History of Research

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Julie Hall

1.1 Introduction

Research is a planned, systematic method of scientific enquiry, which adds to existing knowledge, by providing evidence from the acquisition and analysis of data. It can lead almost anywhere you choose. Research in healthcare provides evidence that can be used to justify new practice or to challenge existing practice. Occasionally, students of radiography question the inclusion of research and statistics material in their courses. However, practitioners rarely, if ever, dispute their responsibility to maintain their skills, and develop clinical practice, in line with an ever-changing evidence base. Research provides evidence on which to base practice. Therefore, it is clear that an understanding of the research process and data interpretation is required to ensure that practice is based upon reliable evidence obtained from good quality research. The origins of research, including a historical background on the application of its theories to current and evidence-based practice, are explored in this chapter. Also considered are some recent drivers of research in radiography and why research is an important part of the role of radiographers whatever their scope of practice.

1.2 Research and Radiography

The role of a radiographer may vary around the world, with a scope of practice ranging from practitioner to autonomous consultant practitioner, but the responsibility for continued professional development, and lifelong learning to ensure optimum professional practice, remains constant. As specialist medical imaging and radiotherapy

J. Hall (✉)
Department of Radiography, Birmingham City University, Birmingham, UK
e-mail: Julie.hall@bcu.ac.uk

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roles become the norm, practitioners find themselves involved in research on a more regular basis; this involvement can be direct or indirect and spans a wide spectrum of clinical and academic activity. Practitioners in more advanced roles are required to carry out their own research and promote a professional culture in which research is an integral component [1]. The emergence of consultant practitioners, in particular, places an emphasis on the integration of research into practice for education, innovation, and development. Both advanced and consultant practitioners use research skills to solve complex problems and transfer knowledge within the wider multidisciplinary environment to benefit service users.

All practitioners therefore require knowledge of research skills for the following purposes.

- To participate in studies contributing to the ongoing development of their profession and practice
- To address specific problems that may arise in clinical practice
- To evaluate evidence from the research of other practitioners within radiography and the wider multidisciplinary team

It is important to consider how our underpinning knowledge base is formed and the extent to which we are open to new information. This consideration leads directly to the fundamental question: What is knowledge? As practitioners involved in research, it is important that we understand the philosophy of knowledge and its emerging paradigms because we need to apply these concepts to our daily practice.

1.3 What Is Knowledge?

Epistemology is the name given to the study of the nature of knowledge; it is essentially a philosophical issue. We not only use information to survive, but also speculate on the nature of that information and our place in relation to it. This is far from being a new preoccupation. Ancient Greece is traditionally identified as the home of the first philosophers. For example, we can recognise a modern outlook emerging in Aristotle's (384–322 BC) close observations of the natural world, and his application of logic in an attempt to explain what he saw. It is then not a difficult step to recognise that it is possible, and probably necessary, to distinguish between the world as it is and the world as we perceive it [2]. Knowledge therefore poses certain problems which research must acknowledge in its attempts to separate so-called fact from belief.

Moving forward almost 2000 years, this problem was taken up by an English philosopher, Francis Bacon (1561–1626). Bacon believed in the need for a new learning, free from the 'idols' of superstition, prejudice, and the preconceptions of the human mind [3]. He was a strong admirer of Aristotle; he however differed in his insistence that observations should drive the logical process rather than vice versa. Thus, an inductive process of building up a logical structure rooted in

observation was established as being a more reliable method than starting with the logic and then applying it to experience in a deductive, top-down fashion. This philosophy gave rise to a systematic method of enquiry which, for the first time, could be termed 'scientific'.

