- Needs clear underlying and integrating pedagogy.
  - Needs to reflect identified problems, e.g. innumeracy, no feel for number or scale, anxiety.
- Some examples
  - Correlation Explorer
  - RLO on descriptive statistics
  - RLO on crosstabulations

Correlation Explorer

Can change number of points and move them around

1995. Now Java version for web.



Descriptive statistics for interval and ratio scale data

RLO: Descriptive statistics for interval and ratio scale data

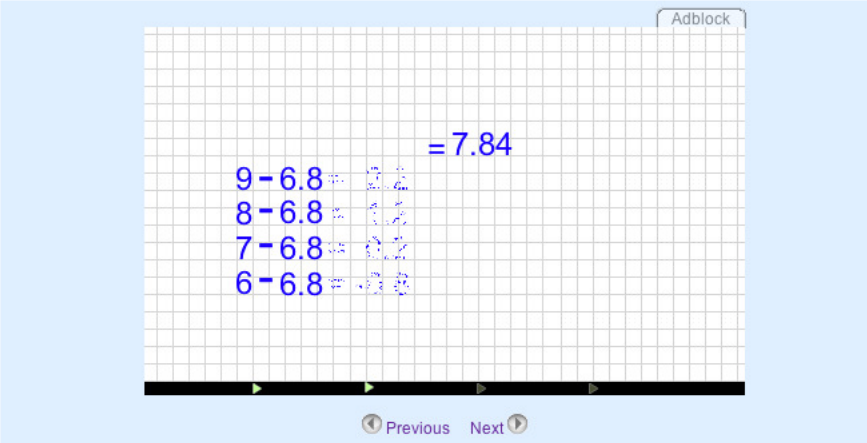
Introduction | Mean | Mode | Median | Measures of Dispersion | Standard Deviation | Activity | Assessment | Feedback | Resources

Standard Deviation

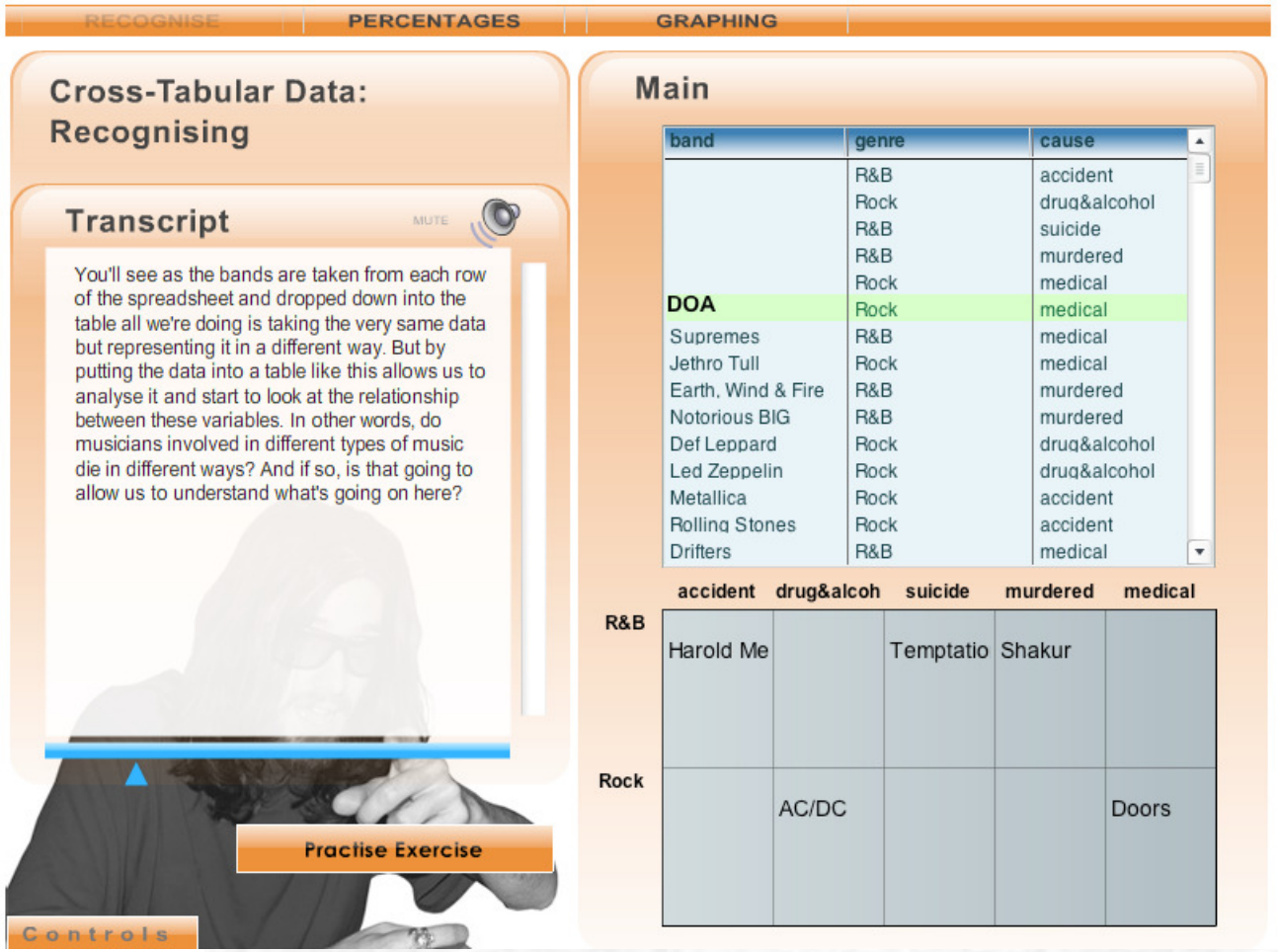
The standard deviation explores the spread of scores, and it does this by giving a value (the standard deviation, or SD for short) which is calculated by looking at the differences between individual values and the mean. Thus, with a small SD we would known that a lot of values are close to the average value. Whereas, a large SD would indicate that values are generally further away from the average value.

For those of you with a mathematical bent then the standard deviation is calculated firstly squaring the difference between the individual value and the mean. We do this for all values, and add them together. This (large) number is then divided by one less than the number of individual scores. Finally we take the square root of this score to get the standard deviation. Sounds complex, but then it does tell us more about the spread of scores than a simple examination of the range might do. It is possible that we could have two data sets which have the same mean, mode, median, and range - so we might be tempted to think they are the same. It is only when we look at the SD do we find if this is the case or not.

One final point. When researchers report their data they often tell us the mean for their interval or ratio scale data, and alongside this (in brackets) they will tell us the SD.



How to convert survey or experimental data into cross tabular data



Conclusions

- There is a serious problem in the social sciences
- In some subjects and some depts this means less quants is taught
- Move away from hand calculation to use of software
- Mixed methods makes quant more interesting
- E-learning has potential, but only if properly designed.