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Appendix A

Instructions and Written Test for Study 1

Following are the instructions which were given verbally to the students before they completed the written test in the pilot and main stages of Study 1.

Instructions to Candidates

1. Thank you for doing the test.

2. This is not a test for school in any way. No-one at school will see your results. In fact there are not even marks awarded for your answers.

3. The purpose of the test is to help us find out how students think about statistics. So you will find that on this test there are no right and wrong answers.

4. It will be a problem if you give no answer, so please try to write something for every question. If you cannot answer the question try to explain why.

5. If any part of the test is unclear, please put up your hand and don't be afraid to ask about it.

6. Do not rush the test, you will be given as much time as you require.

7. The test is all about statistics, so could we please just look at the warm up. Write your name, age, school year and sex on the first page.

8. Then go on to answer part (ii) of the warmup. (Some encouragement may need to be given to those reluctant to write anything, mostly for fear that it is WRONG.) Now try part (iii).

9. When you are ready to go onto Question 1, please start a new page and write the question number and your name at the top of the page. Then start each new question after that on a new page with the question number and your name.

Following is a copy of the written test as used in the pilot and main stages of Study 1.

WRITTEN TEST

Answer all questions to the best of your ability. There is no right or wrong answer, it is your thoughts which we are interested in.

Please provide an attempt for every question.

WARM UP

(i) At the top of your page please write your name, age, school year and sex.

(ii) You've heard the word 'statistics' before. What does this word mean to you ?

(iii) If you were learning about statistics at school what would you expect to be learning about ?

QUESTION 1

PART I

Radio stations have their own way of working out the most popular song on the radio and they often produce Top 40 charts Imagine that you have been asked to do this independently of the radio station and answer the following questions :

(i) Describe the best way to find out what the most popular songs are on the local radio station.

(ii) Why did you decide to find out this way ?

PART II

There are often surveys of the community to see what T.V. programs they like to watch. The editor of the school magazine is interested in writing an article about the viewing habits of the students at A.H.S. and asked you to find out the information.

(i) You are only able to ask 30 students from the school. Which students would you select to ask ? (Don't use names)

(ii) Why would you select these students ?

QUESTION 2

PART I

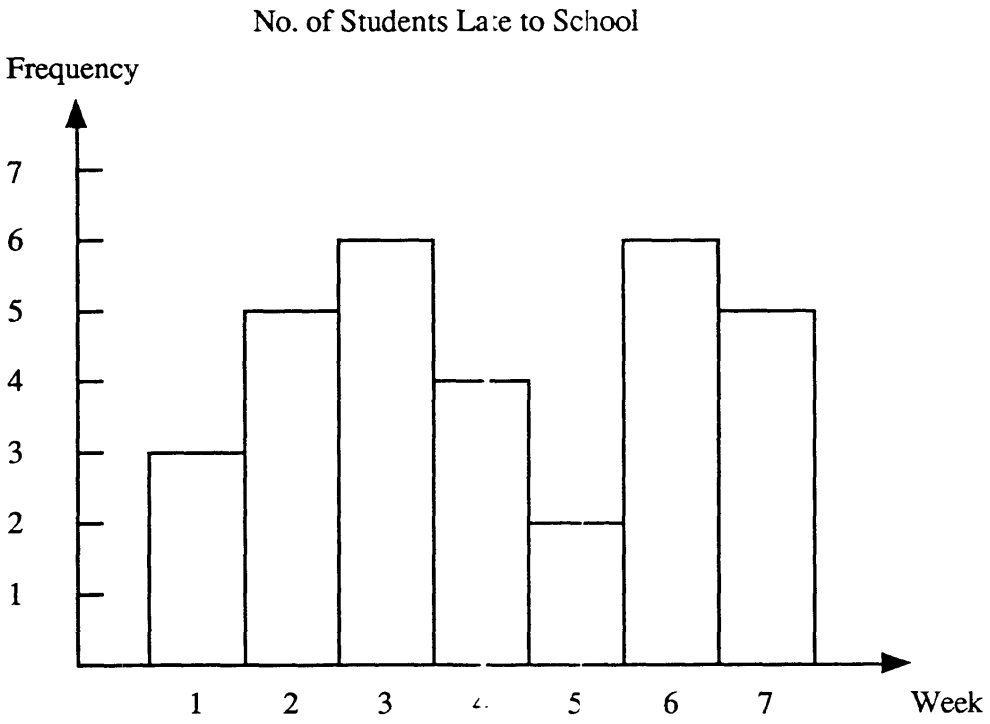
A class teacher wanted students to practice collecting data. One Year 8 student decided to collect data concerning the number of icecreams that she ate during a week for a seven week period. The table the student came up with is given below.

Week 1	3
Week 2	5
Week 3	7
Week 4	4
Week 5	2
Week 6	7
Week 7	5

What does the table tell you ?

PART II

The deputy in the school kept a record of the number of students who were late to school each week. He decided it would be useful to draw a graph to illustrate the information. The graph is presented below.



What does the graph tell you ?

QUESTION 3

PART I

As part of a large project which had to do with measuring and discussing the human body, one of the tasks was to measure the lengths of people's left feet to the nearest centimetre. The results of the 29 students in the class are as follows :

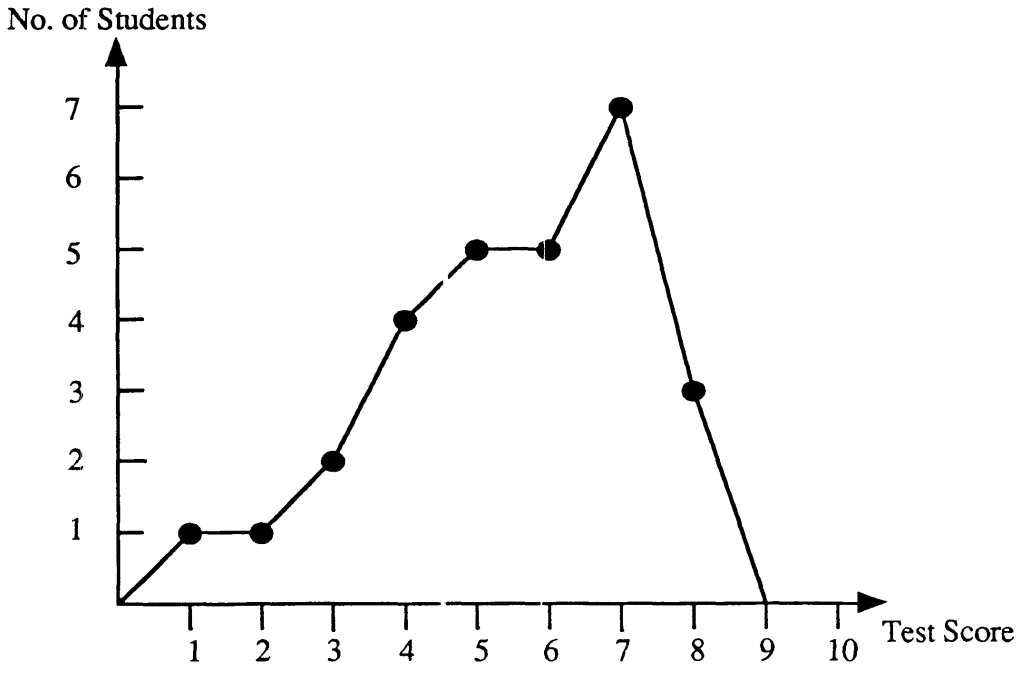
26	26	26	27	27	27	27	28	28	28	28	28	28	29	29
29	29	29	30	30	30	30	30	30	30	31	32	32	33	

(i) If you were asked to give a number, or numbers, (to the nearest cm.) which could be best used to represent the size of the left feet in that class, what numbers, or numbers, would you select ?

(ii) Give reasons for your selection.

PART II

A teacher was interested in how students performed in a spelling test to decide whether they needed extra help. The graph below represents the scores out of 10 achieved by the 28 Year 9 students in his class in the spelling test.



(i) If you were asked to give a number, or numbers, which could be best used to represent the score in the spelling test of students in that class, what numbers, or numbers, would you select ?

(ii) Give reasons for your selection.

QUESTION 4

PART I

A well known intersection in Armidale has had a number of serious accidents. The number of serious accidents was recorded for the last ten years.

1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	4	5	9	3	6	7	10	4	6

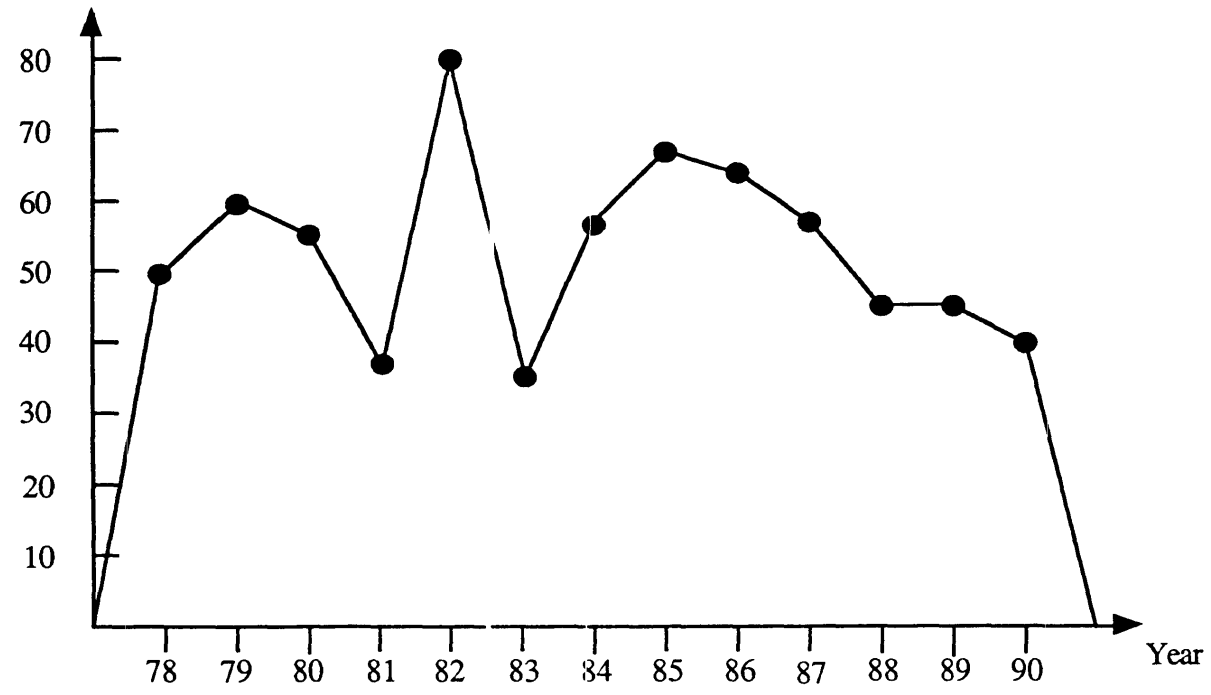
(i) Describe any pattern that you can see in the data.

(ii) Approximately how many accidents would you expect in 1991? Why?

(iii) Suggest some years in the future (after 1990) when you think the number of accidents might exceed 8. Why did you select those years?

PART II

Armidale is fairly well known throughout N.S.W. for its cold weather. The number of actual frosts per year have been recorded for the last 13 years in Armidale and the results are presented in the graph below.



(i) Describe any pattern that you can see in the data.

(ii) Approximately how many frosts would you expect in 1991? Why?

(iii) Suggest some years (after 1990) when you think the number of frosts might exceed 60. Why did you select these years?

Appendix B

Statistics Components of Mathematics Syllabuses for N.S.W. Department of Education

Syllabus Years Year 7 - 8. Board of Secondary Education N.S.W. 1989

S1 Interpretation of graphs used by the community

To be able to:

- appreciate the wide range of graphs used in newspapers, magazines, journals
- recognise the features of a graph, such as:
  - title
  - scale
  - symbols
  - axes
  - specific content
  - relationships between variables
- read and interpret various types of graphs (showing discrete and continuous data) such as:
  - picture graphs
  - column graphs
  - histograms
  - bar graphs
  - composite column/bar graphs
- realise graphs are an effective form of communication.

S2 Interpretation of tables, charts

To be able to:

- read and interpret data from a table or chart
- pose questions from tables and charts
- extract appropriate information to solve problems.

S3 Collection of data:

Types of variables

Sampling versus census

To be able to:

- distinguish between discrete and continuous data
- distinguish between a sample and a census; decide which is more appropriate
- understand meaning of random sampling
- conduct a simple frequency distribution table
- detect a biased sample.

S4 Analysis of data:

Mean, mode, median and range of data

Strengths and weaknesses of these

To be able to:

- find the mean, mode, median and range using discrete data
- use mean, mode, median and range to compare data.

S5 Presentation of data:

Displayed in various equivalent forms

To be able to:

- present statistical data in the form of:
  - frequency tables
  - histograms
  - pictograms
  - column graphs
  - frequency polygon bar graph
  - sector graph
- select and draw an appropriate graph to represent given information.

S6 Misuse of data

To be able to:

- identify graphs and data that are misleading
- detect incorrect use of graphs,
  - eg displaced zeros
  - irregular scales
- question the techniques used for data collection,
  - eg questionnaire bias
  - small random survey.

S7 Prediction

To be able to:

- make predictions about a total population from a sample
- make predictions from scatter diagrams.

Syllabus Years Year 9 - 10. Board of Studies 1984

Advanced Course - Core Topic

9. STATISTICS AND PROBABILITY

9.1 Ways of recording and presenting collections of data.

9.2 Interpreting information from data

- central tendency: mean, median, mode.
- spread of data: range, standard deviation.

Use of this information from sample data to estimate properties of a population.

9.3 Simple experimental probability.

9.4 Concept of theoretical probability.

9.5 Use of counting techniques. Dot and tree diagrams.

Intermediate Course - Core Topic

Content is as for the Advanced Course except that the topic is numbered 7, rather than 9, as for the Advanced Course.

General Course - Optional Topic

5. STATISTICS

Emphasis should be on collection of data by pupils and practical experiments should be a feature of this work. Examples should be confined to discrete units.

Principles of sampling.

Collection, tabulation, illustration and interpretation of data. Pictorial, divided bar, column, line and simple sector graphs.

The mean or average as (sum of scores) ÷ (number of scores).

Simple notions of probability based on real life situations.

Syllabus Years Year 11 - 12. Board of Studies 1981

2 Unit Mathematics in Society - Core Topic

1. Elementary Statistics.

Preamble.

This course thoroughly reviews the statistics encountered in Years 7 to 10. It is expected that concepts, skills, and knowledge would be revised and developed through student involvement in practical activities.

(a) What is Statistics?

(i) Historical background should be discussed. Today, statistics is important in our daily lives. It figures prominently in advertising, manufacturing, education, politics, science, agriculture, marketing, and many other fields, e.g. radio and television ratings, newspaper circulation and statistics associated with sporting teams.

(ii) During such discussion the concepts of sample and census could be revised.

Students should be led gradually to the concept of statistics as scientific methods of collecting, recording, and presenting data from which future trends can be predicted, or as a basis for making decisions and drawing valid conclusions.

(b) Collection, Tabulation and Illustration of Statistical Data

As statistics is the collection, organisation and analysis of data, the approach should be practical.

(i) Students should be involved in surveys and experiments through which the work previously encountered on tally marks, frequency tables, cumulative frequency, relative frequency (and probability) and cumulative relative frequency can be revised.

Surveys and experiments should involve discrete and continuous variates and the necessity for treating some of the resulting data as grouped data should arise naturally from the surveys and experiments.

Some of the results should lead towards a normal distribution and yet others to asymmetric or constant distributions.

(ii) It is not intended that this section on illustrating data should follow that on collection and tabulation of data; rather it is hoped that these would be developed together. Students should encounter the use of pictorial, bar, sector, column and line graphs, examples of which can be collected by the students themselves. Discussion should follow of correct and incorrect use of such graphs, particularly in advertising. Histograms and polygons should be dealt with for both discrete and grouped data. It is expected that students will not only be able to construct frequency and cumulative frequency diagrams, but also be proficient in interpreting and discussing such diagrams.

The data collected, tabulated and illustrated in this section should be retained for analysis throughout the course.

(c) Analysis of Data.

(i) Measures of Central Tendency.

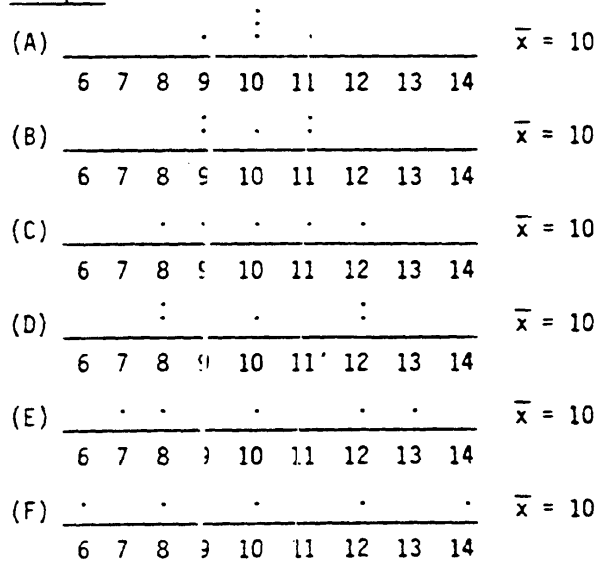
Using results of experiments, calculations of the mean, mode (or modal class) and median can be carried out. Students are allowed to use calculators into which a set of data may be fed in order to obtain a mean directly. It should be noted that the median for grouped data is most conveniently obtained using a cumulative frequency polygon. Students should also be aware of the fact that the information conveyed by the mean alone is incomplete and that it is useful to report other information about the data as well, e.g. its range.

Some of the advantages and disadvantages of the three measures of central tendency should be discussed through the use of suitable examples. It is not intended that students would deal with skewness to much depth. It will be sufficient if they can recognise whether a distribution is skewed positively (to the right) or negatively (to the left), and if they have examined empirically the relative size of means and medians in each case.

(ii) Measures of Dispersion.

It should be understood by students that the usefulness of a "central" measure of a distribution depends upon the degree to which the distribution is scattered about its "centre" and the extent to which it departs from symmetry. This could be done by considering a number of sample frequency distributions which have the same sample mean but can be seen, intuitively, to be spread differently.

Example



It can be observed that scores (B) are spread more from the mean than scores (A); (C) is spread more

than (B); (D) more than (C); (E) more than (D); and (F) more than (E). The concepts of range, interquartile range, mean deviation, variance and standard deviation as measures of spread can now be developed.

Range: The range which may be defined as the difference between the largest and the smallest scores will indicate that (C) and (D) are more widely spread than (A) and (B) but cannot distinguish between the spreads of (A) and (B) or (C) and (D). Since the range only takes into account the extreme scores and ignores the possible concentration of scores around a typical value it appears to be of limited usefulness. It is of value as a measure of spread in a variety of situations such as in weather reporting and with climatic data where temperature ranges are quoted, and in industrial quality control where the range may be used, for example, in quoting the expected life of an electric light bulb.

Inter-Quartile Range: Just as the median divides a set of scores into two equal parts, the quartiles divide a set of scores into four equal parts. There are three quartiles; the interquartile range is the difference between the upper and lower quartiles and the middle quartile is the median. The interquartile range is used to describe the spread of the middle half of a set of scores and, depending on the distribution, may or may not satisfactorily describe this spread.

Deviation and Mean Deviation: Through examples students should see the need for measures of dispersion other than range and interquartile range, e.g. the mean scores on two different sets of algebra tests are both 50 (each test having the same number of possible points). If you score 70 on one test and your friend scores 76 on the other one, does your friend rank higher on his test than you do on yours? In such a situation, the way in which the scores are scattered about their respective means is needed to be able to justify a decision.

The difference between a score and the mean is called the deviation of that score. Students should observe that the sum of the deviations for a distribution is always zero. The mean deviation for the distribution is obtained by calculating the average of the absolute values of the deviations. For the example with the dot diagrams, the mean deviations for (A) to (F) are 0.4, 0.8, 1.2, 1.6, 2.0 and 2.4. It should be noted that in practice deviations are calculated about the median rather than the mean. Students can observe that there is a statistic which places the groups in the order that intuition suggests. Students should calculate mean deviations for the data of their surveys and experiments to consolidate this (especially for data where spreads are difficult to distinguish intuitively). The formula $\Sigma|x - \bar{x}|$ could be introduced although students would not be expected to use it in calculations.

Variance: The variance of a distribution is the average of the squares of the deviations.

The use of the squares of deviations, rather

than their absolute values, should be discussed. Students should verify empirically that variance is a satisfactory statistic for ordering groups of data with regard to their spreads. The formula $\frac{\Sigma(x - \bar{x})^2}{n}$ could be introduced.

