# 5 INFORMATION AND DATA: ANALYSIS AND PRESENTATION

## 5.1 Introduction

This section of the handbook contains general advice on the analysis and presentation of data. You will probably have realized from reading the other sections that processes of analysis and interpretation begin to take place as soon as you make a start on collecting your data. During the initial phases of your project you will find yourself making decisions about what to observe and record, which questions to ask in interviews, which documents to select and so on. In a sense these decisions are a preliminary form of analysis as you are beginning to identify potentially important concepts and hypotheses which will aid later analysis and explanation.

During the course of carrying out a piece of research, something unexpected may occur which causes a change in direction and the formulation of new research questions or hypotheses. When this happens, researchers try analyse why things departed from the expected. Was the original focus of the research inappropriate? What implications can be drawn from the new information? Should the research instruments (questionnaires, interview and observation schedules) be redesigned to take account of the unexpected? Usually this type of exploratory analysis happens during the pilot stage.

As soon as you begin to collect your data you can start to explore what it is telling you, although the picture will probably keep changing as you collect more information. During this phase researchers often begin to formulate preliminary hypotheses about what the data might mean.

The main business of analysis begins once all the information or data has been collected. This is the most exciting phase of the project. All the hard work of data collection has been completed. Now you start to look for patterns, meaning, and orderings across the complete data set which could form the basis of explanations, new hypotheses, and even theories.

Analysing and interpreting qualitative data is a very personal thing. No one can tell you precisely how to set about it, although, as you have seen in previous sections, guidelines do exist. For quantitative data, things are a little easier as there are standard ways of analysing and presenting numerical information.

This section contains some very general guidelines and examples of the analysis of information. The section also includes advice about presenting data in your project report. First of all I shall discuss how to deal with 'unstructured' information from informal interviews, open-ended questionnaires, field-notes and the like. Then I shall take a look at how more structured information, such as that from interview and observation schedules, can be tackled. In the latter case it is usually possible to quantify the information and present it as tables and/or graphs. A set of further readings is given at the end of the section. These can give more detailed guidance on the topics covered here.

You should read this section while you are still designing your study and before you begin to collect any data. You will find it most useful to read through the whole section quickly, and then to go back to the sub-sections which you need to read in more detail when you are deciding which methods to use for your project. You will need to return to this section once you have collected your data. This time you will probably want to concentrate only on those sub-sections of direct relevance to your project.

## 5.2 Description, analysis, explanation and recommendation

Data can be used in two ways: *descriptively* or *analytically* (to support interpretations). In practitioner research the main purpose of analysis and interpretation, whether the data are qualitative or quantitative, is to move from *description* to *explanation* and/or *theory*, and then to *action* and/or *recommendation*. Let's look at some extracts from Margaret Khomo's project report (Sample Project 2) in order to illustrate this.

### Example 5.1 Moving from description to recommendation

In her report, Margaret gives the following account of pupils' reactions to recording their family histories on tape:

> The pupils were particularly enthusiastic when they had to record their findings about their family. Even sensitive information – for example revealing that a mother had been adopted – was included. Most of the pupils couldn't wait to hear the finished tape-recording, the only ones who did not were those pupils who did not like the sound of their voices on tape. Listening to the tape caused amusement.

This is a *descriptive* piece of writing drawn from Margaret's record of her classroom observations. She also, however, tried *analyse* why it was that her 'active learning' approach generated so much interest and enthusiasm from pupils, particularly the 'less able' pupils:

control group

> The active learning approaches used ... created a working situation in which the pupils were sharing their findings and working out their answer(s) together. This appeared to generate a sense of unity within the class whereas within the control group it was very much a case of each individual completing his or her work without a sense of class involvement ...
>
> The active learning approaches used provided more opportunities for the less able pupils... to contribute positively to the work of the class.

Here Margaret has been able to propose an *explanation* as to why 'active leaning' is an effective way of teaching about migration. It encourages a sense of unity among pupils by providing a co-operative learning environment where all pupils, including the less able, feel able to share their own personal knowledge and make positive and valued contributions.

Finally, as a result of her observations Margaret was able to make *recommendations* concerning the management of an active learning environment. Her main recommendation was that active learning was an extremely effective method of teaching history, and that it had particular benefits for less able pupils. When using active learning methods, however, teachers needed to be aware that lesson plans must be more tightly structured than when a didactic approach is used. Also, time limits need to be set for each activity if pupils are to get through all the work.

I have been able to present neat and tidy excerpts from Margaret's final report. What I have not been able to show are the processes of sifting, sorting and organizing her data that she went through to arrive at these explanations and recommendations. So just what do you do when faced with analysing and interpreting pages of field-notes, notes on documents, diary excerpts, observations, records of interviews, transcripts and the like? The next sub-section gives some guidelines.

qualitative

## 5.3 Dealing with qualitative data

constant comparison

When dealing with qualitative data you have to impose order on it and organize it so that meanings and categories begin to emerge. One of the most commonly used methods for doing this is known as the method of constant comparison. Hutchinson explains this method as follows:

coding

> While coding and analysing the data, the researcher looks for patterns. He [*sic*] compares incident with incident, incident with category, and finally, category with category ... By this method the analyst distinguishes similarities and differences amongst incidents. By comparing similar incidents, the basic properties of a category ... are defined. Differences between instances establish coding boundaries, and relationships among categories are gradually clarified.
>
> (Hutchinson, 1988, p. 135)

The main aims of this method are to simplify your data by establishing categories, properties of categories, and relationships between categories which will help you explain behaviours, actions and events. This in turn may lead to new theoretical understanding. In qualitative data analysis, looking for and predicting relationships between categories is the first step towards forming new theories.

grounded theory

In Section 1 I mentioned the notion of 'grounded theory' (Glaser and Strauss, 1967) as this applied to qualitative research. What this means is that, in comparison to quantitative or predictive studies where the researcher starts off with an hypothesis based on an existing theory, in qualitative research it is possible to construct and test hypotheses and theories after the data collection has begun. These new theories are 'grounded' in, or arise directly from, the data.

### Identifying incidents

incident

In the quotation above, when Hutchinson talks about an 'incident' she is referring to observations or records of segments of activity, behaviour, or talk. Identifying where one incident or segment leaves off and another begins is important when analysing qualitative data. The examples of different kinds of field-notes in sub-section 4.3 illustrate some of the many ways in which researchers identify incidents.

event-sampling

In Example 4.3, Will Swann uses 'event-sampling' to identify two episodes or incidents which took place during his lesson. One was an incident where a pupil took off his shoes and socks during an improvization session. The second described children's participation in reading the poem that came out of the improvization session.

In Example 4.4, Janet Maybin organized her field-notes into a series of incidents which took place during a school assembly. This is another example of 'event-sampling'. Note how Janet used the tape counter to help her find each incident.

time-sampling

In Example 4.6, Lorraine Fletcher used a 'time-sampling' strategy to record a series of classroom activities over specified time periods. In this case, however, each segment of time may contain a number of incidents which must be identified.

