Appendix One

First Exploratory Study Interview Tasks and Short Course Outline

A1.1 First Interview Tasks

First Interview Tasks - Part 1

Question 1

A study categorized both alcohol intake (prior to pregnancy recognition) and smoking (during pregnancy) as "none", "moderate" or "heavy". The table below (Table A1.1) gives the probability of the given level of alcohol intake and smoking.

Table A1.1 Smoking and Alcohol Data for Pregnant Women

		Smoking			
		None	Moderate	Heavy	Total
Alcohol drinking	None	.232	.015	.024	.271
	Moderate	.314	.093	.122	.529
	Heavy	.127	.035	.038	.200
	TOTAL	.673	.143	.184	1

Given that a pregnant woman is a heavy drinker, the probability that she is a heavy smoker is:

(a) .2 x .184 (b) .038 / .2 (c) .038 / .184

(d) .2 + .184 - .038 (e) .024 + .122 + .127 + .035

Question 2

In question 1 the probability a woman is a heavy drinker, a heavy smoker or both is:

(a) .024 + .122 + .127 + .035 (b) .2 x .184

(c) .2 + .184 - .038 (d) .038 / .184

(e) .038 / .2

Question 3

During experiments to design an improved solar water heater a commercial heater was run for 16 days. The (%) collection efficiencies of available sunlight were:

41.6, 39.9 , 51.9, 43.0, 39.2, 37.5, 50.2, 41.3, 41.3, 39.7, 52.4, 44.9, 38.4, 35.0, 51.3, 43.5.

The mean $\bar{x}$, and standard deviation *s*, for this data set are:

(a) 43.19, 5.30 (b) 43.32, 5.64 (c) 43.19, 5.48

(d) 43.25, 5.30 (e) 43.32, 5.45

Questions 4 -6 concern the following sets of data.

A study investigated whether a special programme improved the reading ability of school children. Reading ability was measured by a "degree of reading power" (DRP) test after the programme had been running for 8 weeks. A class of 21 students formed the treatment group and another class containing 23 students (of the same age) which did not get the special programme, formed the control group. The test scores for the children are presented in the form of stem and leaf plots (Fig. A1.1) for each group.

Treatment group		**Control group**	
Units 2 | 4 = 24%		Units 1 | 0 = 10%	
1		1	0
1		1	7 9
2	4	2	0
2		2	6 8
3	3	3	3
3		3	7 7
4	3 3 3 4	4	1 2 2 2 3
4	6 9 9	4	6 8
5	2 3 4	5	3 4
5	6 7 7 8 9	5	5 5
6	1 2	6	0 2
6	7	6	
7	1	7	
7		7	
8		8	
8		8	5

Figure A1.1 Stem and Leaf plots on Reading Scores

Question 4

Which one of the following statements is **true**?

(a) Any significant increase found in reading ability in the treatment group is due to the reading programme because this is a controlled experiment.

(b) This is a controlled randomised experiment.

(c) Because the two classes consist of children of the same age, a comparison between the classes is fair and unbiased.

(d) We cannot conclude the special programme caused any significant increase in reading ability because no attempt has been made to make the classes comparable.

(e) Observational studies are ideal for proving causation.

Question 5

For the control group the depth of the median is:

(a) 11 (b) 110 (c) 12 (d) 120 (e) 13

Question 6

The quartiles for the control group are:

(a) (30.5, 53.5) (b) (28, 54) (c) (33, 53)

(d) (35, 50.5) (e) (28, 53)

Question 7

In *Time, 11 October 1993* there is a report from UNICEF that the incidence of malnutrition in children has declined. 60% of malnourished children are found in four countries, China, India, Pakistan and Bangladesh whereas in the rest of the world 1 in 5 children on average are malnourished. If these four countries make up 48% of the world's child population, what is the probability that a child chosen at random suffers from malnutrition?

(Questions 1 - 7 from Department of Mathematics and Statistics, 1993)

First Interview Tasks - Part 2

1. A roulette wheel has 18 black and 18 red numbers. The probability of a ball landing on a red is the same as landing on a black. A gambler observes the ball to land on red six times in a row, that is RRRRRR. What do you expect the next colour to be? (Adapted from Lovitt and Lowe, 1993)

2. Every year in New Zealand approximately seven children are born with a limb missing. Last year the children born with this abnormality were located in NZ as shown on the attached map (Fig A1.2). What do you think?

