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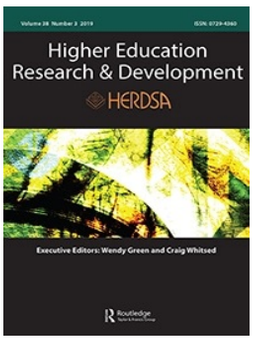

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A review of basic research tools without the confusing philosophy

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ABSTRACT

One consequence of novice researchers studying methodology textbooks is confusion: philosophical terminology is complicated and sometimes poorly defined. Another consequence is that inexperienced researchers divide themselves into epistemological cliques, which can inhibit inter-disciplinary discussions. This is a particular problem in subjects, such as Information Science, that bridge disciplines. This article attempts to address these issues by seeking ground common to researchers, regardless of their philosophical standpoint. It identifies several 'tools of the mind' which are expanded on and discussed. By becoming familiar with these tools, inexperienced researchers can gain practical insights that create context for philosophical terms they later encounter. 'Tools of the mind' discussed are captured in the following questions:

(1) What should I research?
(2) How do I go about researching it?
(3) What assumptions have earlier researchers made?
(4) What assumptions can I make without being challenged?
(5) How can I indicate what it is that I am studying to researchers who wish to build on my work?
(6) What can usefully be compared to the phenomenon I am researching?
(7) When circumstances change, what new research opportunities arise?
(8) How do I tell my research story so that it will be reliably transmitted?

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Introduction

The teaching of research methods and methodologies is commonplace in English-speaking universities. However, this is a relatively recent development, having become the norm only within the last thirty years. Until the 1990s, the quality of research training relied on students' relationships with their supervisors (Knight & Zuber-Skerritt, 1986; Malfroy, 2005; Zuber-Skerritt, 1987). There was a clear risk, therefore, that students only received instruction in methodologies with which their supervisors were familiar.

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Other methodologies, and the philosophical assumptions associated with them, were often neglected.

The philosopher Mary Midgley was in the habit of comparing philosophy to plumbing. Both activities

> have, beneath their surface, a fairly complex system which is usually unnoticed, but which sometimes goes wrong. In both cases, this can have serious consequences. (Midgley, 1992)

One area where the consequences of ignoring philosophy could be serious is in the teaching of research methods to PhD students.

Much has changed since the 1980s though, and currently there is little danger of philosophy being ignored. Arguably, the opposite is true: in discussions of research, particularly in the social sciences, practical concerns often come second to philosophical issues. Midgley's comparison of philosophy and plumbing emphasises the complexity of both. Complexity often leads to confusion (Crossan, 2003; Crotty, 1998; Dillon & Wals, 2006; Pallas, 2001), which can be discouraging, especially to inexperienced researchers.

Discussion of basic issues about the nature of research is undoubtedly important; but so too is discussion of basic issues about methods and how they are used (Morgan, 2007). In this article, I do not seek to downplay the difficulty of philosophy, or to imply that it should not be taught. Indeed, I would strongly argue against both. However, while philosophy is unavoidably complex, there is much about research methods that is not. Once understood, such basics provide a context in which relevant philosophical ideas become less abstract and potentially less confusing.

All professions, whether plumbing, philosophy or research, rely on tools of the trade; but use of a tool is rarely limited to one branch of a profession. Researchers, whether qualitative or quantitative, positivist or interpretivist, use many of the same tools. This article aims to provide a resource for teachers and students of research methods, by identifying elements of the collection, analysis, interpretation and presentation of findings that may be of use to researchers, regardless of their philosophical standpoint.

In addition to discussing relevant literature, I also draw on evidence from my own career. Two experiences, in particular, are key. The first is of a career move that resulted in a change from being a quantitative researcher developing mathematical models of agricultural systems (e.g., Madden, 1995), to becoming a qualitative and mixed methods researcher, exploring aspects of human information behaviour (e.g., Madden et al., 2018). The second experience is that of organising and participating in researcher discussions in the Information Schools of two universities (University of Sheffield in the UK, and Sun Yat-sen University in China).