An incident is not an arbitrary slice or piece of activity, as is a ten-minute section of time. It is a constituent part of an identifiable whole where the whole could be a lesson, an interview, a classroom day, an assembly, a meeting, a consultation and so on. When identifying where one incident begins and another leaves off (or where one topic begins and ends, if you are dealing with talk), you will find that events within an incident are more related to one another than they are to events outside the incident.

categories

## Identifying categories

Once you have identified the incidents then you can begin to sort and categorize them. The process of categorization can probably be explained most clearly by an example.

### Example 5.2 Identifying categories

In her paper in *Practitioner Research in the Primary School* (Webb, 1990), Susan Wright describes how she carried out an investigation of language use in the teaching and learning of mathematics. She conducted a 'closely focused case study of six middle infant children', and collected her data during normal maths teaching sessions over six months. In particular she concentrated on the topics of time, length and weighing. Her data consisted of tape-recordings, an observation diary, and children's worksheets and maths notebooks.

Even before Wright started to collect her data, however, she categorized her research questions into the following four groups:

*Questioning*

For example:

- What kind of questions do I ask?
- What kind of questions do the children ask?
- What kind of response do the various questions elicit?

*Word usage*

For example:

- Which words do children actually use?
- Are there any mathematical words which cause particular difficulty?

*Shared meanings and misunderstandings*

For example:

- Is there any discernible pattern in the areas of misunderstanding?
- Can I as a teacher learn anything from this?

*Non-linguistic evidence of understanding*

- What factors other than language indicate comprehension?

(adapted from Wright, 1990, pp. 127–8)

Once she had collected the data and started to analyse her transcripts she discovered further categories. For example, when Wright looked at her questions to children (there were some 750 examples of these), they could be grouped as follows:

Factual knowledge questions
Personal questions
Prompting questions
Reasoning or hypothetical questions
(Wright, 1990, pp. 130–31)

Similarly, she found she could fit the questions the children asked into these categories:

Checking up questions
Tentative answers
Requests for information
Miscellaneous questions
[Pupils' open questions to each other.]
(Wright, 1990, p. 133)

Wright concluded that, 'There should be greater use of reasoning questions by the teacher and more opportunity for children to hypothesize about their work; children's active use of mathematical vocabulary should be encouraged together with an awareness of the need to extend the personal vocabularies of some children .... ' (Wright, 1990, p. 151).

In this example the 'incidents' that Wright was particularly interested in were questions: the questions the children asked of each other and of their teacher, and the questions the teacher asked the children. When categorizing these questions Wright probably proceeded as follows:

1 Listened to tapes of the lessons, or read through transcripts and made a note of all examples of 'questions'.
2 Sorted these examples into three piles:
   (a) teacher's questions;
   (b) children's questions to teacher;
   (c) children's questions to each other.
3 Sifted through each pile in turn to see if categories of question could be identified.
4 Once categories were identified, sorted the questions into further piles under each category.
5 Saw whether any left-over questions formed a further category, or whether the first set of categories needed to be modified to accommodate the left-overs.

Sub-sections 2.3, 2.5, 4.3, 4.4 and 4.8 give further examples of how to construct categories.

categories

As I mentioned at the beginning of this section there are no hard-and-fast rules about analysing qualitative data. As a starting point most researchers recommend actual physical sorting of the data into basic categories. They do this by writing up each incident on a separate piece of paper or index card which can then be arranged and rearranged into various piles as categorization proceeds. Wolcott (1990) advises that one should 'begin sorting by finding a few categories sufficiently comprehensive to allow you to sort all your data' (p. 33). For example you could sort all the data from interviews with men into one pile, and that from women into another. Or you could differentiate talk produced by adults from talk produced by children; information from government documents with information from local documents, data collected in one school or class from data collected in another and so on.

indigenous categories

If your data include samples of talk, you may find there are examples of *indigenous categories* which reflect a classification system used by the people in the setting you are studying. For example children might categorize themselves as either 'brainy types' or 'sporty types'. Where indigenous categories exist in the data, then analysis involves discovering the properties of these categories, and offering explanations for their derivation.

researcher's categories

Wright's categories in Example 5.2 are examples of *researcher's categories*, that is, categories you create for yourself. As you construct more detailed sub-categories within your original all-embracing categories you will probably find some incidents and statements that fall into more than one category, and some which will not fit at all. Some categories may have to be redefined or even abandoned either if they contain too few entries, or if they are becoming too large. If you have used triangulation (see sub-section 1.6) you will have a means of checking the validity of your categories. If they are valid they should be able to cope with data from different sources.

pre-specified categories

Finally, you can use *pre-specified categories* which others have used and published before you. Section 4 contains examples of these, such as the nursery observation schedule by Glen McDougall (Example 4.7).

The books in the further reading list at the end of this section give more detailed advice and techniques on analysing qualitative data. You should not feel bound to use the methods set out in this handbook if you come across something which is more appropriate.

qualitative

## 5.4 Presenting qualitative data in your report

Section 7 of the *Module Guide* gives general advice on how to write up project reports. The selection of material to include in your report is one of the main tasks facing you when writing about qualitative data. Coolican offers the following advice:

participant observation

> A qualitative research report will contain raw data and summaries of it, analysis, inference and, in the case of participant observation, perhaps feelings and reactions of the observer at the time significant events occurred. These are all valid components for inclusion but it is important that analysis, inference and feeling are clearly separated and labelled as such.
>
> (Coolican, 1990, p. 236)

The main body of your report should contain summaries of your data rather than the actual data itself, unless you want to discuss a particular piece of data in depth (such as a section from a transcript or examples of children's work). For the most part, raw data such as field-notes, accounts of meetings and interviews, transcripts and the like should be included as appendices. Your report should include brief interpretive accounts of how you analysed and categorized your data, and definitions of your categories. Well-chosen illustrative examples will help readers understand your choice of categories.

When you come to select data to summarize for your report, it is worth while remembering that if you have collected a lot of information, then you will not be able to include summaries of all of it in your report. You should go back to your original research questions for guidance on what to select. Data which answers these questions should be included; data which is interesting in itself, but which does not answer or throw new light on the original questions should be discarded.

While most of what you will include in your report will be summaries of your data, this does not mean that we do not want you to put *any* raw data in the report. Qualitative reports are brought to life by quotations. Here is Coolican again:

> The final report of qualitative findings will usually include verbatim quotations from participants which will bring the reader into the reality of the situation studied ... The quotes themselves are selections from the raw data which 'tell it like it is'. Very often comments just stick with us to perfectly encapsulate people's position, on some issue or stance in life, which they appear to hold.
>
> (Coolican, 1990, pp. 235–6)

Carefully chosen quotations can play a very important part in reports based on qualitative data. If you want to include quotations in your report then you must make them work for you. Brief quotations which go straight to the heart of the matter have much more impact than longer, more rambling ones, even if the latter do make important points. Anne Ryding makes very good use of quotations in her project report (reprinted at the end of the *Module Guide*).