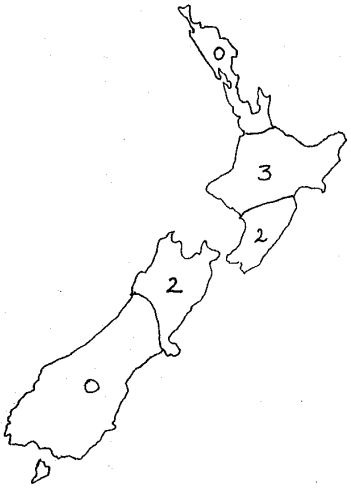


Figure A1.2 Map Question

3. A tourist is strolling around Auckland City without any particular destination in mind. She arrives at a crossroad and she has a choice of going straight ahead, left or right. What is the probability she goes straight ahead?

4. The Smith family has had three girls. What do you expect their next child to be? (Adapted from Lovitt and Lowe, 1993)

5. A small class was given a test on arithmetic and the results were recorded. The same test was given a few weeks later. Attached are box and whisker plots (Fig. A1.3) for both sets of results. Have the results changed much? If so, can you give any possible reasons?

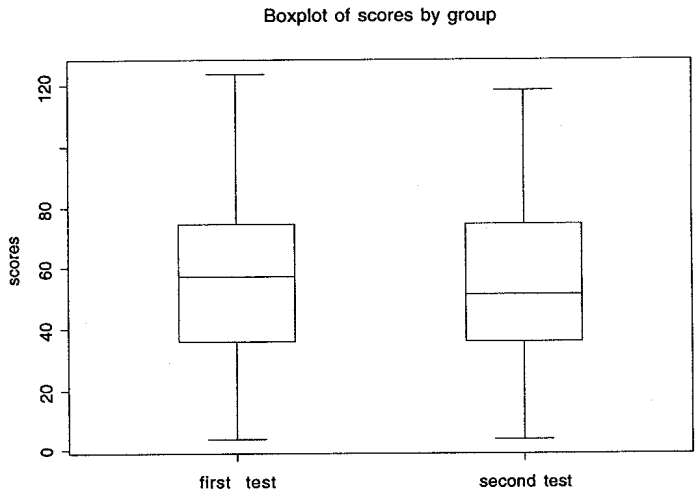


Figure A1.3 Test Results Question

6. A person chooses 1, 2, 3, 4, 5, 6 on their LOTTO card? What do you think about their choice?

7. A **fair** coin is tossed 50 times resulting in 27 heads. Two days later it is tossed again 50 times resulting in 30 heads. What do you think of these results?

8. A **fair** die is tossed seven times resulting in the outcome: 3,3,3,4,4,5,5 (order is unimportant). What do you think of these results?

9. At a nearby polytechnic, half the students are women and half are men. A representative for the student union wants to interview students about recent changes in government financial support for tertiary study. The rep wants to get a good representation of the students and goes to as many different areas on the campus as is possible. Three or four students are randomly chosen and interviewed in each place the rep visits. Out of the last 20 students interviewed, 13 are women and 7 are men. Now, you do not know the time of day it is, to which parts of the campus the rep interviews, do you think more will be women or men? Explain your reasoning. (Adapted from Garfield and DelMas, 1992)

10. After Question 9 has been answered.
What do you think of these possible answers?

(a) The rep seems to interview more women than men - perhaps women are more willing to share their opinions, or maybe the rep goes to areas of the campus where there are more women than men. Either way the rep is likely to interview more women than men in the next 20 students.

(b) Since there are 50% men and 50% women on campus, you would expect 50% men and 50% women in the sample. Since there have been more women than men so far, I expect the opposite to start happening. Out of the next 20 students the rep interviews, there will probably be more men than women so that things start to balance out.

