TEACHER-LED

Research

Designing and implementing **randomised controlled trials** and other forms of **experimental research**

Richard Churches and Eleanor Dommett

Crown House Publishing Limited
www.crownhouse.co.uk

First published by

Crown House Publishing
Crown Buildings,
Bancyfelin,
Carmarthen,
Wales, SA33 5ND, UK
www.crownhouse.co.uk

and

Crown House Publishing Company LLC
6 Trowbridge Drive, Suite 5, Bethel, CT 06801, USA
www.crownhousepublishing.com

British Library Cataloguing-in-Publication Data

A catalogue entry for this book is available from the British Library.

Print ISBN: 978-184590990-1
Mobi ISBN: 978-178583039-6
ePub ISBN: 978-178583040-2
ePDF ISBN: 978-178583041-9

LCCN 2015953355

Printed and bound in the UK by
Bell & Bain Ltd, Thornliebank, Glasgow

Contents

Chapter 1

An introduction to scientific method

By the end of this chapter, you will know about:

- The stages of scientific method.
- The difference between experimental and observational research.
- Research ethics.

Scientific method

Scientific method is the name given to a process of designing and conducting research that involves making observations and interpreting them in the context of very specific questions. It is not a new method. Indeed, there is even a reference to such an experiment in the Bible to examine the impact of eating meat and wine compared to a vegetarian diet with no alcohol:

> But Daniel appealed to a steward who had been assigned by the head of the palace staff to be in charge of Daniel, Hananiah, Mishael, and Azariah. 'Try us out for ten days on a simple diet of vegetables and water. Then compare us with the young men who eat from the royal menu. Make your decision on the basis of what you see.' The steward agreed to do it and fed them vegetables and water for ten days. At the end of the ten days they looked better and more robust than all the others who had been eating from the royal menu.
>
> **Daniel 1: 11–14**

While this biblical reference illustrates that the process is not new, it does not tell us much about how it works beyond the central importance of comparing different conditions. In this case the two 'conditions' are two types of diet. This detail is best illustrated with a flow chart showing the process step by step (see Figure 1.1).

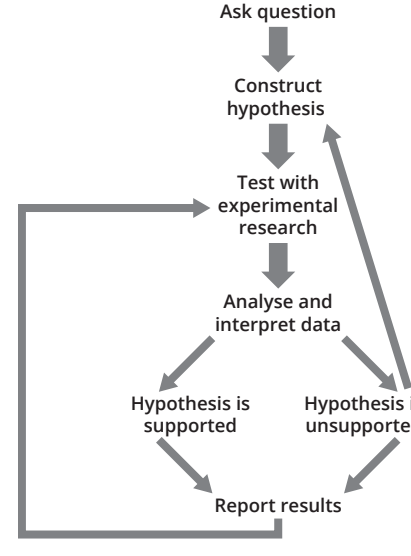

Figure 1.1. Scientific method begins with a specific question.

As you can see, the process of scientific method begins with a specific question. There is nothing special about this question – it will often have arisen through curiosity or some attempt to explain a previous observation.

Let's take a very simple example and ask the question, 'Why are carrots orange?' Once we have asked the question, we might attempt to find some information to help us answer it. This information could be reports from previous research or it could be the opinions of experts on colour pigments. In a classroom context, teachers views based on professional experience might be the starting point.

After we have collected some background information about how this could be measured, we need to construct a **hypothesis**. A hypothesis is a formal statement of what we think the answer to the question might be. In this case the hypothesis may be:

> Carrots are orange because they contain the pigment carotene.

This is a statement that we can test (assuming we had access to carrots and a lab!). Importantly, the hypothesis needs to be a statement that the outcome of the experimental research could support (i.e. agree with) or not support (i.e. disagree with). Once we have completed the test and interpreted the results, in the context of the original hypothesis, the results are then reported somewhere for others to read. We can then continue the process by revising our hypothesis if the results did not support our original hypothesis or attempting to replicate our findings if they did support it.

Replication means repeating a study in order to see if the same result occurs again. As you will learn later, we are only ever dealing with probabilities in this type of research. Specifically, our findings are all related to the probability that the result may have happened by chance, so there is always the possibility that we may be wrong. Replication helps to solve this problem because if the result is true, we are likely to find it repeated more times than not.

Remember: we are only ever dealing with probabilities in this type of research. Replication helps to solve this problem.