No one can really tell you what to select to put into your report. You should, however, try to observe Coolican's guidelines about making clear distinctions between summaries of data, analysis, and interpretation.

quantitative

## 5.5 Dealing with quantitative data

The two principal methods of obtaining quantitative data are measuring and counting.

In sub-section 1.5 we defined as quantitative data anything that could be 'quantified' on some numerical basis. As an example, we gave children's scores on a reading test. Here, it is reading performance that is being measured, and the measure is the numerical score obtained from the test. A second type of quantification we referred to was the assignment of children to groups or categories.

categories

For example, on the basis of the individual reading performance of 28 children, you might want to assign 8 to the category 'above average reading ability'; 15 to the category 'average reading ability' and 5 to the 'below average reading ability' category. In this case you are counting how many instances or cases fall into categories you have selected beforehand.

In this sub-section we shall be dealing mainly with structured data generated by questionnaires, interview schedules, observation schedules, checklists, test scores, marks of children's work, rating scales and the like. Test scores, marks and rating scales all yield numerical data and are therefore quantitative by definition. The kind of information you collect when you are using an observation schedule, checklist or questionnaire is more likely to be in the form of ticks and crosses, and this data has to be converted to numbers before you can start analysing it.

As I mentioned above, qualitative data can be quantified by assigning instances to categories, and then counting up the number of instances in each category. This is a particularly useful technique for dealing with structured data. There is no reason why categories generated from the analysis of the type of unstructured data discussed in sub-section 5.3 cannot be treated in the same way so as to allow numerical comparisons to be made. However, this approach to unstructured data is less common in practice than the qualitative methods discussed in sub-section 5.3.

Discovering categories and assigning incidents to categories simplifies qualitative data and can help you discover underlying patterns and relationships which lead to new hypotheses and interpretations. The same can be said of quantitative data, except that here we have to introduce some new ideas about how to describe the data.

### Categories and variables

When you are planning your investigation two things you need to decide at an early stage are:

- what you intend to measure or count;
- what units of measurement you should use.

Here it is conventional to distinguish categories from variables. Categories have already been discussed in sub-section 5.3. Here we shall concentrate mainly on variables. Alan Graham (1990) describes the differences between categories and variables as follows:

categories v. variables

> Whereas categories are labelled with names, variables are measured with numbers. Variables are so called because they vary, i.e. they can take different values. For example age and family size are variables because age varies from one person to another just as family size varies from one family to another.
>
> ... You may have noticed that it is impossible to measure someone's age with perfect accuracy – you might know it to the nearest minute perhaps, but what about the seconds, tenths of seconds, thousandths of a second ... ? With family size, on the other hand, perfect accuracy is possible, because there is a basic unit – people – and they tend to come in whole numbers!
>
> continuous variable
> discrete variable
>
> ... All variables like age, which can be subdivided into infinitely small units are often called continuous variables. The other type of variable, of which family size is an example, comes in discrete chunks, and is called a discrete variable.
>
> (Graham, 1990, pp. 17–18)

When you are designing your study it is very important to work out whether your methods of data collection are going to give you discrete or continuous data, as this will influence the kind of analysis you are able to do and how you present your data. Unlike variables, which can be either continuous or discrete, categories are always discrete. For example, in a questionnaire about people's political attitudes, 'vote labour', 'vote conservative', etc., are names for discrete qualitative categories. Counting up the number of instances, or the number of people responding positively to each category, quantifies the data.

## Analysing category data

observation schedule

Let's look at an example of some category data to see how we can begin to analyse it. Example 5.3 (overleaf) shows one of the observation schedules used by John Cowgill for his project on gender and classroom interaction in CDT and home economics (HE) lessons (Sample Project 5).

John's observation schedules contained three main categories – teacher addresses pupil (teacher–pupil); pupil addresses teacher (pupil–teacher); and pupils address each other (pupil–pupil). The schedule in Example 5.3 is a record of interactions in an HE lesson on textiles. This lesson centred round the three activities shown on the lefthand side of the schedule. For each activity John has noted, under the appropriate category heading, the number of times interactions take place between ten boys, five girls and their teacher. Each interaction (represented by a tick or a cross) occurs as a *discrete* instance of the behaviour John was recording. Note how he also recorded his own impressions to help him interpret the data later.

Once you have quantified your data, as I have done in Table 1, then there are a number of things that you can do with them. Figure 5 and Table 1 contain raw data. Without further analysis, raw data alone cannot tell you very much. Let's just see what the category data in Table 1 can tell us when we start to analyse them further.

percentages

When I looked at Table 1, I approached it in the following way. First I added up the total number of observations in the table. This came to 134. Next I added up the total number of observations for the girls (48), and for the boys (86) and worked out what these were as a *percentage* of the total number. For the boys this came to 64 per cent (86/134×100), and for the girls it came to 36 per cent (48/134×100).

This was an interesting finding. On the face of it, it looked as if, in this lesson, the boys dominated classroom interaction, and spoke, or were spoken to, twice as often as the girls. Before jumping to conclusions, however, I took another look at the table and

## Example 5.3 Coping with categories

OBSERVATION SHEET NO. 2 — CLASSROOM INTERACTIONS

| ✓ = BOY<br>X = GIRL | TEACHER/PUPIL | PUPIL/TEACHER | PUPIL/PUPIL |
|---|---|---|---|
| ACTIVITIES<br>IRONING/PRESSING | ✓✓✓✓✓✓xxxx<br>✓✓✓xx✓ | ✓✓✓x✓✓xx✓✓✓<br>xx✓ | ✓✓✓xx✓x✓✓✓✓✓x<br>✓✓xx |
| SETTING UP SEWING MACHINE | ✓✓xx ✓✓✓xx✓x<br>✓x✓ | ✓✓✓✓ xx✓xxx<br>✓✓✓xx✓✓ | ✓✓✓✓xx✓✓✓✓✓x<br>xx✓ |
| CUTTING-OUT PATTERN | ✓✓✓✓xx✓✓x<br>✓✓x✓✓✓✓ | ✓✓x ✓✓✓xx✓<br>✓✓x | ✓✓✓✓✓✓xxx<br>✓✓✓xx✓ |
| GENERAL COMMENTS<br>BOY ✓ GIRL X | TEACHER TRIES TO INTERACT WITH ALL PUPILS BOYS DEMANDING. | BOYS SEEK/ASK FOR/DEMAND HELP/ADVICE GIRLS GET ON WITH WORK, NEED SPECIFIC HELP/ADVICE | A LOT OF INTERACTING NOT CONCERNED WITH WORK ESPECIALLY BOYS |

| CLASS | LESSON | GROUP | NO. OF BOYS | NO. OF GIRLS | DATE |
|---|---|---|---|---|---|
| 2R | HOME ECONOMICS TEXTILES | 4 | 10 | 5 | 14.5.90 |

*Figure 5 One of John Cowgill's observation schedules.*

When you count up the number of ticks and crosses in each cell of Figure 5 you arrive at the figures in Table 1.