(c) Half the students on campus are men , and half are women. So the rep has a 50/50 chance of interviewing a man or woman. It should not matter how many men or women the rep has interviewed so far. Out of the next 20 students interviewed about half should be men and half should be women.

(d) So far, the trend has been for the rep to interview more women than men. I would expect the same thing to happen in the next 20 interviews. The rep will likely interview more women than men in the next 20 interviews.

(Adapted from Garfield and DelMas, 1992)

A1.2 Second Interview Tasks

1. Your friend tossed a coin five times and got HHHHH. She said that she expected the next toss to be a tail. Explain to your friend why she thinks that way.

2. Explain to your friend what is meant by chance. Give some examples.

3. She asks you what is probability. Explain and give some examples.

4. She says " I don't believe in probability, because even if there is a 20% chance, it could happen. Even 1%, it could happen. I don't believe in probability." What would you say to her? (From Konold, 1991)

5. The probability of winning LOTTO is $\frac{1}{3838380}$. That is, "no chance" at all, yet someone always wins! Explain why.

6. On TV3 the weather forecast for rain in different areas is always expressed as percentages. If the forecast for Auckland tomorrow is a 70% chance of rain, what does the number tell you?
- How do you think this number is calculated?
- Suppose, in fact, it did not rain. What would you conclude about the statement that there was a 70% chance of rain?

Suppose you wanted to test how good TV3's predictions for Auckland were. You recorded what happened on 10 days for which a 70% chance of rain had been predicted.
- On 3 of those 10 days there was no rain. What would you conclude about the accuracy of TV3's forecasts?
- If TV3's forecasts had been perfectly accurate, what would have happened? What should have been predicted on the days it didn't rain?
- With what percentage chance?

(Adapted from Konold, 1989)

7. I was told this story about a person's disastrous day. First his son "wrote off" the family car and was seriously injured. Next, he was late for work and nearly got sacked. In the afternoon he got food poisoning at a fast-food restaurant. Then in the evening he got word that his father had died. How would you account for all these things happening on the same day? (From Konold, 1989)

8. On average there are 600 deaths due to traffic accidents each year in New Zealand. A person observed the following (Table A1.2):

Table A1.2 Data on Traffic Accident Deaths

February	**Number of Deaths**
Week 1:	3
Week 2:	12
Week 3:	21
Week 4:	14
March	
Week 1:	2

Assume that none of these weeks contain a holiday weekend. Suppose the headlines in the newspaper claimed that week 3 was a "black" week and police reported that speed was a factor. The next week was described in the papers as more evidence that New Zealand driving was deteriorating. At the end of week 5 the police congratulated themselves for the low death rate - their extra patrols had succeeded. What would you say to this person?

What would be sufficient evidence for you to accept that it was just variation?

9. In a firm at Wellington the management was concerned at the number of errors that office staff were making in transactions. The four office staff were audited every day over a month and the following box-and-whisker plots were obtained (Fig. A1.3). If you were the manager and had been presented with this graph what would you think?