Standard Deviation: Standard deviation of a distribution is the square root of variance. Calculation of a sample standard deviation could be based on the formula

$$s = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n}}$$

or students could be taught to use the appropriate keys on a calculator. An estimate of a population standard deviation based on a sample may be calculated from $\sigma = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}}$. It is not intended however, that any mention be made of degrees of freedom in this course. In explaining the use of standard deviation, mention could be made of Chebyshev's theorem: for $h > 1$ at least $(1 - \frac{1}{h^2})$ of all scores lie within h standard deviations of the mean. Thus, at least 3/4 of all scores would be within 2 standard deviations of the mean, irrespective of the form of the distribution.

Standard deviation is used to advantage in sampling theory and appears in other branches of mathematics as well as in the sciences, where it is usually known as "the root-mean-square deviation".

Pupils should verify empirically from the data that they have obtained as the result of surveys that approximately 2/3 of the population lie within one standard deviation of the mean, that is within the interval $\mu \pm \sigma$. Also they should verify that approximately 95% lie within 2 standard deviations of the mean, that is within the interval $\mu \pm 2\sigma$. Similarly, approximately 99% of data lies in the interval $\mu \pm 3\sigma$. This will not apply where data is either skewed or uniformly distributed.

From this we infer that a single variate x will *almost certainly* lie within 3 standard deviations of the mean (i.e. $\mu - 3\sigma \leq x \leq \mu + 3\sigma$) and *very probably* will lie within 2 standard deviations of the mean (i.e. $\mu - \sigma \leq x \leq \mu + 2\sigma$). These limits are called the 3 sigma and 2 sigma probability limits respectively. If a value of a variate lies beyond either of these limits, it is said to differ significantly from the mean at that particular level of confidence.

Note: While students should be aware of the distinction between the population mean μ and the sample mean $\bar{x}$, and between the population and sample standard deviations σ and s, extensive use by students of the μ and σ notations is not required.

Example: A machine is set for the production of cylinders of mean diameter 5.000 centimetres with standard deviation 0.020 centimetres. Within what intervals will the diameters almost certainly lie?

Solution: "Almost certainly" is the 3 sigma limit. Thus the diameters will lie in the interval $\mu \pm 3\sigma$ which is 5.000 ± 0.060 centimetres, i.e. between 4.940 centimetres and 5.060 centimetres.

Example: If a cylinder, randomly selected from this production, had a diameter of 5.070 centimetres, what conclusion could be drawn?

Solution: This measurement is greater than 5.060 cm and hence lies beyond the 3 sigma limit and so differs significantly from the mean. Thus it is a most unlikely event and perhaps the machine may need resetting.

See FITZPATRICK, J.B & GALBRAITH, P.

Modern Mathematics 6, Applied Mathematics Sydney, Jacaranda Press, 1972: pages 66, 67.

and JOHNSON, D.A. & GLENN, W.H.

Exploring Mathematics On Your Own (Series)
The World of Statistics
London, John Murray, 1964: page 5

(d) Sampling

(i) Selecting a Sample

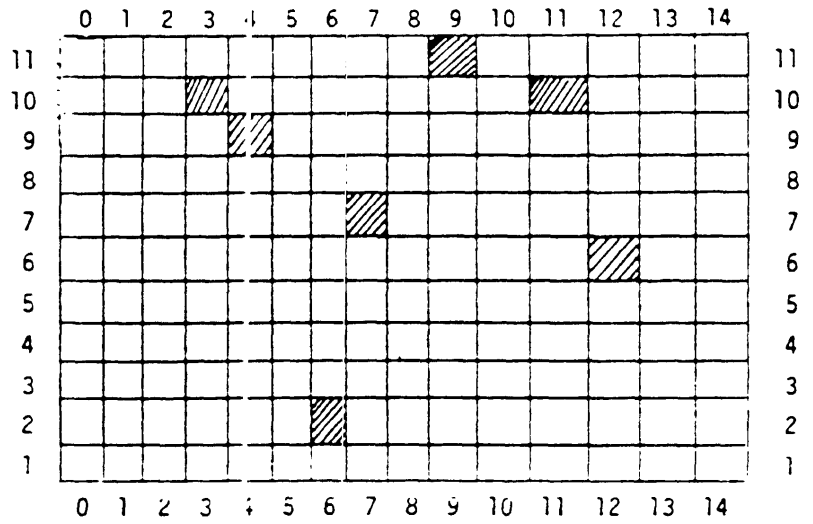
Much of the work on sampling will only need to be revised from the Year 7 - 10 course. It is expected that teachers would revise and consolidate these concepts through practical activities.

One important concept to be stressed is the effect of sample size on the reliability of the measures obtained from a sample. Discuss the advisability of taking a number of large samples, where practicable, and the fact that the mean of a large number of samples will tend towards the population mean. Students then could discuss further the reliability of statistics used in advertising, examining both numerical statements and graphs.

(ii) Sampling Techniques

A variety of sampling techniques could now be discussed, with the concepts being developed around practical activities.

Random Sampling: A random sample may be defined as a sample in which any one individual measure in the population is as likely to be included as any other. A common way of obtaining a random sample is by the use of a table of random numbers. Its use in selection of names from a list could be illustrated with class or school lists. Also, random sampling through the use of a grid can be illustrated by taking an overlay similar to that indicated in the diagram and applying it to ordinance survey maps to estimate the percentage of the country devoted to different forms of land use such as woodland, water, and buildings.



To obtain a sample of grid squares, a table of random numbers may be taken and pairs of digits selected from it. For example, if the grid references (9, 11), (4, 9), (6, 2), (12, 6), (3, 10), (7, 7), and (11, 10) were selected at random, then the hatched areas would be those selected in the sample.

Stratified Sampling: This could be given as a refinement of the sampling procedure discussed so far. In this technique, the population is divided into sub sets, and separate samples are drawn from each. This method is important if the population is made up of distinct groups of different size or character. (See Walker & McLean "Ordinary Statistics", Arnold 1973, chapter 12 for activities). Calculations of central tendency and dispersion should be treated again in relation to sampling. The change in notation in the formulae for standard deviation and Z scores when dealing with population studies should be noted.

Appendix C

Permission Letters for Study 1

UNE
The University of
NEW ENGLAND

Department of Science, Technology
and Mathematics Education
Armidale, NSW 2351 Australia
Telephone +61 67 73 5077/73 5081 Fax +61 67 73 5078

email: charvey@metz.une.edu.au

20th January 1991

Principal,
High School
Dear Mr ,

I am currently enrolled in a Ph. D. at the University of New England and my research is designed to investigate student growth and understanding in statistics. The focus of the study will be students in Year 7 to 12.

The purpose of this letter is to request your permission to conduct research within High School. Accompanying this letter is a detailed proposal for the research. Could you please let me know your decision as soon as possible so that preparations can be made to select a sample of students and send out permission notes to parents/guardians.

Thanking you in anticipation,

[redacted]
Mrs Christine Reading.

1. Researcher:

Mrs Christine Reading
Ph. D. student at
University of New England

Mathematics Teacher
High School
St.,
N.S.W.
Phone (067)

Home Address
1/201 Donnelly St.,
Armidale N.S.W. 2350
Phone (067) 729963

2. Title or Research Project:

Children's Understanding of Statistics

3. Rationale of Proposed Study:

In the last decade there has been an increased awareness in statistics education. Although the teaching of statistics had been featured in topics at earlier conferences, the first International Conference on Teaching Statistics (ICOTS) was held in 1982. These conferences have been held every four years since then but few of the papers presented have focused on children's understanding of statistics. Researchers whose study has included some work in understanding of statistics include Holmes (1980) and Hart (1981). In the United States of America the recommendation has been for increased attention on using statistical methods to describe, analyze, evaluate and make decisions (Curriculum and Evaluation Standards for School Mathematics, 1989). A similar trend is emerging in Australia. The National Statement on Mathematics for Australian Schools (1990) contained a major section, Chance and Data, which included collecting, organizing, summarizing and representing data and drawing conclusions and making inferences. These are the broad areas which have been used as the basis for the content of the questions in the written test and ultimately in the interviews.

4. References:

Biggs, J.B. and Collins, K.F., *Evaluating the Quality of Learning: The SOLO Taxonomy*, Academic Press, New York, 1982.

Curriculum and Evaluation Standards for School Mathematics, National Council of Teachers of Mathematics, Virginia, U.S.A. 1989.

Hart, K.M., *Children's Understanding of Mathematics: 11-16*, John Murry Ltd., London, 1981.

Holmes, P. (director), *Teaching Statistics 11-16*, Schools Council, Foulsham Education, Berks, England, 1980.

National Statement on Mathematics for Australian Schools, Australian Education Council, 1990.

5. Purpose of Research Project:

* To investigate how children grow in terms of their ability to understand statistics from Years 7 to 12.

* To investigate if this growth can be described in levels in terms of the SOLO Taxonomy of Biggs and Collins (1982).

* To investigate whether levels attained by students when working with familiar situations is the same as that attained when working with less familiar situations.

* To investigate whether computational facility affects the level of understanding achieved.

6. Documentation:

The following are included at the end of this submission -
written test
permission letter to parents

7. Participants:

Pupils at High School in Years 7 to 12 will participate in the study. No teachers, at school, other than myself, will be involved in administering the written tests or the interviews.

8. Research Design:

The study has two phases;
Phase 1. The Pilot study to refine the written test.
Phase 2. The main study to administer the written test to 180 students.
Phase 3. The longitudinal study to administer the written test a year later to 180 students followed by interviews of 10% of the group.

Pilot Study **March 1991**

Written Test

The purpose of this test is:
* to check the readability of the test across all age groups
* to check that the ideas are not too difficult
* to check that there is adequate timing for the test and whether two sittings are needed
* to minimize any problems that may occur when the written test is given to a larger group
* to determine whether items are successful in allowing a range of responses
* to develop a tentative framwork for the coding of responses.
The test consists of four questions broadly covering the four areas of collecting, representing and analyzing data and making inferences. It will be attempted by 12 students, two from each year and take approximately one hour to complete.

Main Study **May 1991**

Written Test

The purpose of this test is:
* to determine whether there are levels in the responses which can be categorized
* to determine whether there are patterns in the answers across questions between students
* to, if levels are found, determine whether the SOLO taxonomy adequately describes them i.e. whether there are MODES of functioning in statistics
* to determine whether there is an hierarchy within and/or across the four sections
* to select the students to be interviewed across a range of levels

The written test will be that used in the pilot study, with any alterations deemed necessary in the light of the results of the pilot study. It will be administered to 180 students, spread evenly across the Year 7 to 12 and across the sexes.

Longitudinal Study **May 1992**

Written Test

The purpose of this test is:
* to confirm any results found in the main study
* to establish the robustness of the written test
* to determine whether their is growth of student understanding over time
The same written test, perhaps with minor alterations, will be administered to as many students as are available from the original sample of 180 students.

Interviews **June 1992**

Written Test

The purpose of the interviews is:
* to determine whether students can extend the level of their response under probing
* to determine whether students can extend the level of their response under prompting
The interviews will require the students to provide more information about the way that they have answeed the questions. 18 students, 3 from each year, will be interviwed. They will be spread evenly over the sexes and the range of mathematical abilities. The interviews are expected to last for not more than one hour. A second interview will be initiated for a student if the interview schedule has not been covered within the hour.

9. Time Involved:

The written tests and the interviews will be undertaken during school hours. The written test during a lesson time suitable for the students involved and the interview during lesson time, or at lunchtime, depending on what best suits the student.

10. Confidentiality:

Student names will be included on the written test as it is necessary to select students for follow up testing. Information about the student will not be disclosed and no student names will be used in the write up of the research.

11. Consent:

Separate letters of consent will be sent out to the parents of the students involved in the main study, the longitudinal study and the interviews.

UNE
The University of
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Department of Science, Technology
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Armidale, NSW 2351 Australia
Telephone +61 67 73 5077/73 5081 Fax +61 67 73 5078

email: charvey@metz.une.edu.au

5th February 1991

Dear Parent / Guardian,

I am currently enrolled in a Ph. D. at the University of New England and my research is designed to investigate student growth and understand ng in statistics. The focus of the study will be students in Year 7 to 12 at High School.

The purpose of this letter is to request you permission to include your daughter / son / ward in the study.

The study, which has the support of the Principal, is designed in such a way that disruption of the normal school process will be minimal. It will consist of each student being given a written test of approximately one hour and then, possib y, a short follow-up interview. The interviews will be taped for later analysis. There will be com plete confidentiality with respect to the written tests and the interviews for both students and the sc hool.

The purpose of the study is to identify a hierarchy in children's understanding in statistics. The expectation is that the results of this study will allow changes in statistics in the school curriculum to more accurately reflect how students grow in statistical understanding. The end result being that school statistics will become more use ful and more meaningful to the student population. This is especially important in the senior schoo mathematics, where it is anticipated that more statistics is to be introduced.

If you have any concerns or enquiries you can contact me or the Principal for more information.
If you are willing to allow your daughter son / ward to participate could you please complete the form below and return it to the school.

Yours faithfully,

[redacted]

Mrs Christine Reading
Mathematics Teacher
High School

I give my daughter / son / ward _____
permission to be included in the research project to be carried out by Mrs Christine Reading.

Printed Name _____

Signature _____ Date _____

Appendix D

Selection of Responses to Question 1 Part II

The responses presented here are those which were felt to be different enough to those given in Part I to be useful to complement those presented in Chapter 4. Responses at Level 0 and 8 to Part II of the question were presented with the Part I responses in Chapter 4, as there were no Level 0 or 8 responses to Part I. Details of level descriptions can be found in the **Data Collection** section of Chapter 4

First Group

First are those responses where only the requirements of the question are dealt with and within this group three broad levels, coded as 0, 1 and 2, were observed. These responses show no real concern for the actual collection of data. The following is a sample, from each level, except 0, which is discussed in Chapter 4.

Level 1

(7203)	(i)	*Yes*
	(ii)	*Because they say they watch a lot of T.V.*

Level 2

(7105)	(i)	*Student councillers and seniors*
	(ii)	*because they are important*
(8207)	(i)	*My Music class*
	(ii)	*They know what kind of music*
(10203)	(i)	*Year 10*
	(ii)	*because then I could ask people I know.*

Second Group

The second group of responses are those concerned with rationalizing the method of collection of the data. The same three levels, as for Part I, were observed within this group. These responses are only concerned with aspects of the collection rather than the quality of the resulting sample.

Level 3

(7213)	(i)	*I would select 4 children from each year*
	(ii)	*Because it's one way of doing it.*

Level 4

(7108)	(i)	*I would ask the most sensible people because they would give you proper answers for the survey.*
	(ii)	*I would select them because they would be sensible and responsible.*
(8104)	(i)	*I would pick them out of a hat*
	(ii)	*because then there's no fighting over who was picked*
(9204)	(i)	*I would ask leaders of groups because they would no the T.V. show every one watches*
	(ii)	*Because they are the leader of the group and all the information would go to them.*

Level 5

(7104)	(i)	*Some student from each year from year 7 - 12*
	(ii)	*Because you are getting people of different ages*
(8205)	(i)	*I would use year 9 students*
	(ii)	*because there in between the school years*
(9203)	(i)	*I would ask 5 out of each year.*
	(ii)	*Because then you'd get an equal variation.*
(11202)	(i)	*I would ask 6 people from each year from every maths class.*
	(ii)	*different ages different ranges of intelligence*

Third Group

The final group of responses indicate that the physical aspects of the method of data collection have been rationalized and concern is now centred on the accuracy of the data in the resulting sample. This group was found to have three levels of responses, coded as 6, 7 and 8. As Level 8 responses were not observed in Part I of the question these were presented in Chapter 4 and following are sample responses to Levels 6 and 7.

Level 6

(9113) (i) *I would select an even amount of students from each year, so to be sure it wasn't biased.*

(ii) *I would select these students because I don't want a biased survey e.g. certain years like certain T.V. programs*

(11213) (i) *The students that I would select to ask would be five students from each year at the school.*

(ii) *I would select these students because it would be the fairest way to choose people from the school & you would be able to see if the TV shows that people watch differ with age.*

Level 7

(7111) (i) *I would select 5 students from each year ranging from the smarter kids to the not so smart kids.*

(ii) *I would select a range of students because it is a wider viewing range because of the difference in age ...etc...*

(10213) (i) *I would select 5 people from each year and use even amount of boys and girls.*

(ii) *I would select these students as you would get totally different answers from each person.*

(11209) (i) *I would select students from all years and both students with extracurricular activities and those without.*

(ii) *because it would give an accurate result of the average student*

(12215) (i) *Select equal numbers from different years and then equal between males and females. Attempt to get people who are not friends and also attempt to get people from a wide variety of economic, social and racial backgrounds.*

(ii) *This would achieve an average viewing habits of people at A.H.S. with no emphasis placed upon a certain group.*

Appendix E

Selection of Responses to Question 2 Part II

The responses presented here are those which were felt to be different enough to those given in Part I to be useful to complement those presented in Chapter 4. Details of level descriptions can be found in the **Data Tabulation and Representation** section of Chapter 4.

First Group

First are those responses where only the requirements of the question are dealt with.

Level 1 Any responses which totally misunderstood the graph were also included here.

(7111) *The graph tells us about the number of late arrivals to school.*

(7201) *How many days a week he arrives late.*

(8102) *That people get to school late all the time, but shows that some days people are getting later to school.*

Level 2

(8213) *Along the horizontal axis it shows what week it was and along the vertical axis, the frequency of students late.*

Second Group

Having understood the question, responses in the second group are attempting to understand the data which in this case is in the form of a graph. Attempts to process the data are hampered by the lack of experiences and tools for describing data.

Level 3

(9205) *The graph tells me the number of late students to school each week over a seven week period.*

(10115) *No. of students late to school over 7 weeks and the frequency of when they were late.*

Level 4

(10210) *The graph tells me that in wk 1, 3 students were late in wk 2 5 students were late, in weeks 3 & 6 6 students were late, in week 4 4 were late, in week 5 2 were late & in week 7 5 students are late. It tells me that the deputy kept a record of late students for 7 weeks.*

Level 5

Path A

(8109) *That students who were late differs a bit from week to week.*
(9201) *It got higher and lower and then higher again.*
(9212) *The graph tells me 6 people were late to school in week 3 and week 6.*
(12205) *Every week there are always people late to school.*

Path B

(8106) *The graph tells me that lots of kids are late (can't blame them though).*
(9102) *There were a big number of students late to school each week.*
(10212) *The graph tells me that there is a small amount of people who are sick.*

Third Group

The final group of responses describe the data in an acceptable statistical form.

Level 6

Path A

(8104) *It tells us that in the 1st week 3 students were late, in the 2nd 5 were, in the 3rd 6 were, the 4th 4 were, the 5th 2 were, in the 6th 6 were and the 7th 5 were. Also in weeks 3 and 6 the students were the latest for school.*

(8107) *The graph tells me that in the first 3 weeks the number of students late got higher, then in weeks 4 & 5 they dropped, then in 6 it grew again & in 7, dropped off slightly.*

(10108) *Most people were away during the weeks 2, 3, 6, 7.*

(10207) *The graph tells me that the number of students late per week hasn't exceeded 7 in the 7 weeks its been in operation.*

(10213) *The graph tells me that kids were late to school on an average of about 4.*

(11201) *The graph tells us that at least 2 people are late to school each week.*

Path B

No responses were observed at this level. Perhaps this is so because if students have data in graphical form then it is easier for them to make more than one judgement by using features of the bars on the graph.

Level 7

Path A

(7112) *It tells you the highest number of people late for school in this order 3, 6, 7, 2, 4, 1, 5.*

(8114) *The graph tells you that there were always at least two students late every week during the seven weeks. The highest amount of late students were in weeks 3 and 6.*

(12101) *The graph tells you how many children were late to school over a period of seven weeks. The first week there was only 3 and continuing on the 3rd week the number of children arriving late to school doubled. At the 5th week the number has dropped below the first week but it soon increased equally back up to 6 children a week.*

Path B

(9110) *This graph also tells you that there is a wide range of people being late and that a lot of students are late quite often.*

(12113) *The graph tells me again the obvious the no. of students who were late to school each week. Also that on an average people are away more at the beginning of the year because of extra holidays and also in the middle of the term as people slacken off.*

Responses which are not distinctly Path A or B.

(8113) *The graph tells you that a lot students come late every week, but the most students away was in weeks 3 and 7.*

(11104) *This graph tells me that on some weeks there was a high number of pupils late to school. It also tells us that there was not one week go by without a student being late.*

Appendix F

Selection of Responses to Question 3 Part II

The responses presented here are those which were felt to be different enough to those given in Part I to be useful to complement those presented in Chapter 4. Details of level descriptions can be found in the **Data Reduction** section of Chapter 4.