The nature of Information Studies (IS) makes it particularly relevant to the theme of this article. It is a diverse discipline with roots in librarianship, communication studies and computer science. Research in an Information Sciences department ranges from the development and evaluation of computer programs designed to retrieve and analyse text and images from databases (e.g., Li et al., 2018), through to aspects of library governance (e.g., Zhang et al., 2019); so researchers within a single department may subscribe to very different research philosophies. As a result, the discussion groups in which I participated involved conversations between researchers who labelled themselves post-positivists, interpretivists, constructivists and critical theorists.

Mertkana and Bayrakli (2017) note that the worldviews which inform qualitative research *shape, to a large extent, researcher identity*. The same is presumably true of quantitative researchers, and it seems that these worldviews are formed early in a researcher's career. Most of those taking part in the conversations were PhD students, so were still working their way through textbooks on methods and methodologies. Since the textbooks began with descriptions of the philosophical underpinnings of research paradigms (Onwuegbuzie & Leech, 2005), these descriptions were echoed in exchanges between the novice researchers.

However, when the researchers stopped arguing about philosophical differences and focused on the processes of research, they found that they had more in common than they had supposed.

Tools of the mind

The lecture I have given most frequently is an 'Introduction to Information Seeking'. I begin by asking students what, in their opinion, is the most useful information seeking tool. Most answers refer to digital technology: some are as general as 'the Internet'; others are more specific and are dependent on location. In the UK, 'Google' is a favourite answer, and in China, the search engine 'Baidu' is common. Occasionally, someone (usually a mature student) will insist that information seeking is highly contextual, so it is not possible to single out a particular tool.

My response is that, in my opinion, the most useful information seeking tool is a good question. After reflection, students seem to find this a helpful observation, but some challenge the use of the word tool. Yet the idea of 'tools of the mind' (Gregory, 1981, p. 48) has been well-established since early in the twentieth century (Madden et al., 2018, p. 709). Dewey (1998, p. 58) nominated language as 'the tool of tools', and both he and Vygotsky have contributed greatly to the development of cognitive tools in education (e.g., Jonnassen, Mayes, McAleese, 1993), while paradigms have provided 'intellectual tools' such as 'concepts, laws and theories' (Kuhn, 1970, p. 46).

The suggestion that a question can be a tool of the mind becomes reasonable if it is accepted that a tool does not need to be tangible, but can be 'a thing used as means to consequences' (Dewey, 1998, p. 58), and can 'serve as the conductor of man's influence on the object of his activity' (Vygotsky, 1978, p. 55). Understood in this way, 'thinking tools' (Jonnassen et al., 1993) can include mnemonics, systems, organising strategies and focusing techniques, many of which are directly relevant to research.

A researcher's tool-kit

Research is an information seeking activity, so good questions are key to good research. In keeping with the idea that a question is a useful tool of the mind, the research tools discussed in this article are summarised in the following list of questions. The ideas behind these questions are discussed below, in subsections labelled with the same number. The ideas are then revisited in a different form (but with the same numbers) in Figure 1.

(1) What should I research?
(2) How do I go about researching it?
(3) What assumptions have earlier researchers made?
(4) What assumptions can I make without being challenged?
(5) How can I indicate what it is that I am studying, to researchers who wish to build on my work?
(6) What can usefully be compared to the phenomenon I am researching?
(7) When circumstances change, what new research opportunities arise?
(8) How do I tell my research story so that it will be reliably transmitted?

Needless to say, this list is far from exhaustive: other researchers with different experiences could usefully add to it.

(1) Focusing ignorance

The role of questions in inspiring discovery is emphasised by Yuval Noah Harari in his book, 'Sapiens', where he argues that

> The great discovery that launched the Scientific Revolution was the discovery that humans do not know the answers to their most important questions
>
> (Harari, 2014, p. 251),

making the Scientific Revolution not a revolution in knowledge but in ignorance.

