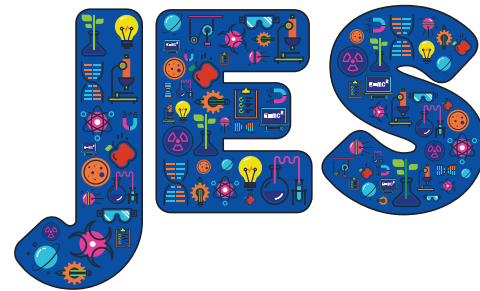


Exploring ways of defining the relationship between research philosophy and research practice



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Abstract

Without thoughtful reflection about who we are as researchers and our research 'frame' – how we act and think as researchers – we risk making superficial choices about methods and could fail to expose the inherent biases that impact on our analysis when communicating our research. This article examines the relationship between research philosophy and research practice in science education settings, taking stimulus from the 'Research Onion' (Saunders et al, 2019) to devise and describe how research is framed. This paper aims to explore the process of constructing a research frame, rather than the contents of the frame itself. In doing so, it explores the philosophical, theoretical and analytic approaches of the Science & Engineering Education Research and Innovation Hub (SEERIH), with the aim of prompting those involved in small or larger research practice to reflect on their own standpoints.

Keywords: Research paradigm, analytical frameworks, research methods

Introduction

Evidence-based practice is a term that has become increasingly commonplace within educational settings, where senior leaders and teachers seek to conceptualise the nature of effective pedagogies that have a recognised or reported track record of success (Hattie, 2008; Sotiriou et al, 2017). Evidence can be gathered via both evaluative and research methods that require engagement in schools and classrooms, involving teacher and/or pupil feedback such as observation, diaries, interviews, etc. This article describes the influences

on how evidence is gathered in research, and how explicit reflection and description of these influences, including the philosophical, theoretical and analytical paradigms, should guide the planning, undertaking and analysis of research in schools.

Since 2014, the Science & Engineering Education Research and Innovation Hub (SEERIH) at The University of Manchester has designed programmes of professional learning for in-service teachers and led on innovative school engagement projects to enhance participation in science and engineering in primary schools. It has also pioneered research activity to scrutinise and understand teacher professional development and pedagogical approaches in STEM education.

This article is written to attempt to define the ways in which we have collectively worked to develop a research frame that theorises the pragmatic research elements of our projects. With the support of Professor Debra McGregor (Oxford Brookes University), we have worked to articulate our research frame in order to explain the choices we make about data collection and analysis during a research programme. This involved reflecting on:

- ❑ our philosophical position in relation to our research activity;
- ❑ the main research paradigms that are significant to SEERIH's practice; and
- ❑ the way in which we develop theory from practice, distinguishing between deductive (theory testing) and inductive (theory building) practices.

To guide this examination, we reviewed the work of Saunders et al (2019), who explain the research process through the 'Research Onion'. Through an

iterative dialogue, infused with professional challenge, we have identified and described our approach to research through the SEERIH Research Frame. This article prompts those involved in research to professionally reflect on their own choices when undertaking research in schools, whether that be small tests of change through to more in-depth academic research activity.

Saunders et al's Research Onion (2018)

Figure 1 presents the multi-layered diagram that places how we collect and analyse data at the heart of the 'Onion'. By focusing on the techniques, tools and procedures that we use, the Onion allows us to examine the decisions and choices that have led to the selection. This selection can be influenced by many factors, some of which are upfront and visible, e.g. the time available to collect data or the access we have to participants. Others are often implicit, e.g. our philosophical positions that we hold as researchers or our approach to analysing

data and building meaning. Without thoughtful reflection about who we are as researchers and our research 'frame' – how we act and think as researchers – we risk making glib choices about methods and we fail to expose the inherent biases that impact on our analysis when communicating our research. Further to this, the selection of research tools and approaches could also be fundamentally at odds with the paradigm within which we are working, e.g. random sampling of participants when, in strictly qualitative terms, they should have a clear rationale for selection.