First Group

First are those responses where only the rquirements of the question are dealt with. These responses show no real concern for data reduction.

Level 0

(9202)	(i)	*Beats me*
(10205)	(i)	*Don't understand.*

Level 1 Any responses which totally misunderstood the graph were also included here.

(8103)	(i)	*I would select the people who were doing good in the test.*
	(ii)	*Because the people who are good at spelling could help people that aren't going good at spelling.*
(8204)	(i)	*5 10 15 20 etc.*
	(ii)	*because at least one person isn't going to get 1 so you go up by fives.*
(10202)	(i)	*2 - 3*
	(ii)	*it rose from 2 to 3 in score.*
(12204)	(i)	*I would take 1 28 (so you can see the best, the second...*
	(ii)	*so you can see the best, the second,...*

Level 2

(7210)	(i)	*5 - 6*
	(ii)	*I do not really no why I selected those one. It was just a guess.*
(10107)	(i)	*7*

(ii) *Because people are progressing each week, so that means they are getting better each week.*

(10203) (i) *9*

(ii) *good mark*

Second Group

Having understood the question, responses in the second group are attempting to understand the data, which in this case is in the form of a graph. Attempts to process the data were hampered by the lack of experiences and tools for reducing data.

Level 3

No responses were observed at this level. Perhaps this occurred because if students have data in graphical form it is easier for them to make observations about the data once they are able to read the graph. A possible response consistent with the style of Part I responses would be :

(i) *6*

(ii) *because that would tell you how the students performed*

Level 4

(9103) (i) *1, 2, 4, 5, 7, 3*

(ii) *It represents each numeral.*

Level 5

Path A

(8115) (i) *I would choose numbers 4, 5 & 6*

(ii) *I would coose these numbers because they are an approximation of the average scores.*

(8214) (i) *I would average it.*

(ii) *Averaging it gives us an idea of the whole classes performance.*

Path B

(11103)	(i)	*1 & 9*
	(ii)	*It shows the variation between the numbers.*
(11209)	(i)	*I would say between 1 and 8*
	(ii)	*Because it would not be incriminating for any particular student as it includes "all" students.*
(12201)	(i)	*1 - 9*
	(ii)	*It really starts on 1 (the first dot) & it goes through to 8.5 but we'll say 9.*

Third Group

The final group of responses reduce the data into an acceptable statistical form and attempt to justify the reduction in relation to the data.

Level 6

Path A

Mode -

(7103)	(i)	*I would give the number 7*
	(ii)	*Because it is the highest number on the graph.*
(7107)	(i)	*7*
	(ii)	*that was the most popular score.*
(11207)	(i)	*7*
	(ii)	*because a moderate amount of students got the score.*

Median -

(82028)	(i)	*4 1/2*
	(ii)	*Because it is in between.*
(11202)	(i)	*4 or 5*
	(ii)	*it's the median*
(11214)	(i)	*5, 6*
	(ii)	*middle of the range*

Mean -

(7214)	(i)	*129 / 280*

	(ii)	*because that's the score they got altogether.*
(12210)	(i)	*The mean*
	(ii)	*The average gives an indication of how individuals are going compared to the class.*

Path B

(7108)	(i)	*9,1 0, 7, 8*
	(ii)	*My reason for this selection is most people got good scores around there.*
(12101)	(i)	*3 to 8*
	(ii)	*Because the score 3 to 8 out of ten is what most of the students averaged.*
(12206)	(i)	*5 - 7*
	(ii)	*the majority of the class fell into this category.*

Level 7

Path A

(7215)	(i)	*7, 1, 4*
	(ii)	*7 got most, 1 got least, 4 got avg. (sic)*
(9107)	(i)	*Most students got 7 (7 students got 7) the class average was 4.*
	(ii)	*I'd tell everyone how brainy the 7 people are, I really don't know.*
(11112)	(i)	*I would select either the mode, 8 or the mean, which is 5.46 or 5. They are very different and would give very different opinions of the class. I think I would select the mode, 8.*
	(ii)	*because it makes them look better !!!!! Well, no, because it shows that the majority of the class achieved 8.*
(12104)	(i)	*7 and 5.5*
	(ii)	*Because most students in the class got 7. Because thats (sic) approx the average score in the group.*

Path B

(7204)	(i)	*4 - 6*
	(ii)	*There is a equal number of scores from 10 to 6 and from 1 to 4.*

(8112) (i) *The numbers I would use are 1 2 3 4 5 saying this is the minority of the class and the ones who need more help and the numbers 6 7 8 as the majority of the class saying these are the ones who don't need so much help.*

(ii) *the reasons for this are because that is what the graph is telling me and the way in which I would use to discribe (sic) it.*

Responses which are not in Path A or B.

(8211) (i) *I would average the data 5 1/2*

(ii) *these numbers reflect the result of a perfect bell shaped proabability curve for when any numbers of 1 to 10 are randomly chosen and averaged the answer will be close to 5.5 the more numbers you do the closer it will get.*

(11113) (i) *I would select 5 or 6*

(ii) *Because they are in the middle and there is a fairly even number of results on either side.*

(12209) (i) *7*

(ii) *Most people got 7 in the test. Only a very small amount got over 7 but most got 7 or below. Not as many people got 2, 3, 4 as did get 7. a few people got 6 so maybe it would be used too.*

(12213) (i) *The numbers 5, 6, 7 would be best in this case. However, if I had to choose one number, then 6 would be it as it seems to be the mean.*

(ii) *I chose those numbers because they represent the numerous 'middle range'. A figure above 7 would be ridiculously high while anything below 5 would be too low.*

Level 8

(10106) (i) *Numbers 1 - 5 - 9*

(ii) *Because that way I would see how the mark of the class increase or decrease between the score of 4 both sides.*

Appendix G

Selection of Responses to Question 4 Part II

The responses presented here are those which were felt to be different enough to those given in Part I to be useful to complement those presented in Chapter 4. Details of level descriptions can be found in the **Interpretation and Inference** section of Chapter 4.

First Group

These responses only deal with the requirements of the question and do not refer to features of the data in describing the pattern or justifying the predictions.

Level 0

(10201)	(i)	*cant answer*
	(ii)	
	(iii)	

Level 1

(7204)	(i)	*The green house efect over the last 8 years*
	(ii)	*20 Because the green house efect is getting worse*
	(iii)	*I don't think in the future the numbers of frosts would exide 60*
(8105)	(i)	*None*
	(ii)	*60 Again a random number*
	(iii)	*1996 a random number*
(11105)	(i)	*Don't see any because there's not enough data for me*
	(ii)	*About 10. Don t know.*
	(iii)	*Have no idea.*

Level 2

(7209)	(i)	*I can't see any patterns*
	(ii)	*70 because it's going to be cold in winter.*
	(iii)	*1996, 1998 because they sound good.*

Second Group

Having understood the question, responses in the second group are attempting to understand the data which in this case is in the form of a graph. Attempts to describe patterns in the data or to make predictions were hampered by the lack of experiences and knowledge of statistical tools.

Level 3

7203	(i)	*in the 80's there were heaps*
	(ii)	
	(iii)	

Level 4

(10113)	(i)	*50, 60, 55, 33, 80, 55, 70, 68, 58, 50, 50, 40, I can't see any pattern*
	(ii)	*50 frosts in 1991, don't know why*
	(iii)	*1993, 1995, 1999 (wouldn't have a clue why)*

Level 5

Path A

(8201)	(i)	*We have had a lot of frosts in 1982*
	(ii)	*83 because it is a cold place*
	(iii)	*1993 because it might get colder*
(9209)	(i)	*The frosts have started not to come as frequent as usual (in the last 3 years)*
	(ii)	*38-41 It was about the same as last year*
	(iii)	*1993 because it's about the time we would be due for a lot of frosts.*

Path B

(7108)	(i)	*its unstable*
	(ii)	*Round about 70 - 80 cause of the weather we have*
	(iii)	*2000 & on cause of the ozone layer & all breaking up*
(7208)	(i)	*I can see the pattern going up by great numbers and going down moderately*

	(ii)	*I expect about 50. Because of the weather and the hole in the ozone layer*
	(iii)	*nineteen ninety six because hopefully pollution will be getting less.*
(7214)	(i)	*hills*
	(ii)	*66 don't know*
	(iii)	*1993, 1998, don't know*
(9208)	(i)	*3 year cycles*
	(ii)	
	(iii)	

Third Group

The final group contains responses which describe the pattern in an acceptable statistical form and attempt to justify the predictions in relation to the pattern.

Level 6

Path A

(10210)	(i)	*average of about 55%*
	(ii)	*50 just below average*
	(iii)	*don't think they will*
(11109)	(i)	*Every 3 years no. of frosts is at a high*
	(ii)	*60 because follows flow of graph*
	(iii)	*could not find it as I can't see a pattern in the graph to tell me this*
(12211)	(i)	*after 1985 the no. of frosts is lessening*
	(ii)	*between 30 & 40, because of the recent trend in the results of the no. of frosts declining*
	(iii)	*I don't think the number of frosts will exceed 60 for a long time.*

Path B

(10207)	(i)	*The graph appears to look like waves with some years having higher frosts than others*
	(ii)	*about 80 frosts in 1991 because the graph seems to be going down*
	(iii)	*1993, 1996 etc. because of the pattern on the graph.*
(11115)	(i)	*There could be an approximate zig-zag pattern, with the number of frosts increasing then decreasing to 35 per year.*

(ii) *Possibly the number of frosts could decrease further*

(iii) *93, 94, 97, 98, Approximately following a zig-zag pattern.*

Level 7

Path A

(7104) (i) *That the highest no of frosts is 80 and the lowest is 40 but the average is 50*

(ii) *40 to 50 frosts because it is the average*

(iii) *I don't think any years because of the pollution and the Earth is burning down.*

(9114) (i) *Every 3-4 years the number of frosts drops, every 9 years it rises*

(ii) *Over 70, because according to the pattern it is time for a sharp rise.*

(iii) *1994, 1997, 2000. The pattern is a small rise every three years, a l are one every 9.*

(11212) (i) *The only pattern that I can see is that the number is usually around 60 or 50.*

(ii) *About 40 or 30 as it looks as if the number of frosts is declining*

(iii) *I can't select the years from that data.*

Path B

(10215) (i) *I think the results were pretty irregular. I couldn't see any pattern.*

(ii) *Around 50 because no of frosts has been changing from year to year roughly between 40 and 60 normally but there are some exceptions*

(iii) *Around the year 1998 because the number of frosts only exceeds 60 on rare occasions so it wouldn't happen very often.*

(12213) (i) *Generally the number of frosts has remained about constant in the 50 - 60 range with major alterations in 1981, 1982, 1983*

(ii) *Around 50 would be correct considering the pattern but also the presently quite mild winter we're having*

(iii) *This is impossible to answer as the factors responsible are beyond our control and thus our predictive capacity are very limited here.*

Responses which are not in Path A or B.

(8215) (i) *The graph takes a peak trough pattern that might be associated with a heart beat or brain wave pattern, thou with great irregularity*

(ii) *I would expect roughly 40 because that appears to be the point at which the downward trend stops.*

(iii) *possibly 93, 96 & 97, 2000, judging by the usual peaking patterns of the graph.*

(12106) (i) *The no. of frosts doesn't exceed around 35. No following on pattern. Recently seems to be steadying.*

(ii) *Perhaps a number around 35 - 40 following the line of the graph. It seems this line will steady off & continue for a while around the mark 30-40.*

(iii) *Around the year 1996-1998 the no. of frosts could exceed 60. These years were chosen because the pattern seems to stay constant then dramatically increase.*

Appendix H

Tables for Results - Study 1

These tables should be read in conjunction with the analysis of Study 1 in Chapter 4.

Table H.1.1 - Level Comparison within Students - Question 1

		Q1 Part I									
		0	1	2	3	4	5	6	7	8	Total
Q1 Part II	0	0	0	0	0	1	0	0	0	0	1
	1	0	0	1	0	0	0	0	0	0	1
	2	0	3	0	2	4	0	0	0	0	9
	3	0	0	0	1	0	1	0	0	0	2
	4	0	4	3	11	16	0	0	0	0	34
	5	0	1	1	14	15	14	4	0	0	49
	6	0	1	5	12	19	6	7	1	0	51
	7	0	0	2	8	11	4	5	2	0	32
	8	0	0	0	1	0	0	0	0	0	1
	Total	0	9	12	49	66	25	16	3	0	180

Table H.2.1 - Response Level by Mathematical Ability - Question 2 Part II

	Mathematical Ability			
Level	Low	Middle	High	Total
1	3	7	6	21
2	19	18	23	60
3-4	2	6	10	18
5	21	13	10	44
6	5	9	5	19
7	5	7	6	18
Total	60	60	60	180

Table H.2.2 - Response Path by Mathematical Ability - Question 2 Part II

	Mathematical Ability			
Path	Low	Middle	High	Total
A	13	20	17	50
B	17	9	3	29
Total	30	29	20	79

Table H.2.3 - Response Level by Gender - Question 2 Part II

	Gender		
Level	Female	Male	Total
0-1	9	12	21
2	31	29	60
3	6	9	15
4-5	21	26	47
6	9	10	19
7	14	4	18
Total	90	90	180

Table H.2.4 - Response Path by Gender - Question 2 Part II

	Gender		
Path	Female	Male	Total
A	26	24	50
B	15	14	29
Total	41	38	79

Table H.2.5 - Level Comparison within Students - Question 2

		Q2 Part I								
		0	1	2	3	4	5	6	7	Total
	0	0	0	0	0	0	0	0	0	0
	1	1	4	5	1	1	7	2	0	21
Q2	2	0	2	34	7	3	5	2	7	60
Part	3	0	0	3	9	1	0	1	1	15
II	4	0	0	0	0	1	1	0	1	3
	5	0	1	5	2	2	17	9	8	44
	6	0	1	1	0	2	6	5	4	19
	7	0	0	1	1	0	4	4	8	18
Total		1	8	49	20	10	40	23	29	180

Table H.3.1 - Response Level by Mathematical Ability - Question 3 Part I

	Mathematical Ability			
Level	Low	Middle	High	Total
0-2	11	3	3	17
3-5	13	9	16	38
6	34	33	25	92
7-8	2	15	16	33
Total	60	60	60	180

Table H.3.2 - Response Path by Mathematical Ability - Question 3 Part I

	Mathematical Ability			
Path	Low	Middle	High	Total
A	34	44	39	117
B	10	5	6	21
Total	44	49	45	138

Table H.3.3 - Response Level by Gender - Question 3 Part I

	Gender		
Level	Female	Male	Total
0-2	6	11	17
3-5	17	21	38
6	47	45	92
7-8	20	13	33
Total	90	90	180

Table H.3.4 - Response Path by Gender - Question 3 Part I

	Gender		
Path	Female	Male	Total
A	63	54	117
B	8	13	21
Total	71	67	138

Table H.3.5 - Response Level by Mathematical Ability - Question 3 Part II

	Mathematical Ability			
Level	Low	Middle	High	Total
0-2	17	9	3	29
3-5	13	11	16	35
6	33	35	29	97
7-8	2	5	12	19
Total	60	60	60	180

Table H.3.6 - Response Path by Mathematical Ability - Question 3 Part II

	Mathematical Ability			
Path	Low	Middle	High	Total
A	31	39	40	110
B	11	8	14	33
Total	42	47	54	138

Table H.3.7 - Response Level by Gender - Question 3 Part II

	Gender		
Level	Female	Male	Total
0-2	8	21	29
3-5	15	20	35
6	54	43	97
7-8	13	6	19
Total	90	90	180

Table H.3.8 - Response Path by Gender - Question 3 Part II

	Gender		
Path	Female	Male	Total
A	59	51	110
B	8	15	33
Total	77	66	143

Table H.3.9 - Level Comparison for Parts I and II - Question 3

	Question 3		
Level	Part I	Part II	Total
0	5	10	15
1	5	10	15
2	7	9	16
3-4	11	1	12
5	27	34	61
6	92	97	189
7-8	33	19	52
Total	180	180	360

Table H.3.10 - Path Comparison for Parts I and II - Question 3

		Question 3		
		Part I	Part II	Total
	Path A	117	110	227
	Path B	20	33	53
	Total	137	143	280

Table H.3.11 - Level Comparison within Students - Question 3

		Q3 Part I									
		0	1	2	3	4	5	6	7	8	Total
	0	2	1	1	0	0	1	5	0	0	10
	1	2	2	0	1	0	2	3	0	0	10
Q3	2	1	0	1	0	1	2	4	0	0	9
Part	3	0	0	0	0	0	0	0	0	0	0
II	4	0	0	0	0	1	0	0	0	0	1
	5	0	0	2	0	4	13	10	5	0	34
	6	0	2	3	1	2	6	64	17	2	97
	7	0	0	0	0	1	3	6	6	2	18
	8	0	0	0	0	0	0	0	1	0	1
	Total	5	5	7	2	9	27	92	29	4	180

Table H.3.12 - Group Comparison within Students - Question 3

		Q3 Part I			
		First	Second	Third	Total
Q3	First	10	7	12	29
Part	Second	2	18	15	35
II	Third	5	13	98	116
	Total	17	38	125	180

Table H.3.13 - Path Comparison within Students - Question 3

		Q3 Part I				
		Before	A	B	After	Total
	Before	13	13	4	0	30
Q3	A	5	91	7	7	110
Pt.	B	10	9	10	4	33
II	After	0	4	0	3	7
	Total	28	117	21	14	180

Table H.4.1 - Response Level by Mathematical Ability - Question 4 Part I

	Mathematical Ability			
Level	Low	Middle	High	Total
0-2	16	10	9	35
3-5	23	21	10	54
6	15	23	18	56
7-8	6	6	23	35
Total	60	60	60	180

Table H.4.2 - Response Path by Mathematical Ability - Question 4 Part I

	Mathematical Ability			
Path	Low	Middle	High	Total
A	13	15	13	41
B	22	27	30	79
Total	35	42	43	120

Table H.4.3 - Response Level by Gender - Question 4 Part I

	Gender		
Level	Female	Male	Total
0-1	8	16	24
2	7	4	11
3-4	2	11	13
5	19	22	41
6	33	23	56
7-8	2	14	35
Total	90	90	180

Table H.4.4 - Response Path by Gender - Question 4 Part I

	Gender		
Path	Female	Male	Total
A	26	15	41
B	42	37	79
Total	68	52	120

Table H.4.5 - Response Level by Mathematical Ability - Question 4 Part II

	Mathematical Ability			
Level	Low	Middle	High	Total
0-2	15	13	8	36
3-5	22	11	6	39
6	16	28	34	78
7	7	8	12	27
Total	60	60	60	180

Table H.4.6 - Response Path by Mathematical Ability - Question 4 Part II

	Mathematical Ability			
Path	Low	Middle	High	Total
A	18	15	12	45
B	18	29	31	78
Total	36	44	43	123

Table H.4.7 - Response Level by Gender - Question 4 Part II

Level	Gender Female	Male	Total
0-1	8	19	27
2	5	4	9
3-4	8	4	12
5	12	15	27
6	43	35	78
7	14	13	27
Total	90	90	180

Table H.4.8 - Response Path by Gender - Question 4 Part II

Path	Gender Female	Male	Total
A	28	17	45
B	65	43	78
Total	93	60	123

Table H.4.9 - Level Comparison for Parts I and II - Question 4

Level	Question 4 Part I	Part II	Total
0-1	24	27	51
2	11	9	20
3-4	13	12	25
5	41	27	68
6	56	78	134
7-8	35	27	62
Total	180	180	360

Table H.4.10 - Path Comparison for Parts I and II - Question 4

	Question 4 Part I	Part II	Total
Path A	41	46	87
Path B	79	77	156
Total	120	123	243

Table H.4.11 - Level Comparison within Students - Question 4

		Q4 Part I 0	1	2	3	4	5	6	7	8	Total
Q4 Part II	0	0	0	1	0	0	1	2	0	1	5
	1	1	6	1	2	2	4	3	3	0	22
	2	0	0	2	0	1	3	2	1	0	9
	3	1	1	1	0	0	0	0	1	0	4
	4	0	2	0	0	1	3	2	0	0	8
	5	0	7	0	0	1	15	4	0	0	27
	6	0	4	6	1	4	10	37	16	0	78
	7	0	2	0	0	1	5	6	11	2	27
	8	0	0	0	0	0	0	0	0	0	0
	Total	2	22	11	3	10	41	56	32	3	180

Table H.4.12 - Group Comparison within Students - Question 4

		Q4 Part I First	Second	Third	Total
Q4 Part II	First	11	13	12	36
	Second	12	20	7	39
	Third	12	21	72	105
	Total	35	54	91	180

Table H.4.13 - Path Comparison within Students - Question 4

		Q4 Part I Before	A	B	After	Total
Q4 Pt. II	Before	22	6	18	2	48
	A	11	17	16	2	46
	B	15	14	43	5	77
	After	0	4	2	3	9
	Total	48	41	79	12	180

Appendix I

Tables for Overview - Study 1

These tables should be read in conjunction with the analysis of Study 1 in Chapter 5.

