Methodological Approaches to STEM Education Research Volume 6

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Edited by

Peta J. White, Russell Tytler,
Joseph Paul Ferguson, John Cripps Clark
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FOREWORD

JULIANNE LYNCH

I'm delighted to write the foreword for *Methodological Approaches to STEM Education Research - Volume 6*, an edited collection drawn from presentations at the 2024 Contemporary Approaches to Research (CAR) symposium. The CAR symposium has been organised by Deakin University in Victoria, Australia, annually since 1993. CAR stands out among STEM education conferences by virtue of the sustained opportunity to share and discuss philosophies, practicalities, and innovations in research methodology. While the symposium attracts many regular participants from the STEM education research community, spanning the sciences, mathematics and the technologies, it also attracts new faces each year: international guests, STEM education research students, and valued interlopers from other disciplines who are attracted by the methodological focus. Participants will always find an inspiring and safe space in which they can test their methodological thinking, engage in constructive dialogue about the problematics of education research, and explore innovative methodological responses to those problems. CAR offers opportunities for the deep consideration of philosophical questions about what we can know, what counts as evidence, the ways that evidence can be generated, and whose interests are served by research.

Reflecting on what contributes to the success of CAR, I considered the value I get from the symposium. The time given for discussion of methodological issues and practices across disciplinary contexts is key, laying the ground for the cross-fertilisation of ideas. I've always had a propensity for interdisciplinary scholarship. Studying secondary teaching methods in mathematics and English, I was somewhat of an anomaly as an undergraduate teacher education student. I recall a practicum experience in a large, inner suburban school in Melbourne in the late 1980s. My supervising teachers in the mathematics and English departments did not know one another—they lived parallel lives in separate departmental staffrooms at opposite ends of the school campus. As an undergraduate, peers and lecturers often noted my unusual disciplinary combination. I developed pat responses: among them, "Subject English is actually highly

analytical", and "Like literature, mathematics is about creating new worlds to explore important problems." It was the buildings and the timetables that hid the commonalities and the potential connections and collaborations between the different worldviews of mathematics and English.

The disciplines have created structural barriers, an element of mystique, and othering practices that can stifle intellectual exchange, collaboration, and innovation. The notion of STEM education (and similar configurations—STEME, STEAM) responds, at least in part, to the limitations of arranging knowledge, learning, and problem solving along disciplinary lines. STEM recognises the value of thinking and working across disciplines to tackle shared problems.

Following my initial teacher education, I continued to resist disciplinary pigeonholing, undertaking an inter-disciplinary Master's degree in critical theory and a PhD in educational technology (and yes, I succeeded in getting English teachers to work with mathematics teachers!!). These degrees were punctuated by appointments in mathematics education research at La Trobe University and technology education research at Monash University. This trajectory brought me to Deakin in 2002 to teach units in curriculum and pedagogy, providing opportunities to collaborate with colleagues from a range of disciplinary backgrounds—humanities, mathematics, science, English, the arts—on a series of research projects. What connected me to these projects were trans-disciplinary educational issues and values: gender, rurality, Indigenous education, equity and access, place-based learning, educational innovation and change, and teacher professional learning, practice and professionalism. Across these projects, I learned the value of different perspectives when designing research and I learned that research methodology is itself a trans-disciplinary concern in education research.

Methodological theory and principles are highly mediated when they are enacted in the field of education: first, by the normative values of the field and, second, by the situated interests of stakeholders in education settings (research sites) (see Figure F.1).

At its core, education research is a change-oriented field, purposefully pursuing values associated with the criticality and integrity of knowledge and learning, learner equity and inclusion, and ethics and care in educational relatings. In pursuit of these values, education research *intervenes*—with ideas and materials and instruments and practices—to generate new knowledge and new practices, and—through education—to change people. Even ethnographic methods—ostensibly focused on documenting everyday

