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Introduction to quantitative research

1.1. What is quantitative research?

Research methods in education (and the other social sciences) are often divided into two main types: quantitative and qualitative methods. This book will discuss one of these two main strands: 'quantitative methods', and what distinguishes quantitative from qualitative methods.

When you think of quantitative methods, you will probably have specific things in mind. You will probably be thinking of statistics, numbers, and many of you may be feeling somewhat apprehensive because you think quantitative methods are difficult. Apart from the last one, all these thoughts capture some of the essence of quantitative methods.

The following definition, taken from Aliaga and Gunderson (2000), describes what we mean by quantitative research methods very well:

Quantitative research is 'Explaining phenomena by collecting numerical data that are analysed using mathematically based methods (in particular statistics)'.

Let's go through this definition step by step. The first element is explaining phenomena. This is a key element of all research, be it quantitative or qualitative. When we set out to do some research, we are always looking to explain something. In education, this could be questions like 'why do teachers leave teaching?', 'what factors influence pupil achievement?', and so on.

The specificity of quantitative research lies in the next part of the definition. In quantitative research, we collect numerical data. This is closely connected to the final part of the definition: analysis using mathematically



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based methods. In order to be able to use mathematically based methods, our data have to be in numerical form. This is not the case for qualitative research. Qualitative data are not necessarily or usually numerical, and therefore cannot be analysed by using statistics.

Therefore, as quantitative research is essentially about collecting numerical data to explain a particular phenomenon, particular questions seem immediately suited to being answered using quantitative methods. How many males get a first-class degree at university compared to females? What percentage of teachers and school leaders belong to ethnic minority groups? Has pupil achievement in English improved in our school district over time? These are all questions we can look at quantitatively, as the data we need to collect are already available to us in numerical form. Does this not severely limit the usefulness of quantitative research though? There are many phenomena we might want to look at, but which don't seem to produce any quantitative data. In fact, relatively few phenomena in education actually occur in the form of 'naturally' quantitative data.

Luckily, we are far less limited than might appear from the above. Many data that do not naturally appear in quantitative form can be collected in a quantitative way. We do this by designing research instruments aimed specifically at converting phenomena that don't naturally exist in quantitative form into quantitative data, which we can analyse statistically. Examples of this are attitudes and beliefs. We might want to collect data on pupils' attitudes to their school and their teachers. These attitudes obviously do not naturally exist in quantitative form (we don't form our attitudes in the shape of numerical scales!). Yet we can develop a questionnaire that asks pupils to rate a number of statements (for example, 'I think school is boring') as either 'agree strongly', 'agree', 'disagree' or 'disagree strongly', and give the answers a number (e.g. 1 for 'disagree strongly', 4 for agree strongly). Now we have quantitative data on pupil attitudes to school. In the same way, we can collect data on a wide number of phenomena, and make them quantitative through data collection instruments such as questionnaires or tests. In the next three chapters, we will look at how we can develop instruments to do just that. The number of phenomena we can study in this way is almost unlimited, making quantitative research quite flexible. This is not to say that all phenomena are best studied by quantitative methods. As we will see, while quantitative methods have some notable advantages, they also have disadvantages, which means that some phenomena are better studied by using different (qualitative) methods.

The last part of the definition refers to the use of mathematically based methods, in particular statistics, to analyse the data. This is what people usually think about when they think of quantitative research, and is often

seen as the most important part of quantitative studies. This is a bit of a misconception, as, while using the right data analysis tools obviously matters a great deal, using the right research design and data collection instruments is actually more crucial. The use of statistics to analyse the data is, however, the element that puts a lot of people off doing quantitative research, as the mathematics underlying the methods seems complicated and frightening. As we will see later on in this book, most researchers do not really have to be particularly expert in the mathematics underlying the methods, as computer software allows us to do the analyses quickly and (relatively) easily.

1.2. Foundations of quantitative research methods

1.2.1. Realism, subjectivism and the 'paradigm wars'

Now we have defined quantitative research, it is a good idea to compare it with qualitative research, to which it is usually put in opposition. While quantitative research is based on numerical data analysed statistically, qualitative research uses non-numerical data. Qualitative research is actually an umbrella term encompassing a wide range of methods, such as interviews, case studies, ethnographic research and discourse analysis, to name just some examples.

The difference between quantitative and qualitative research is often seen as quite fundamental, leading people to talk about 'paradigm wars' in which quantitative and qualitative research are seen as warring and incommensurable fractions. Many researchers define themselves as either quantitative or qualitative. Where does this idea come from?

This idea is linked to what are seen as the different underlying philosophies and world views of researchers in the two 'paradigms' (also called 'epistemologies').