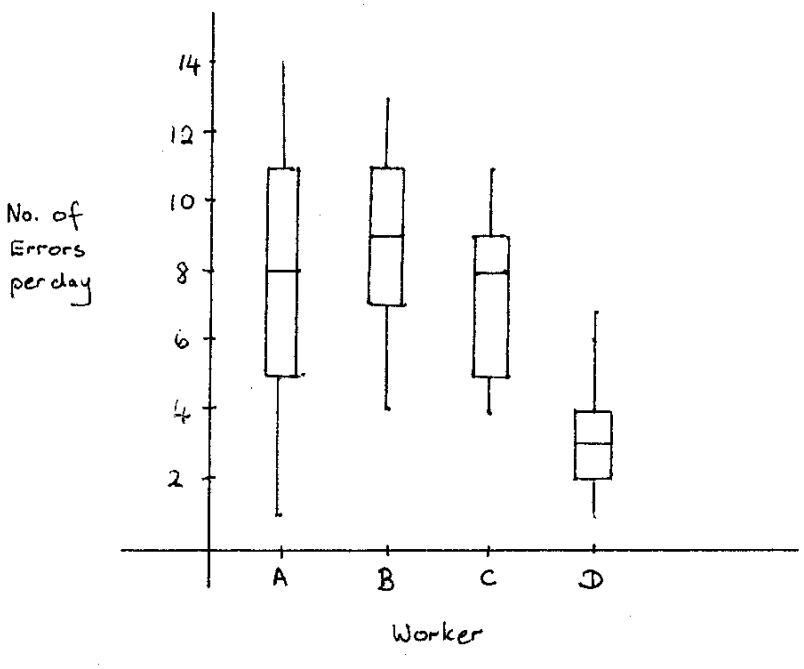


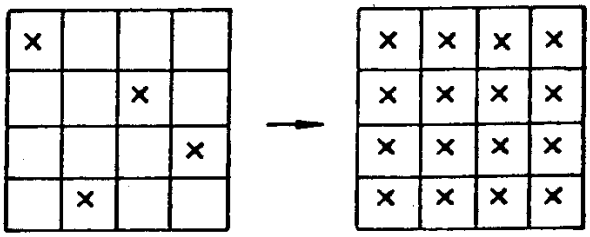
Figure A1.4 Error Rate Question

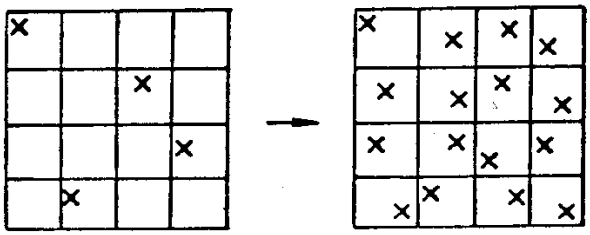
What would you do? You may assume that I am the office manager and could answer some of your questions?

10.

A garden bird-table is made up from a flat piece of wood supported on a pole. The surface is marked into 16 small square sections, like this:  It begins to snow. At first just a few snowflakes fall, then after a while more have landed.

Below are three sets of two pictures. Each set shows the pattern of snowflakes landing on the bird-table - first 4 flakes, then 16 flakes.

SET A 

SET B 

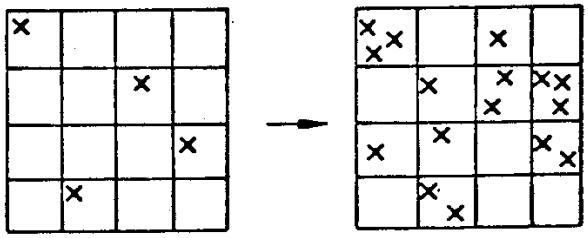
SET C 

Figure A1.5 Snowflake Patterns 1

Which one of these sets (Fig. A1.5) best shows the kind of pattern you would get as the snowflakes land? (From Green, 1982)

11.

Below are three sets of three pictures. Each set shows the pattern of snowflakes building up on the bird-table - first 4 flakes, then 16 flakes, then 64 flakes.