In its simplest terms, Saunders' Research Onion prompts us to reflect and describe six layers of influence in our research approach:

❑ **What is your research philosophy? (Outer layer)**

Here we seek to unearth what shapes how we do and understand our research: the assumptions we hold about reality, the contexts and people we

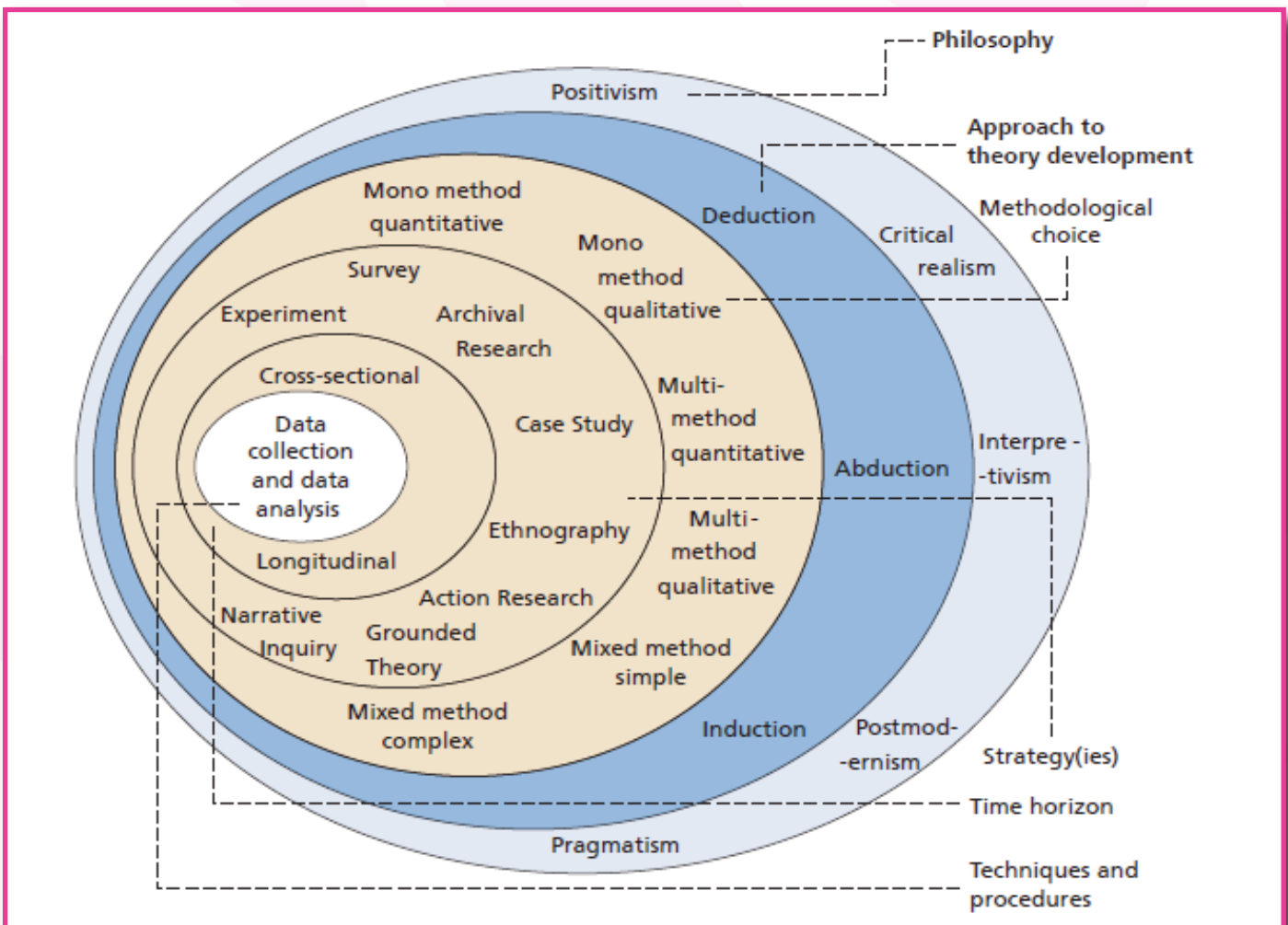


Figure 1. The 'Research Onion' (Saunders et al, p.130).