Of course, in this simplified example the process looks quite straightforward, so you may find it hard to see how scientific method, when described in this way, can be applied to complex contexts such as education, which will clearly require more complex experimental research than that required for testing for the presence of a particular pigment in a carrot. In order to see how this can be done, it is necessary to explain a little more about the concept of experimental research. Before we do this, you may want to complete the activity in Learning Zone 1.1 so that you have some ideas to play with later on.

Learning Zone 1.1. What would you like to find out?

Think about a topic you are interested in exploring and try to come up with some questions on which you could base some research. Here are a few ideas to get you started.

- Which is better for learning times tables – rote learning or flash cards?
- What is the effect of group work on reducing misconceptions in column addition?
- Do girls or boys perform better when given structured homework compared to a freer approach?
- Does an intervention you are thinking of using (which is shown to be effective in another context) work in your own school?

Approaches to research

Now that you have some questions of interest, let's look more carefully at what is meant by experimental research. The term 'experimental' is banded around quite freely so most people have a general idea of what it means. If we think of something as experimental we are recognising that the outcome, whether it is taking a drug or trying a new hair style, is somewhat unknown. This is also true of the term when it is used in the context of research; however, here it takes on a rather more specific meaning.

Experimental research refers to a type of investigation that uses the manipulation of **variables** (or things of interest) and controlled testing to understand causal events. Although this sounds complex, it is easy to understand if we compare experimental research to another type of research – **observational research**. In observational research, the researcher observes participants and measures variables without controlling for other factors or directly allocating people to certain conditions. For example, if a researcher is interested in the effect of multivitamins on self-esteem in women, this could be studied using experimental research or observational research. Table 1.1 illustrates the different approaches.

Experimental	Observational
Find 100 women who do not currently take any vitamins and have 'average' or 'normal' levels of self-esteem.	Find 100 women, 50 of whom have been taking multivitamins for three months.
Randomly allocate 50 women to a group in which they must take multivitamins and 50 to a group where they must not take multivitamins.	
Measure self-esteem after the women have been in the conditions for three months.	Measure self-esteem in these women.
Analyse and interpret the data.	Analyse and interpret the data.

Table 1.1. The difference between experimental and observational research.

For the experimental research approach, you can see that the researcher directly manipulates the variable of vitamin intake by placing some participants in one condition (where they receive vitamins) and others in a different condition (where they do not receive vitamins). By doing this, the researcher is able to examine causality between two things (multivitamins and self-esteem) rather than simply associations between the two things. There is, however, no such manipulation for the observational version of the study.

In education, until recently, we have tended to take an observational approach without comparing our intervention to something else at the same time (such as a control condition) – a practice that generally means we have never been entirely sure whether the change might have happened anyway.

Types of experimental research

Experimental research typically involves some form of **randomisation** to different groups before exposing them to a treatment or a control (see Figure 1.2). It is also possible to collect both quantitative and qualitative research data during this process.

In this way, studies could be seen as fitting into one of the four quadrants in Figure 1.3.

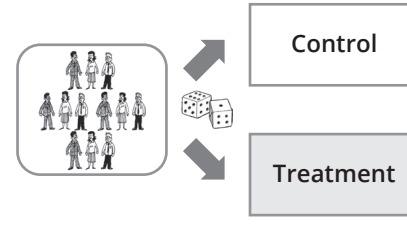

Figure 1.2. A typical piece of experimental research.

	Experimental	Observational
Quantitative	Manipulation of the area being explored by creating comparison conditions Numerical data	No manipulation Numerical data
Qualitative	Manipulation of the area being explored by creating comparison conditions Other forms of data	No manipulation Other forms of data

Figure 1.3. Types of research.

Qualitative research refers to research using methods that provide information about the 'human' or personal side of the issue or subject being investigated – for example, information about beliefs, opinions and subjective responses to situations. It typically employs open-ended questions in semi-structured interviews. This information is not quantified or turned into numbers, but rather may exist as text or transcript from interviews.

By contrast, **quantitative research** tends to work with fixed scales, closed questions and aspects that can be objectively measured, such as body temperature. These data exist as numbers which then allows for complex statistical analysis. For example, where a piece of experimental quantitative research might randomise patients into a group for treatment (comparing this to a control group) and then measure how many patients were cured as a result of the treatment, a piece of experimental qualitative design might follow the same sort of randomisation process but then collect semi-structured interview data. In a school context, you could randomly allocate classes to different forms of pedagogy and then collect similar data.