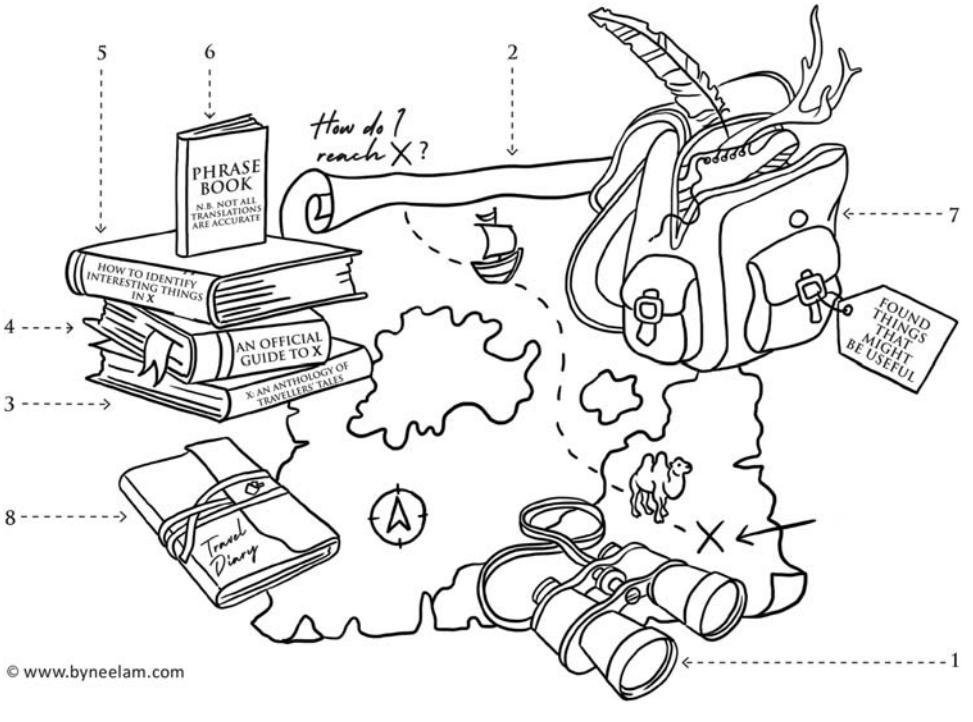

Figure 1. Researcher's travel kit. (Numbers correspond to the subheadings above.)

To many people, though, shaping a question in ways that make it an appropriate focus for a research exercise does not come naturally. The early stages of supervising student research projects often involve many iterations before the student arrives at a question that is manageable and can be explored with the resources available. However, a research question (RQ) that achieves the balance of being 'general enough to permit exploration but focused enough to delimit the study' (Marshall & Rossman, 2016) is arguably the most important 'tool of the mind' for researchers.

(2) An appropriate route map

An essential requirement of a RQ is that it takes into account practicalities and so can be addressed using available research methods.

The Greek origin of the word 'method' is rooted in the idea of a journey or 'hodos' (the same Greek word is part of 'Exodus'). A research method is a path to evidence. Tashakkori and Teddlie (1998) implicitly draw on the metaphor of a journey when they divide research methods into exploratory and confirmatory. A confirmatory study follows a well-trodden path that is clearly sign-posted, with succinct descriptions. Researchers who follow the path look closely to see whether their observations and analysis accord with those of their predecessors. If a study is exploratory, descriptions of the method are less prescriptive. Research that draws on exploratory studies may identify new paths for exploration, or may add details that can be confirmed by later researchers.

Such variation is implicit in Thomas Kuhn's division of academic studies into pre-paradigmatic and paradigmatic disciplines (Kuhn, 1970). In pre-paradigmatic disciplines, narratives compete. If one narrative proves to be significantly more successful than others at explaining phenomena and predicting events, it becomes the basis of a Kuhnian paradigm, and the route maps associated with it become more confirmatory. If this does not happen, different narratives will propose other paths to evidence and offer more scope for exploration.