**Table 1**
**The total number of interactions between pupils and teachers in an HE lesson.**

| | Type of interaction | | | | | |
|---|---|---|---|---|---|---|
| | *Teacher–pupil* | | *Pupil–teacher* | | *Pupil–pupil* | |
| Activities | *Boys* | *Girls* | *Boys* | *Girls* | *Boys* | *Girls* |
| Ironing/pressing | 10 | 6 | 9 | 5 | 10 | 6 |
| Setting up sewing machine | 8 | 6 | 10 | 7 | 9 | 5 |
| Cutting out pattern | 12 | 4 | 8 | 4 | 10 | 5 |
| Totals | 30 | 16 | 27 | 16 | 29 | 16 |

Total no. of interactions = 134 (86 boys, 48 girls)

No. of girls = 5; no. of boys = 10

The number of interactions per category for boys and girls (bottom two rows of Table 1) can be converted into the percentages shown in Table 2.

**Table 2 The percentage of interactions attributed to boys and girls according to type of interaction.**

| | Teacher–pupil | Pupil–teacher | Pupil–pupil |
|---|---|---|---|
| Boys | 34.8 | 31.4 | 33.7 |
| Girls | 33.3 | 33.3 | 33.3 |

noticed that there were *twice as many boys (10) as there were girls (5)* in this class. It is not really surprising, therefore, that there were more interactions generated by boys.

average
mean

To confirm this I worked out the average or mean number of interactions per pupil by dividing the total number of interactions (134) by the total number of pupils (15). This comes to a mean of 8.9 interactions per pupil. Next I worked out the mean number of interactions generated by boys, which came to 8.6 (86/10), and by girls, 9.6 (48/5).

While it is not strictly legitimate to calculate means when you have discrete data, as you cannot have 0.6 of an interaction, working out the means has told us something very useful. Boys and girls were equally likely to engage in some form of classroom interaction in this HE lesson. If anything, the girls engaged in more interactions on average (9.6) than the boys (8.6), and my first impression that it was the boys who were doing all the talking was wrong. (In Sample Project 5, you will see that John carried out different calculations but reached the same conclusion.)

Of course we cannot draw firm conclusions about patterns of classroom interactions on the basis of a single observation session of one lesson and one group of pupils. John actually collected data from six lessons over a two-week period, which gave him a richer data base to work with. His analyses led him to the conclusion that, 'The opportunities for interaction within the lessons observed were equal for both boys and girls'.

Next I looked to see if the patterns of interaction were different depending on who was doing the talking. Did teachers address more remarks to boys or to girls? Did the girls talk among themselves more than the boys? Using the data at the bottom of Table 1, I worked out the percentages of interactions attributed to boys and girls in each category (see Table 2). Again the pattern is quite clear. The 48 interactions attributed to the girls were equally divided between the three categories. The boys were addressed by their teacher slightly more frequently than the girls (34.8 per cent versus 33.3 per cent) and spoke to the teacher marginally less often than girls (31.4 per cent as opposed to 33.3 per cent). These differences between boys and girls are not sufficiently large to claim that there is a real difference between them.

continuous variable

You can see from this example that working out *percentages* and *means* are two very useful techniques for analysing category data, although as I explained above you must be careful when using means because of the discrete nature of the data. Means are more useful when it comes to dealing with data in the form of continuous variables. Converting things to percentages allows you to make direct comparisons of discrete data from unequally sized groups.

When you are dealing with this type of data the trick is to simplify it so that patterns begin to emerge. I did this for Example 5.3 by converting the data to percentages and means. Also, I looked at overall totals across Table 1 rather than the numbers in each individual cell. Looking at overall totals across categories is known as *collapsing the data*, and is a useful way of looking for patterns and relationships in quantitative data. Wolcott (1990) advises you to look for the broadest possible category divisions when you begin to analyse qualitative data (see sub-section 5.3). Similarly, collapsing categories is a good way to start looking at quantitative data.

## Analysing variables

Example 5.4 gives a *summary table* of some data collected by Renfrow when she evaluated the effects of two different art training programmes for gifted children. Based on her own observations and observations in published literature, this study is an example of a predictive experimental study. Renfrow wanted to evaluate different methods of teaching art to gifted children, and to see how their drawing skills could be improved. Her own ideas about teaching art as well as those in published research reports led her to formulate the following hypothesis: '... Given nine weeks of systematic training in perception and copying, gifted ... students between the ages of eight and 11 would be able to draw the head of a human being more realistically than gifted students receiving traditional art instruction ... ' (Renfrow, 1983, p. 28).

experimental approach

predictive studies

In this study the variables were (a) children's age; (b) two different types of art instruction and (c) two sets of scores on a drawing test. Variables (a) and (b) are known as independent variables. Independent variables are those which researchers are free to control or 'manipulate'. For example, Renfrow was free to choose the art instruction programmes and the ages of the children she wanted to test. Variable (c) is known as a dependent variable because the effects it measures are dependent on the researcher's manipulations of the independent variable (or variables). In Renfrow's experiment, how well children performed on the drawing test *depended* on their age and the type of instruction they were given. In experimental research the dependent variable is always the one that is being measured.

independent variable

dependent variable

To test her hypothesis, Renfrow's experimental group were given 18 forty-minute art lessons over nine weeks and worked on tasks such as copying upside-down line drawings; recording perspective; expressing shape through shadow; and copying photographs and drawings. The control group also had 18 forty-minute traditional

experimental group

control group

### Example 5.4 Coping with variables

Table 3 gives the data from the 36 children taking part in Renfrow's experiment. There were nine children in each of two age-groups and 18 children in each of an experimental and a control group. The pre- and post-test scores in the table are the marks out of 20 given to drawings the children produced at the beginning and end of the experiment.

**Table 3 Total (T) and mean (M) pre-and post-test scores for older and younger children's drawings in the experimental and control groups (N = 36, n = 9; maximum scores = 20).**

| Age (years) | | Experimental group | | | Control group | | |
|---|---|---|---|---|---|---|---|
| | | *Pre-test scores* | *Post-test scores* | *Pre-test/ post-test gain* | *Pre-test scores* | *Post-test scores* | *Pre-test/ post-test gain* |
| 8-9 | T | 55.5 | 126.5 | 71.0 | 51.5 | 60.0 | 8.5 |
| | M | 6.2 | 14.1 | 7.9 | 5.7 | 6.6 | 0.9 |
| 10-11 | T | 82.5 | 138.0 | 55.5 | 68.0 | 93.0 | 25.0 |
| | M | 9.2 | 15.3 | 6.1 | 7.6 | 10.3 | 2.7 |
| Overall | T | 138.0 | 264.5 | 126.5 | 119.5 | 153.0 | 33.5 |
| Overall | M | 7.7 | 14.7 | 7.0 | 6.6 | 8.5 | 1.9 |

[N stands for total number of children; n stands for the number in each group.]

(adapted from Renfrow, 1983, pp. 30–31)

art lessons and used a variety of media to explore texture, line, colour and composition. Renfrow taught the experimental group, one of her colleagues taught the control group.