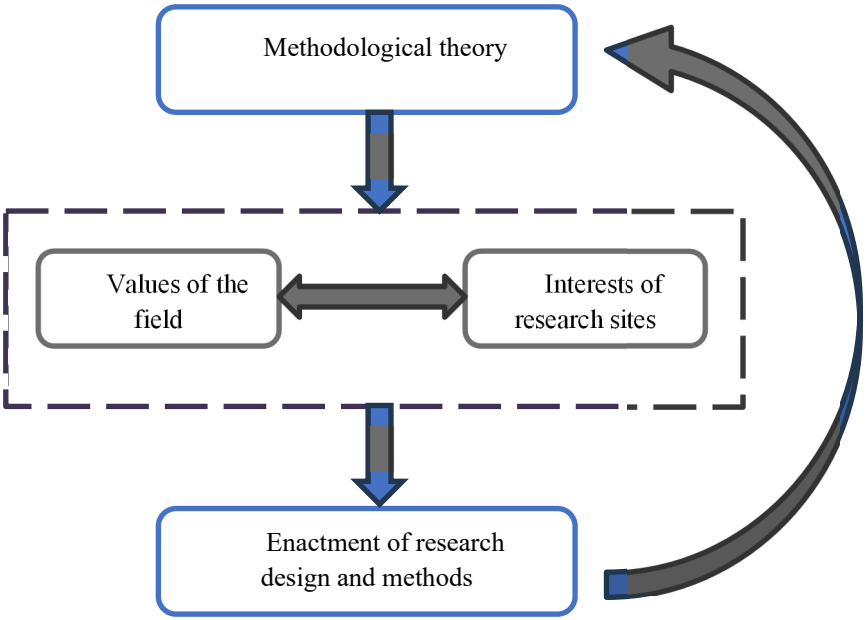

Figure F.1: The mediation of methodological theory by education values and contexts

practices—are understood by contemporary methodology scholars in education research as actively productive co-constructions that influence educational realities. That is, research can shape educational practices, not only through the impact of research outputs, but through research encounters during the enactment of research. This orientation towards action and change *through* research practices brings with it an imperative to collaborate with participants and stakeholders, engaging with complex and often tensioned needs and interests. This complex of theory, values, and interests can be illuminated and informed by considering the diverse ways in which the subfields and disciplines of education conceptualise, negotiate, and enact the mediations involved. Which is exactly what CAR enables and facilitates by bringing together research practitioners who share orientations towards educational transformation but bring the different worldviews and contexts of the STEM disciplines to discussions about approaches to research.

An orientation towards value-driven inquiry that contributes significantly to the field while also promoting value-aligned change in research participants

and their settings can be seen in almost all the contributions to this book. Several chapters specifically advance design-based methodologies in STEM education contexts to produce new knowledge about educational transformation while also supporting transformative agendas at the research sites. Among them, Kim et al.'s chapter proposes a hybrid approach to design-research developed to support co-design of training programs in a community-based research institute in South Korea. Beyond the methodological and pragmatic value of their approach, they also discuss how, by engaging the complex needs of a research site, they helped a traditional research institution to become a more adaptive learning organisation. Similarly, Pramudiani et al., whose study aims to create new knowledge about how to strengthen teacher education in Indonesia, emphasise the dual benefits of their design-based approach which also built skills among participants in teaching mathematical reasoning. Strachan et al. also use design-based research to develop approaches for preparing science teachers to become more transformative environmental educators. What I find interesting about this chapter is how their design-based research approach (linking knowledge and action) echoes contemporary pedagogical-content aims of this science subdiscipline, with participant teachers learning strategies for linking scientific knowledge with imperatives for environmental action. The chapter by Tytler et al. takes a broader perspective on analysing and discussing contemporary research trends and contexts. The authors engage critically with contemporary epistemic politics in education research, especially active attempts by education authorities to marginalise smaller-scale, situated studies. Through examples, they demonstrate the validity and impact of design-based research co-design, emphasising the power of such approaches to inform education policy. They also highlight the role of qualitative studies in contributing to theory—a prerequisite component for developing larger-scale quantitative research.

Unsurprisingly, education research—the home of action research—has contributed significantly to developments in action-oriented approaches to research, including: critical action research, participatory action research, design-based research, and co-design approaches. Education researchers' contribution to these change-oriented methodologies includes bringing sophisticated sociological, psychological, historical, and philosophical theory and critique to productive engagements with the pragmatic needs of settings and stakeholders. In my view, this is something that the humanities and social sciences (HASS) do better than the sciences; and that STEM education fields (as HASS fields) do better than the STEM disciplines. A philosophical-historical-theoretical sensitising of situated, problem-focused

research and development is critical if ethical, acceptable, and sustainable solutions are to be developed to the complex problems that education practitioners and stakeholders face. In education research, theory and critique is often a hallmark of maturation of knowledge. This can be seen in Hobbs' account of the methodological history of research into out-of-field teaching and reflection on her own contribution across fifteen years, where detailed and theorised knowledge about the phenomenon supported a progression towards methodologies of critique and action.