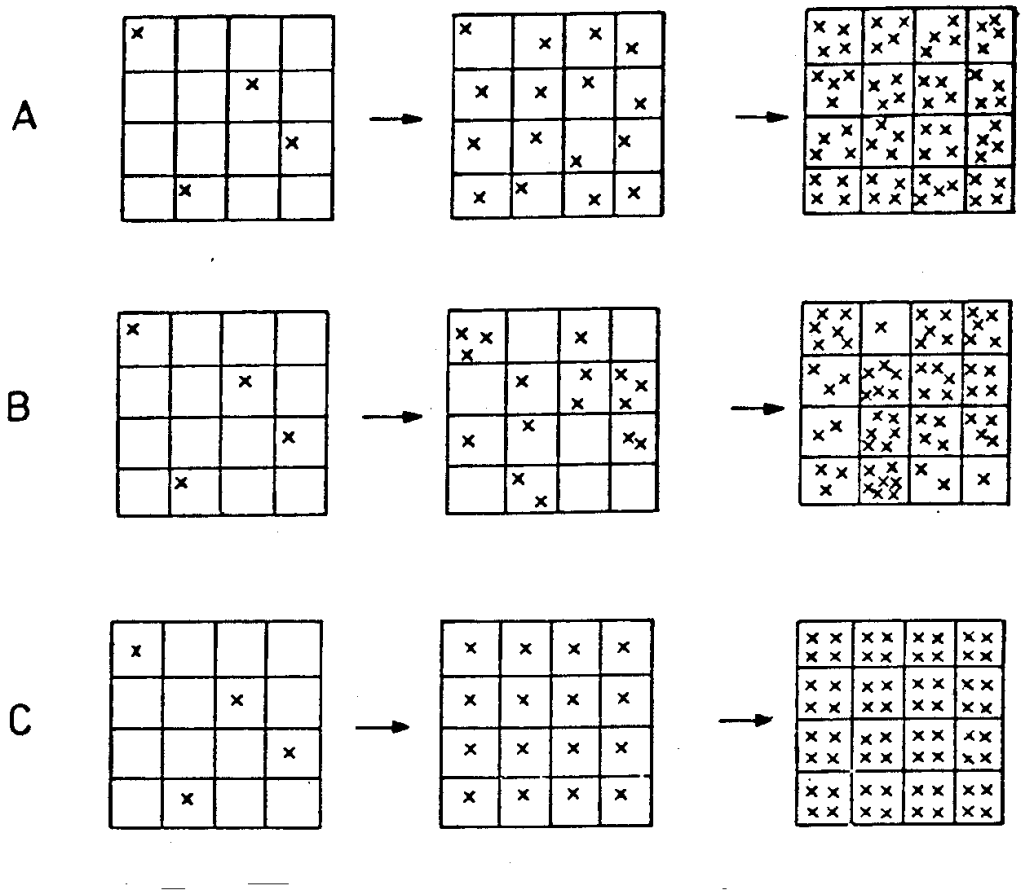


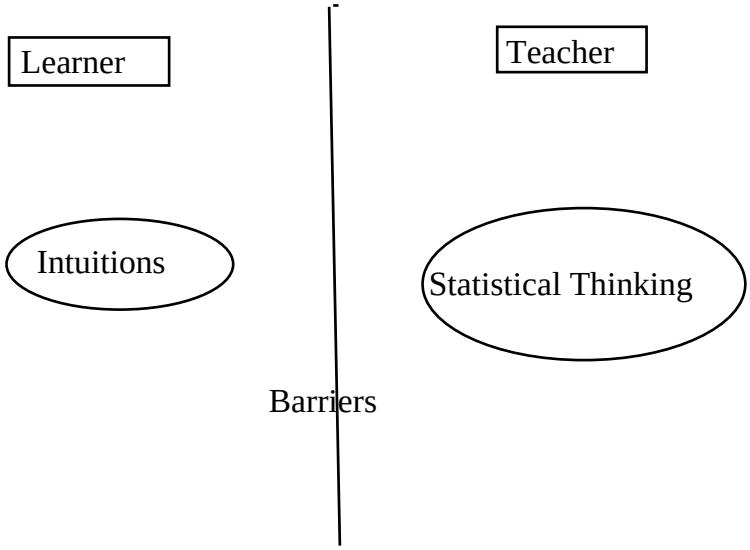
Figure A1.6 Snowflake Patterns 2

Which one of these sets (Fig. A1.6) best shows the kind of pattern you would get as the snowflakes build up? (From Green, 1982)

A1.3 Short Course Outline

Overheads used in short course as discussion points

First Overhead



Too few links between intuitions and the mathematical model

Figure A1.7 Intuitions and Statistical Thinking
(adapted from Borovcnik and Bentz, 1991)