engage with (ontological assumptions). This is an area of thinking that makes us reflect on our assumptions about knowledge and what people can know (epistemological assumptions), and the extent to which our own values, political or ideological positions influence our research (axiological assumptions). This leads us to consider our positioning – examples of philosophical standpoints include positivism, critical realism, interpretivism, postmodernism and pragmatism.

Raising these large concepts here we hope will stimulate you to read more, using authors such as Saunders *et al* (2018), Williams (2016) or Scott (2008) to support your reflection.

❑ **What is your approach to theory development? (Second layer)**

This decision will be influenced by whether we seek to theory test or theory build. It has a significant implication for the way in which we design the research, guiding us towards the selection of research techniques and tools: for instance, surveys versus focus group discussion. The two commonly used approaches towards reasoning and meaning-making are referred to as deductive (the process of reasoning where a conclusion is tested in reality – theory testing) or inductive (conclusions are derived from specific observations – theory building).

❑ **How does your research paradigm influence methodological choices? (Third layer)**

Here we are encouraged to consider the qualitative or quantitative methods that can support evidence gathering. These choices will be reflective of a deductive or inductive approach. More typically qualitative techniques will align to inductivist approaches.

❑ **What research strategies suit your methodology?**

❑ **What is the timescale of your data collection?**

❑ **What will you select as your data collection and analysis techniques and procedures?**

The final 3 questions lead us to the specifics of the research design and will be impacted by the philosophical and analytical standpoint. Here we consider the nature of the research strategies to be

employed with participants, the duration of the research and how often within that timescale evidence will be collected. At this point the choice of analysis technique and procedures will reflect whether the research data would be considered through a deductivist or inductivist frame.

Exemplifying practice

Figure 2 outlines SEERIH's Research Frame, showing how Saunders *et al*'s work has been translated to apply to our research activity. Although initially scoped using the 'Onion' model, we have found that a tabular format was preferable to visualise our approach, encompassing the key features of the original model in Figure 1. This is offered for exemplification and includes additional elements that were found to strengthen the frame. This paper aims to explore the process of constructing a research frame, rather than the contents of the frame itself. Further reading about the SEERIH theoretical model can be found at Bianchi (2017).

Firstly, the research context, purpose and setting are identified in order to describe and position our research and to identify ourselves as researchers in the field of science and engineering education, with a core focus on constructivist pedagogies. Our commitment to mainstream education influences our practice and the focus on primary and early secondary education impacts on what and where we publish its outcomes. When reflecting on this frame, it is worth noting that SEERIH has a wide range of activities, which are different in type and purpose; therefore, individuals or smaller research teams are likely to contain fewer elements within their frame.

Bianchi (2017) explains our theoretical model for teacher engagement using the Trajectory of Professional Development, which describes a 5-step model to teachers' socially-constructed professional learning – pre-engage, participate, collaborate, co-create and connect. This model impacts on many aspects of research design, in particular with regard to the expectations for teacher professional engagement within the research process (e.g. their level of participation): the way in which we review and describe their engagement and, in supporting them, to recognise and articulate impact of the research on their

Figure 2. SEERIH Research Frame.