It would probably be contentious to try and fix a date when the scientific process truly came of age. Certainly Isaac Newton set a dramatic and definitive new standard in bringing together observations of the natural world with the theoretical model purporting to explain it. The eighteenth century in Europe, dubbed 'the Enlightenment', recognised this and was characterised by an insistence that belief and observation should be mutually consistent. Its philosophers prized intellectual progress and perceived this as a measure of the advance of reason over superstition [4]. Indeed, the scientific method has been so successful that it can be argued (and often is) that it has become a dogmatic system in its own right. The strength of the challenge it offers to existing dogmas was clearly seen in the reaction provoked by Darwin's publication of *On the origin of species* in 1859. Interestingly, well over a century later there is still fierce debate, between those who believe in creationism and intelligent design and those who believe in the scientific theory of evolution through natural selection.

Clearly, the definition of knowledge and its relation to belief are not separable from social pressures, and so in looking at the pursuit of knowledge it is necessary to be transparent in taking these pressures into consideration.

1.4 Social Context of Research: Paradigms and the Pursuit of Knowledge

Once a topic of enquiry has been conceived, an appropriate method of investigation has to be applied to it. This then requires researchers to consider the beliefs and assumptions they may already hold which could limit or distort their approach. American physicist and philosopher Thomas Kuhn (1922–1996) [5] identified that research will inevitably take place within a dominant paradigm: an overarching theoretical context or set of expectations which is socially agreed, perhaps unconscious in its effect, and rooted in culture and history. For this reason, the most significant advances in knowledge and understanding are experienced as revolutionary: the so-called paradigm shifts a term coined by Kuhn. This view was strongly endorsed by Paul Feyerabend (1924–1994) [6], who argued, citing Galileo's difficulties with the Catholic Church in the seventeenth century by way of illustration, that 'science is essentially an anarchic enterprise' and that new insights are likely to meet strong resistance.

Paradigms can provide a structure that addresses the contextual and anarchic issues associated with research to support the generation of knowledge. Researchers are more likely to produce a credible outcome if they are aware that they are working within a particular paradigm. Simply put, any method of enquiry must be consistent with the nature of the research question being addressed, and both are likely to be derived within a particular paradigm. The three most common paradigms can be described as positivism, interpretivism, and critical theoretical.

1.5 Positivism

The scientific version of knowledge has become increasingly dominant in modern times; this dominance is associated with a belief that the information that science yields is true and reliable. This popular belief is drawn from a particular paradigm that is defined as positivistic.

The assertion that a belief must be testable in observed experience is clearly a powerful driving force, and the fact that this is just an assertion can easily be forgotten. The positivist outlook tends to support the assumption that an objective and measurable reality exists and simply requires a researcher to devise a way of measuring this reality as accurately as possible. Practical experimentation and observation have been pursued with increasingly subtle ingenuity and investment in advanced technology, and society can see the material fruits of this in everyday life. We can split the atom, put a man on the moon, and decode genetic structures. Clearly, in a practical sense, this sort of science works. So long as there is a quantity to be measured and an objective observer to measure it, positivists believe that eventually the truth will be revealed. From a philosophical point of view, this is something of an oversimplification, but it does provide methodologies by which certain sorts of theory can be tested. This is because the positivistic notion of a separate reality allows for the manipulation and control of that reality with no consequent loss of validity. Thus, an experimenter can manipulate an independent variable and control confounding variables, and be reasonably confident that a dependent variable will yield a reliable and valid outcome.

For example, using a radiographic phantom it is possible to vary the kilovoltage peak (kVp) for a given exposure and measure the consequent effect on image contrast, resolution, and density. The expectation is that a researcher has control over all identifiable variables, and in particular can isolate and measure the effect of varying a specific parameter.

This method forms the basis of randomised controlled clinical trials where, typically, a sample of volunteers is randomly allocated to one of two groups: one receives a placebo drug or treatment and the other receives a new version, with all other factors being the same for both groups. An attempt is thus made to eliminate systematic bias and minimise chance variability in the expectation that any subsequent difference experienced by the two groups will arise as a consequence of the new intervention. The logic is sound, the outcome is measurable, and the system works pretty well. However, there are many other situations in healthcare that also require firm evidence but are not amenable to this sort of approach. Therefore, it is often necessary to recognise the limits of the positivist outlook and adopt a more appropriate paradigm.