Second Overhead

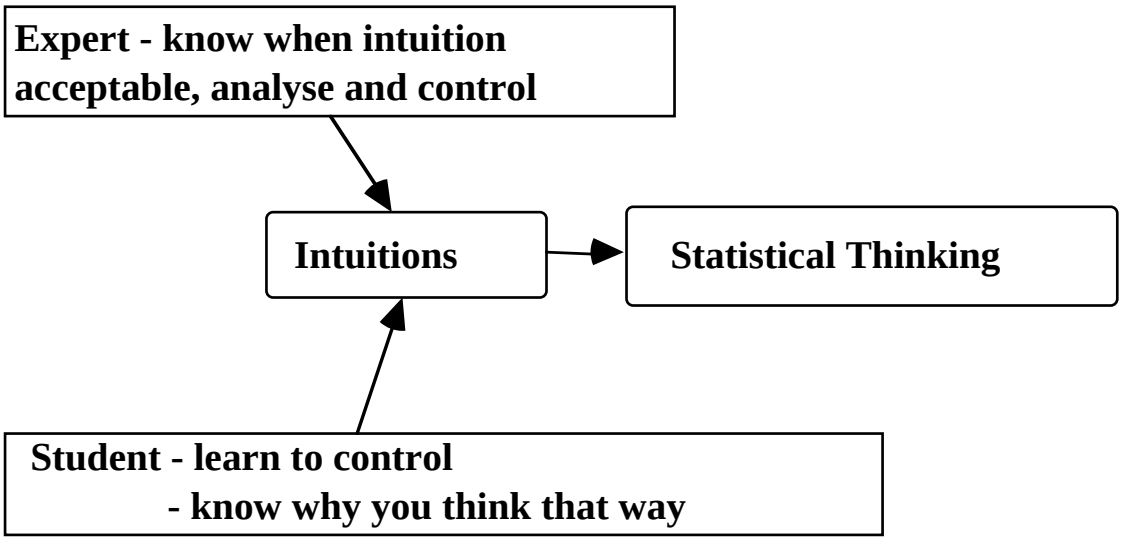


Figure A1.8 Using Intuitions

Third Overhead

Einstein

God does not play dice
Statistical laws were based on a causal reality

Late 19th Century

Chance was recognised as a fundamental aspect of the world in a way that it was not before.

Today

probabilistic revolution
shift in world-view from a deterministic description of reality

Students

expect the world to be deterministic
variation is unexpected and uncomfortable
public discourse is in statistical language
private musings in deterministic habits of thought

Teaching

might be a firm psychological basis for the historical persistence of determinism
transform the private musings

Fourth Overhead

MAIN IDEAS

USE STATISTICAL THINKING IN ALL SITUATIONS

Variation

Concepts of uncertainty are introduced partly because we are ignorant of the multiplicity of variables affecting our data and because there is error in our measurements. It accounts for human short comings. We view chance (variation) as an irreducible part of natural phenomena.

If we draw samples from a population we will see a lot of variation between the small samples, whereas in large samples we will see less variation between the samples.

We expect a random sample/small sample to be a representative sample.

Disregarding chance fluctuations (variation) we expect population proportions to be globally represented in every sample irrespective of size.

