

INTRODUCTION

Politics by other means? STS and research in education

Radhika Gorur^{a,*}, Mary Hamilton^b, Christian Lundahl^c, Elin Sundström Sjödin^d

^a Deakin University, Australia; ^b University of Lancaster, UK; ^{c,d} Örebro Universitet, Sweden

Science and Technology Studies (STS) has been surprisingly slow to become widely known and deployed in the field of education. Yet STS has a rich array of concepts and analytical methods to offer to studies of: knowledge practices and epistemic cultures; the interrelationship between states and knowledge; regulatory practices, governance and institutions; and classrooms, pedagogy, teaching and learning. Most importantly, it provides a fresh perspective on how power operates in ordering societies, disciplining actors and promoting ideas and practices. In this paper, we provide an introduction to STS and elaborate what it offers education scholars. Using examples from the emerging body of STS work in the field of education, and in particular from the papers in this special issue, we argue that STS is not only useful, but an exciting and generative form of critique – one that is especially suited to investigating contemporary issues in education policies and practices.

Keywords: Science and Technology Studies (STS); Actor-Network Theory (ANT); politics of the mundane; knowledge practices; education

Introduction: politics by other means

What does it mean to do ‘politics by other means’? This phrase, coined by Latour (1988) in his seminal publication *The Pasteurization of France*, was explained elegantly by Lucy Suchman in her remarks as President of 4S (the Society for the Social Studies of Science) at the 2016 EASST/4S Conference¹ in Barcelona in in this way:

As STS scholars, we recognize now that all forms of human activity can be characterized as politics by other means insofar as we understand politics as matters of encounter, ordering and distribution. At the same time, we can resist ideas like the proposition that war is a logical extension of politics if we insist that the ‘means’ matter, and that other means are possible (Suchman, 2016)

Understanding politics as ‘matters of encounter, ordering and distribution’ is a deceptively simple and stunningly powerful approach to the study of power and its effects. It shifts us away from the usual explanations of politics as simply a matter of

* Corresponding author’s email: radhika.gorur@deakin.edu.au

interests or of the hegemony of the powerful. Refusing to accept power as something inherent in individual ‘powerful’ actors or institutions, it insists that we study how ‘encounter, ordering and distribution’ are effected in particular instances, and how power comes to be assembled. There are no ready-made explanations and no off-the-shelf theories in Science and Technology Studies (STS). The researcher is afforded no god’s eye view (Haraway, 1988) and no neat, transcendent explanations (Latour, 2005). Empirically examining which actors are engaged and implicated in encounters, how actors are disciplined and ordered, and how agency comes to be re/distributed – this is the task of scholars in STS. This is what makes each STS-inspired investigation both interesting and generative, since each study has opportunities to produce new concepts and theories.

Suchman (2016) follows up her explanation of *what* ‘politics by other means’ signifies, with the all-important *why* of STS. What is the point of STS research? What is the political impulse that drives these studies? As Suchman elaborates, ‘“means” matter, and ... other means are possible’. In exploring how things come to be ordered in a particular way, bringing together particular actors in a particular set of relations, STS studies demonstrate the contingent nature of these orderings. And if things could have been otherwise, STS scholars argue, *they might still be otherwise*. STS is a hopeful theory – one that does not simply explain how things have come to be the way they are, but also opens up possibilities for things being ordered in other ways, for the introduction of new and diverse actors, and for rearranging relations of power. So in this iconic phrase, ‘*politics*’ epitomises both the STS view of politics and the politics of STS.

In this Editorial introduction, we explore how this seemingly simple but incredibly rich approach – STS – has been, and can be, exploited by scholars in education. We do this using examples from existing literature as well as from this current Special Issue of Discourse, *Politics by Other Means? STS and Research in Education*.

A brief history of STS

For ‘insiders,’ STS is a well-established and thriving, if constantly evolving and extremely diverse, field of study. It has an international association (4S) which has annual international conferences as well as several regional associations such as EASST (European Association for the Studies of Science and Technology) and the APSTSN (Asia Pacific Science and Technology Studies Network). It has well-rehearsed origin stories and a long history documented over several Handbooks and other texts (Jasanoff, Markle, Peterson, & Pinch, 1995; Fuller, 2006; Hackett, Amsterdamska, Lynch, & Wajcman, 2008; Felt, Fouché; Miller & Smith-Doerr, 2016). It has its heroes and its legendary arguments and disagreements. STS courses are offered in many universities and there are well-established journals dedicated to STS.²

Surprisingly, although the field of education research has long played host to an eclectic range of theoretical and conceptual approaches, STS has been a late entrant into this field. It is not uncommon, when you mention STS to scholars in education, to get a puzzled look in response. Elaborating ‘STS’ into ‘Science and Technology Studies’ does not help – often you are simply mistaken for a science educator or a STEM scholar.