1.6 Interpretivism

People and their circumstances are not easy to control or measure. It may be a simple matter to check an individual's blood pressure or record their weight, but this tells us nothing about what they are thinking or feeling. Therefore, it must be

recognised that, in certain areas, there is a problem of measurement and equally so of the role of the person doing the measuring. The appropriate paradigm for this sort of enquiry is defined as interpretivist and it differs from the positivist outlook in fundamental ways. The interpretivist paradigm works on the principle that reality is socially constructed; it emphasises subjectivity rather than objectivity and regards an observer as essentially inseparable from the phenomena under observation. It is more likely that the sort of data gathered by an interpretivist enquiry will reflect the quality of an experience rather than its quantity and will tend to be concerned with theory building rather than theory testing.

For example, in a radiotherapy setting a researcher may wish to interview patients to gain insight into their experience of the treatment process. Researchers would need to be alert to the extent to which their own expectations could influence the choice of questions put to the participants, and also to a possible similar bias in the subsequent analysis of the responses.

Historically science has fought against dogma to establish itself as a reliable source of information, but perhaps it was inevitable that at some point it would reach the limits of its applicability and risk becoming a dogma in its own right. An example of this is the progress of behaviourism as a psychological model. The model of behaviourism is based on the premise that the only observable phenomenon is outward behaviour, therefore making it impossible to comment directly on possible mental events. At the start of the twentieth century, the subject matter of psychology was consciousness, and the method of enquiry introspection, but by the latter half of the twentieth century psychology was largely given over to the behaviourist biological and operant conditioning model of learning. Psychology moved on, and the importance of consciousness and the inner experience was reasserted with the development of a variety of humanistic models and methodologies. So, for example, a positivistic view of learning as a measured change in behaviour can be compared with an interpretivist version: 'learning occurs when individuals … respond, or try to respond, meaningfully to what they experience and then seek to … integrate the outcomes into their own biographies' [7].

In order to capture the lived quality of an individual's experience, an interpretivist paradigm must be embraced. This brings with it the need for a methodology which can deal with subjectivity that is nevertheless rigorous and systematic and in that sense scientific and credible. Within the interpretivist paradigm, it is possible to identify several distinct approaches and these need to be briefly described.

1.7 Phenomenology and Hermeneutics

Typically, an interpretivist approach will involve recording someone's own account of something they have experienced. The problem is to do it in such a way that a person's words are captured and used to present a credible insight which is faithful to that experience. Phenomenology aims to achieve this. Edmund Husserl (1859–1932), usually regarded as the founder of phenomenology, believed that it was possible to delineate an individual's conscious experience by a process of 'bracketing'. This involves the deliberate attempt to identify and set aside a researcher's own

preconceptions, so that one is left with a complete yet unadorned description of the phenomenon in a respondent's own terms [8]. However, there may be difficulty in achieving the desired level of objectivity when immersed in essentially subjective material. Furthermore, it may be questioned whether such a description would be meaningful anyway, since a respondent's own terms are themselves a product of that individual's circumstances. This latter point rests at the heart of hermeneutics, a phenomenological approach developed by the German philosopher Martin Heidegger (1889–1976), in which bracketing is dismissed; a researcher aims to capture individual meaning through subjective dialogue with the material [9].

For example, diagnostic imaging and therapy practitioners both come into contact with people who present with serious illness and may wish to understand their patients' condition more thoroughly. In this example it would be appropriate to talk with willing participants and allow them to describe and discuss their personal experience in some depth. A suitable methodology here may be to conduct an extended interview, gathering as much spoken and non-verbal communication as possible, and then transcribe it faithfully. Researchers would need to immerse themselves in such material and try to make sense of it while setting aside their own biases and opinions.

This is clearly a far cry from the positivist approach which tends to ignore individuals and their social context.