At the beginning of the nine week programme all children made a drawing of a human head. This pre-test established how well they could draw before the programme started. At the end of the programme they produced another drawing of a human head. This was the post-test. Drawings from the pre- and post-tests were then randomly ordered so that it was impossible to tell which test or group of children they had come from. The drawings were given marks out of 20 by two teachers not involved in the training programme. Here 'marks out of 20' is an

continuous variable

example of a continuous variable.

Although Table 3 is not raw data (raw data here would be each child's marks out of 20 on the pre- and post-test), it still contains too much information for you to see any patterns between the variables. Let's use it to try to extract the information which will allow us to compare children's pre- and post-test performance in the two groups.

If you look at the bottom of columns 2 and 5 in Table 3, you can see that the overall mean post-test score for the experimental group was 14.7 as against 8.5 for the control group. This means that after nine weeks of experimental art training this group of children's drawings were given higher marks than those of children following the traditional programme.

Before you can make any claim that the experimental programme is superior, however, you need to look at the pre-test/post-test gains for each group. You need to do this because it is just possible that the children allocated to the experimental group were better at drawing in the first place. Subtracting the pre-test scores from the post-test scores gives a measure of how much improvement there has been. Looking at the bottom of columns 3 and 6, you can see that, on average, children's scores in the experimental group have improved by 7 marks, while those in the control group have only improved by 1.9 marks.

Next we can look to see whether the experimental art programme was as effective for the younger children as for the older children. I found it useful to draw up another table here, again using the information in columns 3 and 6 of Table 3.

**Table 4 Mean pre-test and post-test gains for older and younger children in the experimental and control groups.**

| Age (years) | Experimental group | Control group |
|---|---|---|
| 8–9 | 7.9 | 0.9 |
| 10–11 | 6.1 | 2.7 |

Table 4 immediately shows that improvements in drawing skills were much greater for younger and older children in the experimental group than for children in the control group, in spite of the fact that both groups had nine weeks of art lessons. It also shows that the experimental programme was relatively more beneficial for the eight- to nine-year-olds (mean gain = 7.9) than for the older children (mean gain = 6.1). By contrast, the traditional art programme hardly improved the younger children's scores at all (mean gain = 0.9), and only had a small effect on the older children (mean gain = 2.7).

As with John Cowgill's data in Example 5.3, when you analyse raw quantitative data, it is best to try and simplify them first by drawing up a summary table of totals and means. You can then extract information selectively to help answer your research questions and hypotheses. Data like Renfrow's are suitable for statistical analysis. We don't expect that many people studying this module will want to carry out statistical analysis on their data. If you should, however, recommended texts are given in the further reading list at the end of this section.

## 5.6 Presenting quantitative data in your report

You should not include raw data from questionnaires, observation schedules and the like in the main body of your report. For example, you would not put Figure 5 in your report. As with qualitative data, raw data belongs in the appendices. There are a number of standard techniques for presenting quantitative data in reports. These include, tables, graphs, bar and pie charts and histograms.

### When to use tables

You can see from Examples 5.3 and 5.4 above that tables which summarize raw data can be useful aids to analysis and interpretation. They are also useful for presenting your findings in your project report. You can use tables to display both category and variable data. If you choose to display your data in the form of a table, however, you need to make sure that it is clearly labelled with all the information your readers will need in order to interpret it for themselves.

In Tables 1 and 3 note that both the rows and the columns are clearly labelled. Both tables give information about the number of children taking part in the study and what the numbers in the table represent. Some of this information is given in the caption for the table and some in the table itself. Writing an appropriate caption for a table is very important, as captions should contain information which helps the reader interpret the table.

The caption for Table 1 tells you that the figures in the table represent *the number of interactions* observed in the various categories. The caption for Table 2 tells you that the numbers in the cells are *percentages.* The caption for Table 3 tells you that the figures contained in the table are *total and mean scores* on a drawing test. Your readers need all of this information if they are to understand your arguments. If, for example, you do not know how old the children are, or what the maximum test score is in Table 3, then the information it contains is not very useful. Clearly labelled tables with well-written captions speak for themselves; they save you having to describe your data in words.

Another thing to remember when using a table is that it should not contain too much information. Drawing up tables like Tables 1 and 3 is a useful exercise for you, but does it help your reader? Less complex tables such as Tables 2 and 4 have much more impact, even though they contain information that can be extrapolated from their larger parent tables.

### When to use bar charts, pie charts and histograms

Bar charts, pie charts and histograms are sometimes more effective ways of representing data than tables. Bar and pie charts should be used to represent discrete category data. Histograms are normally used for continuous data.

### Example 5.5 Using a bar chart to represent data

As part of a project designed to explore why some children found using the school computers easier than others, a primary school teacher collected information about how many children in each class had regular access to a computer at home. Of the 125 children in the school, 47 had access to computers (see Table 5)

**Table 5 Number of children with access to home computers.**

| | | |
|---|---|---|
| Reception | 10 | (no. in class = 18) |
| Class One | 7 | (no. in class = 24) |
| Class Two | 3 | (no. in class = 20) |
| Class Three | 12 | (no. in class = 23) |
| Class Four | 9 | (no. in class = 21) |
| Class Five | 6 | (no. in class = 19) |

The information in Table 5 could be presented as the bar chart shown in Figure 6.

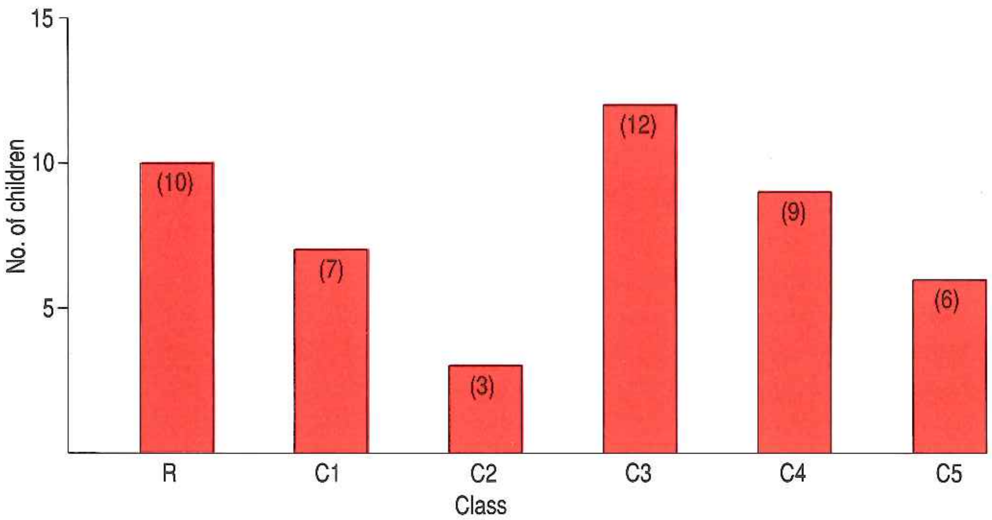



*Figure 6 Bar chart showing the number of children with access to home computers.*