Now widely used to study a variety of phenomena, STS was originally deployed in the social studies of science.³ Indeed, the phrase ‘politics by other means’ was

originally used by Latour to argue that ‘Science is politics by other means.’ The origins of STS are generally traced to the 1970s in the aftermath of the Kuhnian revolution (Kuhn, 1962/2012) when a group of scholars began to study the relationship between science, technology and society. These studies challenged enlightenment discourses of objectivity and rationality and highlighted the social practices which enabled science to make claims about its objectivity and rationality. Tracing the practices of knowledge-making in science, STS scholars demonstrated that the division between a pristine, objective ‘laboratory’ and a messy, political ‘world’ outside the laboratory was a socio-material construction. From Latour and Woolgar’s studies of laboratory practices (Latour, 1988; Latour & Woolgar, 1979) to Knorr-Cetina’s work on epistemic cultures (Knorr-Cetina, 1999), STS has focused on how knowledge gets made, how knowledge-makers are able to convince others of their claims, and what goes into the processes of stabilising, mobilising and contesting knowledge.

Since those early days, STS has wandered many paths. The burgeoning role of technology in society prompted studies that explored the origins, dynamics and consequences of science and technology (Hackett et al., 2008) and the relationship between technologies and society (Bijker & Law, 1992; Callon, Law, & Rip, 1986). More broadly, STS has continued to engage in the study of knowledge in all its forms – how it is generated, stabilised, contested, and translated (Jasanoff, 2004).

Alongside science, STS has also concerned itself with politics, governance and regulation. The political concerns of STS have pivoted around the formulation and criticism of liberalism. Liberal values of individualism, instrumentalism, meliorism, universalism, and conceptions of accountability and legitimacy have been closely related to understandings of scientific rationality, empiricism, and scientific and technological progress (Hackett et al., 2008). In addition, we can see the preoccupation in STS with science and technology policies, lay expertise and the public understanding of science (Callon, Lascoumes, & Barthe, 2009; Jasanoff & Kim, 2013).

A broad church from the start, and without any strict commandments that adherents are required to follow, STS has continued to diversify. Being a loose coalition, STS has a number of breakaway groups and disagreements – sometimes bitter, but often amicable – among scholars. This has meant that this study of knowledge practices has turned its critical eye on its own knowledge practices. The STS diaspora (Law, 2009) has seen feminist scholars, historians, post-colonialist scholars, and scholars in finance and accounting, development studies, and a host of other disciplines utilizing – and adding to – the suite of STS conceptual vocabularies and tools. Methodologically, too, STS is non-prescriptive, admitting a range of approaches to trace practices, such as ethnomethodology (e.g. Lynch, 1985), socio-technological ensembles (e.g. Bijker, 1995), and actor-network theory (e.g. Callon, 1986; Latour, 1987). Although the focus on practices has meant that most studies involve qualitative methodologies, STS also uses, less commonly, quantitative methods such as bibliometrics and digital mapping (Marres, 2015).

Since STS is located and grounded in an array of empirical case-studies, the approach itself is in constant movement – making use of new links between, and developing new combinations of, data, theories, methods and research fields. In this special issue we see, for example, how STS is used in combination with Deleuze to explore relations between learning and affect (Mulcahy, this issue); in combination with Rose to explore how ‘mentalities of rules’ are created to govern both individual and collective conduct (Sundström Sjödin, this issue); and in combination (or in

tension) with Bourdieu to explore assemblages of human, discursive and material actors in mobile students' social capital (Filho & Kamp, this issue). A key commonality in these varied approaches is that STS scholars take the empirical seriously. STS posits practices as performative, or 'world making.' So, worlds are made at the same time as action 'within them' occurs. This 'flat ontology' enables a radically different set of arguments in relation to matters of power, agency and regulation than more 'traditional' sociological approaches where existing power structures are seen, a priori, as powerful (Latour, 2005). This insistence on seeing power as both relational and dynamic, rather than structural and monolithic, is one of the main markers of STS (Law, 2009).

One of the most established approaches in the field of STS is Actor-Network Theory (ANT), a perspective used by several of the papers in this collection. Despite the word 'theory' in ANT, it is not regarded as a coherent theoretical approach or a ready-to-use methodological package or template (Latour, 2005). It is not considered a theory since it does not try to explain the world before empirically studying it (Law, 2009). As Fenwick and Edwards (2010) put it, ANT is more of a sensibility whose main contribution is to 'suggest analytic methods that honour the mess, disorder and ambivalences that order phenomena, including education' (p. 1). Using empirical case studies, ANT researchers explore the mundane and everyday practices through which, eventually, ideas and fact-making are stabilised and systems are established. They attempt to open up the black boxes of the taken-for-granted and of common sense to reclaim their tentativeness and contingency by tracing their routes to naturalisation.