Fifth Overhead

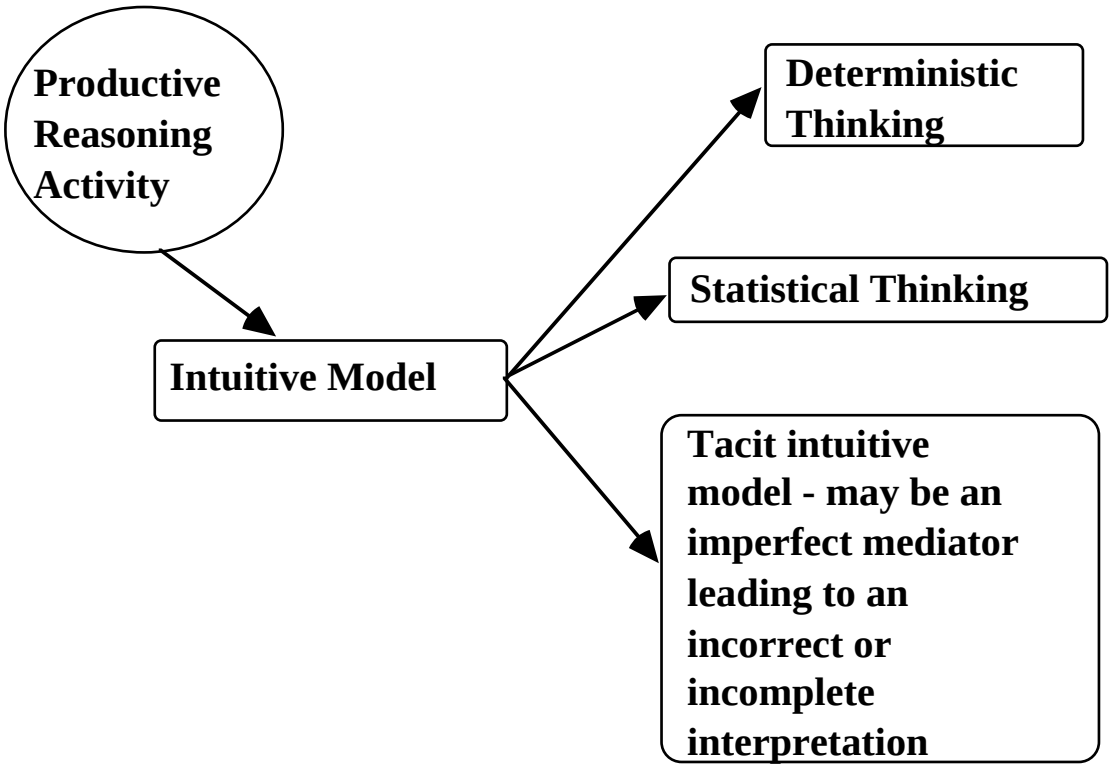


Figure A1.9 Intuitive Models and Thinking

PROGRAMME

9.30
An overview on thinking deterministically and probabilistically (use overheads as discussion starters).

10.00
The test problem
Get at the idea of variation
Sat a test, obtained 75%. If they sat test on another day would they get exactly the same result? Why not? (Refer to SC markers)
Reasons - deterministic and statistical.

Netballer example. Was in an important game. Average rate was 0.8 for getting a goal. Missed a shot 3 times.
Reasons - deterministic and statistical.

Measuring a page length. Get students to measure page width. Measurements are not exactly the same.
Reasons - deterministic and statistical.

Class think of examples.

What do we mean by statistical thinking, by chance, by variation? (Refer to OHT)

Local versus global thinking.

Do computer simulations on height.
Do computer simulations on test results.

What do we "notice"?

(OHT from Galton's notes)

TAPE ON FOR REFLECTIONS (or would they prefer to write?)
What have I learnt? What are my reactions? Reasons for my reaction? What questions do I still have?

10.30
Maps of NZ
Reasons -Deterministic and Statistic

Set up assumptions
Throw dice 7 times - record on map.
Use random number tables - record on map
Use computer simulation - record on map

Compare results with rest of group.

What do we "notice"?

Why was our original thinking incorrect?
(Idea that the prob. is very small here?)

Bring in idea that a small sample is not a representative sample.

Computer simulation of larger sample.

TAPE RECORDING OR WRITING FOR REFLECTIONS on my learning.

11.15 Break

11.30
Set up the coin problem (OHT)
Take a vote. Stress that both arguments seem to be logical and yet both cannot be correct.

Coin simulation. Each student try 20 times to get a run of 4 heads - then record once have got the four heads.

Computer simulation.

Logically work out why with a tree diagram.
Notions of independence, conditional probability, long run frequencies.

TAPE RECORDING OR WRITING for reflections.

12.30 - 1.15 Lunch

1.15
Roulette wheel problem
Discuss answer and possible tacit models we were using that lead to incomplete interpretation.

Smith family
Reasons - deterministic and statistical
Deterministic - one does not codify statistically - may believe that 4th child will be a girl with prob. 0.9 - if reaffirmed 50% of the time that is good enough.

Interview problem
Reasons - deterministic and statistical

TAPE RECORDING OR WRITING for reflections.

2.00
LOTTO problem
Reasons - deterministic and statistical

Discuss
The probability of winning is very small but someone wins.

How can we think about choosing 1 2 3 4 5 6 so it makes "sense"?
As human beings we look for patterns and think it is unusual if it occurs because we recognise it.
Look at past LOTTO results and discuss.

2.35
Sum up (OHT)
Review beginning OHTs.
Looking forward to rest of 26.181

3.00
TAPE RECORDING OR WRITING for reflections