According to this view, two fundamentally different world views underlie quantitative and qualitative research. The quantitative view is described as being 'realist' or sometimes 'positivist', while the world view underlying qualitative research is viewed as being 'subjectivist'.

What does this mean? Realists take the view that what research does is uncover an existing reality. 'The truth is out there', and it is the job of the researcher to use objective research methods to uncover that truth. This means that the researcher needs to be as detached from the research as possible, and use methods that maximise objectivity and minimise the involvement of the researcher in the research. This is best done by methods



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taken largely from the natural sciences, which are then transposed to social research settings (such as education). Positivism is the most extreme form of this world view. According to positivism, the world works according to fixed laws of cause and effect. Scientific thinking is used to test theories about these laws, and either reject or provisionally accept them. In this way, we will finally get to understand the truth about how the world works. By developing reliable measurement instruments, we can objectively study the physical world. This view that there is a true reality out there that we can measure completely objectively is problematic. We are all part of the world we are observing, and cannot completely detach ourselves from what we are researching. Historical research has shown that what is studied, and what findings are produced, are influenced by the beliefs of the people doing the research and the political/social climate at the time the research is done.

According to this viewpoint, qualitative researchers are subjectivists. In contrast to the realist view that the truth is out there and can be objectively measured and found through research, they point to the role of human subjectivity in the process of research. Reality is not 'out there' to be objectively and dispassionately observed by us, but is at least in part constructed by us and by our observations. There is no pre-existing objective reality that can be observed. The process of our observing reality changes and transforms it, and therefore subjectivists are relativistic. All truth can only be relative, and is never definitive, as the positivist claims. The extreme relativist position is obviously as problematic as the extreme positivistic one, as it would in theory deny that anything more than social consensus and power distinguishes modern science from witchcraft.

If you look at the extreme forms of the two views we have set out here, it would seem that quantitative and qualitative research methods are pretty incompatible. These extremes are, however, a gross simplification of the views of both quantitative and qualitative researchers. Very few people in either 'camp' hold these extreme views. I have included them here because they are frequently presented in only slightly less extreme forms as straw men for critics of one method (qualitative, for example) to attack users of different methods (for example, quantitative) with. It is worth pointing out here that, as 'qualitative methods' is an umbrella term for a large number of different research methods (e.g. participant observation, interviews, case studies, ethnographic research) which are quite different, they are used by researchers with quite different world views, some of which clearly lie towards the realistic end of the spectrum. To ascribe radical subjectivist views to all qualitative researchers is a fallacy.

To label all quantitative researchers positivists is equally inaccurate. Quantitative researchers have taken up many criticisms of positivist views,



and there is now a variety of epistemologies underlying theory and practice in quantitative research. I think it is true to say that very few quantitative researchers nowadays are radical positivists.

1.2.2. Post-positivism, experiential realism and pragmatism

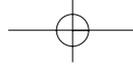
Post-positivists accept the critique of traditional positivism that has been presented by the subjectivists, without going so far as to reject any notion of realism. Post-positivists accept that we cannot observe the world we are part of as totally objective and disinterested outsiders, and accept that the natural sciences do not provide the model for all social research. However, they do believe in the possibility of there being an objective reality. While we will never be able to totally uncover that reality through our research, post-positivists believe that we should try to approximate that reality as best we can, all the while realising that our own subjectivity is shaping that reality. Rather than finding the truth, post-positivists will try to represent reality as best they can.

In contrast to positivists, post-positivists believe that research can never be certain. Rather than focusing on certainty and absolute truth, post-positivist social science focuses on confidence – how much can we rely on our findings? How well do they predict certain outcomes?

A second world view or epistemology that underlies the work of some quantitative researchers is called *experiential realism*. Experiential realism claims, as do anti-positivist positions, that we cannot observe the world in a purely objective way, as our perception itself influences what we see and measure. In contrast to subjectivist positions, however, experiential realists believe that there is a limit to subjectivity. We are limited in our subjectivity by the fact that we use a limited number of schemas to formulate our views of the world. This is because our perception is 'embodied'. We don't observe passively, but actively interact with the world through our bodies.

Experiential realists see the use of metaphor as crucial to the way we make sense of the world around us. We use metaphors to understand our world. One of the main metaphors we use to do this is the subject-object schema, which divides the world into objects (things) and subjects (people). This metaphor has its origins in the fact that in our dealings with the world we find that there is a distinction between an external world consisting of edges, surfaces and textures that are not us, and those things that are us, the actor. As we move around our world, the objects remain invariant. Science, according to this view, is an activity that is based on this subject-object schema (Mulaik, 1995).