Expansive, transdisciplinary theory and critique are important means by which emerging practices and new knowledge can be connected to what has previously been learned. Theory and critique can also help researchers and practitioners alike to recognise patterns across contexts or, conversely, to derive context-specific value and actions from the abstract constructs of research. Several chapters in this book address interactions between big theory and the situated enactment of research. For example, White and Ferguson, employing their triadic theorisation of values for climate change education, discuss interrelations between theory and practice in differently contextualised enactments of climate change education programs. While White and Ferguson test the value of their theory against practice, several chapters centre the role of theory in shaping research methodology, identifying how expansive theories of human practice can inform research design and method decisions in their STEM education studies, thereby bringing theoretical coherence to novel research practices. For example, the chapter by Bothe combines the theory of practice architectures and curriculum theory to develop a framework that guides her methodological decisions in a study of integrated STEM units in teacher education programs. Similarly, investigating mathematics leadership amid top-down pedagogical reform, Sexton uses cultural-historical activity theory to tune into teacher agency. This use of theory provides important insights into teacher practice that might otherwise be overlooked.

Also addressing interrelations between research methods and theory, the chapter by Kennedy, Devis and Smith introduces systems thinking as the basis of a holistic approach to understanding phenomena. These authors demonstrate how modelling the broader system in which a phenomenon occurs can inform methodological design that produces more meaningful and useful results than studies that take narrow approaches. While systems thinking is most-often associated with an analysis of interrelations between components of a whole system, Sakurai et al. take a different approach. Driven by phenomenological aims, these authors seek to understand the complexity of the learner *as* a system within whom factors interact

holistically. They explain how this approach was used to develop new insights about how personal values impact low performing mathematics students' lived experiences.

An important aspect of action-oriented, design-based methodologies is that they capture and respond to the diverse perspectives and interests of stakeholders participating or collaborating in the research and that the participants directly involved in the research benefit from the research encounters. The approach to navigating educational theory and philosophy, methodological traditions, and the practicalities of actual settings, can result in (or demand) the development of pragmatic and/or novel approaches to research. Several chapters discuss the tensions between research conventions and the needs and experiences on-the-ground when enacting change-focused education research. In mathematics education research, Davidson and Driscoll discuss the methodological challenges of collaborative research with teacher leaders. They illustrate how a pragmatic approach to methodology enables researchers to address the range of roles enacted within the research. Investigating out-of-school science settings, such as museums, Dillon's chapter addresses the benefits of researching out-of-school settings that—because they sit outside the often-restrictive policy environments of schools—provide more freedom for pedagogic innovation. He also illustrates how stakeholder diversity requires novel methodological strategies in complex out-of-school settings.

I will finish this short tour of threads that my own reading of the chapters produced with a final common interest: technological-material novelty or innovation involving new types of instrumentation, new sources of data, and new approaches to interpreting data. These matters are of interest because introducing new materiality into educational contexts can enable new types of educational activities and their data collection corollaries. Inquiry into complex educational practices benefits from multiple data sources, particularly when abstract concepts such as *reasoning, attitude,* and *learning* are being investigated, as is often the case in education research. Brown discusses the role of novel materials in design-based research, specifically, cartoons to support mathematical reasoning. Tangible materials like cartoons can be used to make intangible phenomena, such as reasoning, manifest as objects for attention, thus serving both as a pedagogical and a methodological tool. Addressing a similarly abstract phenomenon—students' attitudes—Kennedy, Platt and Vass take up the perennial issue of researcher uncertainty about how to interpret students' responses to Likert-like scales. The authors propose incorporating an item that uses a vignette, as a test item to mitigate against Type I and Type II

errors when interpreting data and improve the internal validity of survey research. Digan's chapter also focuses on novel manifestations—in this case, the chatbot histories that record students' interactions with generative artificial intelligence (GenAI). Generated via new learning practices, these histories provide a new source of data in the form of records of prompts and responses from GenAI chatbot interactions. These data can complement other artefacts to provide insights into the abstract phenomenon of learning. Termaat is interested in the different ways that researchers can interact with data and how analytical approaches shape interpretations. She shows how different analytical methods provide different insights into the underlying structures in transcripts of audio recorded lessons.