Table I.1 - Comparison of Estimate Means for Academic Years - Matrix of Pairwise Mean Differences

Year	7	8	9	10	11	12
7	0.000					
8	0.178	0.000				
9	0.230	0.052	0.000			
10	0.301	0.122	0.071	0.000		
11	0.498	0.320	0.268	0.197	0.000	
12	0.781	0.602	0.551	0.480	0.283	0.000

Table I.2 - Comparison of Estimate Means for Academic Years - Scheffe Test - Matrix of Pairwise Comparison Probabilities

Year	7	8	9	10	11	12
7	1.000					
8	0.759	1.000				
9	0.504	0.999	1.000			
10	0.198	0.941	0.995	1.000		
11	0.002	0.143	0.322	0.670	1.000	
12	0.000	0.000	0.000	0.000	0.003	1.000

Table I.3 - Comparison of Estimate Means for Mathematical Ability - Matrix of Pairwise Mean Differences

Math. Ability	Low	Middle	High
Low	0.000		
Middle	0.263	0.000	
High	0.356	0.093	0.000

Table I.4 - Comparison of Estimate Means for Mathematical Ability - Scheffe Test - Matrix of Pairwise Comparison Probabilities

Math. Ability	Low	Middle	High
Low	1.000		
Middle	0.004	1.000	
High	0.000	0.493	1.000

Table I.5 - Comparison of Estimate Means for Gender - Matrix of Pairwise Mean Differences

Gender	Female	Male
Female	0.000	
Male	-0.227	0.000

Table I.6 - Comparison of Estimate Means for Gender - Scheffe Test - Matrix of Pairwise Comparison Probabilities

Gender	Female	Male
Female	1.000	
Male	0.000	1.000

Table I.7 - Item Estimate Tau Values

Level	2	3	4	5	6	7
Q 1 Part I	-0.86	-1.70	-0.58	0.71	0.50	1.93
Q 1 Part II	-1.26	1.41	-2.09	0.13	0.58	1.22
Q 2 Part I	-1.64	0.77	0.63	-0.96	0.83	0.37
Q 2 Part II	-1.28	0.99	1.17	-2.24	0.9	0.46
Q 3 Part I	0.17	0.98	-1.12	-0.78	-0.71	1.46
Q 3 Part II	0.57	0.48	-2.24	-0.70	1.88	
Q 4 Part I	0.49	0.89	-0.97	-1.20	-0.05	0.83
Q 4 Part II	0.70	0.42	-0.60	-1.06	-0.76	1.30

Note for Table I.7 : The column headings are the level being entered. For example, the column heading 4 refers to the tau values for a measure of the difficulty in moving from Level 3 to Level 4. A value was not given for Level 7 of Question 3 Part II as it exceeded the range and so the maximum value of 1.93 was used for the graph in Chapter 5.

Table I.8 - Item Estimate Threshold Values

Level	2	3	4	5	6	7
Q 1 Part I	-1.30	-0.84	-0.08	0.77	1.31	2.56
Q 1 Part II	-1.88	-0.91	-0.83	-0.35	0.24	1.18
Q 2 Part I	-1.75	-0.18	0.04	0.15	0.56	1.04
Q 2 Part II	-1.16	0.06	0.20	0.23	0.76	1.35
Q 3 Part I	-0.86	-0.60	-0.55	-0.45	-0.22	1.35
Q 3 Part II	-0.55	-0.38	-0.38	-0.36	-0.11	1.92
Q 4 Part I	-0.55	-0.35	-0.31	-0.22	0.13	1.11
Q 4 Part II	-0.48	-0.34	-0.28	-0.21	0.00	1.47

Note for Table I.8 : The column headings are the level being measured. For example, the column heading 4 refers to the threshold values for a measure of the score needed for a person to have a 50% chance of attaining Level 4.

Appendix J

Figures for Overview - Study 1

These figures should be read in conjunction with the analysis of Study 1 in Chapter 5.

Infit Mean Square		**Outfit mean Square**	
Mean	0.89	Mean	1.01
SD	0.08	SD	0.11
Infit t		**Outfit t**	
Mean	-0.07	Mean	0.15
SD	0.69	SD	0.74

Figure J.1 - Fit Statistics - Question Estimates

Infit Mean Square		**Outfit mean Square**	
Mean	0.99	Mean	1.01
SD	0.58	SD	0.64
Infit t		**Outfit t**	
Mean	-0.02	Mean	0.05
SD	1.02	SD	0.94

Figure J.2 - Fit Statistics - Student Estimates

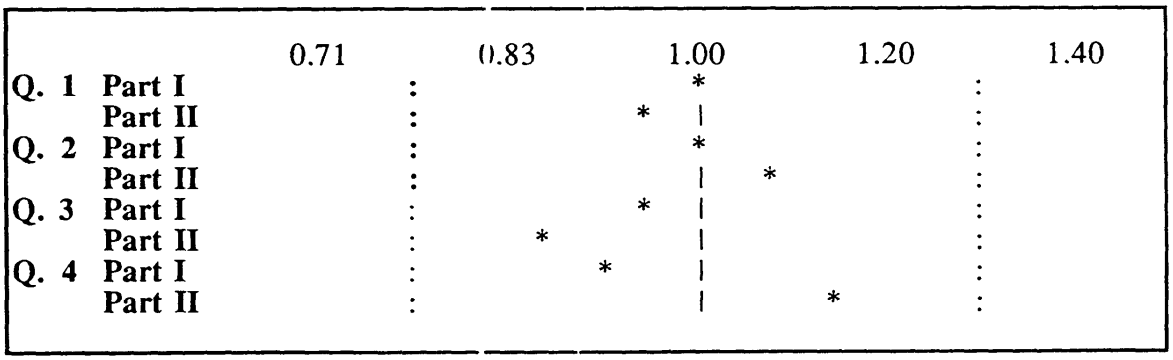


Figure J.3 - Infit Mean Square Map - Parameter Fit

Note for Figures J.4, J.5 and J.6 Each X respresents one student and the - - - - lines represent the mean estimates.

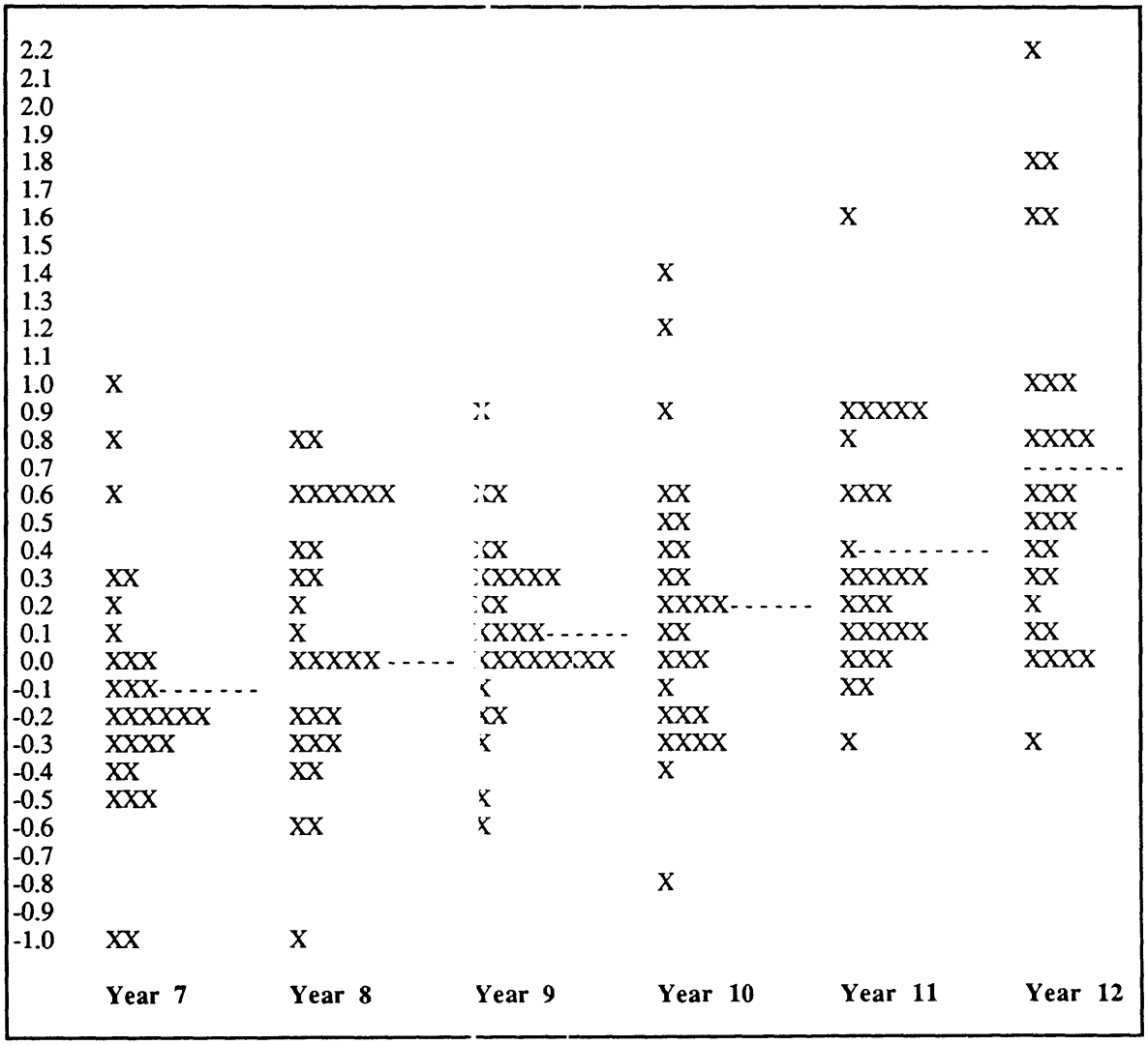


Figure J.4 - Estimates of Understanding by Academic Year

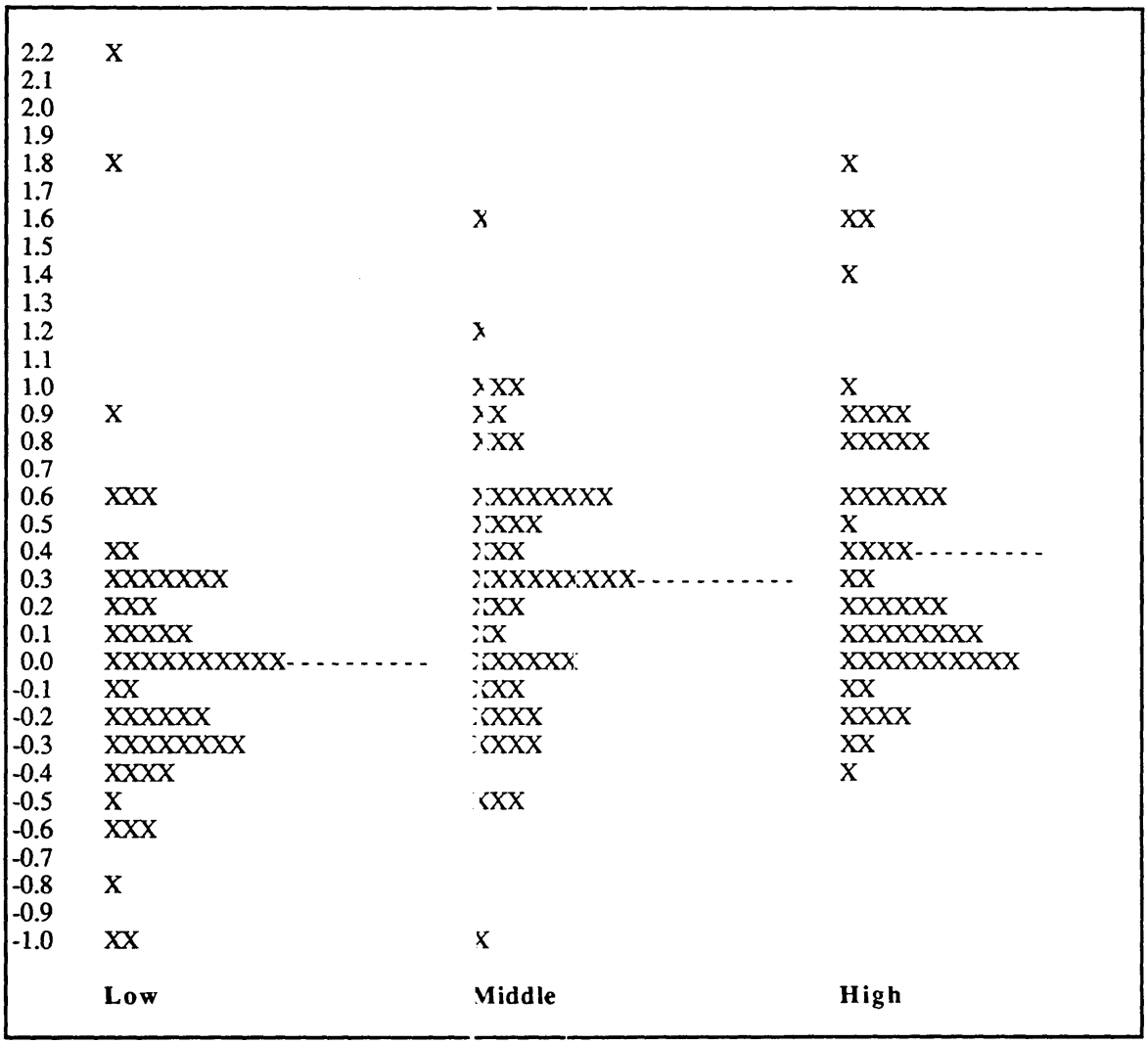


Figure J.5 - Estimates of Understanding by Mathematical Ability

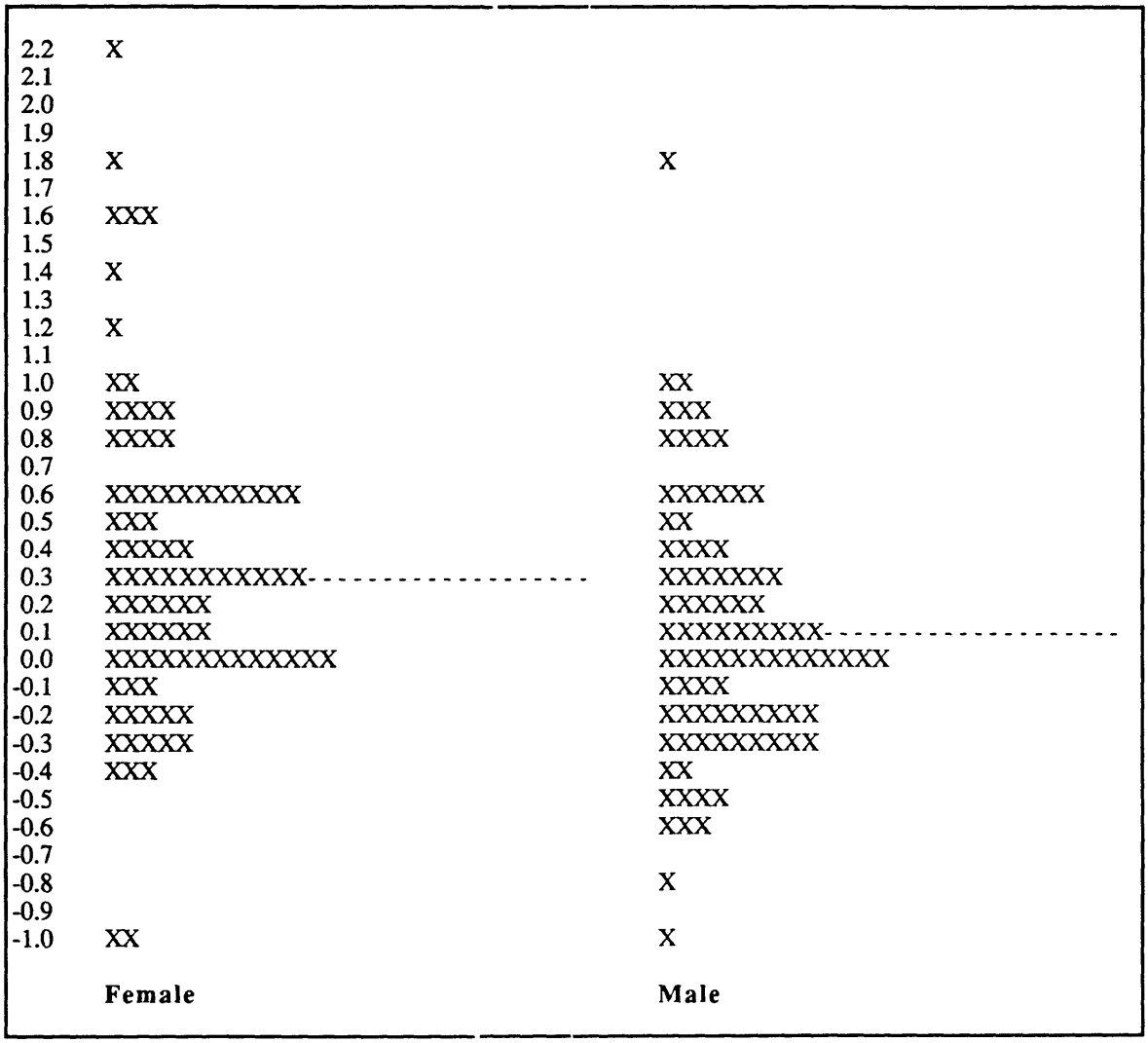


Figure J.6 - Estimates of Understanding by Gender

Appendix K

Permission Letter for Study 2

UNE
The University of
NEW ENGLAND

ARMIDALE
Department of Science, Technology and Mathematics Education
Armidale, NSW 2351 Australia
Telephone (067) 73 4246 Fax (067) 72 9593

25th March 1992

Dear Parent / Guardian,
I am currently enrolled in a Ph. D. at the University of New England and my research is designed to investigate student growth and understanding in statistics. The focus of the study will be students in Year 7 to 12 at High School.
Your daughter / son / ward was a participant in the first phase of this study last year. Preliminary analysis of responses to the questionnaire in the first phase of the test revealed that in some questions students differed in the approach they took in their answers. To gain further insight into this phenomena it would be useful if each student who completed the questionnaire would now be able to undertake
(1) a short test of spacial thinking and short term memory (this term) and
(2) another statistics questionnaire similar to that undertaken last year (next term).
The test and questionnaire, which have the support of the Principal, are designed in such a way that disruption of the normal school process will be minimal. Each student will be given written tests and oral tests of approximately one hour duration. Some students will be asked to do a short follow-up interview. There will be complete confidentiality with respect to the tests and interviews for both students and the school.
The taking of the test should prove to be a worthwhile educational experience for the students, as well, the results should provide further insight into possible explanations for the phenomena noticed in responses to the earlier questionnaire.
As explained last year, the purpose of the study, in general, is to identify a hierarchy in children's understanding in statistics. The expectation is that the results of this study will allow changes in statistics in the school curriculum to more accurately reflect how students grow in statistical understanding. The end result being that school statistics will become more useful and more meaningful to the student population. This is especially important in the senior school mathematics, where it is anticipated that more statistics is to be introduced.
If you have any concerns or enquiries you can contact me or the Principal for more information. If you are willing to allow your daughter / son / ward to participate could you please complete the form below and return it to the school.

Yours faithfully,

[redacted]

Mrs Christine Reading
Mathematics Teacher
Armidale High School

- -

I give my daughter / son / ward _______________
permission to be included in the research project to be carried out by Mrs Christine Reading.

Printed Name ________________________

Signature ______________ Date ________

Appendix L

Luria Test for Study 2

1 N/L (number/letter) Search Test

INSTRUCTIONS TO PARTICIPANTS:

Please write your name, and course number in the spaces provided at the top of the sheet.

ENSURE THAT ALL PENCILS ARE ON THE DESK

This is a test of your ability to shift your attention from one thing to another.

Place A CROSS on the letters and numbers as indicated in the left hand column. Go as fast as you can but do not be too concerned if you are unable to finish.

USE THE BOARD TO DEMONSTRATE LETTER AND NUMBER SEQUENCES.

For example, after the word 'Vowel' place a cross on each vowel.

B G E R U L O O P G T

After the word 'Odd' place a cross on each odd number in the line.