Context	Creativity in Science & Engineering Education				
Purpose	<p>Enhancing children’s opportunities to think and work as scientists and engineers</p> <p>Inspiring teachers into professional learning to innovate and reflect with constructivist pedagogies within science and engineering education</p> <p>Improving pupils’ identity, agency and engagement in science and engineering education</p>				
Setting	Primary and KS3 classrooms in the UK. Higher Education STEM learning				
Theoretical model of teacher engagement	Pre-engage	Participate	Collaborate	Co-create	Connect
Philosophical position	Positivism				
			Interpretivism		
Methodological choice	Mono-method Quantitative – based on Guskey (1986)				
Data collection technique	<i>Online quantitative standardised surveys</i>				
Methodological choice			Multi-method – illustrative cases developed with participants aligned to specific research questions		
Data collection technique			<i>Qualitative, semi-structured interviews, focus groups, diaries/portfolios, case study</i>		
Timescale	Cross-sectional (one-off moments in time)		Phased-periodic (insights over time, e.g. 6-12 months)		
Analytical approach – theory development	Deductive		Inductive & Deductive Examining ‘why and so what?’ with a view to describing an outcome/theory		
Analytic techniques and tools	<i>Excel data-sorting, processing, management and graphing/tabulation</i>		<i>Thematic analysis (Braun & Clarke, 2006) Hand coding, Electronic coding (NVivo)</i>		
Publication	Internal reports (e.g. funder/ stakeholder reports) Verbal and written presentations		Public access published reports. Peer-reviewed academic papers. Academic conference presentations and posters		



practice. This is closely associated with our philosophical positioning and how we move from positivist to interpretivist paradigms.

The frame makes visible how SEERIH shifts from a positivist approach, where we are seeking to identify an observable social or educational reality (wanting to find out how much of something happens), for instance when researching the frequency of opportunity that children have to ask their own scientific questions in the classroom, to an interpretivist approach where we are seeking to understand and create meaning by working *with* teachers, therefore placing emphasis on them as professionals. Here we would work to study classroom practice and the classroom as a social setting for science learning, through which we can create new, richer insights exposing organisational realities.

We have found that the shift in engagement when teachers collaborate, co-create and connect enables a shift towards interpretivism. This offers the opportunity to include teachers' lived experiences and the voices of those within schools alongside our own interpretations. In this way we can gather deeper meaning, for instance about the levers and barriers to encouraging children to ask their own scientific questions and the implications that this has for the classroom.

Timescales for data gathering then influence the choices of methodological approaches and techniques applied. Here we notice the use of deductive and inductive forms of analysis. Where one-off quantitative methods such as a survey or questionnaire are used, the analysis is deductive, following the positivist philosophy as we seek to examine 'how much?' of something is taking place. When data are increasingly qualitative, the analytical approach that leads to a theory being put forward must shift towards meaning-making and, for us, we have selected the Braun and Clarke (2006) 6-step model of Thematic Analysis to guide this process, and notably move to a mixed methods approach.

Our work context is such that publication is required in different formats; therefore, we have added this to our research frame, so that, as a group, we are clear in how our choice of methods supports dissemination. It should be noted that our

current academic publications are mainly drawn from the work we do with teachers when working within an interpretivist-inductive frame, where new ideas emerge and forge new contributions to knowledge in the field. It should not be assumed from our representation that academic publications cannot be developed from our quantitative data; it is just not the focus of our current research publications.

Conclusion

What has become clear through this introspection is the benefit and influence of articulating our research philosophy. Engaging in shared reflexive dialogue, with professional challenge, has led to us asking ourselves many questions about why we do things and expose the beliefs and assumptions that we hold. We have scrutinised these positions and debated to the extent that we have come closer together as a research team and more rigorous in our research practice.

The thoughtful deconstruction of what underpins how we engage with teachers and schools on SEERIH research projects has undoubtedly unearthed deeply held philosophical standpoints about learning within the research team. It has also stimulated dialogue about how best to involve participants in research, questioning their depth of engagement and stimulating consideration of whether they should have further engagement in the analysis of outcomes. In particular, by working through a guided process of reflection, we have made visible where our biases impact on meaning-making from research, therefore strengthening the way we present and discuss data within academic publications. Indeed, the cumulative effect is that research proposals also become more critical and justified, as we can write collaboratively with a common understanding of research purpose and design – in essence, the research frame clarifies the language for research practice across the team.

If you are embarking on research, or are already involved in research activity, I would urge you to reflect on your research frame, as this may offer you additional insight into your practice.

As with all such endeavours, the mere act of critical reflection can itself stimulate refinement.



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