Striking a divergent chord, Nicholas et al. are also concerned with the interpretation of artefacts and the artefacts of interpretation. Their provocative, philosophical chapter challenges analytic methods that treat data as representations of something abstract and unseen (e.g., learning), arguing instead that the materiality of data can and ought to be analysed for what it is, objectively, as an object. Using the example of interviews with students about a learning intervention, they demonstrate how the generated data (recorded speech) can be understood as evidence of learning 'as it occurs', rather than as reflection on learning 'after the fact'. For me, this chapter returns nicely to an appreciation of research encounters as productive, rather than representational, bringing trouble to those who would like to disentangle education research practices from the objects of educational research.

In summary, I started this foreword with some memories and thoughts about how interdisciplinary exchange and collaboration can produce transdisciplinary value and how CAR contributes to this by bringing together researchers of STEM education to discuss approaches to research. I provided a simple representation of how, in education research, methodological theory is mediated by field values and research site interests. Exchanges like those promoted at CAR symposia, that share accounts and theorisations of research practices, in turn feed back into the methodological literature. A tour of chapters illustrated:

- the value-driven, change-oriented character of much STEM education research;
- the role of theory and critique in shaping research approaches;
- the ways that the situated interests of collaborators and participants can contribute to the shaping of research designs and methods; and

the types of novel approaches to the materiality and instrumentation of data found in contemporary STEM education research.

Of course, these flows of ideals, ideas, interests, circumstances, and materials are a feature—to varying degrees—of all the chapters. Reading through the chapters in this book, I'm reminded of the theoretico-methodological sophistication of education research—a trait that serves as a lure to many new researchers and also as a caution to visitors from outside the humanities and social sciences. What impresses me about this collection is the close attention to what it means when theory and methodology meet educational settings and stakeholders on-the-ground, and the careful attention to generating real value for participants and the enterprises they represent while also contributing to knowledge about STEM education. The book invites and will reward an equally careful reading.

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Professor Julianne Lynch is a transdisciplinary researcher and teacher educator at Deakin University. Her research investigates technology practices, innovation, and change in education. She is passionate about research that connects with the expertise and aspirations of teachers and young people working in high poverty settings. By combining careful theoretical work with place-based methodologies in a wide range of contexts associated with disadvantage, she has contributed to foundational knowledge on educational technology, curriculum innovation, education policy enactment, teacher practice, and teacher professional learning. Theoretically, Julianne is internationally recognised for her contribution to practice theory and practice-focused methodologies in education research.

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INTRODUCTION

RUSSELL TYTLER, PETA J. WHITE,
JILL P. BROWN, JOSEPH PAUL FERGUSON,
AND JOHN CRIPPS CLARK

Now in its sixth year of the series, this edited volume represents contemporary perspectives on the methodological practices of the STEM education research community that is unique in our experience, in representing both a variety of methodologies and their implementation in practice. As Julianne Lynch points out in her foreword, researching in practice must respond to the values of the field and the contextual interests of stakeholders, and the chapters in this and previous volumes represent the playing out of these productive tensions in describing the grounded complexities and decisions about methodologies, theories, and research designs in projects across a wide range of interests in the educational field. In some cases the chapters deal with the particular adaptation of methodologies sensitive to the requirements of the project, such as different analysis approaches to unpack dimensions of classroom practice or enrichment of approaches to outcome measures. In other cases, chapters explore the features and repercussions of methodological traditions to critique, extend and reflect upon the affordances and limitations of these, such as the need to account for system complexity in framing research designs, exploration of objective measures to interpret participant responses, or of exploring the different evidential bases of qualitative methodologies compared to randomised control trials. Yet others explore the theoretical and philosophical bases underpinning methodological choice.

It is in this refined articulation and exploration of methodological theorising practice that STEM researchers have gained insights and strength from the annual Contemporary Approaches to Research (CAR) Symposium at Deakin University, from which this series emerged. CAR has been both a proving ground and a rich communicative forum for STEM and allied researchers over many years, focusing our attention on the methodological bases of our work as a generative aspect of our lives as research academics.