1 3 8 6 9 5 2 8 4 9 5

STRESS THE IMPORTANCE OF PLACING A CROSS.

When you are asked to stop, please place your pencil on the desk immediately.

Ready? Begin. (TIME WITH STOPWATCH 2 MINUTES 30 SECONDS)

Stop. (ENSURE THAT ALL PENCILS ARE ON THE DESK.

COLLECT SHEETS.

1. N/L number/letter Search Test

Name: .....

Please place a cross on the letters and numbers as indicated by the instruction in the left hand column.

1.	Vowel	a	m	x	s	i	e	r	i	y	t	b	b	f	l	o	z	b	c	p	t	c	g	l	r
2.	Odd	6	6	2	6	5	7	4	7	1	7	3	4	4	7	2	7	6	8	8	5	6	3	6	2
3.	Consonant	c	l	j	k	ß	q	l	a	a	p	s	t	b	u	l	o	u	c	d	j	i	m	f	q
4.	Odd	1	8	2	9	7	3	2	5	5	3	7	6	5	2	4	1	3	5	8	6	5	4	8	7
5.	Even	9	5	5	2	6	1	7	7	6	7	1	4	9	8	5	6	8	6	2	7	2	2	1	4
6.	Even	6	5	4	8	1	1	7	6	7	4	1	7	4	6	8	5	8	9	5	2	5	8	4	7
7.	Consonant	o	d	a	v	w	c	u	l	w	m	e	e	e	q	m	x	f	h	y	d	k	n	o	t
8.	Vowel	f	g	p	s	m	a	n	o	e	g	t	u	i	q	u	s	s	t	b	m	l	g	r	x
9.	Consonant	h	g	l	p	h	s	m	u	n	o	q	f	x	m	p	p	x	a	d	l	t	n	v	o
10.	Odd	9	1	4	9	9	1	4	5	2	3	6	8	1	7	9	2	7	6	8	6	4	6	1	6
11.	Even	6	1	1	9	6	9	4	4	4	6	2	6	4	5	7	4	7	7	4	5	1	9	2	4
12.	Odd	6	4	4	9	3	5	2	4	9	4	7	2	4	6	3	3	8	2	4	4	5	8	6	3
13.	Even	3	2	1	7	9	8	2	5	9	7	8	7	3	7	9	2	5	2	4	1	4	5	5	2
14.	Vowel	a	a	c	e	m	d	p	d	f	x	r	b	z	w	q	b	u	o	m	d	g	l	a	f
15.	Odd	9	8	6	8	6	2	4	8	2	6	4	5	2	4	8	2	8	4	2	4	4	4	9	9
16.	Vowel	u	t	p	l	l	p	q	e	e	n	f	r	z	i	r	b	j	t	x	d	t	o	n	r
17.	Odd	7	4	4	2	9	4	3	9	6	2	7	5	5	7	3	2	2	7	8	9	7	7	3	5
18.	Even	5	4	1	7	8	4	5	6	1	1	8	9	9	3	3	7	1	4	3	2	5	3	2	2
19.	Consonant	r	q	t	x	o	f	s	s	u	r	n	a	v	r	o	f	l	g	m	k	l	g	r	z
20.	Vowel	m	j	k	v	m	s	m	u	c	r	s	e	m	x	s	c	m	o	r	b	d	t	p	u
21.	Consonant	a	b	p	t	e	u	m	n	g	e	l	l	x	b	c	r	t	u	m	m	q	x	t	p
22.	Consonant	s	n	o	u	b	p	y	d	f	x	b	q	l	f	r	a	s	e	l	i	i	b	n	r
23.	Odd	1	1	6	6	4	4	9	8	8	3	5	2	4	7	9	8	4	8	2	7	5	9	3	8
24.	Even	4	8	3	2	4	7	7	9	2	8	3	1	2	4	9	6	4	7	1	6	8	2	2	9

PLEASE STOP AND PLACE YOUR PENCIL ON THE DESK WHEN INSTRUCTED

2 Form Board Test

NAME:.....

This is a test of your ab..lity to tell what pieces can be put together to make a certain figure.

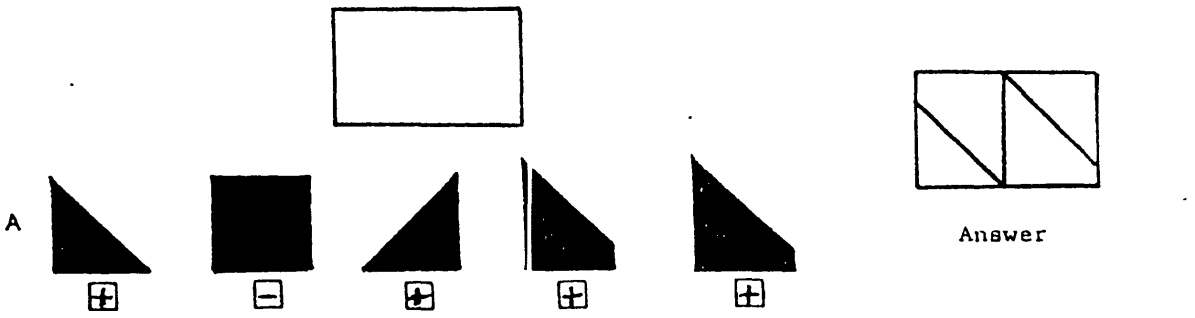
Each test page is divided into two columns. At the top of each column is a geometrical f..gure. Beneath each figure are several problems. Each problem consists of a row of 5 shaded pieces.

Your task is to decide wh..ch of the 5 shaded pieces will make the complete figure when put ..ogether.

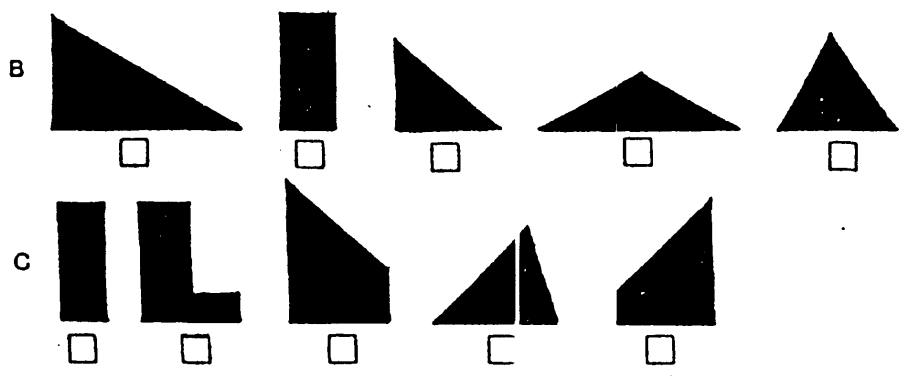
Any number of shaded pie..es, from 2 to 5, may be used to make the complete figure. Each pi..ce may be turned around to any position but it cannot be turned o..er.

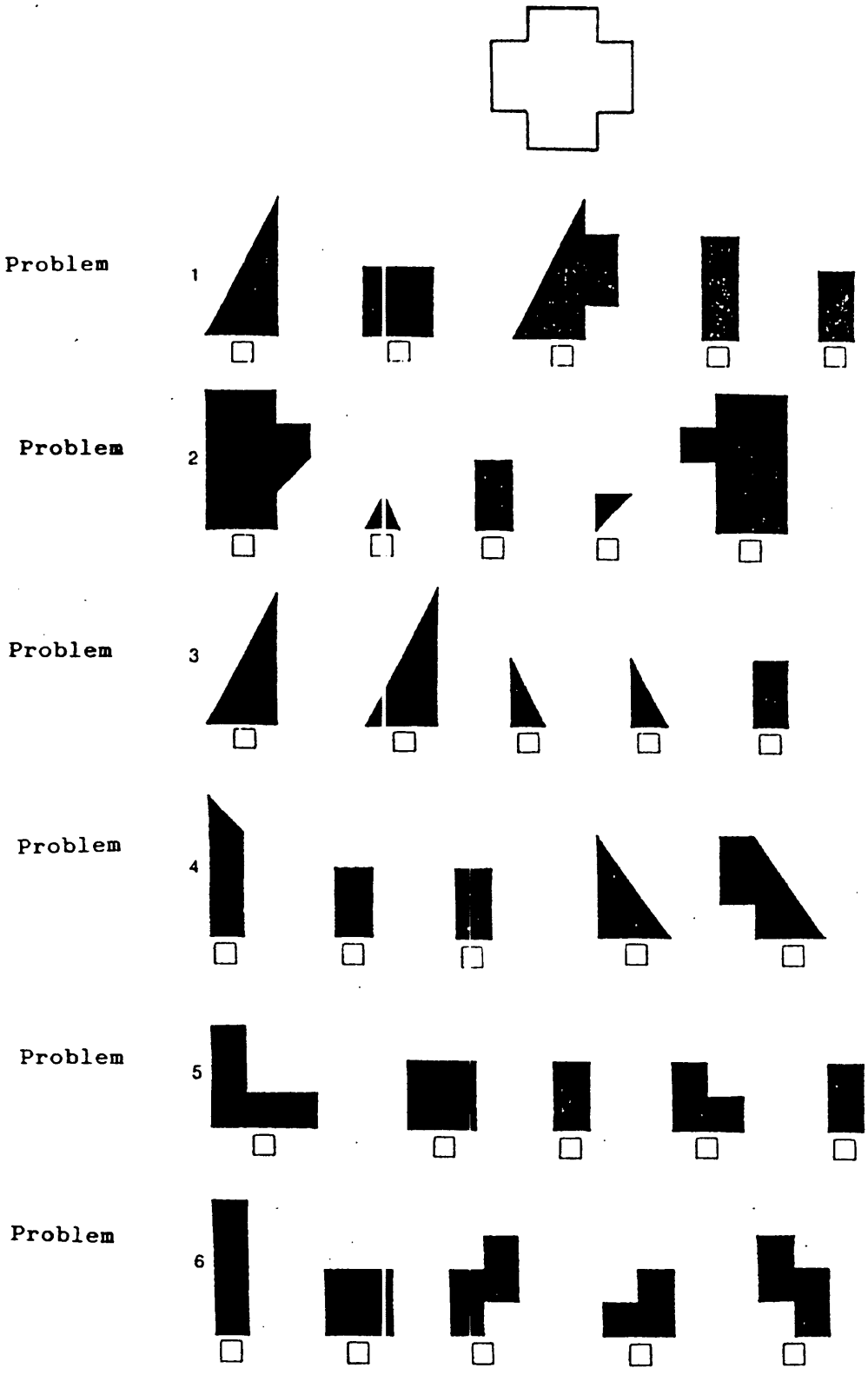
It may help you to sketch the way the pieces fit together. You may use any blank space for d..ing this. When you know which pieces make the complete figure, mark a plus (+) in the box under ones that are used, and a minu..s (-) in the box under ones that are not used.

In Example A below, the r..ctangle can be made from the first, third, fourth and fifth p..ieces. A plus has been marked in the box under these places. The ..econd piece is not needed to make the rectangle. A minus has b..en marked in the box under it. The rectangle drawn to the ri..ht of the problem shows one way in which the four pieces could be ..ut together.



Now try to decide which pieces in Examples B and C will make the rectangle.

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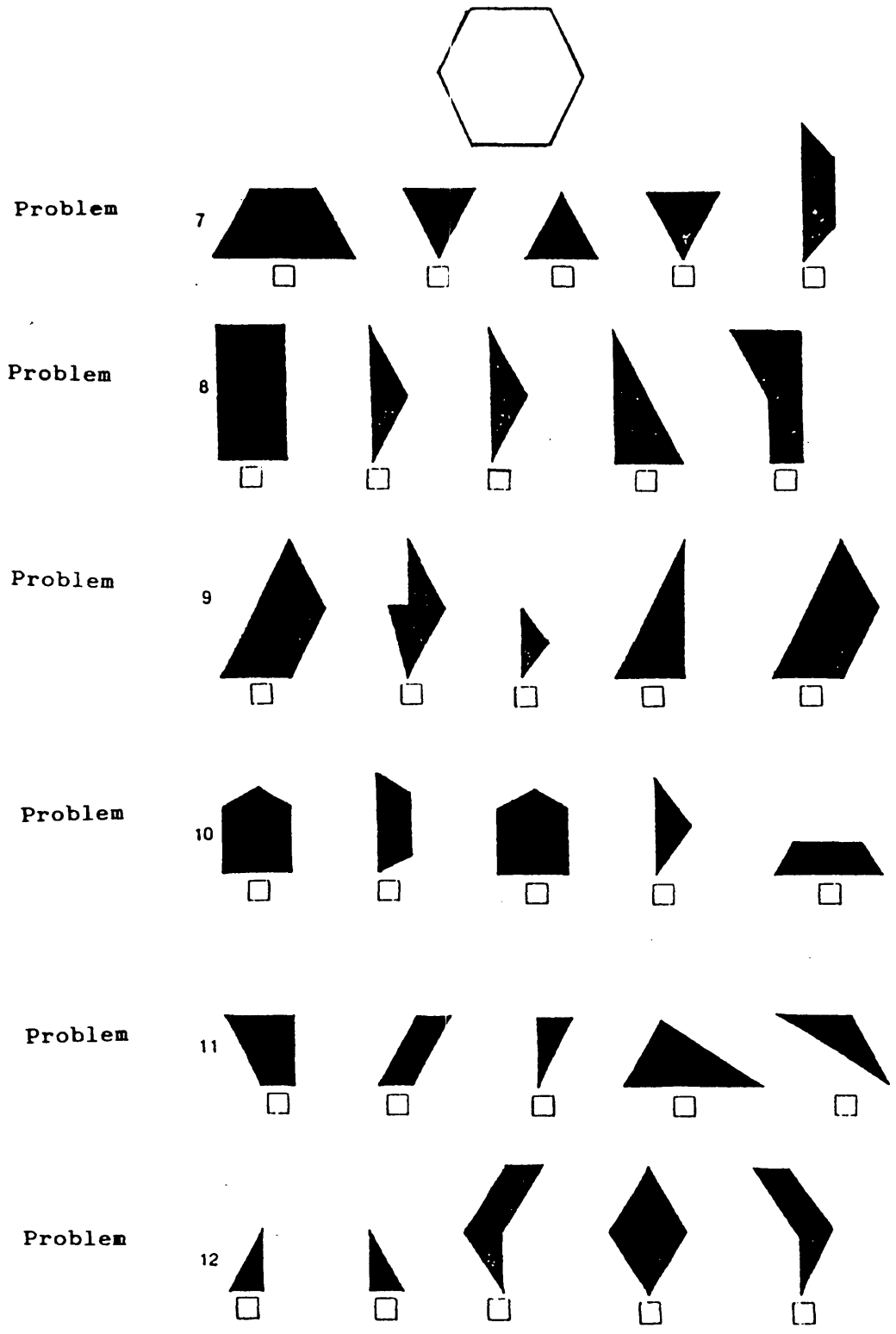
Problem 2
Problem 3
Problem 4
Problem 5
Problem 6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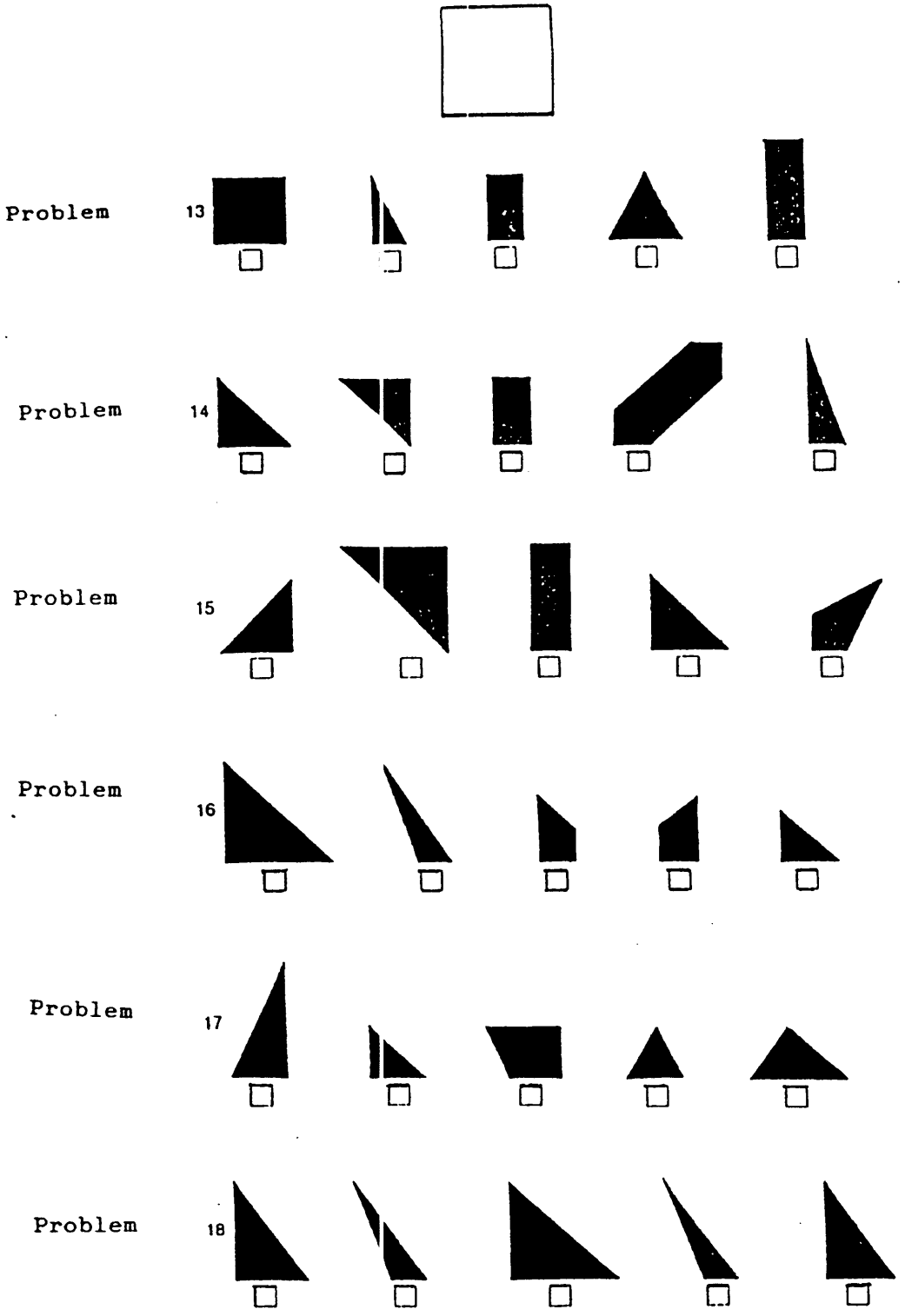
Problem 8
Problem 9
Problem 10
Problem 11
Problem 12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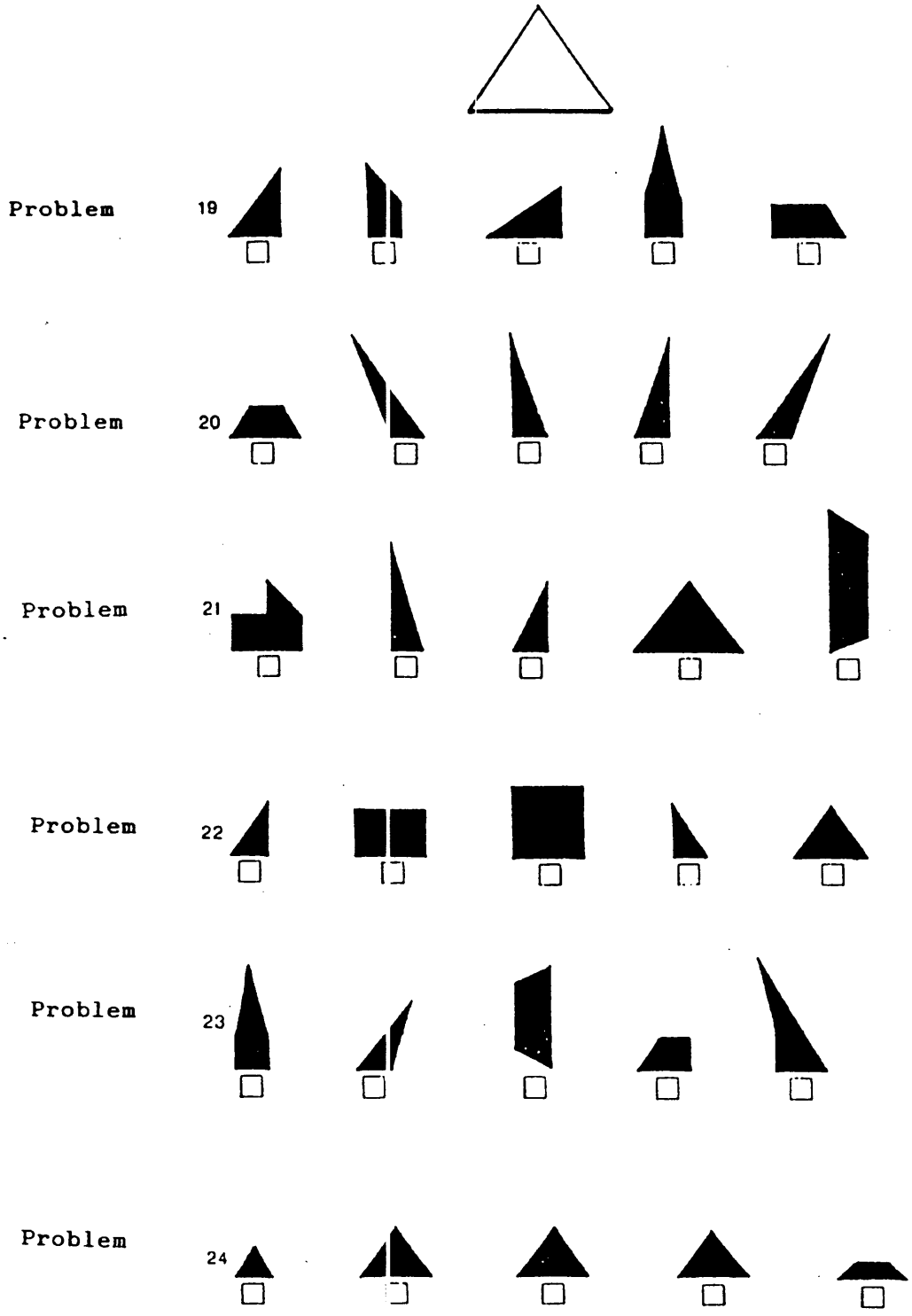
Problem 14
Problem 15
Problem 16
Problem 17
Problem 18


Problem 19
Problem 20
Problem 21
Problem 22
Problem 23
Problem 24

3 Auditory Word Span Test

INSTRUCTIONS TO PARTICIPANTS:

This is a test of your ability to remember sets of words. I will call out the words. After I have finished each set of words you are to write down the words in the exact order in which they were called out. Please do not write any words of a set until I have finished calling out the whole set. There will be 20 sets.