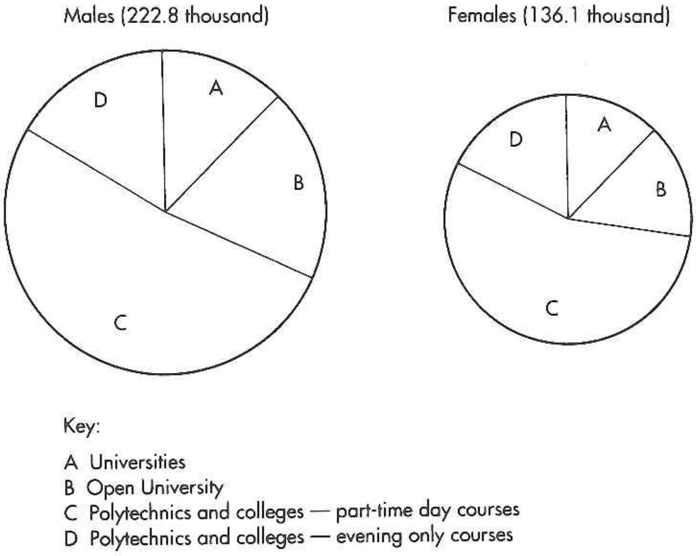
If you compare the height of the bars in Figure 6, you can see that there is no obvious relationship between age and whether or not children have access to a computer. Reception class children's homes have the second highest number of computers, and the oldest children have the second lowest number of home computers. As there are approximately equal numbers of children in each class, computer ownership must be related to some factor other than children's age; parental income or occupation perhaps.

Bar charts represent categories as columns and are commonly used to draw attention to differences between two or more categories.

Like bar charts, pie charts are useful for presenting discrete data. Each slice of the pie represents a particular category. The number of slices depends on the number of categories in thé raw data (make sure you don't have too many or too few). The size of each slice is determined by measuring the angle it makes at the centre of the pie. If one category contains 10 per cent of the total number of or cases, its angle will be one-tenth of 360 degrees, or 36 degrees. Pie charts are extremely useful for representing data expressed as percentages.

**Example 5.6 Using a pie chart to represent data**

Figure 7 shows how government statistics about the number of part-time students in higher education in the years 1986/87 can be represented using a pie chart.




Source: Central Statistical Office, *Social Trends 19*, London, HMSO, 1989, p. 60

*Figure 7 Part-time students in higher education 1986/7 (from Graham, 1990, p. 31).*

If you want to compare two pies, as in Figure 7, the size of each circle must be in proportion to the number of cases it contains. In Figure 7, for example, there are fewer females in part-time higher education than males. The circle representing information about female students, therefore, is proportionally smaller than the one for males. As you can see from this example, pie charts can be useful for presenting statistical information from published sources.

The histogram in Example 5.7 shows that staff opinion in the 25–35 year age range is strongly polarized with almost equal percentages agreeing and disagreeing with the statement. A significant percentage of 36–45 year-olds also agree with the statement, but a higher percentage disagree, and in the two older age groups, the majority of staff members favour schools remaining in local authority control.

continuous variable

Histograms should be used whenever you have continuous data. The main difference between a histogram and a bar chart is that the columns of a histogram are allowed to touch, whereas the bars of a bar chart should not touch. This is because the scale on the horizontal axis of a histogram should always describe a continuous variable (such as 'age group' in Figure 8), whereas on a bar chart, the horizontal axis should describe a discrete category. As with tables, the labelling of the axes of bar charts, pie charts and histograms needs to be accurate, and captions must be thought out carefully.

## When to use graphs

continuous variable

As well as histograms, graphs can be used to plot continuous data. They should not be used for discrete data because it makes no sense to draw lines joining discrete data points. Graphs are, however, very useful for looking at relationships between continuous variables.

## Example 5.7 Using histograms

Supposing you had drawn up a structured questionnaire using a five-point rating scale to measure staff's attitudes to recent changes in the way schools are managed. The questionnaire is sent to 200 staff in local schools, and 186 people return it. One of the statements contained in this questionnaire is:

Statement 6: *Comprehensive schools should opt out of local authority control.*

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

Responses to this statement from staff in different age groups might be as shown in Table 6.

**Table 6**
**Numbers of teachers responding to Statement 6 by level of agreement.**

| Age (years) | Agree/ strongly agree | Neither agree nor disagree | Disagree/ strongly disagree |
|---|---|---|---|
| 25–35 (n = 41) | 18 | 5 | 18 |
| 36–45 (n = 80) | 32 | 2 | 46 |
| 46–55 (n = 46) | 10 | 7 | 29 |
| 56–65 (n = 19) | 5 | 3 | 11 |
| Totals | 65 | 17 | 104 |

In this table I have collapsed the categories 'agree'and 'strongly agree' into one as there were not enough numbers in each. I have also done this for the 'disagree' and 'strongly disagree' categories. Using the total number of responses in each age group, I can convert the information in the table to percentages and represent it in the four-part histogram shown in Figure 8.

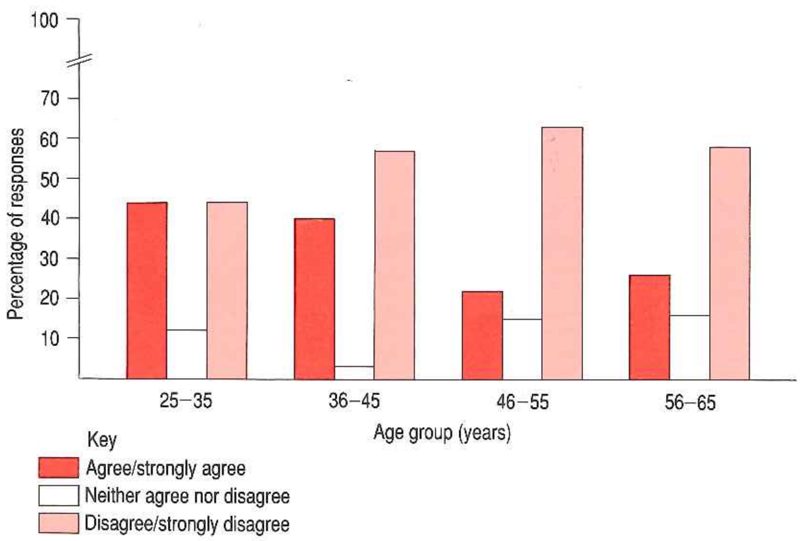



*Figure 8 Percentages of staff responses to Statement 6 by age group.*

### Example 5.8 Using graphs

The data from Renfrow's experiment given in Table 4 could equally well be presented as the graph shown in Figure 9.