This sensitivity to the nuances of education research, subject as it is to multiple and often opposing values and political influence, has become an important if not necessary part of the understandings that research academics need to develop. Questioning at the policy level of the academic research enterprise has led, in Australia and elsewhere, to the promotion of practices described as 'evidence-based' to the detriment of more complex understandings of the variety of forms of evidence that inform different aspects of educational work. This includes contested views about the nature of learning and what is to be learnt, and the policy framing of educational purposes. At stake is the justification and enactment of a richer set of practices than can be accompanied by narrow views of education in STEM. As education researchers we need to concern ourselves with how best to proceed to support a rich and socially just education system. Through these rhetorics of evidence, methodology has become implicated in the 'culture wars' that attend to contestation about fundamental educational purposes, and as educational researchers we need to be ready to defend our methodological choices and the values and presumptions underpinning them. This is where CAR, and this book series, can perform a valuable function.

We wrote in the introduction to Volume 5 that editing this book and series is a labour of love, and described how each of the editors has had a long association with the CAR symposium and with this book series. We are pleased this year to have Jill Brown join the editing team. She represents insights from the mathematics education community. She has a long history of interest in methodology and has been advocating publicly for methodological diversity to support teachers' enactment of rich and varied pedagogical practices. She advocates for methodological and teaching approaches that support all aspects of mathematics and the mathematics curriculum including ways of mathematical thinking described in the proficiencies and processes of the Australian curriculum.

This book, and the series, is intended to provide a useful resource for researchers similarly interested in methodological explorations. Each volume has a range of foci, and each is different in the balance of methodological themes running through it. Across the series, readers will find an impressive array of methodological foci applied across a range of STEM topics. There are many examples of interdisciplinary work, including for instance arts-based practices and sustainability-related topics. In common across all is a commitment to articulating the bases of our methodological choices and the evidence flowing from these. The book

series can be found at this site https://www.cambridgescholars.com/pages/book-series?series_id=133.

The Contemporary Approaches to Research (CAR) is a hybrid Symposium and we welcome participants from all around the world. Please see the website for further details (https://deakinsteme.org/event-category/car-symposiums/).

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research dips into: science and technology education, online learning (Activity Based Instructional Design), play in Physics, Peirce and graphing, entrepreneurship education, and school gardens.

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CHAPTER 1

RESEARCHING TEACHING OUT-OF-FIELD: METHODOLOGICAL DIVERSITY FOR A RESEARCH TRAJECTORY OF NOTICING, UNDERSTANDING AND ACTING

LINDA HOBBS

Abstract

Teaching is a learning profession but learning to teach a subject 'out-of-field' places subject-specific demands on teachers that can challenge teachers' knowledge, practice, and identity. As with any complex phenomenon involving students, teachers, schools and systems, a diversity of methodological approaches and theories are needed to understand it but also to inform and shape a resilient education system that increasingly relies on out-of-field teaching as a solution to teacher shortage. Within a particular context, research into out-of-field teaching can tend to follow a trajectory of noticing the phenomenon, understanding its effects for different stakeholders, and evaluating or calling for certain actions. In this chapter, I demonstrate how this trajectory is evident at a systems level in Australia. I then draw from three studies from my program of research into the out-of-field teaching phenomenon that follow this trajectory and the diverse methodologies, methods, and theories that have been used to notice, understand and be action-oriented in deciding on the research problem and generating research outcomes. I conclude by identifying next steps for this field of research, though for each researcher, this trajectory of noticing, understanding and acting will mean that the field will continue to develop at each of these three levels as we all commit to shedding new light on different aspects of a complex phenomenon.

Keywords: Research trajectory; teaching out-of-field; noticing, understanding and acting through research

Introduction

This chapter explores how a phenomenon in education gets noticed, how we gain deep understanding of it, and how research can cause action. Many researchers begin their journey through a PhD, often focused on something that they want to learn and change, and research is seen as a mechanism for bringing about such change (Bryman, 2008). Educational research can generate new knowledge but can also inspire change (OECD, 2008). This chapter will explore the research methodological approaches used by researchers and others to become aware of, understand, and take or influence action in relation to the phenomenon of teaching out-of-field, a school practice where teachers are assigned to teach subjects they are not qualified to teach (Hobbs & Törner, 2019). There are many aspects of this phenomenon that can be elucidated through research through, for example, generating more and more data, applying different theoretical lenses to conceptualise aspects of it, and by focusing on the causes and drivers, effects, meanings, changes, people, relationships, and solutions across contexts. Contexts might refer to different school subjects (e.g., comparing subject-specific demands on teachers), different schools (e.g., comparing case studies of schools), across jurisdictions (e.g., across countries or states with different system settings and pressures), chronologies (e.g., single point in time or over a period of time), and different scales (individual teacher to teacher workforce).