Some of the sets may be too long for you to remember all of the words. If you do not remember some of them, leave a blank space for them and write down all the words that you do remember. Try to remember all the words if possible, and be sure to write them down in the exact order in which they were called out.

For example, I might call out, 'Set one. Tree - card - bottle - letter - page. Begin.'

When I say 'begin' (showing that the set is complete), write the words on the answer page opposite the number one.

It is very important that you do not write words while a set is being called out, since this is a test of your memory for words.

TIME: 1 second per word.

Set 1 MAN - LETTER - STRING

Set 2 HORSE - PEN - THORN - BABY

Set 3 TABLE - CAMP - PARTY - LAKE - BODY - ARROW - HALL

Set 4 PAPER - MOSS - RIVER - DREAM - SKIN

Set 5 GRASS - CUP - HOUSE - DOOR

Set 6 AIR - CHIN - INSECT - SNAKE - TICKET - SOCK

Set 7 MOTHER - APPLE - GOLD - BOOK - DRESS - SUGAR - CHAIR

Set 8 PEEPER - CLAW - SLAVE - POLE - ARMY - CAT

Set 9 CLOCK - LIP - ARM - FISH - CARD - BELL - INK

Set 10 TOY - FUR - FORK - ANT - LAND

Set 11 STONE - PEACH - ELBOW- MONEY - IRON - TANK - SKY - FLOOR

Set 12 CHURCH - NAIL - CORN - BIRD - STEP - KING

Set 13 HAIR - QUEEN - HEAD - DOLL

Set 14 KISS - WINE - PACE

Set 15 ICE - FLAG - SKIRT - FROG - BLOOD - FIRE - SEAT - JAR - PLATE

Set 16 DOG - TREE - FOX - CITY - GIFT

Set 17 JELLY - ROAD - TRAIN - PIN - CAR - FISH - BAR - STEP - TOAST

Set 18 WIFE - CHILD - ROCK - STEAM - WINTER - PENCIL

Set 19 PIPE - SUN - BREAD - CAKE - HAND

Set 20 HOTEL - FOREST - WINDOW - TAP - HILL - JAM - SHIP

3 Auditory Word Span Test

NAME: .....

Set 1 .....

Set 2 .....

Set 3 .....

Set 4 .....

Set 5 .....

Set 6 .....

Set 7 .....

Set 8 .....

Set 9 .....

Set 10 .....

Set 11 .....

Set 12 .....

Set 13 .....

Set 14 .....

Set 15 .....

Set 16 .....

Set 17 .....

Set 18 .....

Set 19 .....

Set 20 .....

4 Auditory Number/Letter Attention Span Test

INSTRUCTIONS TO PARTICIPANTS:

Please write your name, and course number in the spaces provided at the top of the sheet.

This is a test of how well you can attend to either numbers or letters in a sequence of numbers and letters mixed together. I will say either the word 'numbers' or the word 'letters' and then call out the sequence. After I have finished, you are to write down either the numbers or the letters in the exact order in which they were called out. Please do not write anything until I have finished calling out the whole series. There will be 20 series.

For example, I might call out, 'Ready. Series One. Numbers. M 2 L 8 T 5. Begin.'

When I say 'begin' (showing that the sequence is complete), write the numbers on the answer page opposite the number one in this manner:

USE THE BOARD TO DEMONSTRATE THE NUMBER SEQUENCE

2 8 5

If I had said 'Ready. Series One. Letters. M 2 L 8 T 5. Begin,' you would write the letters on the answer page opposite the number one in this manner:

USE THE BOARD TO DEMONSTRATE THE LETTER SEQUENCE

M L T

It is very important that you do not write numbers or letters while a sequence is being called out. Try to remember all of them if possible, and be sure to write them down in the exact order in which they were called out.

If you do not remember some of the numbers or letters, leave a blank space for them and write down all of those you do remember.

It is very important that you do not write anything while a series is being called out, since this is a test of your memory for a series.

4 Auditory Number/Letter Attention Span Test Page 2

TIME: 1 second per number/letter.

Series 1	Letters	6 - F - 2 - S - 9
Series 2	Letters	7 - R - 1 - I - A - 4
Series 3	Numbers	L - 3 - H - 2 - T - 6
Series 4	Letters	9 - K - H - 3 - 4
Series 5	Numbers	K - 1 - A - 5 - 8 - 5
Series 6	Letters	2 - S - 5 - F - 6 - 7 - 4
Series 7	Numbers	6 - 9 - V - R - 7 - A - W
Series 8	Numbers	I - 2 - R - 5 - V - 8 - J - I
Series 9	Letters	X - 5 - R - 2 - S - I - V - 7
Series 10	Numbers	7 - F - 2 - W - 9 - J - 6 - R - 4
Series 11	Letters	A - F - 9 - Y - 5 - R - K - 8
Series 12	Numbers	T - 6 - A - 9 - R - 7 - 2 - S - 8 - 3
Series 13	Numbers	A - 1 - Y - V - 6
Series 14	Letters	3 - 2 - W - 4 - F - K - 7 - T - 1 - A
Series 15	Letters	9 - A - H - 8 - A - 2 - K - 5 - 7
Series 16	Numbers	8 - L - 1 - S - 5 - K - 3 - R
Series 17	Numbers	6 - F - 2 - J - 9 - 1 - V
Series 18	Letters	6 - J - 7 - S - K
Series 19	Numbers	4 - R - 7 - W - 3 - A
Series 20	Letters	H - 5 - A - Q - 3 - 1 - S - V

4 Auditory Number/Letter Attention Span Test

NAME: .....

Series 1 .....

Series 2 .....

Series 3 .....

Series 4 .....

Series 5 .....

Series 6 .....

Series 7 .....

Series 8 .....

Series 9 .....

Series 10 .....

Series 11 .....

Series 12 .....

Series 13 .....

Series 14 .....

Series 15 .....

Series 16 .....

Series 17 .....

Series 18 .....

Series 19 .....

Series 20 .....

5 Paper Folding Test

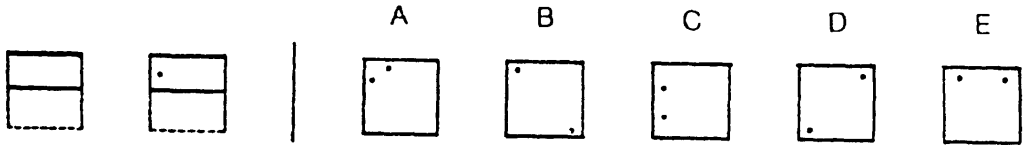
NAME:.....

In this test you are to imagine the folding and unfolding of pieces of paper.

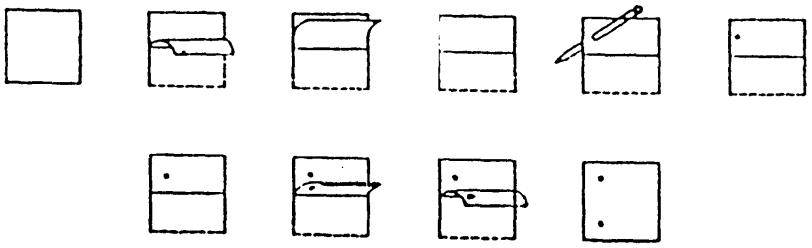
In each problem in the test there are some figures drawn at the left of a vertical line and there are other figures drawn at the right of the line. The figures at the left represent a square piece of paper being folded, and the last of these figures has one or two small circles drawn on it to show where the paper has been punched. Each hole is punched through all the thicknesses of paper at that point.

One of the five figures at the right of the vertical line shows where the holes will be when the paper is completely unfolded. **You are to decide which one of these figures is correct and draw an X through that figure.**

Now try the sample problem below (in this problem only one hole was punched in the folded paper).

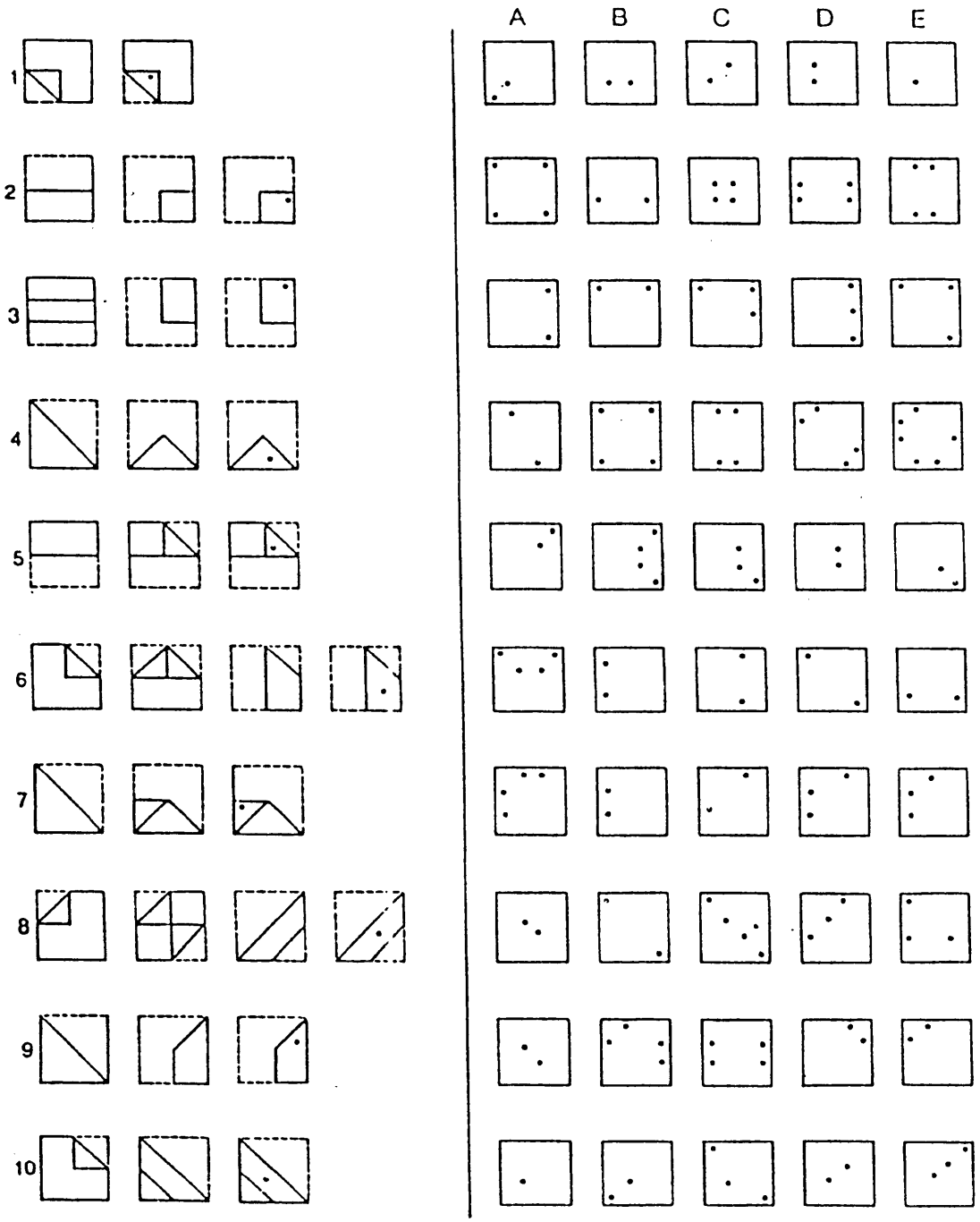


The correct answer to the sample problem above is C and so it should have been marked with an X. The figures below show how the paper was folded and why C is the correct answer.



In these problems all of the folds that are made are shown in the figures at the left of the line, and the paper is not turned or moved in any way except to make the folds shown in the figures. Remember, the answer is the figure that shows the positions of the holes when the paper is completely unfolded.

5 Paper Folding Test Page 2



6 Auditory Number Span Test

INSTRUCTIONS TO PARTICIPANTS:

This is a test of your ability to remember series of numbers. I will call out the numbers. After I have finished each series of numbers you are to write down the numbers in the exact order in which they were called out. Please do not write any numbers of a series until I have finished calling out the whole series. There will be 20 series.

Some of the series will be too long for you to remember all of the numbers. If you do not remember some of them, leave a blank space for them and write down all the numbers you do remember. Try to remember all the numbers if possible, and be sure to write them down in the exact order in which they were called out.

For example, I might call out, 'Series one. 7 - 2 - 4. Begin.'

When I say 'begin' (showing that the series is complete), write the numbers on the answer page opposite the number one.

USE THE BOARD TO DEMONSTRATE

7 2 4

It is very important that you do not write numbers while a series is being called out, since this is a test of your memory for numbers.

6 Auditory Number Span Test Page 2

TIME: 1 second per number.

Series 1	8 - 1 - 9 - 5 - 7 - 2
Series 2	4 - 6 - 2 - 9
Series 3	3 - 7 - 1 - 4 - 9 - 2 - 5 - 8 - 1 - 6
Series 4	9 - 2 - 6 - 2 - 8 - 6
Series 5	7 - 9 - 5 - 3 - 8
Series 6	5 - 2 - 9 - 4 - 1 - 6 - 8 - 3 - 7
Series 7	2 - 6 - 3 - 1 - 5
Series 8	2 - 4 - 8 - 5 - 1
Series 9	6 - 8 - 2 - 4 - 1 - 3 - 9 - 7 - 2 - 5 - 3
Series 10	9 - 2 - 8 - 5 - 7 - 1
Series 11	7 - 4 - 2 - 9 - 3 - 5 - 8 - 6
Series 12	4 - 3 - 7 - 2 - 3 - 9
Series 13	5 - 7 - 3 - 1 - 6 - 9 - 4 - 8 - 5 - 1 - 7 - 2
Series 14	6 - 2 - 5 - 9 - 7 - 1 - 8 - 3
Series 15	4 - 7 - 9 - 3 - 6 - 1 - 5 - 8 - 4 - 2 - 7
Series 16	5 - 1 - 8 - 7 - 2 - 3 - 1
Series 17	8 - 2 - 6 - 9 - 1 - 7 - 3 - 8 - 5 - 9 - 6 - 4
Series 18	5 - 1 - 9 - 2 - 7 - 4 - 8 - 3 - 6
Series 19	7 - 5 - 2 - 6 - 4 - 9 - 1
Series 20	3 - 2 - 1 - 8 - 1 - 4 - 6 - 5

6 Auditory Number Span Test

NAME: .....

Series 1 .....

Series 2 .....

Series 3 .....

Series 4 .....

Series 5 .....

Series 6 .....

Series 7 .....

Series 8 .....

Series 9 .....

Series 10 .....

Series 11 .....

Series 12 .....

Series 13 .....

Series 14 .....

Series 15 .....

Series 16 .....

Series 17 .....

Series 18 .....

Series 19 .....

Series 20 .....

Appendix M

Written Test for Study 2

WRITTEN TEST

Answer all questions to the best of your ability. There is no right or wrong answer, it is your thoughts which we are interested in.

Please provide an attempt for every question.

WARM UP

(i) At the top of your page please write your name, age, school year and sex.
(ii) You've heard the word 'statistics' before. What does this word mean to you ?
(iii) If you were learning about statistics at school what would you expect to be learning about ?

QUESTION 1

PART I

Radio stations have their own way of working out the most popular albums played on the radio and they often produce Top 10 charts. Imagine that you have been asked to do this independently of the radio station and answer the following questions :
(i) Describe the best way to find out what the most popular songs are on the local radio station.
(ii) Why did you decide to find out this way ?

PART II

There are often surveys of the community to see what magazines they like to read. The editor of the school magazine is interested in writing an article about the reading habits of the students at A.H.S. and asked you to find out the information.
(i) You are only able to ask 30 students from the school. Which students would you select to ask ? (Don't use names)
(ii) Why would you select these students ?

QUESTION 2

PART I

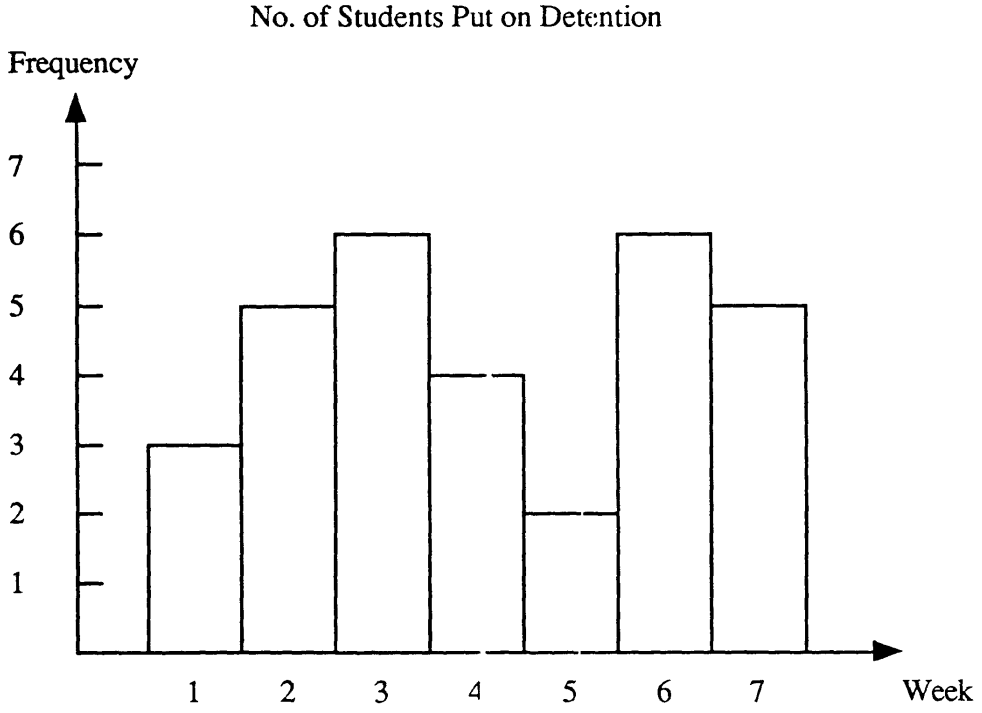
A class teacher wanted students to practice collecting data. One Year 7 student decided to collect data concerning the number of times that she rode her bike during a week for a seven week period. The table the student came up with is given below.

Week 1	3
Week 2	5
Week 3	7
Week 4	4
Week 5	2
Week 6	7
Week 7	5

What does the table tell you ?

PART II

The deputy in the school kept a record of the number of students who were put on detention at the school each week. He decided it would be useful to draw a graph to illustrate this information. The graph is presented below.