As a teacher or school leader, the types of effectiveness that you will probably be interested in measuring will include things like attainment, progress, behaviour, attendance and maybe aspects of engagement, confidence and pupil well-being. Some of these may be best measured qualitatively and others quantitatively.

Using quantitative research in the best way

Quantitative experimental research is not always the most effective way to answer a research question. It is best deployed when you want to compare one thing with another and see which one is better according to a particular test or numerical scale. In other words, you need to have something in mind that you want to test the effectiveness of, either against a control condition (such as normal practice) or against another intervention, or perhaps with regard to the responses of different groups when they are exposed to the same intervention.

By contrast, quantitative experimental research is not very good at more generally exploring or answering questions that require you to figure out what something means to a group of people. For example, if you wanted to find out about the experience of newly qualified teachers in New Zealand or the impact of a new teaching approach, you would need to use a different form of research – for example, qualitative research or an observational study. You might even need to embed yourself in the context as a participant observer and do ethnographic education research.

Advantages and disadvantages of quantitative experimental research

The advantages of using quantitative experimental research design can be summarised as follows:

- It can be much more objective than other forms of research, and providing the measures used are valid and reliable there is less risk of misinterpretation.
- Replication can remove the risk of the falsification of results or of findings that are unusual and unlikely to occur again.
- As the analytical approach is statistical, there is the potential for in-depth understanding of the characteristics that underpin the findings and for later **meta-analysis** (the combining of evidence from a wide range of studies of the same topic in order to make some robust generalisations about the effects of a treatment in the real world).
- Collecting the data you need and the initial analysis of what you have found can be much faster – depending on your research design.
- It is possible to recommend a future study that builds on your design in a way that can further validate and confirm your findings in an objective way.

The disadvantages of using quantitative experimental research design can be summarised as follows:

- Quantitative experimental research is not good at telling you why something is happening, and in the end it still requires interpretation – taking into account the context and the circumstances in which the experiment took place.

- It cannot elicit complex ideas about the way people perceive things to be or their understanding of a situation.
- It only tells you something about the thing you have measured and only whether one thing is different to another. It is quite possible that something important has gone on which you have not measured, so you must always consider this when writing up.

There are many different ways of conducting experimental research and we do not have time to discuss them all here. Rather, this book is concerned with quantitative experimental research only. If you are interested in learning about a wider range of research methods, we highly recommend:

> Ian Menter, Dely Elliot, Moira Hulme, Jon Lewin and Kevin Lowden, *A Guide to Practitioner Research in Education* (London: SAGE, 2011).

Learning Zone 1.2. To experiment or not to experiment? That is the question ...

Take each of the ideas that you generated in Learning Zone 1.1 and consider them in the light of the advantages and disadvantages of using quantitative experimental research. Then decide on which of the approaches might be best:

- Experimental or observational research.
- Quantitative or qualitative design.

Make sure you have at least one idea that you think you can test with quantitative experimental research, as this will be the focus of the remainder of this book and we will be asking you to plan a research study as you improve your understanding.

Research ethics

Before we move on to look at how you conduct research in more detail, it is important to be aware of the ethical implications of your work. If the research is a drug trial for a particular medical condition or a psychological experiment investigating a sensitive issue, it is easy to see why ethics are important. However, the same considerations are necessary in classroom research because any form of research that involves people is not without 'risk of harm'. This can take different forms and can range from a risk of physical harm (e.g. when a participant takes part in a study on sports) to a risk of psychological harm (e.g. when a participant is subjected to psychological stress, such as through additional school tests).

Privacy and data protection

An important aspect of research is the protection of the participants' privacy. It is important that test results are not shared with the rest of the world in such a manner that individuals can be identified. Data should be anonymised in some way so that each participant in the study gets a unique identification number and their test data is stored under this ID number rather than under their name or other identifiable feature. In this way, people outside the research group cannot identify an individual. Within the UK, researchers must also comply with the Data Protection Act 1998.

Getting approval

In addition to legal requirements, research normally needs to be approved by an independent ethics committee before it can take place. The ethics committee will look at a detailed plan of the research and do a cost benefit analysis to see if it can be justified. In a school, the head teacher and/or the governing body are generally the equivalent. However, if you are doing your research as part of an MA, MED, MSc or PhD, you may need to engage with both the school's senior leadership and your university. Once approved, the researcher should carry out the work exactly as they have planned.