1.8 Symbolic Interactionism, Grounded Theory, and Ethnomethodology

The impact of social context and the roles that we derive from it form the subject matter of symbolic interactionism. Here the sense of self is regarded as arising out of the interplay between members of a social group in which we communicate by means of words, gestures, and display. The clothes we wear, the words we choose, and the mannerisms we adopt all contribute to a social consensus within which our own identity is established with reference to other people. At the level of large groups of people or populations, this process is addressed through ethnomethodology, which focuses on socially agreed customs. Within the same sociological tradition, Glaser and Strauss [10] pioneered the approach known as grounded theory. It acknowledges that individuals constantly change, and so does research.

For example, a suitable application of grounded theory could be to explore student practitioners' experience of clinical placement. Students could be asked to maintain a journal while on placement in which they record their thoughts, feelings, and behaviour. A researcher could then look for themes in these written accounts, perhaps meet with the participants, and suggest a possible analysis of the main factors which the students themselves regarded as significant to their learning. Having developed such an analysis a researcher would need to meet again with these students to confirm the extent to which a researcher's version 'rang true'. In the light of the new participant response a researcher would need to revisit their explanatory model, iterating this consultative process until consensus is reached that the model is credible.

The method is inductive, aiming to build theory from the 'bottom up' using participants' reports, and revisiting those people to check that the result is in accordance with their experience. The process of data collection and analysis is therefore iterative and ongoing, with constant elaboration and refinement in an attempt to establish a consensus.

Thus, interpretivism seeks to understand the world, while positivism expects to predict it. The third paradigm is the critical theoretical, and it aims to change it.

1.9 Critical Theoretical

Both paradigms discussed so far incorporate an ethos that the process of research is in some way separable from the area being researched. The positivist approach takes this as axiomatic and interpretivism, although it addresses individuals' experiences within their social context, still proceeds as if that context is well defined. In contrast, the critical theoretical paradigm starts with the premise that not only is research embedded in its social context, it is actually part of it. Furthermore, because society itself is neither fixed nor well defined, the validity of the product of research is therefore called into question. Thus, research is faced with both a challenge of credibility and an opportunity to be an agent of change. Action research, for example, specifically sets out to evaluate and possibly recommend change in a system at the very same time that it is gathering data on the system. This requires a team approach and potentially offers emancipatory power to the participants, but it brings problems of its own, to do with a need for flexibility and a possible challenge to existing power relationships. In this respect, it is not difficult to see the same concerns at the heart of the standpoints on research of feminists and black people. The former approach points to the failure of traditional research to address topics of particular relevance to women and places women firmly in the role of researcher and women's issues at the focus of enquiry. Likewise, the latter approach is a response to the need for culturally sensitive and competent research with an emphasis on the impact of ethnicity and culture on life and life chances. These differing standpoints share the concern that in order to be meaningful, research must be transparent in recognising personal and societal agendas. In order to achieve this, a researcher must adopt a post-modern awareness of the complexity of how the world presents to us, and how we in turn choose to perceive it. This requires a researcher to look for the 'truth behind the truth' by deconstructing existing social terms and forms of representation.

For example, role extension provides a possible example within radiography of where the status quo might be questioned or even challenged by critical theoretical research. A practitioner's role can be defined on a spectrum ranging from protocol-driven, technical tasks to autonomous patient management at consultant level. The latter end of this spectrum particularly needs to be supported by a credible evidence base, and in acquiring such a base the issue of professional boundaries would need to be addressed. The terms, conditions, and scope of the research and a researcher's own agenda cannot now be regarded as separate from the underpinning research

aim. Existing power relationships will come into play and a researcher must recognise these, allow them to inform his or her work, and so deal with them.

Language is thus crucial to any line of enquiry. For example, discourse analysis can be used to investigate social and cultural structures. This is achieved by identifying patterns of thinking revealed by language rather than the words used; hence the context for discourse analysis is sociological and regards language as an active process that reflects meaning in society [11]. Van Dijk [12] drew attention to the multileveled nature of discourse, the strategies we employ in comprehending it, and the consequent encoding of social structures and power relationships in the very words that people use. Thus, all players in a research process have agendas and it is necessary to identify and declare these. Within the critical theorist paradigm, not only is knowledge provisional, but in the words of Habermas [13], there is a 'singular interlocking of knowledge and interest'.