This process is apparent if one looks at early research into scientific phenomena. For example, in December 1671, Isaac Newton published his 'New theory about light and colors[1]' (Newton, 1671). At the start, he outlines the method that led to his new theory:

> … in the beginning of the Year 1666 … I procured me a Triangular glass-Prisme, to try there with the celebrated Phenomena of Colours. And in order thereto having darkened my chamber, and made a small hole in my window shuts, to let in a convenient quantity of the Suns light, I placed my Prisme at his entrance, that it might be thereby refracted to the opposite wall. It was at first a very pleasing divertisement, to view the vivid and intense colours produced thereby; … I became surprised to see them in an oblong form; which, according to the received laws of Refraction, I expected should have been circular.

Newton is reporting a phenomenon that, at the time, was poorly understood. His account is discursive and includes qualitative details (such as an expression of surprise) that would be out of place in a modern description of a physics experiment but are appropriate in an account of exploratory research. He uses over three hundred words to explain what he did with his 'Triangular glass-Prisme' and to describe his observations. It is not until after this that he introduces his great insight, which was to use a second prism to examine the bands of coloured light that emerged from the first. Later accounts, which

sought to confirm Newton's findings, eliminate most of the description and concentrate on the prism and its effect on light. The website of Woolsthorpe Manor (Newton's home), for example, describes the whole experiment in little more than one hundred words (Fara, 2020).

(3) An inventory of assumptions

A research question should be practical, but a good research question should also be interesting. One way in which it can achieve this is by helping to generate an interesting theory.

Davis (1971), in his analysis of what makes a social theory interesting, suggests that its intended audience must feel that 'it denies the truth of some part of their routinely held assumption-ground'. Karl Popper (2002, p. 83) also emphasises the importance of challenging assumptions, particularly in the pure sciences. He argues that where 'applied science takes pure science as 'given' or 'known'', pure science is the logical reduction 'of 'known' facts and 'known' theories to assumptions of which we know very little as yet, and which have still to be tested'.

In 1973, Anthony Biglan proposed a classification of academic subjects that has now become familiar. According to Biglan's primary classification (Hard / Soft), a subject's status is determined by whether the subject is shaped by an underlying paradigm. However, it is his secondary classification (Pure / Applied) that is of particular relevance to this section. Taking the above observation of Popper, it could be argued that what determines whether a discipline is Pure or Applied is the discipline's relationship to assumptions: a Pure subject challenges and tests assumptions, while an Applied one is built on acceptance of them.

It is therefore important to stress that what is being discussed in this section is one way to make a RQ interesting. It should not be inferred that RQs associated with Applied research are intrinsically less interesting. They are, though, interesting for different reasons such as, for example, the exploration of affordances (see Section 7) arising from earlier research.

A standard description of reasons for a literature review is that it enables a researcher 'to justify the research topic, design and methodology' (Hart, 2018, p. 11). One of the most important ways a literature review does this is by summarising evidence that helps to identify and justify assumptions relevant to the planned study. Typically, this leads to the identification of gaps in research, and the formulation of RQs designed to fill those gaps. Alvesson and Sandberg (2011) draw on the ideas of Davis (1971) and suggest that more interesting RQs arise when researchers challenge the assumptions that underpin studies summarised in the literature review.

However, all literature reviews have limitations (Onwuegbuzie & Leech, 2005), one of which is that not all assumptions are identified in a survey of literature. One exercise I use when teaching research methods in China helps to reinforce this point. I ask students to imagine two office blocks, 35 km apart: one in Hong Kong, the other in Shenzhen. Both are built to the same design, have the same dimensions, and are constructed from the same materials. The two buildings have the same number of storeys, with the same gap between floors. In Hong Kong, on a given day, a man climbs to the fifth floor, raises a 2 cm diameter (30 g) ball-bearing above his head, and at midnight, releases it.

Meanwhile, his identical twin brother climbs to the fifth floor of the building in Shenzhen and does the same thing at the same time. Which ball hits the ground first?

Typically, students treat the question as an exercise in physics and discuss wind resistance, expansion and contraction of the ball-bearing, variations in local weather conditions, etc. When the discussion takes this course, the consensus is that it is impossible to answer the question because there are too many immeasurable local variables.