When dealing with complex phenomena, a range of methodologies is needed, otherwise a researcher can have a limited view and understanding of the phenomenon itself. In this chapter, I approach methodological diversity from the perspective of methodology for different purposes when noticing, understanding, and acting in response to the out-of-field teaching phenomenon. Researchers, governments, subject associations, or teacher unions may ‘notice’ the phenomenon through personal experience (in the case of a teacher researcher) or data capturing the prevalence and inhibiting effects of out-of-field teaching, leading to demand for accountability. Once acknowledged by the sector, research can build ‘understanding’ of the phenomenon by focusing on the effects and outcomes for different stakeholders and might include breadth and depth in how the phenomenon is studied and the type of recommendations that might ensue. This research is often more qualitative or mixed method and more theoretically informed,

with researchers tending to centre on the teacher and their experiences, learning and contexts, and impacts for their students. 'Action' oriented research then draws on these understandings but uses methodologies designed to critique, influence and change policy, such as research collaborations across sections and action-oriented approaches to create and evaluate initiatives.

In this chapter I illustrate what noticing, understanding, and acting has played out in relation to this phenomenon of teaching out-of-field, first by looking at a range of methodologies used to inform research and provide commentary on teaching out-of-field, and then by describing my own research trajectory of observing, comprehending, and taking and informing action in relation to this phenomenon. Three questions guide this analysis:

1. Who **notices** what, why do they notice, how do they notice, and who do they tell?
2. Who **understands**, how do they understand, and for what purposes?
3. Who **acts**, who prompts the acting, what is the outcome, how do we know the effects?

The chapter begins by introducing the field of research relevant to teaching out-of-field by defining key terms and the breadth of the phenomenon that can be problematised through research. Sensemaking theory (Weick, 1995) is then used to situate my approach to noticing, understanding, and acting for this paper. I then demonstrate how educational and political systems have recognised and understood out-of-field teaching through research, as well as how research has shaped actions and consequences of such actions. In an effort to illustrate how different methods can be used to notice, understand and act, I then introduce the methodological approaches used by three studies I have engaged within a 15-year research agenda focused on the out-of-field teaching phenomenon.

Teaching out-of-field as a research field

It is important to appreciate that using a single term to define teaching out-of-field oversimplifies the complexity of what is involved for the teacher in context, that is the teacher in the context of their school and its collegial and leadership environment, for their particular subject, and in their cultural / social / economic / geographical contexts. Drawing on Hobbs et al. (2022), technically, 'teaching out-of-field by specialisation' is determined by the alignment between a teacher's qualifications and the subjects they teach. This is complicated by 'composite' school subjects where teachers are often

responsible for teaching a range of disciplines (e.g., Humanities) or sub-disciplines (e.g., General Science), and which can render a teacher 'out-of-field by specialisation' though technically still in-field. Research shows, however, that principals can appoint or assign teachers according to 'fit' (Blackmore et al., 2024) or 'suitability' (Hobbs, 2020) where the school and students' needs are balanced against the teachers' capabilities. Out-of-field-*ness* is a guide to whether a teacher feels out-of-field or not, and what factors are considered in such determination (Hobbs, 2013). 'Out-of-field by capability' takes into consideration teachers' expertise, including knowledge developed through prior study, work, and teaching experiences. Related to this is a teachers' sense of identity, confidence, and other similar factors. Also, the culture of support through collaboration within the context of innovation has also been seen to be important for teachers to feel confident (Hobbs, 2013; Mesias & Pelicano, 2024; Nakar & DuPlessis, 2023). In addition, a teacher's workload, including the proportion of subjects they teach out-of-field and the frequency with which they transition between different subjects or year levels, can also affect their expertise development (Carlyon, 2018), therefore can determine out-of-field-*ness*. These various factors contributing to out-of-field-*ness* of a teacher require different research methodologies to accurately identify, understand, and address the issues that teachers face.

It is important to understand that, as a phenomenon, teaching out-of-field arises for various reasons, with teacher shortages across the entire system or certain locations being the main reason. Other factors are relevant to understanding the reasons, such as school decisions about timetabling (Porsch & Hobbs, 2024) and level of the subject (Shah et al., 2020), school needs (Blackmore et al., 2024), and teachers' personal decisions about expertise and career trajectory (Hobbs, 2014). Institutional and system level factors include school funding, competition between schools, and policies relating to teacher education, teacher registration / accreditation / licensure, and professional learning requirements (e.g., Hobbs et al., 2020; O'Meara & Faulkner, 2021; Porsch & Hobbs, 2024; Shah et al., 2020). These factors require data to notice and understand the effects and to critique the system to instigate change at a system level.