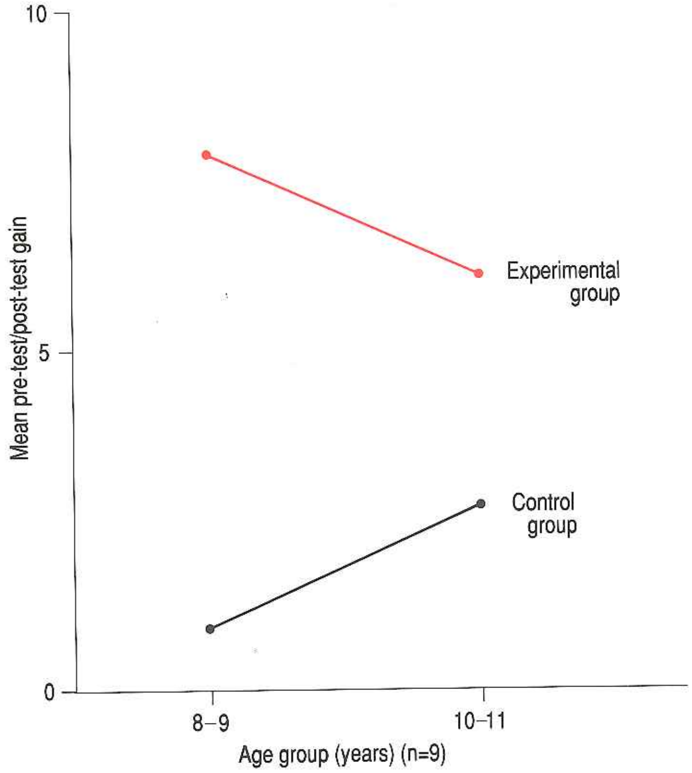


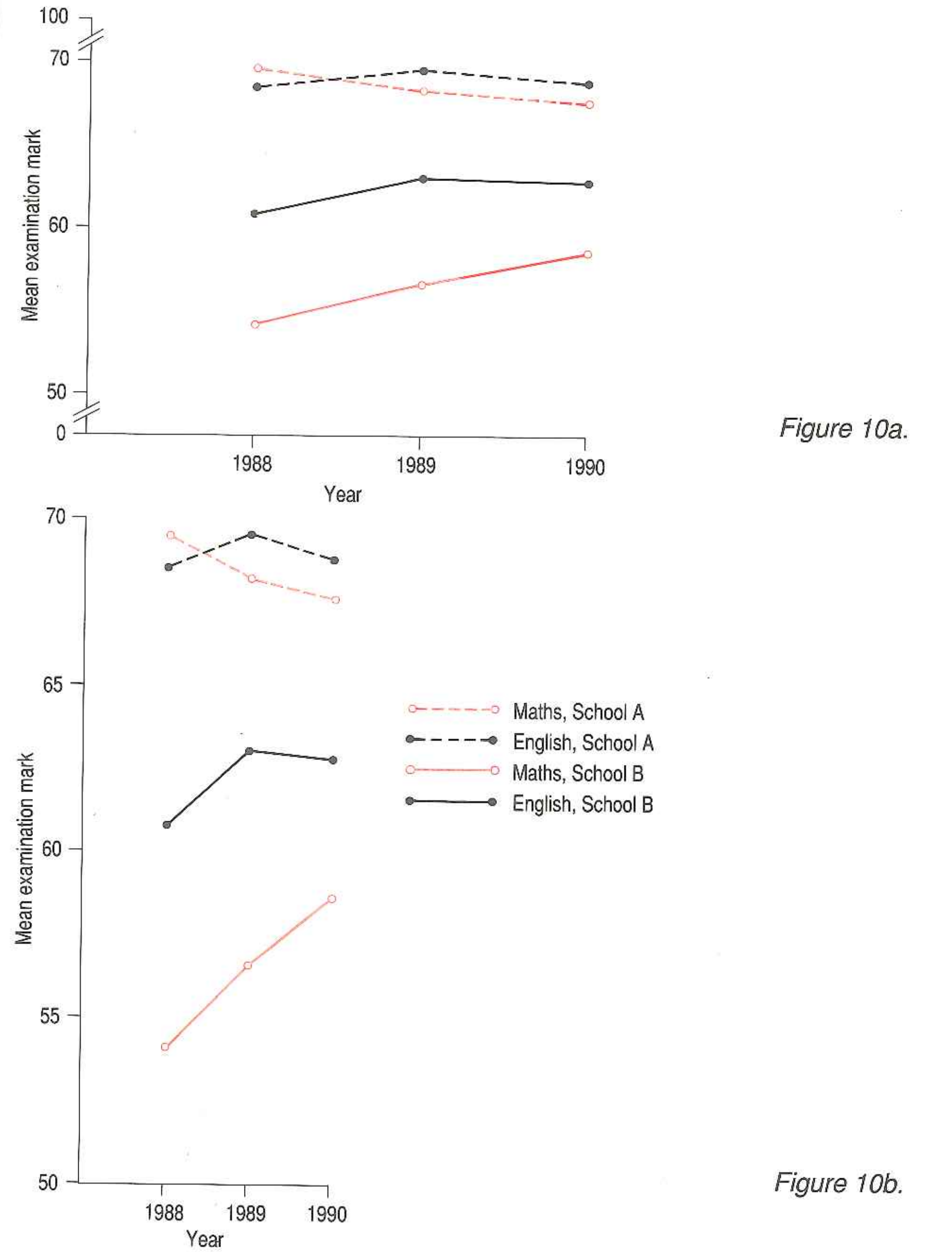

*Figure 9 Mean pre- and post-test gains in drawing scores as a function of age and experimental condition.*

When the information from Table 4 is presented as a graph, the different effects the two art programmes had on younger and older children are immediately apparent. Note that both axes are clearly labelled. When you plan graphs, choosing the scales for the axes is all important. Large effects can be diminished by an inappropriate scale. Conversely, small effects can be exaggerated, as Example 5.9 shows.

### Example 5.9 Plotting graphs

**Table 7 Mean end-of-year examination marks (out of 100) in maths and English for two hypothetical schools over a three-year period.**

| | 1988 | 1989 | 1990 |
|---|---|---|---|
| *School A* | | | |
| Maths | 69.6 | 68.5 | 67.4 |
| English | 68.0 | 69.5 | 68.9 |
| *School B* | | | |
| Maths | 53.4 | 56.7 | 58.9 |
| English | 61.7 | 63.2 | 62.8 |




*Figures 10a and 10b Graphic representations of the data from Table 7 showing appropriate (10a) and inappropriate (10b) uses of scale.*

Figure 10a, which has been plotted using reasonable scales on each axis, shows that there is quite a large difference between the two schools in terms of their examination scores. It also shows that while there is not much difference between the maths and English scores over three years for School A, School B's English results are better than their maths results. The maths results, however, appear to be improving.

If you were basing your interpretation on Figure 10b, however, you might be tempted to think that School A's maths exam results show a pronounced decline over the years 1988–90, whereas those of School B show a marked improvement. This is because in Figure 10b the scale of the vertical and horizontal axes is not appropriate. Points on the vertical are too far apart and points on the horizontal axis are too close. In actual fact, School A's maths results decline from a mean of 69.6 in 1988 to a mean of 67.4 in 1990, a mean difference of 2.2 marks. For School B, however, there is a mean increase of 4.6 marks between 1988 and 1990. Without using some form of statistical analysis it is not possible to say whether these trends represent significant changes in maths performance or whether they are due to chance. The example does illustrate, however, how it is possible for graphs to give false impressions about data.