Many researchers, both quantitative and qualitative (me included), take a



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pragmatist approach to research, using different methods depending on the research question they are trying to answer. In some cases, this will lead them to quantitative research, as, for example, when they need to give a quantitative answer to a question, need to generalise findings to a population, or are looking to test a theory mathematically; in other cases, they will employ qualitative methods. In many cases, a mixed-methods approach combining quantitative and qualitative methods will be the most appropriate.

Philosophers such as Peirce, Dewey and James developed pragmatism as a philosophy in the USA. One of the main contentions of this school of philosophy is that the meaning and the truth of any idea are a function of its practical outcome(s). Pragmatists strongly oppose the absolutism they see as a key part of most other philosophical beliefs. They feel that too often a chosen philosophy is put in opposition to other philosophies (think of the positivist/subjectivist debate), which are totally rejected.

As for the subjectivists, there is no definite truth in pragmatic philosophy. Truth is constantly changing and being updated through the process of human problem solving. The key question for pragmatists is not 'is it true?', or 'is it right?', but 'does it work?'.

1.3. When do we use quantitative methods?

If we take a pragmatic approach to research methods, the main question that we need to answer is 'what kind of questions are best answered by using quantitative as opposed to qualitative methods?'

There are four main types of research questions that quantitative research is particularly suited to finding an answer to:

1. The first type of research question is that demanding a quantitative answer. Examples are: 'How many students choose to study education?' or 'How many maths teachers do we need and how many have we got in our school district?' That we need to use quantitative research to answer this kind of question is obvious. Qualitative, non-numerical methods will obviously not provide us with the (numerical) answer we want.
2. Numerical change can likewise accurately be studied only by using quantitative methods. Are the numbers of students in our university rising or falling? Is achievement going up or down? We'll need to do a quantitative study to find out.
3. As well as wanting to find out about the state of something or other, we often want to explain phenomena. What factors predict the recruitment of maths teachers? What factors are related to changes in student achievement over time? As we will see later on in this book, this kind of question can also be studied successfully by quantitative methods, and

many statistical techniques have been developed that allow us to predict scores on one factor, or *variable* (e.g. teacher recruitment) from scores on one or more other factors, or *variables* (e.g. unemployment rates, pay, conditions).

4. The final activity for which quantitative research is especially suited is the testing of *hypotheses*. We might want to explain something – for example, whether there is a relationship between pupil's achievement and their self-esteem and social background. We could look at the theory and come up with the hypothesis that lower social class background leads to low self-esteem, which would in turn be related to low achievement. Using quantitative research, we can try to test this kind of model.

What is a hypothesis?

A hypothesis is a tentative explanation that accounts for a set of facts and can be tested by further investigation.

For example, one hypothesis we might want to test is that poverty causes low achievement, or that there is a relationship between pupils' self-esteem and the amount of time they spend watching television.

Quantitative researchers design studies that allow us to test these hypotheses. We will collect the relevant data (for example, parental income and school achievement) and use statistical techniques to decide whether or not to reject or provisionally accept the hypothesis.

Accepting a hypothesis is always provisional, as new data may emerge that reject it later on.

Problems one and two above are called 'descriptive'. We are merely trying to describe a situation. Three and four are 'inferential'. We are trying to explain something rather than just describe it.

As I mentioned above, while quantitative methods are good at answering these four types of questions, there are other types of questions that are not well suited to quantitative methods.

1. The first situation where quantitative research will fail is when we want to explore a problem in depth. Quantitative research is good at providing information in breadth, from a large number of units, but when we want to explore a problem or concept in depth, quantitative methods can be too shallow. To really get under the skin of a phenomenon, we will need to go for ethnographic methods, interviews, in-depth case studies and other qualitative techniques.

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2. We saw above that quantitative research is well suited for the testing of theories and hypotheses. What quantitative methods cannot do very well is develop hypotheses and theories. The hypotheses to be tested may come from a review of the literature or theory, but can also be developed by using exploratory qualitative research.
3. If the issues to be studied are particularly complex, an in-depth qualitative study (a case study, for example) is more likely to pick up on this than a quantitative study. This is partly because there is a limit to how many variables can be looked at in any one quantitative study, and partly because in quantitative research the researcher defines the variables to be studied herself, while in qualitative research unexpected variables may emerge.
4. Finally, while quantitative methods are best for looking at cause and effect (causality, as it is known), qualitative methods are more suited to looking at the meaning of particular events or circumstances.

What, then, do we do if we want to look at both breadth and depth, or at both causality and meaning? In those cases, it is best to use a so-called *mixed-methods* design, in which we use both quantitative (for example, a questionnaire) and qualitative (for example, a number of case studies) methods. Mixed-methods research is a flexible approach, where the research design is determined by what we want to find out rather than by any predetermined epistemological position. In mixed-methods research, qualitative or quantitative components can predominate, or both can have equal status.