All researchers have blind spots which cause them to make assumptions without realising it. The purpose of the exercise is to provide an example of an easily overlooked assumption that has a profound effect on an outcome. In this example, students tend only to regard physical factors (dimensions of the buildings, the twins, and the ball-bearings) as being relevant. Occasionally though, a student will recall that, because of British influence, the twin in Hong Kong would enter the building on the ground floor and climb five storeys, while the twin in Shenzhen would enter on the first floor and climb four storeys. The Hong Kong twin would therefore be one storey further from the ground than his brother.

Here, the consequences of the oversight are trivial and it would be easy to compensate for the differences in floor numbering. Other examples are more significant, and range from the disturbing (Plenke, 2015) to the dangerous (Oppenheim, 2020).

Plenke describes problems experienced by black hotel guests when they tried to use an automatic soap dispenser. Unfortunately, there must have been a data gap in the research process that led to the dispenser's final design. Its sensors only responded to pale skin, so a significant minority of guests found themselves unable to use it.

Criado-Perez (2020) provides numerous examples of data gaps leading to blindspots. The examples she cites are all problems caused when decisions were based on research that overlooked physical differences between men and women. One that became particularly significant at the time of the COVID-19 outbreak was the design of Personal Protective Equipment (PPE). Despite the fact that, according to the British Medical Association, 75% of UK National Health Service workers are women, the PPE they relied on was designed for the 'size and shape of male bodies' (Oppenheim, 2020).

Such cases highlight the value of reviewing not only the research literature, but also the researchers who generated it, and asking how the reported findings might have differed if the research had been carried out by someone of a different sex, a different colour, or from another culture. For anyone planning a research project, therefore, it is useful to consider how their experiences and circumstances differ from those of researchers who carried out similar work, and to think about how those differences might affect findings and the interpretation of those findings.

(4) Going back to a point of agreement

When I identify assumptions that I believe should be challenged, then implicitly I also identify assumptions with which I am in agreement. It then becomes helpful to ask who else agrees with these assumptions. All researchers whose work is connected with mine will also be making assumptions. The set of assumptions upon which there is maximum agreement represents a kind of academic ground zero; and it can be instructive to try to identify this and to make it explicit.

Understanding where experts agree is particularly valuable in fields that bridge disciplines (such as Information Science). Two seminal papers, both highly cited in Information Science, attempt such an exercise. Maslow's famous *hierarchy of basic needs* draws on physiological and psychological research to explain human motivation. Maslow (1943) argues that humans are motivated by several desires, which are prioritised according to circumstances. People must satisfy the desire for basics such as food and water before they can focus on other desires, such as safety, love and 'self-actualization'. In introducing his ideas, Maslow emphasises that, rather than trying to challenge assumptions in any of the fields upon which he draws, he is seeking to develop a theory that conforms to 'known facts, clinical and observational as well as experimental'. The resulting theory is presented as 'a suggested program or framework for future research'.

Similarly, Claude Shannon's 'Mathematical Theory of Communication' (Shannon, 1948) does not seek to challenge the theories that his colleagues in Bell Labs relied on. At the time that the theory was being developed, Shannon was working with engineers whose expertise was in telegraphs, telephones, television or radio. Shannon's breakthrough came after he set out to identify and analyse 'The fundamental problem of communication'. He developed a mathematical model based on the observation that all the engineers he was working with, regardless of the technology in which their expertise lay, shared an interest in transmitting and receiving signals, and in overcoming obstacles to transmission.

Both papers attempt to build on what, at the time they were written, were seen to be uncontroversial assumptions, and even though there has subsequently been criticism (particularly in the case of Maslow: e.g., Neher, 1991), both articles still provide a useful starting point for new research.

(5) Descriptions include, definitions divide

Definitions allow researchers to point to the phenomena they are researching. Good definitions help subsequent researchers to align their work to earlier studies. However, definitions are not the only way of pointing and may not be the best means of doing so.