What does the graph tell you ?

QUESTION 3

PART I

As part of a large project which had to do with measuring and discussing the human body, one of the tasks was to measure the lengths of people's left hand to the nearest centimetre. The results of the 29 students in the class are as follows :

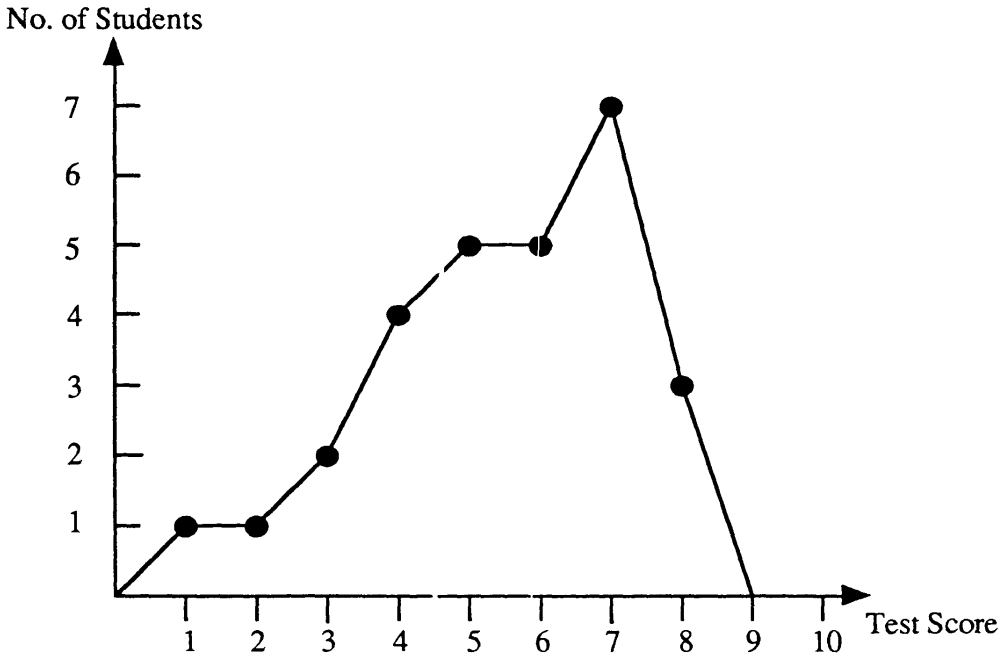
22	22	22	23	23	23	23	24	24	24	24	24	24	25	25
25	25	25	26	26	26	26	26	26	26	27	28	28	29	

(i) If you were asked to give a number, or numbers, (to the nearest cm.) which could be best used to represent the size of the left hands in that class, what numbers, or numbers, would you select ?

(ii) Give reasons for your selection.

PART II

A teacher was interested in how students performed in a mathematics test to decide whether they needed extra help. The graph below represents the scores out of 10 achieved by the 28 Year 8 students in his class in the spelling test.



(i) If you were asked to give a number, or numbers, which could be best used to represent the score in the mathematics test of students in that class, what numbers, or numbers, would you select ?

(ii) Give reasons for your selection.

QUESTION 4

PART I

The number of serious fires in a city was recorded for the last ten years.

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	4	5	9	3	6	7	10	4	6

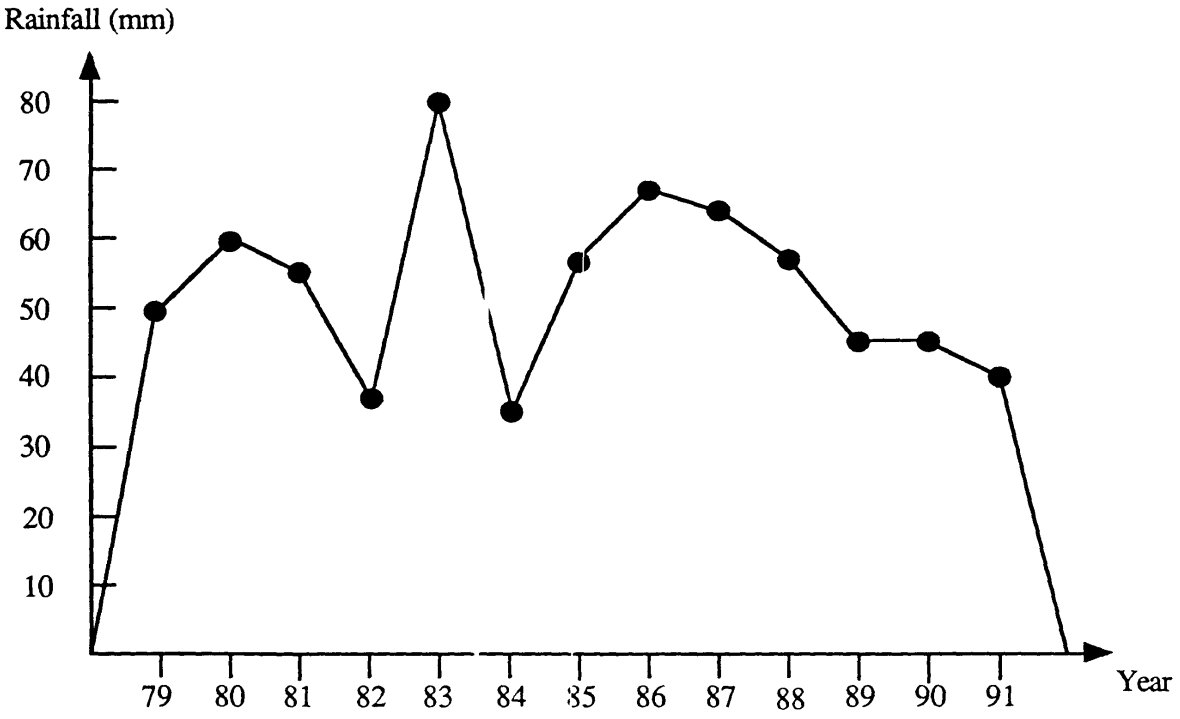
(i) Describe any pattern that you can see in the data.

(ii) Approximately how many serious fires would you expect in 1992? Why?

(iii) Suggest some years in the future (after 1991) when you think the number of serious fires might exceed 8. Why did you select those years?

PART II

The rainfall (in millimetres) has been recorded in a coastal city and the results represented on the graph below.



(i) Describe any pattern that you can see in the data.

(ii) Approximately how much rain (in millimetres) would you expect in 1992? Why?

(iii) Suggest some years (after 1991) when you think the rainfall might exceed 60. Why did you select these years?

Appendix N

Interview Schedule for Study 2

The schedule used for the Interview Study as part of Study 2.

The following procedure was followed for each question in the written test.

1. Student reads the question aloud.

2. What is the question asking you to do?

3. What does ..... mean? Used for any words that appear to puzzle the student or at which the student appears to falter.

4. How would you answer this question now?

5. Probe : Good? ..... Anymore? ... Can you add anything to that? ...

6. If the answer is different to that given in the written test, read out the answer given in the written test and ask the student to choose which answer is preferred and why?

7. Prompt : What if I were to ask .....?
What if I were to tell you .....?
What about.....?

The actual prompts used depended on the question and also on the responses that the student had already given.

Appendix O

Tables for Results - Study 2

These tables should be read in conjunction with the analysis of Study 2 in Chapter 7.

Table O.1.1 - Successive Processing Style

			Low	Mid	High	Total			Low	Mid	High	Total
Q.2	P.I	A	9	5	9	23	P.II	A	9	6	9	24
		B	8	8	7	23		B	8	4	4	16
			17	13	16	46			17	10	13	40
Q.3	P.I	A	27	15	28	70	P.II	A	22	14	24	60
		B	0	2	4	6		B	5	4	7	16
			27	17	32	76			27	18	31	76
Q.4	P.I	A	7	5	13	25	P.II	A	12	3	9	24
		B	16	8	15	39		B	14	11	17	42
			23	13	28	64			26	14	26	66

Table O.1.2 - Simultaneous Processing Style

			Low	Mid	High	Total			Low	Mid	High	Total
Q.2	P.I	A	3	5	15	23	P.II	A	7	3	14	24
		B	12	5	6	23		B	8	3	5	16
			15	10	21	46			15	6	19	40
Q.3	P.I	A	29	11	30	70	P.II	A	22	10	28	60
		B	2	1	3	6		B	5	3	8	16
			31	12	33	76			27	13	36	76
Q.4	P.I	A	9	4	12	25	P.II	A	8	5	11	24
		B	12	9	18	39		B	16	10	16	42
			21	13	30	64			24	15	27	66

Table O.2 - Tau Value Comparisons

		Level	1991	1992		Level	1991	1992
Q.1	Part I	2	-0.46	-2.09	Part II	2	-1.74	-0.41
		3	-1.34	-0.88		3	1.28	-1.33
		4	-0.34	0.32		4	-1.65	0.15
		5	1.17	0.51		5	0.17	1.59
		6	0.97	2.14		6	0.53	3.00
		7	3.00	3.00		7	1.41	3.00
Q.2	Part I	2	-1.75	-2.12	Part II	2	-1.20	-1.38
		3	0.56	0.72		3	0.68	0.63
		4	0.72	1.28		4	1.82	1.28
		5	-0.88	-1.14		5	-2.57	-1.38
		6	0.46	0.50		6	0.58	0.91
		7	0.89	0.76		7	0.68	-0.06
Q.3	Part I	2	0.25	-0.56	Part II	2	0.10	0.51
		3	0.98	0.51		3	-0.56	0.88
		4	-1.05	-1.15		4	-1.27	-0.09
		5	-0.83	-1.12		5	1.73	-1.76
		6	-0.83	2.31		6	3.00	-1.87
		7	1.48	3.00		7	3.00	2.33
Q.4	Part I	2	0.29	0.31	Part II	2	0.16	0.59
		3	1.06	1.41		3	0.84	0.32
		4	-0.50	-1.73		4	-0.97	-0.39
		5	-1.71	-0.99		5	-0.88	-1.43
		6	-0.12	-0.29		6	-0.76	-0.65
		7	0.97	1.29		7	1.62	1.55

Table O.3 - Threshold Value Comparisons

		Level	1991	1992		Level	1991	1992
Q.1	Part I	2	-1.19	-3.00	Part II	2	-2.28	-3.00
		3	-0.76	-1.75		3	-0.89	-0.97
		4	-0.04	-0.34		4	-0.78	-0.97
		5	1.00	0.67		5	-0.32	-0.71
		6	1.71	1.39		6	0.23	0.18
		7	3.00	2.88		7	1.27	1.77
Q.2	Part I	2	-1.81	-2.28	Part II	2	-1.09	-1.44
		3	-0.13	-0.19		3	-0.03	0.06
		4	0.07	0.06		4	0.21	0.18
		5	0.19	0.13		5	0.24	0.24
		6	0.59	0.47		6	0.68	0.59
		7	1.34	1.12		7	1.41	0.92
Q.3	Part I	2	-0.89	-1.31	Part II	2	-0.56	-0.70
		3	-0.66	-0.80		3	-0.37	-0.55
		4	-0.61	-0.80		4	-0.37	-0.53
		5	-0.51	-0.74		5	-0.37	-0.50
		6	-0.31	-0.57		6	-0.19	-0.41
		7	1.32	1.84		7	1.99	2.28
Q.4	Part I	2	-0.52	-0.61	Part II	2	-0.67	-0.56
		3	-0.28	-0.39		3	-0.41	-0.40
		4	-0.23	-0.36		4	-0.36	-0.34
		5	-0. 9	-0.25		5	-0.26	-0.27
		6	0. 7	0.09		6	-0.02	-0.01
		7	1.27	1.48		7	1.73	1.68

Table O.4.1 - Response Level by Academic Year - Question 1 Part I

Level	Year					Total
	8	9	10	11	12	
1	0	0	0	0	0	0
2	1	2	3	0	1	7
3	13	4	4	6	5	32
4	7	11	9	11	8	46
5	0	8	3	4	6	21
6	0	1	4	2	3	10
7	0	1	0	0	0	1
Total	21	27	23	23	23	117

Table O.4.2 - Response Level by Academic Year - Question 1 Part II

Level	Year					Total
	8	9	10	11	12	
1	0	0	0	0	0	0
2	3	2	2	0	1	8
3	0	0	0	0	0	0
4	3	3	1	3	0	10
5	7	10	9	6	12	21
6	8	9	10	13	4	10
7	0	3	1	1	6	1
Total	21	27	23	23	23	117

Table O.4.3 - Response Level and Path by Academic Year-Question 2 Part I

Level	Year					Total
	8	9	10	11	12	
1	3	1	0	0	0	4
2	8	7	7	8	7	37
3	5	2	3	3	3	16
4	1	2	0	0	1	4
	A B	A B	A B	A B	A B	
5	0 1	1 6	2 2	1 1	1 6	21
6	0 2	2 1	3 1	6 2	1 1	19
7	0 0	2 1	3 0	0 1	3 0	
	1	2	2	1	0	16
Total	21	27	23	23	23	117

Table O.4.4-Response Level and Path by Academic Year-Question 2 Part II

Level	Year										Total
	8		9		10		11		12		
1	5		0		2		1		3		11
2	8		4		7		11		8		38
3	2		2		3		3		6		16
4	1		1		1		0		0		3
	A	B	A	B	A	B	A	B	A	B	
5	0	3	2	9	0	3	0	2	2	0	44
6	0	0	1	2	3	1	1	1	0	1	19
7	1	0	4	0	3	0	3	0	3	0	
	1		2		0		1		0		18
Total	21		27		23		23		23		117

Table O.4.5 - Response Level and Path by Academic Year - Question 3 Part I

Level	Year										Total
	8		9		10		11		12		
0	1		0		0		1		0		2
1	1		0		0		0		0		1
2	3		1		1		0		0		5
3	0		0		0		0		0		0
4	0		1		1		0		0		2
	A	B	A	B	A	B	A	B	A	B	
5	0	0	4	0	2	1	3	0	1	1	12
6	12	2	15	2	13	3	12	4	11	7	81
7	1	0	3	0	1	0	0	0	2	0	
	1		1		1		3		0		13
8	0		0		0		0		1		1
Total	21		27		23		23		23		117

Table O.4.6-Response Level and Path by Academic Year-Question 3 Part II

Level	Year										Total
	8		9		10		11		12		
0	2		1		0		2		0		5
1	2		2		0		1		1		6
2	2		2		0		0		0		4
3	1		0		0		0		0		1
4	0		0		1		0		0		1
	A	B	A	B	A	B	A	B	A	B	
5	3	0	0	0	1	0	0	2	1	1	8
6	10	1	11	8	14	5	10	5	15	4	83
7	0	0	2	0	0	0	3	0	1	0	
	0		0		2		0		0		8
8	0		1		0		0		0		1
Total	21		27		23		23		23		117

Table O.4.7 - Response Level and Path by Academic Year - Question 4 Part I

Level	Year										Total
	8		9		10		11		12		
0	1		0		0		1		0		2
1	7		3		2		1		2		15
2	3		2		1		2		0		8
3	0		0		1		0		0		1
4	3		2		3		0		0		8
	A	B	A	B	A	B	A	B	A	B	
5	1	2	2	3	2	2	2	6	1	4	25
6	1	2	3	1	3	6	2	7	2	6	43
7	0	1	0	0	1	1	1	1	1	5	
	0		1		1		0		2		15
Total	21		27		23		23		23		117

Table O.4.8 - Response Level and Path by Academic Year-Question 4 Part II

Level	Year										Total
	8		9		10		11		12		
0	4		0		0		2		0		6
1	3		5		2		2		0		12
2	2		2		1		0		1		6
3	0		0		1		1		1		3
4	1		0		1		1		1		4
	A	B	A	B	A	B	A	B	A	B	
5	2	3	1	4	1	5	1	2	0	2	21
6	2	3	1	11	1	9	2	10	4	9	52
7	0	1	1	0	0	1	0	1	1	1	
	0		2		1		1		3		13
Total	21		27		23		23		23		117

Table O.5.1 - Response Level by Mathematical Ability - Question 1 Part I

Level	Mathematical Ability			
	Low	Middle	High	Total
1	0	0	0	0
2	1	4	2	7
3	9	9	14	32
4	20	15	11	46
5	5	6	10	21
6	2	4	4	10
7	0	1	0	1
Total	37	39	41	117

Table O.5.2-Response Level by Mathematical Ability-Question 1 Part II

Level	Mathematical Ability Low	Middle	High	Total
1	0	0	0	0
2	5	1	2	8
3	0	0	0	0
4	8	2	0	10
5	8	18	18	44
6	15	13	16	44
7	1	5	5	11
Total	37	39	41	117

Table O.5.3 - Response Level and Path by Mathematical Ability-Q. 2 Part I

Level	Mathematical Ability Low	Middle	High	Total
1	4	0	0	0
2	10	13	14	37
3	6	5	5	16
4	3	1	0	4
5	6	11	4	21
6	6	5	8	19
7	2	4	10	16
Total	37	39	41	117
Path				
A	6	8	11	25
B	7	12	6	25
Total	13	20	17	50

Table O.5.4 - Response Level and Path by Mathematical Ability-Q. 2 Part II

Level	Mathematical Ability Low	Middle	High	Total
1	4	6	1	11
2	13	15	10	38
3	2	3	11	16
4	1	2	0	3
5	12	6	3	21
6	3	3	4	10
7	2	4	12	18
Total	37	39	41	117
Path				
A	5	5	13	23
B	11	7	4	22
Total	16	12	17	45

Table O.5.5 - Response Level and Path by Mathematical Ability - Q.3 Part I

Level	Mathematical Ability Low	Middle	High	Total
0	2	0	0	2
1	1	0	0	1
2	4	1	0	5
3	0	0	0	0
4	1	1	0	2
5	5	3	4	12
6	23	32	26	81
7	1	2	10	13
8	0	0	1	1
Total	37	39	41	117
Path				
A	22	29	29	80
B	7	6	7	20
Total	29	35	36	100

Table O.5.6 - Response Level and Path by Mathematical Ability-Q.3 Part II

Level	Mathematical Ability Low	Middle	High	Total
0	4	1	0	5
1	5	1	0	6
2	2	1	1	4
3	1	0	0	1
4	0	1	0	1
5	3	3	2	8
6	22	30	31	83
7	0	2	6	8
8	0	0	1	1
Total	37	39	41	117
Path				
A	19	23	29	71
B	6	11	9	26
Total	25	34	38	97

Table O.5.7 - Response Level and Path by Mathematical Ability-Q.4 Part I

Level	Mathematical Ability Low	Middle	High	Total
0	2	0	0	2
1	5	7	3	15
2	5	1	2	8
3	1	0	0	1
4	3	1	4	8
5	12	7	6	25
6	8	17	18	43
7	1	6	8	15
Total	37	39	41	117
Path				
A	8	9	5	22
B	13	19	25	57
Total	21	28	30	79

Table O.5.8 - Response Level and Path by Mathematical Ability-Q.4 Part II

	Mathematical Ability			
Level	Low	Middle	High	Total
0	4	1	1	6
1	3	5	4	12
2	1	3	2	6
3	2	0	1	3
4	0	3	1	4
5	11	2	8	21
6	14	21	17	52
7	2	4	7	13
Total	37	39	41	117
Path				
A	6	5	6	17
B	19	21	22	62
Total	25	26	28	79

Table O.6.1 - Response Level by Gender - Question 1 Part I

	Gender		
Level	Female	Male	Total
1	0	0	0
2	3	4	7
3	17	15	32
4	24	22	46
5	10	11	21
6	7	3	10
7	1	0	1
Total	62	55	117

Table O.6.2 - Response Level by Gender - Question 1 Part II

	Gender		
Level	Female	Male	Total
1	0	0	0
2	3	5	8
3	0	0	0
4	2	8	10
5	21	23	44
6	28	16	44
7	8	3	11
Total	62	55	117

Table O.6.3 - Response Level and Path by Gender - Question 2 Part I

	Gender		
Level	Female	Male	Total
0	0	0	0
1	2	2	4
2	20	17	37
3	10	6	16
4	2	2	4
5	7	14	21
6	9	10	19
7	12	4	16
Total	62	55	117
Path			
A	13	12	25
B	12	13	25
Total	25	25	50

Table O.6.4 - Response Level and Path by Gender - Question 2 Part II

	Gender		
Level	Female	Male	Total
1	6	5	11
2	23	15	38
3	8	8	16
4	2	1	3
5	8	13	21
6	4	6	10
7	11	7	18
Total	62	55	117
Path			
A	11	12	23
B	10	12	22
Total	21	24	45