1.4. Units and variables

When we collect data in quantitative educational research, we have to collect them from someone or something. The people or things (e.g. schools) we collect data on or from are known as *units* or *cases*.

The data that we are collecting from these units are known as *variables*. Variables are any characteristic of the unit we are interested in and want to collect (e.g. gender, age, self-esteem).

The label 'variable' refers to the fact that these data will differ between units. For example, achievement will differ between pupils and schools, gender will differ between pupils, and so on. If there are no differences at all between the units we want to study, we probably aren't going to be able to do any interesting research (for example, studying whether pupils are human would not yield interesting findings).

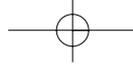
Common misconceptions

1. *I have to have an epistemology to do research, don't I?* No, not necessarily. While you may have strong epistemological and philosophical beliefs that determine what kind of research you want to do, you can also start out wanting to solve a particular problem, or wanting to find out about a particular phenomenon. In that case you will be able to pragmatically choose what methods are best suited to answering your research question.
2. *Data have to be in a quantitative format to do quantitative research, don't they?* Not necessarily. If data are not naturally available as numbers, you can try to turn non-quantitative data (like attitudes or opinions) into quantitative data by measuring them numerically (for example, by using a questionnaire rating scale).
3. *Qualitative and quantitative research are incompatible, aren't they?* Not necessarily. Qualitative and quantitative research can be usefully combined in mixed-methods designs, which often produce much useful information. Also, depending on your research question, you might in one instance want to use quantitative and in another instance qualitative research. This is something I personally often do.
4. *The most important thing about quantitative research is the statistics, isn't it?* Not at all. While the way in which you analyse your data matters, if you haven't designed your research well, and collected the data in a valid and reliable way, you will not get valid results however sophisticated your analyses.
5. *Qualitative research is purely subjective, isn't it?* Not necessarily. While some qualitative researchers might take a strong subjectivist stance, there is a wide variety of qualitative methods that can accommodate a variety of viewpoints.
6. *We can never explain things by using quantitative research. To do that we need to use qualitative methods.* That is not strictly true. While qualitative research usually provides more depth and less breadth than quantitative research, a well-designed quantitative study will allow us not just to look at what happens, but to provide an explanation of why it happens as well. The key lies in your research design and what variables you collect.

1.5. Summary

In this chapter we have discussed what quantitative research is. We said quantitative research is about explaining phenomena by collecting quantitative data, which are analysed by mathematically based methods.

The fact that the data have to be quantitative does not mean that they have to be naturally available in quantitative form. Non-quantitative



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phenomena (such as teacher beliefs) can be turned into quantitative data through our measurement instruments.

Quantitative research is often placed in opposition to qualitative research. In many cases, this turns into a 'paradigm war', which is seen to result from apparently incompatible world views underlying the methods. When you look closer at researchers' actual beliefs, it appears that the so-called subjectivist (qualitative) versus realist (quantitative) divide is not that clear-cut.

Many researchers take a pragmatic approach to research, and use quantitative methods when they are looking for breadth, want to test a hypothesis, or want to study something quantitative. If they are looking for depth and meaning, they will prefer to use qualitative methods. In many cases, mixed-methods approaches will be appropriate.

1.6. Exercises

1. Gender (male/female) is not a quantitative variable. Can you think of any ways you could study gender in quantitative research?
2. Attitude to school (e.g. 'I like school', 'I think school is boring') is not a quantitative variable. Can you think of any ways you could study learning styles in quantitative research?
3. What is your world view (epistemology) with regard to research? Do you think it is compatible with using quantitative methods?
4. Can you think of a research question you could study by quantitative methods?
5. What kind of research question would you study using a mixed-methods design?
6. What are the main distinctions between post-positivism and positivism?

1.7. Further reading

If you want to know more about quantitative and qualitative research, a good overview of a range of methods is given in Cohen, L., Manion, L. & Morison, K. (2000), *Research Methods in Education* (5th edn) (Routledge Falmer). This also gives an introduction to the subjectivist–realist epistemological debate.

An excellent introduction to mixed methodology research is Tashakkori, A. & Teddlie, C. (2000), *Mixed Methodology* (Sage).

A fascinating but tough work by a leading proponent of experiential realism is Lakoff, G. (1990), *Women, Fire and Dangerous Things. What Categories of Thought Reveal About the Mind* (University of Chicago Press).

Menand, L. (ed.) (1998) *Pragmatism* (Random House), is a selection of writings by pragmatist philosophers, old and new, and is probably the best available overview of this philosophy.