A classic form of paradox discussed by ancient Greek philosophers is the sorites paradox (derived from the Greek word for 'heap'; Hyde, 1997). It is summed up in the following assertions:

(a) I have a heap of sand;

(b) If one grain of sand is removed, I still have a heap.

The paradox becomes apparent if these assertions are used to form the basis of an algorithm:

{ 1. Take a heap of sand
1. Remove one grain } (Repeat).

If assertions (a) and (b) are both true, then regardless of how many times a grain of sand is removed, I still have a heap. Clearly, there is a problem.

The paradox arises where there is an implicit assumption that a clear boundary (determined by the number of grains of sand) separates heaps from non-heaps. To define something is (according to the word's Latin origin) to put a boundary around it and thereby mark its limits; but as illustrated by this example, limits can be hard to mark.

One of the reasons why limits can be hard to mark is that definitions are influenced by domain. Every culture and community defines things according to how it relates to those things: a definition may be based on the nature of a thing, on how it's used, or on what it does. A botanist's definition of fruit, for example, is different from that of a cook. Botanists relate to plants as subjects of study, and define fruits according to their role in a plant's life cycle. Cooks relate to plants as things to be eaten, and define fruit according to what they contribute to a meal. Botanists class aubergines, chillies, courgettes, okra, and olives as fruit. Cooks do not trust botanists to make fruit salads.

Although the subject being researched will determine what is defined, researchers can choose how something is defined, allowing definitions to be shaped by the objectives of the researcher. Confirmatory research assumes limits, while exploratory research attempts to identify and describe limits. This contrast between the definitive and the descriptive is at the core of Information Science. While some Information Scientists explore the nature of information by considering users of information and their relationship to it (e.g., Buckland, 1991), others work with Shannon's mathematical definition, which unequivocally separates information from non-information, and quantifies the former (Shannon, 1948).

However, just as assumptions regarding the nature of a heap lead to a paradox, so too do assumptions associated with Shannon's definition of information. Shannon identifies the domain of his definition by stating that *semantic aspects of communication are irrelevant to the engineering problem*. According to Shannon's definition, information is the content of a signal. If the signal is long, it has a lot of information; if it is short, it has little information. A signal can be meaningless, repetitive, or wholly unoriginal and (by Shannon's definition) still contain information. For engineers wishing to transmit signals, this is not a concern: information has been unambiguously defined. People in receipt of a large number of signals though, may find themselves suffering from an overload of information that is meaningless, repetitive, unoriginal, and consequently, completely uninformative (Madden, 2011).

A definition therefore, not only helps to identify the limits of entities and phenomena being researched, it also helps to mark the domain within which the research is relevant. Sometimes, though, particularly in exploratory research, attempts to define phenomena may be unnecessarily limiting. The physicist Erwin Schrödinger set a useful example when, in a famous essay, he considered the question: 'What is life?' Rather than trying to define life, Schrödinger chose to describe it, concentrating on descriptions of the things living entities do that distinguish them from non-living entities (Schrödinger, 1992). It is an approach I adopted in an article exploring the link between information and biology. The article does not attempt to say what information is; instead, it begins with a description of what information does (Madden, 2014). As is often the case, it is possible to study the impact of something without having a clear understanding of its nature.

(6) Comparing and contrasting

Comparators can be particularly useful tools when describing the focus of a research study. Understanding one thing in terms of another is a common approach in many areas of research: phenomenon **B** may be compared with phenomenon **A**, or it may be compared with a conceptual model derived from a synthesis of data from several sources.

Studies of the brain, for example, have long drawn on contemporary technologies to interpret their findings. Nowadays, it is normal to compare the brain to a computer. Previously, models of brain functioning were based on a telephone exchange. Prior to that, the brain was compared to a telegraph system, and earlier still, it was likened to a mill (Searle, 1991).

Where similarities are sufficiently robust, it becomes possible to classify **B** with **A**, allowing knowledge of **A** to be applied to **B**. It was induction of this sort that led to the systematic ordering of species in biology, and enabled chemistry's Periodic Table to be compiled (Jensen, 1986).