Table O.6.5 - Response Level and Path by Gender - Question 3 Part I

	Gender		
Level	Female	Male	Total
0	1	1	2
1	0	1	1
2	3	2	5
3	0	0	0
4	2	0	2
5	6	6	12
6	42	39	81
7	7	6	13
8	1	0	1
Total	62	55	117
Path			
A	42	38	80
B	10	10	20
Total	52	48	100

Table O.6.6 - Response Level and Path by Gender - Question 3 Part II

	Gender		
Level	Female	Male	Total
0	3	2	5
1	3	3	6
2	2	2	4
3	0	1	1
4	1	0	1
5	2	6	8
6	46	37	83
7	4	4	8
8	1	0	1
Total	62	55	117
Path			
A	40	31	71
B	11	15	26
Total	51	46	97

Table O.6.7 - Response Level and Path by Gender - Question 4 Part I

	Gender		
Level	Female	Male	Total
0	2	0	2
1	8	7	15
2	4	4	8
3	0	1	1
4	5	3	8
5	11	14	25
6	23	20	43
7	9	6	15
Total	62	55	117
Path			
A	11	11	22
B	29	28	57
Total	40	39	79

Table O.6.8 - Response Leve and Path by Gender - Question 4 Part II

	Gender		
Level	Female	Male	Total
0	4	2	6
1	5	7	12
2	3	3	6
3	1	2	3
4	2	2	4
5	13	8	21
6	30	22	52
7	4	9	13
Total	62	55	117
Path			
A	3	14	17
B	42	20	62
Total	45	34	79

Table O.7.1 - Comparison of Parts I and II - Question 1

Level	Part I	Part II	Total
2	7	8	15
3	32	0	32
4	46	10	56
5	21	44	65
6	10	44	54
7	1	11	12
Total	117	117	234

Table O.7.2 - Comparison of Parts I and II - Question 2

Level	Part I	Part II	Total
1	4	11	15
2	37	38	75
3	16	16	32
4	4	3	7
5	21	21	42
6	19	10	29
7	16	18	34
Total	117	117	234
Path			
A	25	23	48
B	25	22	47
Total	50	45	95

Table O.7.3 - Comparison of Parts I and II - Question 3

Level	Part I	Part II	Total
0	2	5	7
1	1	6	7
2	5	4	9
3	0	1	1
4	2	1	3
5	12	8	20
6	81	83	164
7	13	8	21
8	1	1	2
Total	117	117	234
Path			
A	80	71	151
B	20	26	46
Total	100	97	197

Table O.7.4 - Comparison of Parts I and II - Question 4

Level	Part I	Part II	Total
0	2	6	8
1	15	12	27
2	8	6	14
3	1	3	4
4	8	4	12
5	25	21	46
6	43	52	95
7	15	13	28
Total	117	117	234
Path			
A	22	17	39
B	57	62	119
Total	79	79	158

Table O.8.1 - Comparison of Estimate Means for Academic Years - Matrix of Pa rwise Mean Differences

Year	8	9	10	11	12
8	0.000				
9	0.569	0.000			
10	0.508	-0.061	0.000		
11	0.470	-0.098	-0.037	0.000	
12	0.631	0.063	0.124	0.161	0.000

Table O.8.2 - Comparison of Estimate Means for Academic Years - Scheffe Test - Matrix of Pairwise Comparison Probabilities

Year	8	9	10	11	12
8	1.000				
9	0.000	1.000			
10	0.003	0.990	1.000		
11	0.007	0.943	0.999	1.000	
12	0.000	0.989	0.892	0.757	1.000

Table O.8.3 - Comparison of Estimate Means for Mathematical Ability - Matrix of Pairwise Mean Differences

Math. Ability	Low	Middle	High
Low	0.000		
Middle	0.252	0.000	
High	0.492	0.240	0.000

Table O.8.4 - Comparison of Estimate Means for Mathematical Ability - Scheffe Test - Matrix of Pairwise Comparison Probabilities

Math. Ability	Low	Middle	High
Low	1.000		
Middle	0.026	1.000	
High	0.000	0.031	1.000

Table O.8.5 - Comparison of Estimate Means for Gender - Matrix of Pairwise Mean Differences

Gender	Female	Male
Female	0.000	
Male	-0.085	0.000

Table O.8.6 - Comparison of Estimate Means for Gender - Scheffe Test - Matrix of Pairwise Comparison Probabilities

Gender	Female	Male
Female	1.000	
Male	0.252	1.000

Appendix P

Figures for Results - Study 2

These figures should be read in conjunction with the analysis of Study 2 in Chapter 7.

Infit Mean Square		**Outfit mean Square**	
Mean	0.96	Mean	1.05
SD	0.19	SD	0.24
Infit t		**Outfit t**	
Mean	-0.25	Mean	0.33
SD	1.27	SD	1.29

Figure P.1 - Fit Statistics - Question Estimates

Infit Mean Square		**Outfit mean Square**	
Mean	0.96	Mean	1.05
SD	0.61	SD	0.89
Infit t		**Outfit t**	
Mean	-0.09	Mean	0.06
SD	1.05	SD	0.98

Figure P.2 - Fit Statistics - Student Estimates

```
                  0.71      0 83      1.00      1.20      1.40
Q. 1  Part I           :              |          *     :
      Part II          :              |           *    :
Q. 2  Part I           :   *          |                :
      Part II          :          *   |                :
Q. 3  Part I        *  :              |                :
      Part II          :       *      |                :
Q. 4  Part I           : *            |                :
      Part II          :              |         *      :
```

Figure P.3 - Infit Mean Square Map - Parameter Fit

Note for Figures P.4, P.5, P.6 and P.7 : Each X respresents one student and the - - - - lines represent the mean estimates.

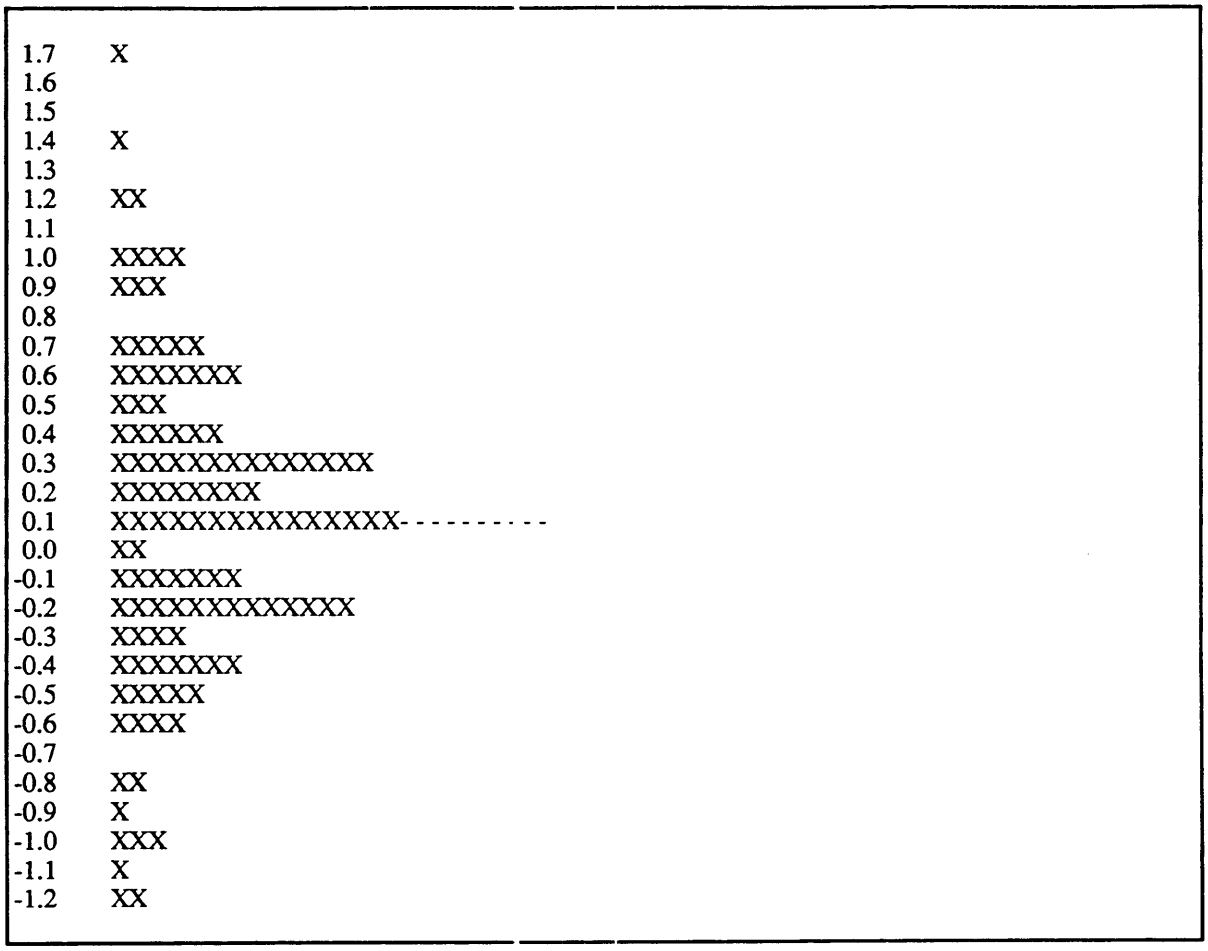


Figure P.4 - Estimates of Understanding

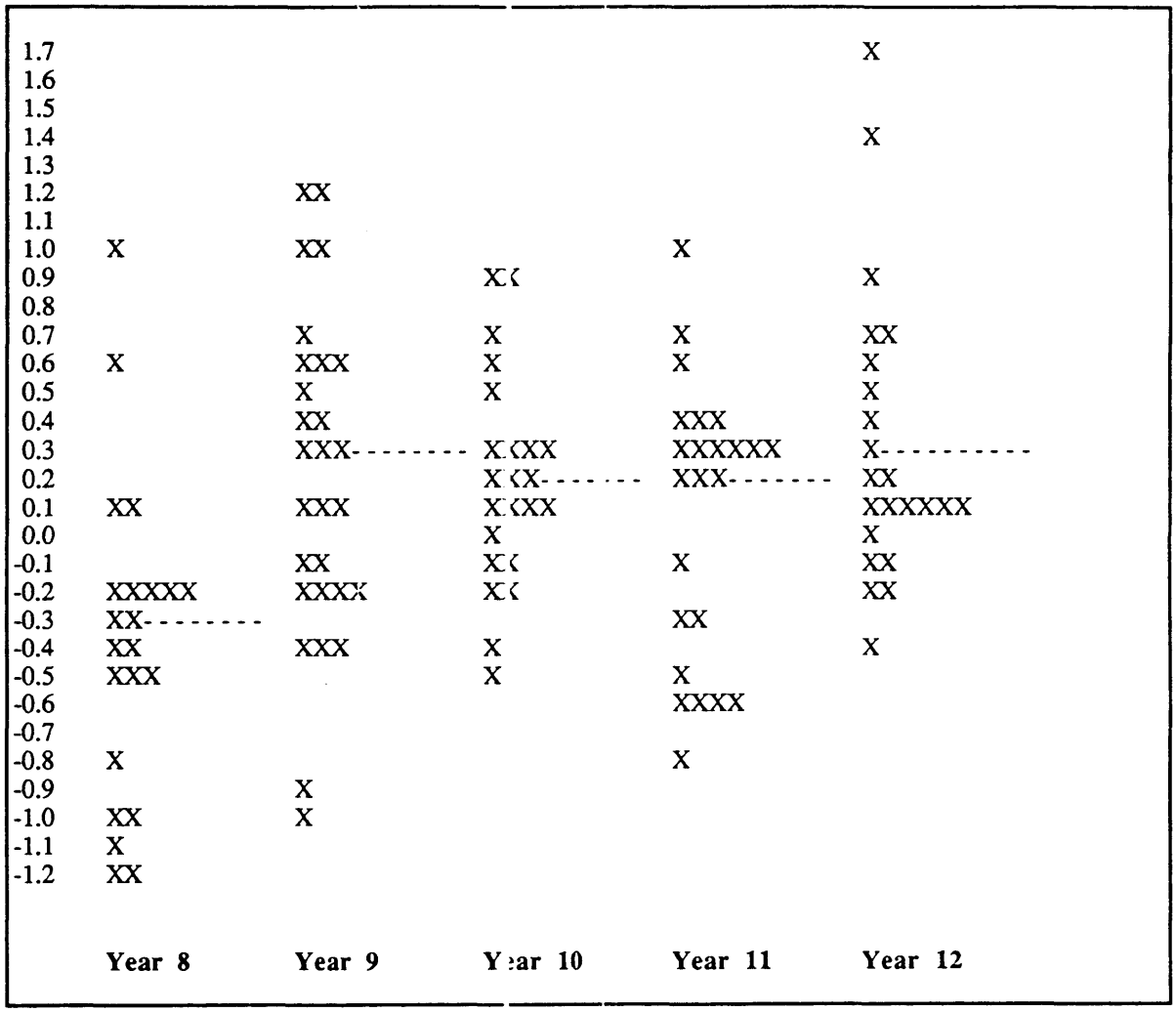


Figure P.5 - Estimates of Understanding by Academic Year

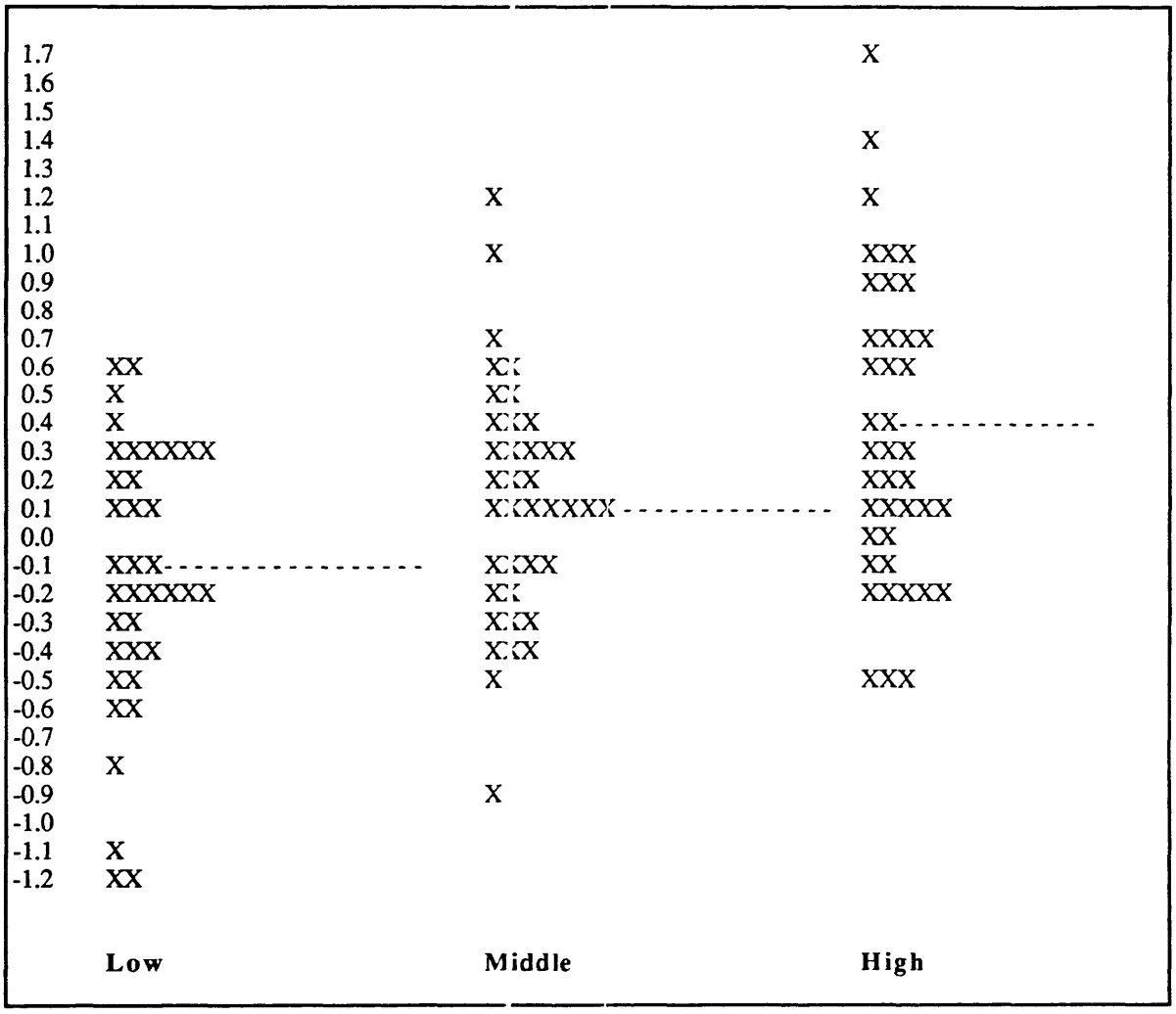


Figure P.6 - Estimates of Understanding by Mathematical Ability

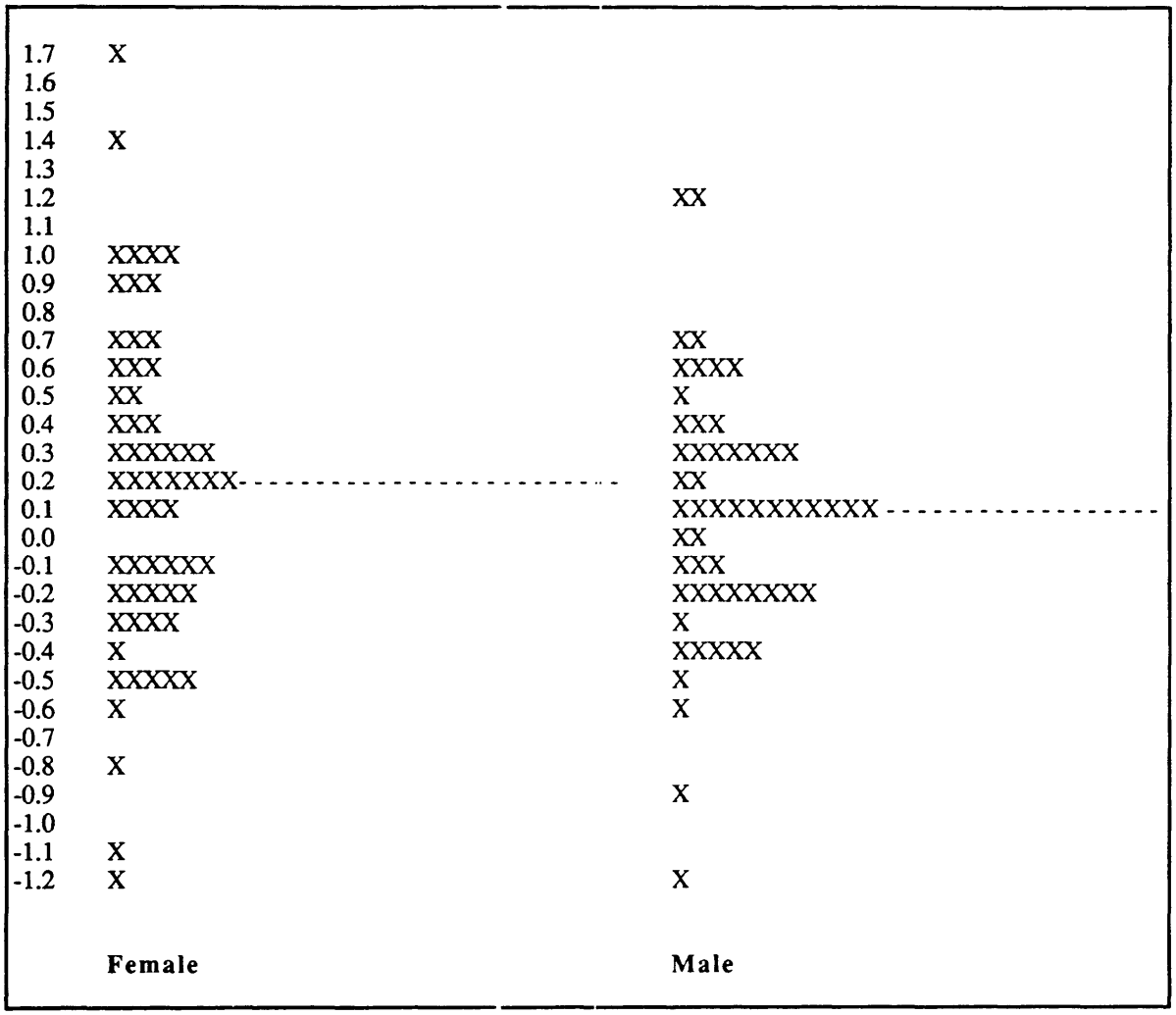


Figure P.7 - Estimates of Understanding by Gender