Informed consent

When carrying out the research, it is important that consent is obtained from the participants. This is not simply them verbally saying yes or turning up for your study; the consent cannot be implied or informal. In fact, the type of consent required from your participants is called **informed consent**. To obtain this, each participant must be informed about the aims of the study, what it will actually involve and what you believe the benefits and risks to be. This is the *informed* part of the consent.

Normally, you would provide participants with an **information sheet** which would specify these details and which they would be required to read. This sheet is normally part of the research detail that is approved by the ethics committee. After each participant has read the information sheet and you have answered any questions they may have, they must formally give their *consent*. Similar to the information sheet, the written consent is not simply an empty piece of paper, but a standard 'informed consent form' that the ethics committee will have approved. Note that when a participant is under 18 years of age you must have consent from a parent or guardian for their participation, and this individual has the right to see the data from a child in their care if they request it. It is important to note that the participant has the right to withdraw from the study at any point, including after their data has been collected, and they must be made aware of this (it is normally covered on the information sheet). If participants withdraw, their data must be removed or destroyed.

Learning Zone 1.3. Finding out what people say about the question of ethics

We recommend extending your thinking about how, and within what ethical framework, to apply a psychological experimental method within an education setting. To do this you may want to read the code of ethics that the American Psychological Association and British Psychological Association have produced. These can be found at the following websites, where there are specific sections relating to the protection of research participants:

www.apa.org

www.bps.org.uk

The British Educational Research Association (BERA) also has a research ethics publication which is available at:

www.bera.ac.uk

Test yourself 1

Question 1

Why is replication important in scientific method?

Question 2

A researcher, interested in the impact of caffeinated drinks at lunchtime on afternoon concentration levels, decides to measure attainment in 30 children who have routinely drunk caffeinated drinks and 30 who have not. Is this an experimental or observational study?

Question 3

Identify two advantages and two disadvantages of quantitative research.

What next?

Now that you have learned about what is meant by scientific method and experimental research, we will move on to the first stage of carrying out this kind of research. This involves turning your research question into a hypothesis. To do this, you need to make some decisions about what exactly you will manipulate and measure. These considerations are the focus of the next chapter.

Accessible, well-illustrated and informative – highly recommended for those engaged in, or planning, school-based research.

Dr Jane Doughty CBE, Education Consultant

Provides a wealth of valuable examples of how teacher-led research can support the development of classroom practice and contribute to school improvement and attainment through rigorous experimentation.

Professor Steven Higgins, School of Education, Durham University

With knowledge of scientific method, teachers can conduct their own research into areas of particular interest in their classrooms, taking control of education research and using it to inform their practice. They can, for example, assess the impact of different pedagogies and prove which strategies work, which can ultimately enhance learning and attainment for pupils and drive whole-school improvement. *Teacher-Led Research* is an essential guide for anyone wanting to conduct randomised controlled trials, carry out their own classroom-based studies, collaborate with other schools on projects or just better understand teacher-led research and what it could mean for their practice.

By the end of this book, you will know:

- The stages of scientific method
- Various different ways to design experiments
- How to create a research plan
- How to use descriptive and inferential statistics to analyse your data
- How inferential tests allow you to accept or reject hypotheses
- The fundamentals of research ethics
- How to interpret your results
- How to report and write up your findings

This volume by Richard Churches and Eleanor Dommett is very carefully crafted to be of use to hardworking, busy teachers who have a commitment to improve their professional practice through research. Their big achievement is to convey the necessary understanding of what can be dry and technical matters with humour and passion.

Ian Menter, Emeritus Professor of Teacher Education, University of Oxford, Former President of the British Educational Research Association

Rigorous teacher-led research has much to offer in helping to create an ambitious and accountable self-improving education system. Richard and Eleanor's book offers schools a way to engage in research that is both compelling and deeply worthwhile.

Steve Munby, Chief Executive, Education Development Trust

Richard Churches is principal adviser for research and evidence based practice at Education Development Trust (formerly CfBT Education Trust). He has worked as a government adviser on multiple policy initiatives in the UK and abroad, recently leading the Closing the Gap: Test and Learn programme which implemented 11 randomised controlled trials and replications in collaboration with 200 teaching schools and 700 trial site schools.

Eleanor Dommett has a degree in psychology from Sheffield University, an MSc in neuroscience from the Institute of Psychiatry, Psychology and Neuroscience (King's College London) and a doctorate in neuroscience from Sheffield University. In 2015, Eleanor joined King's College London as a senior lecturer in psychology to teach on the BSc psychology degree programme.

www.crownhouse.co.uk

ISBN: 978-1845909901

Education Teaching skills