Where comparison is used to classify phenomena, then implicitly circumscription is occurring. This is *a rule of conjecture that can be used … for 'jumping to certain conclusions'* (McCarthy, 1980). Circumscription produces a set of assumptions that can be 'taken as read'. If **A** and **B** are grouped together, then what applies to **A** is assumed to apply to **B** until new evidence suggests otherwise.

New evidence emerges because each comparator brings with it the questions: *(i) In what ways are **A** and **B** alike? (ii) In what ways are they different?* Wherever comparison is used in a research exercise, some variation of these questions can helpfully be incorporated as a RQ.

Maslow's Hierarchy of Needs is a familiar example of comparing phenomena (individual humans) and assuming that person **B** is sufficiently similar to person **A** that knowledge of **A** applies to **B**. Criticisms of Maslow's work have arisen from attempts to address questions (i) and (ii) above. Neher (1991) makes a particularly useful point when he criticises Maslow for ignoring the impact of cultural difference on human motivation: 'we develop our 'humaness' [*sic*] … through being socialised into the norms of our particular culture'. Neher argues that, although Maslow neglected the importance of culture, the factors that Maslow identifies as motivating 'normal' humans are 'in the mainstream of Western values that tend to glorify the individual'.

According to this argument, therefore, Maslow is not comparing real person B with real person A. Instead, he is comparing B to an unacknowledged norm based on Western values. Use of norms as comparators is common and can be helpful, but failure to acknowledge them creates the kind of biases that create soap dispensers which only work on pale hands, and PPE that does not fit women.

(7) Reviewing emergent opportunities

Careful planning is key to any research project, but sometimes it becomes advisable to change plans. This may be because things go wrong and planned activities become impossible or impractical. Often though, there are more positive reasons for altering plans. In abductive research, lessons learned in the course of a project may yield explanatory inferences (Douven, 2011) that make it worth rethinking elements of the project.

Sometimes, when collecting quantitative data, qualitative observations provide insights that help with analysis and interpretation (Onwuegbuzie & Leech, 2005). Also, new developments may suggest approaches that were unavailable at the planning stage: for example, Madden (1995) was based on a re-analysis of my PhD findings that became possible after I was given access to new software.

Regardless of whether a change in plans is brought about by unforeseen problems, new insights, or the availability of new tools, it will generate new opportunities. One concept of particular value in reviewing those opportunities is *affordances*.

The word 'affordance' was coined by the psychologist James Gibson to help explain his theory of perception (Gibson, 1979). Gibson argued that an animal does not perceive its environment in terms of the absolute properties of the environment's component parts. Rather, it perceives the actions afforded to it by those parts. These actions (affordances) differ according to the relationship that the animal has with its environment, and according to the animal's circumstances at the time. For a human being, air affords breathing; water affords drinking; a round stone affords throwing; a sharp stone affords cutting. The same elements of an environment would clearly offer different affordances to a bird or a fish.

Gibson used the term 'affordance' with reference to physical environments, but it is also relevant to the cognitive environment of researchers. Changed circumstances, new insights and new techniques all offer new affordances, but identifying them may require divergent thinking.

(8) Choose a narrative

Bruner (1990, p. 64) observed that *people do not deal with the world event by event*. Instead, they frame events in larger structures that *provide an interpretive context for the components they encompass.* In other words, they tell stories.

The telling of stories is commonplace in all human societies (Gottschall, 2013) and is an important means of cultural transmission (Mesoudi & Whiten, 2008). Stories identify factors that link players and places and present them as sequences of events, with a beginning, a middle and an end (Fludernik & Häusler-Greenfield, 2010). In so doing, they suggest associations and causes, thereby assigning 'relational significance' to actions and events (Polkinghorne, 1995). What distinguishes research tales from other tales though, is that, in research tales, the associations and causes are systematically questioned and tested.

I am using the word 'story' in a looser sense than Polkinghorne. He asserts that the subject matter of stories is human action, involving humans (or anthropomorphised non-human characters), and suggests that 'the knowledge carried by stories differs from that which has been promoted by the Western scientific tradition'. If, however, instead of humans, the protagonists in a story are taken as being entities that affect, or are affected by, other entities with which they share a space, then the phenomena described in the Western scientific tradition become the subject of stories.