You can find out more about the construction of tables, bar and, pie charts, histograms and graphs in Coolican (1990) and Graham (1990) (see the further reading list below).

## 5.7 Conclusion

This section has described how to analyse and interpret qualitative and quantitative data. Throughout I have tried to illustrate the kind of reasoning processes you must engage in when you begin to analyse your data. As I mentioned at the outset, analysing and writing about qualitative data is very much a matter of personal style, and you will have to develop methods and techniques you feel comfortable with. When it comes to analysing quantitative data, there is less scope for individuality. Certain conventions have to be observed. Discrete category data must be treated in a different way from data obtained from the measurement of continuous variables. Nevertheless, even here people develop different styles of presenting their data. I personally find it easier to interpret data when I can draw a picture of them, and I therefore prefer graphs to tables. I hope that this section will encourage you to develop your own style of analysis and presentation.

## Further reading

COOLICAN, H. (1990) *Research Methods and Statistics in Psychology*, London, Hodder and Stoughton.

This book gives good advice on analysing both qualitative and quantitative data. It is easy to read and contains exercises which can be worked through.

GRAHAM, A. (1990) *Investigating Statistics: a beginner's guide*, London, Hodder and Stoughton.

This book is for the number-shy. Its aim is to provide a painless introduction to the key ideas of statistics so that the reader can come to grips with numerical data. Each chapter contains a series of activities and exercises to help the reader understand key concepts.

NORTHEDGE, A. (1990) *The Good Study Guide*, Milton Keynes, The Open University.

This book gives advice on study skills in general, and includes a useful chapter on how to handle numbers and interpret statistical data. It also contains two chapters on writing techniques. It has been specifically written for adults studying part-time and for people returning to study after a long break. It is a set book for The Open University Social Science Foundation Course.

ROWNTREE, D. (1981) *Statistics Without Tears: a primer for non-mathematicians*, New York, Charles Scribner and Sons.

This is another user-friendly text about how to use statistics. It introduces the main concepts and terminology of statistics but without allowing the reader to get bogged down in formulae and calculations. It is at a slightly more advanced level than Graham (1990) above.

WOLCOTT, H.F. (1990) *Writing up Qualitative Research*, Qualitative Research Methods Series 20, Newbury Park (Calif), Sage Publications.

This book is a very readable introduction to analysing and writing up qualitative data. It gives good advice on how to approach report writing, and recognizes that, for the beginner, this is not an easy task.

# 6 FINDING AND USING RESOURCES

## 6.1 Introduction

At some stage in your project you are likely to need access to published material and other resources to support your project. You may find that your own collection of resources or that of a colleague contains all the material you need. On the other hand, you may wish to supplement what you already have. This section suggests various sources of information which may be of help to you.

Published accounts of research often devote considerable space to a 'literature review' – an account of work that has been carried out by other researchers that is felt to be relevant to the research being reported. In this module, we expect that the ideas for your work will arise from your own professional context, and that the work will (mainly) inform your own practice. You probably will not need to carry out an extensive literature review. On the other hand, if you look no further than your own practice, you are in danger of re-inventing the wheel. It is useful to refer to published sources that can illuminate your own work.

Published material may provide you with ideas for things to investigate – for instance, you may want to try out and evaluate in your own classroom something that has been recommended elsewhere. Published material may also provide suggestions for analysing and interpreting the information you collect. When writing a report of your work, it is a convention to mention any published sources you have drawn on.

This section provides guidance on tracking down published material and other information relevant to your research. It also suggests how you may draw on such materials in your project report. We hope these suggestions will save you time.

You will not need to work as closely through this section as you did with previous sections in the handbook. We suggest you use this section as follows:

- Read sub-section 6.2, on *local sources*, to remind yourself of information that is readily available locally. It may be that local sources provide all the information you need for your project.
- If you need further, or more specific information, check quickly through sub-section 6.3, on *finding information in libraries*. Use the headings to help you identify relevant sources. Familiarity with these should help you carry out a literature search for your project more easily.
- Look through sub-section 6.4, which lists *national organizations* concerned with education, and gives a brief annotation on the aims of each. This may provide further useful sources to support your work.
- Read sub-section 6.5, which gives advice on *keeping track of information* you collect.
- Read through sub-section 6.6, on *drawing on published sources* quickly now, and then more carefully when you are assembling material for your project report. This sub-section provides guidance on referring to published sources and drawing up a reference list.

Starting to track down resources can seem a daunting prospect, but you can save yourself a lot of unnecessary time and effort by defining your topic using the following questions to help you structure your thoughts:

- What do you need to know?
- How quickly are answers needed?

- How much detail is necessary?
- What are the key terms involved?
- What do you know already?
- What remains to be found out?

## 6.2 Local sources of information

One of the most readily available sources is people. Apart from your tutor, you may be able to find ideas and advice on your project from those involved with your school – colleagues, governors, headteachers, parents – or from local authority advisers and inspectors. These may also be able to direct you to published sources, including local publications, that are relevant to your project.

As well as people, there are a number of places or institutions to approach. For example, there will be a wide range of books, reports and so on available in your local teachers' centre, or school library service, where these are provided.

Local organizations, such as subject organizations, teaching unions, or other teachers' groups, may also be able to help. Some of these will exist only in your area, while others are part of a national network. Colleagues or advisers may be able to help you get in touch with those you have not already contacted. Alternatively, they may be traced through yellow pages, lists available at local libraries, or published sources such as directories and handbooks.

Public libraries are a familiar local source, but perhaps it is less well-known that most academic libraries (i.e., college, polytechnic, university) can be used for reference purposes on application to the librarian. Borrowing rights may be granted in some circumstances, but there is often a charge for this. Teachers are entitled, in most areas, to belong to the library of the School or Institute of Education nearest to them. Again, in some cases, there may be a charge for borrowing.

In Example 6.1, John Cowgill describes how he used information from local sources (see also Sample Project 5).

### Example 6.1 Using local sources

‘When I carried out my project, I was head of design and technology in a secondary school in Hertfordshire. I was concerned about gender bias and gender inequalities in technology. I wanted to observe classroom interactions in CDT and home economics and textiles, to see if this could provide any material for discussion and future strategies.

Hertfordshire LEA has an arrangement with Hatfield Polytechnic whereby local teachers are allowed access to the polytechnic library. This was one possible source of information. The local teachers' centre also had books and other information that I could browse through. I used books and information gathered from a previous course on management which I had participated in, run by the Cambridge Institute of Education. I needed help with tracking down specific information on gender and classroom interaction, and with designing a suitable observation schedule. I met the LEA adviser for equal opportunities who brought along useful documents, information, and examples, and also suggested other helpful sources. The LEA adviser visited my school and suggested how I might construct an observation schedule and carry out observations to measure the aspects of classroom interaction in which I was interested. Later, I obtained comments on a draft schedule from my course tutor, who made further suggestions on observation schedules and their construction.’