Key to ANT, and to STS more broadly, is its acknowledgement of the material – the non-human or the more-than-human – as actors. By not limiting the range of actors to merely the human, ANT studies provide new and important insights into the ways in which politics and power relations are distributed through 'things' – materials and technologies, numbers and standards – things that often are underestimated or overlooked as agents in educational research. ANT studies make visible the ways that power operates as human, non-human and discursive actors become enmeshed in the social.

Critiques of STS

As STS itself teaches us, the course of any knowledge-practice or innovation does not run smoothly. Education scholars, and in particular scholars from traditions designated 'critical sociology', have not always welcomed STS warmly. One concern they raise is that of assigning 'agency' to non-human objects. The fear is that responsibility is delegated to the object and diverted away from humans. This criticism is puzzling to STS scholars for whom objects are never just 'material' but always 'socio-material' – objects are thoroughly drenched in the politics and contexts of their production. At the same time, humans are never 'non-material' – even those of us who are not literally attached to machines in the form of a pacemaker or an orthotic appendage can barely function in the way we do without 'combining' with objects of varying technological sophistication. Rather than deflecting attention and responsibility from the role of humans in politics or controversial phenomena, STS scholars would argue that by also paying attention to the non-human, their studies provide empirical accounts of how human agency is enabled. Gorur (2018), for example, shows the ontological politics of standards. Hamilton, Maddox and Addey

(2015) powerfully argue that quantification has radically changed education practices in relation to literacy.

We would contend that studies in education need to take into greater account the ways that teachers, for example, ally with things and technologies of different kinds in their work. These alliances are never innocent, neutral or predictable activities. Rather, these material semiotic relations involve politics and exert power in sometimes surprising ways (Sundström Sjödin & Wahlström, forthcoming). See, for example Lundahl (2014) who shows how a circumstantial network of scholars, places, letters/telegrams, data sheets and guidelines interact in encyclopaedic inscriptions. Williamson's (2019) work on the role of digital and adaptive technologies in regulating student learning and behaviour is another argument for attending to non-human agency. Once we become alert to the ways in which objects configure – enable, constrain, discipline, domesticate, monitor, and sculpt – humans and other non-humans, we realise how much is lost when objects are discounted in the study and analysis of social and educational issues (Latour, 1992).

Linked to the disgruntlement of critics of STS with the acknowledgement of material agency is their claim that STS has no theory of power. In particular, they note that the traditional explanations of race, class, gender, etc., are not prominent in STS studies. As should be clear from our introductory discussion above, STS scholars would answer that the theory of power is intrinsic to the understanding of how worlds are made. STS's determination to refrain from jumping to conclusions and overlaying the empirical with already formed theories, its insistence on letting the actors in any situation tell their own stories, means it does not automatically revert to explanations based on class, race, or gender. Because STS focuses on day-to-day practices, it does not use big concepts like 'neoliberalism', 'globalisation', 'class', 'race', etc., as a priori explanations (Latour, 2005; Ong, 2007; Ong & Collier, 2005). Rather, STS scholars take on these categories as subjects of their investigation – they are what needs to be explained (Latour, 2005). 'Standardising', 'contextualising' and 'categorising' themselves become the objects of study (see Bowker & Star, 2000; Lampland & Star, 2009). This approach of refusing to take the 'given' as inevitable, and instead investigating how these 'givens' achieve their status, is a hall-mark of STS approaches, and a major contribution of this research tradition.

When neoliberalism, globalisation, class, race, etc., cease to be taken-for-granted explanations and themselves become what needs to be explained (Latour, 2005), the emphasis falls on their provisionality. It is not that such actors as 'race' and 'gender' are ignored; rather, they are seen as produced through everyday practices, and are thus both relational and emergent. These powerful monoliths are thus broken down into chains of practices, making greater opportunities for 'interference' (Law, 2009). The playfulness, agnosticism, and a certain irreverence with regard to old orthodoxies in STS studies generate new conceptual vocabularies and novel forms of engagement.

A third criticism of STS is that it is focused on description and does not provide any explanation. STS scholars believe that they do not have any privileged perspective that gives them a better vantage point than the actors who are actively involved in – and make up – the phenomena being investigated. Accordingly, as Latour (2005) states with regard to ANT, a good check for the quality of any research account is who does the talking – 'are the concepts of the actors allowed to be stronger than that of the analysis, or is the analyst doing all the talking?' (p. 30). STS scholars would argue that a good description *is* an explanation, and that they contribute to understanding by providing accounts of how different actors construct their worlds. These understandings are often silenced in strong theories that provide a

priori explanations. Because they are interested in the politics of the mundane, STS scholars often pick topics of study that other scholars might not find worthy. These descriptions detail the powerful work done by unassuming, unremarkable actors which other traditions do not take to be of interest. In doing so, multiple points of interference become available.