Players in a story need not be human, or even animate. *A cat, while walking along a shelf, knocked a plate onto the floor. The plate fell and broke*. The cat and plate are (respectively) active and passive players, linked by the cat's actions. In Newton's account of the experiment that led to his 'New theory about light and colors', he

placed his *Prisme* in a position where *a convenient quantity of the Suns light* could pass through it. The prism then refracted the sunlight *to the opposite wall*. Newton, the prism and the sunlight are the players connected by actions and consequences.

In later tellings, the story is stripped down. In subsequent confirmatory research into the interaction between prisms and light, the experimenter is removed from the narrative and the only players are the prism and the light. After sufficient confirmatory research, their interaction becomes accepted as a fact. In the context of certain physics experiments, there is no need to regard the prism and light as separate players. Instead, prism + light + refraction merge to become a phenomenon that forms part of the stage on which other stories are played out.

Stripping down of stories is not necessarily a matter of choice on the part of researchers, however. Stories get simplified in the process of transmission, losing details and becoming shorter (Mesoudi & Whiten, 2008). Evidence suggests that story-telling is as much about reconstruction as about remembering (Mesoudi & Whiten, 2008). Remembered details, such as key statistics and relevant images (e.g., Figure 1) form a skeleton on which the flesh of new stories is grown, sometimes resulting in distortions. So, for example, when people are advised to drink eight glasses of water (c2 litres) a day, this is a misrepresentation of research which recommends that adults should take in 2.5 litres per day (Labos, 2018). The 'eight glasses' advice omits the important contextual detail that *Most of this quantity is contained in prepared foods* (National Research Council, 1948).

Researchers therefore need to prioritise details and emphasise the most significant; but in emphasising what is significant, context should be presented in a way that frames any findings and clearly identifies the limits of their relevance.

Conclusions

Novice researchers seeking to learn basic research skills are often confronted with detailed discussions of the philosophical implications of approaches they are considering (or have been told to consider) for their research. To draw on Midgely's plumbing analogy, they are treated like a thirsty person being given an explanation of how a tap works instead of a glass of water.

Except that, because they encounter a *cacophony of diverse epistemologies* and a *welter of names* (Pallas, 2001), they must first decide whether their water will come from a tap, a faucet or a spigot. To make matters worse, philosophical terminology is used inconsistently, with the same term being used in different, and sometimes contradictory, ways (Crotty, 1998, p. 1).[2]

Earlier, when considering definitions, I emphasised their value in helping researchers to point to the phenomena being researched. Definitions can only achieve this if used consistently. However, as was stated above, defining something is not the only way of indicating it. The purpose of this article is to identify elements that are common across different branches of research. I described a collection of research 'tools' and presented them, initially as a set of questions, and later (in Figure 1), as an analogy.

Discussion between researchers with varying levels of experience has an important role in the development of novice researchers (Knight & Zuber-Skerritt, 1986; Malfroy, 2005; Zuber-Skerritt, 1987). I began this article with the observation that, in

researcher discussion groups, when the researchers stopped arguing about philosophical differences and focused on the processes of research, they found that they had more in common than they had supposed. The set of research tools listed here is based on my experiences as a mixed methods researcher and a teacher of research methods. As such, it is far from exhaustive and can usefully be supplemented. I hope, though, that it will help to create a context in which researchers can better understand their approaches in relation to those of others.

The answers that researchers give to the listed questions will vary according to the nature of their research. Good research training will encourage them to reflect on what answers other researchers might give, and what different choices may arise because of those answers. In this way, inexperienced researchers can begin to explore the philosophy of research before attempting to decide which epistemological label to attach to themselves.

Notes

1. Spelling used in the original was variable and has been preserved.
2. There has even been the unintentional coining of new terms. Several publications refer to 'anxiology', which is presumably a study of the concerns arising from attempts to get to grips with philosophy.

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