The majority of research takes place at the *micro* level, focusing on conceptu alising the problem, describing teachers' experiences, and examining effects to highlight specific practices. Research at the *meso* level addresses institutional factors, primarily at the school level, while research at the *macro* level considers system-wide factors, including incidence rates, which often draw on out-of-field teaching by specialisation, as described earlier.

The factors at each level can be explored by focusing on the conditions, processes, and effects. Analysing the phenomenon in this way allows researchers to consider areas to problematise through their work. Figure 1.1 maps factors at the *micro, meso,* and *macro* levels (Hobbs & Porsch, 2022).

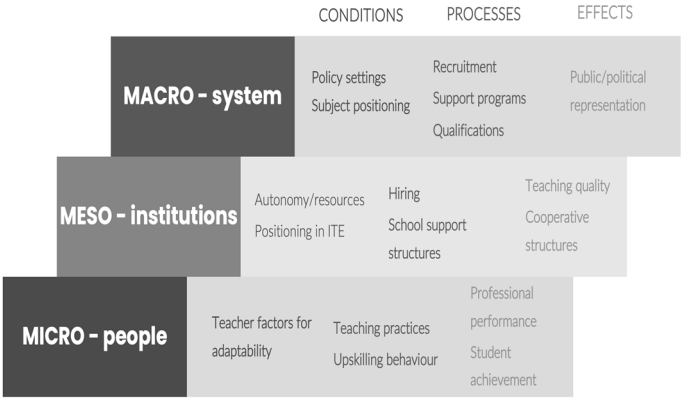

Figure 1.1: The phenomenon of teaching out-of-field (from Hobbs & Porsch, 2022, used with permission)

Approach to acting, understanding and acting

Sensemaking Theory (Weick, 1995) provides a framework to explore the dynamic interplay between noticing, understanding and acting, making it a valuable tool for examining complex social educational phenomena. Sensemaking Theory was developed by organisational theorist Karl Weick (1995). It focuses on the process through which individuals and groups interpret and make sense of ambiguous or complex situations. This theory is particularly relevant in educational research for understanding how teachers and students navigate and respond to their educational environments. Weick et al. (2005), in their elucidation of the process of sensemaking, state the distinguishing features are:

> its genesis in disruptive ambiguity, its beginnings in acts of noticing and bracketing, its mixture of retrospect and prospect, its reliance on presumptions to guide action, its embedding in interdependence, and its culmination in articulation that shades into acting thinkingly. (p. 413)

Sensemaking can also be applied to understanding how systems behave. In the context of systems, whether they are educational, organisational or

social systems, sensemaking involves the collective process by which individuals within the system notice, interpret, and act upon events or information. This can be particularly useful for analysing how organisations or educational systems respond to challenges, changes, and innovations. By applying Sensemaking Theory to how systems behave in response to out-of-field teaching, researchers can gain insights into the dynamic processes through which systems notice, understand, and act in response to complex and evolving situations.

Systems noticing, understanding, and action

Teaching out-of-field occurs globally, though it may not always be acknowledged and often goes unrecognised (Lopez & Roble, 2022; Luft et al., 2020). Over the past 15 years of research, I have observed a common process in which a country, state, or jurisdiction first recognised the phenomenon, often prompted by poor performance in international student achievement tests or other pressures related to teacher shortages. This recognition leads to scrutiny of the teacher workforce and subject allocation. Once identified, researchers, governments, subject associations, and teacher unions may begin to 'notice' the issue through data capturing the prevalence and negative effects of out-of-field teaching, often driving demands for accountability.

As illustrated in Figure 1.2, awareness is typically raised through systematic or government-funded data collection (e.g., Weldon, 2016), surveys to assess the scope of the issue (McConney & Price, 2009; Wyatt & Hobbs, 2024), parliamentary inquiries highlighting specific challenges and teacher workforce challenges (e.g., Audit Office of New South Wales, 2019; Department of Education, Skills & Employment, 2021), and media attention (e.g., Baker, 2021).

Figure 1.2: Ways that out-of-field teaching is noticed, understood and acted on