Clearly the type of knowledge being sought and the methods used to seek it are interdependent, and Box 1.1 attempts to summarise this relationship.

The divisions in Box 1.1 do not necessarily indicate the order in which a researcher works. It is not wrong to start with a methodology or even a method. Often, we start with a question in mind, develop a method that seems appropriate, and only then appreciate how a paradigm can inform or constrain our research design.

It can be convenient to divide research into quantitative and qualitative approaches. The former are often associated with the positivistic paradigm; the latter are often similarly associated with the interpretivist paradigm. However, this can be an oversimplification and it may therefore be safer simply to use the terms 'quantitative' and 'qualitative' as descriptions of the methods that we use, the data that we collect, and how we analyse it. For example, consider a study designed to explore the feelings of a patient undergoing a diagnostic examination or a course of radiotherapy treatment. We may assume that the approach being taken is qualitative because we are trying to capture the nature of a patient's experience and the data collected would be in the form of words requiring interpretation. However, the distinction would become slightly blurred if our analysis then involved counting the number of times that a particular feeling was expressed, because these numbers would make our approach quantitative. Furthermore, this simplistic count could lose the context in which the feeling was experienced, considering the following the examples.

- I was anxious before my examination.
- I was expecting to be anxious before my examination.

By only counting the word anxious the meaning is lost. The important thing to get right is to choose a methodology which allows you to answer your research question.

In summary it is necessary to recognise that any particular piece of research will be limited in what it can achieve; limits are set by the world view or paradigm within which a researcher is operating. We have identified three different

paradigms, but whichever approach is adopted there is a common requirement that the process of enquiry itself should be rigorous and systematic, and it is to this that we turn next.

1.10 Secondary Research

So far the assumption has been that research is all about discovering, assessing, and comparing new data. Practice can also be informed by revisiting the research carried out by others. This can be done by combining a number of studies in order to answer a specific research question (or to summarise the findings) and usually takes the form of a systematic review. A systematic review involves the painstaking collection of all relevant studies, whether they have been published or not. A good quality systematic review applies the same rigour in the review of research evidence as should have been applied in the original production of that evidence and presents the collated evidence in an impartial and balanced way. Meta-analysis is used to combine statistical data from these combined studies in a meaningful way; it takes into account the relative sizes of the studies included in a systematic review. A reliable source of this type of research is the Cochrane Database of Systematic Reviews [14]. Cochrane reviews cover a wide range of subject areas. The database is easily searched. Two recent examples include (1) 'Antidepressants for the treatment of depression in people with cancer' (April 2018) and (2) 'Prostate MRI, with or without MRI-targeted biopsy, and systematic biopsy for detecting prostate cancer' (April 2019).

1.11 Secondary Data

Another approach to research is to use secondary data: data previously collected by someone else, possibly for some other purpose. However, care must be exercised when defining what constitutes secondary data. For example, if you compiled a new data set unique to your study from existing survey material you would be considered to be doing primary research, but if you used existing summary results or results compiled by other researchers this would be considered secondary data and so your research would also be considered as secondary.

1.12 Evidence-Based Medicine: A Systematic Approach to Knowledge

We have explored the proposition that knowledge does not arise in a vacuum. In fact, putting philosophy to one side, there is nowadays an expectation that research will lead to useful applications, not least in the field of healthcare. It is this expectation that underpins the practice of evidence-based medicine, whereby current clinical activity is constantly reviewed in the light of new research. It is accepted

therefore that knowledge is only ever provisional, and with that caveat in place a research process must be robust enough to offer a definitive version of the latest 'best practice'. This must start with a systematic and critical appraisal of what is known, what is not known, and, therefore what is needed to be known to make an evidence-based decision.

The essence of evidence-based practice is how evidence is used to inform the decision-making process to meet a clinical need. The aim is to achieve the best outcome for patients by applying professional knowledge to their particular circumstances; this 'knowledge' is based upon a critical understanding of the available research and its application. However, a decision cannot be made based on the results of an appraisal of primary and secondary research alone; professional experience and consensus will inform decision-making as will the wishes of a patient. This raises another important issue: the health information seeking behaviour of patients.

Access to research and related information is no longer restricted to healthcare professionals. Patients are more frequently carrying out their own 'research', often via the Internet or other digital platforms. This activity can be positive and improve the relationship between patient and practitioner [15]. Patients who participate in their own healthcare in this way have been termed e-patients and their number appears to be increasing. This development provides yet another incentive for practitioners to be research aware, even if they are not research active, as they will be required to justify their practice to a more informed patient group.

1.13 Conclusion

We have argued that research should be a systematic and rigorous process of collecting, analysing, and sharing data. This must be done in a way which transparently acknowledges its social context. We should recognise that the knowledge we acquire is likely to be influenced by our own interests—all the more reason to therefore derive a firm knowledge base using an appropriate methodology. We can build theories from qualitative interpretation or test them by making quantitative measurements, but the fundamental principle to observe in all cases is to develop a clear focus for a research question and allow this to inform our actions.

As practitioners we are professional people, and as such we have an obligation to maintain our clinical practice to the highest standards. We practice within the wider healthcare team and in a patient-centred manner. We should take the lead in developing our profession and continue to provide an interface, which makes the highly technical environment in which we practice accessible to other professions and the patients that we encounter. Development in healthcare proceeds on the basis of clinical evidence. The way to acquire this is through research.

Box 1.1 Summary of Research Terms

Epistemology

The study of the nature of knowledge or what is out there to know in the world around us.

Paradigms

The assumptions we make about the world which influence our expectations of what it is possible to know and how we go about knowing it.

Examples: positivism, interpretivism, critical theoretical.

Methodologies

These are the general approaches to research found within each paradigm.

For example, an experimental approach is an appropriate methodology within the positivist paradigm.

Methods

These are the particular ways of carrying out a given methodology.

Using the experiment as an example of a general approach, a particular way of conducting the experiment could be a randomised controlled trial.

References

1. SCoR. Education and professional development strategy: new directions. 2010.
2. Harré R. The philosophies of science. London: Oxford University Press; 1972.
3. Peltonen M, editor. The Cambridge companion to bacon. Cambridge: Cambridge University Press; 1996.
4. Cassirer E. The philosophy of the enlightenment. Princeton: Princeton University Press; 1968.
5. Kuhn TS. The structure of scientific revolutions. 2nd ed. Chicago: University of Chicago Press; 1970.
6. Feyerabend P. Against method. 3rd ed. London: New Left Books; 1975.
7. Jarvis P, Holford J, Griffin C. The theory and practice of learning. 2nd ed. London: Kogan Page; 2003.
8. Parahoo K. Nursing research: principles, process and issues. 3rd ed. London: Macmillan; 2014.
9. Miller S. Analysis of phenomenological data generated with children as research participants. Nurse Res. 2003;10:70–3.
10. Glaser B, Strauss AL. The discovery of grounded theory. London: Weidenfeld and Nicolson; 1967.
11. Jolley J. Introducing research and evidence-based practice for nursing and healthcare professionals. 2nd ed. London: Taylor & Francis; 2013.
12. Van Dijk TA, Kintsch W. Strategies of discourse comprehension. London: Academic; 1983.
13. Habermas J. Knowledge and human interests. London: Heinemann; 1972. p. 209.
14. Cochrane Database of Systematic Reviews. https://www.cochranelibrary.com/cdsr/reviews. Accessed 27 June 2019.
15. Swee-Lin Tan S, Goonawardene N. Internet health information seeking and the patient-physician relationship: a systematic review. J Med Internet Res. 2017;19(1):e9.