STS and education research

STS and educational scholarship share several topics of mutual interest. STS also offers some key concepts and approaches that have much to interest the curious and intrepid researcher in education. Early, ground-breaking contributions by Jan Nesper (1994) and Helen Verran (2001) brought STS to the attention of educational researchers. Mary Hamilton (2001), Tara Fenwick and Richard Edwards (2010) and Radhika Gorur (2011a; 2011b), among others, helped to introduce and settle ANT as an accepted approach within the field.

In 2011, Fenwick and Edwards catalogued the work of ANT researchers in a special issue of *Educational Philosophy and Theory* (issue 43(1s)), where six studies of the use of ANT in the field of education were featured. The list included Hamilton and Gorur, two of the editors of this SI, as well as Mulcahy, who features in this Special Issue. Fenwick and Edwards (2010) also presented an overview of ANT in *Actor-Network Theory in Education*, detailing the potential of ANT and providing examples from the emerging body of ANT studies in education.

It has been less than a decade since those publications, and a number of exciting scholars are now engaged in studying a range of phenomena in the field. These include policy and governance, measurement and quantification, curriculum, educational history and both general and subject specific didactics. The call for papers for this Special Issue produced twice as many excellent papers as we could accommodate. The empirical examples offered in this Special Issue of Discourse ‘show and tell’ some of the ways in which STS can be useful to scholars in the field of education. The usefulness of ANT, in particular, is demonstrated in the papers by Elam, Mäkitalo and Solli; Filho and Kamp; and Sundström Sjödin.

We argue that now, perhaps more than ever before, STS is needed to make sense of, and to respond to, the unique pressures facing the field of education. As we grapple with increasing inequities, growing standardisation and internationalisation, the deprofessionalisation of teachers, the entrenchment of detrimental neoliberal practices of governance and accountability, the erosion of institutions and the increasingly unquestioning trust in numbers (Porter, 1995), STS provides the means for engaging with the ontological politics of these phenomena. We can benefit from the range of studies in the fields of medical practice (Mol, 2002; Timmermans & Berg, 2003), environmental policy (Asdal, 2011), economics and markets (Callon & Muniesa, 2005) and so on to understand and challenge the status quo. In particular, these studies highlight the contributions that STS can make to the study of power.

One reason STS studies are so exciting is that they do not just ‘apply’ theories to the empirical – their empirical work is constantly adding concepts to the theoretical. The articles in this issue amply demonstrate this by the range of new terms and concepts the authors introduce to the field of education, such as Ratner’s ‘description devices’, Chang’s use of ‘sociotechnical futures’, and Sundström Sjödin’s use of ‘folded valuations’. We can also see how STS/ANT analyses help reconstruct

classical concepts and theories such as ‘social capital’ in Salomão Filho and Kamp’s article, and ‘Behaviorism’ in Saari and Harni’s article.

Knowledge making practices

STS is above all a sociology of knowledge processes, touching the very core of education:

the day-to-day actions and processes through which the producers of social knowledge actually go about the on-the-ground work of making, evaluating, and disseminating the kinds of social knowledge that they are involved in producing. (Camic, Gross, & Lamont 2011, p. 6)

An understanding of knowledge as socially constructed, as a matter of not only creating the knowledge itself, but also constructing and ordering the world in which that knowledge can hold as valid and true (Callon et al., 2009; Jasanoff, 2005), has deep implications for academic endeavour across all fields of education.

This is well demonstrated by Helene Ratner’s article in this issue, *Describing children at risk: Experiments with context*, in which she unpacks how social services and educational psychology respectively use ‘context’ as a tool for producing information about ‘children at risk’. Building on Latour and Woolgar’s (1979) concept of ‘inscription device’, the paper develops the analytical concept of ‘description device’ to analyse the use of ‘context’, and in particular the ways that teachers’ attentions are displaced from child to context when describing ‘children at risk’ and how this displacement produces certain kinds of inscriptions. There are contexts that are accessible to teachers as well as those that are out of reach, and the study shows how these contexts are addressed and interpreted via specific referents (for example a child’s appearance).

Continuing with the theme of co-creating problems and worlds or contexts in which the problems are rendered sensible, in *Creating the valuable: Reading as a matter of health and successful parenthood*, Elin Sundström Sjödin (this issue) draws on the emerging field of valuation studies within STS to unfold the valuations and values about ‘reading to children’ that are co-created in health-related information brochures. Valuation studies provide an effective approach to explore the interwoven and overlapping practices in which worth and values are created and stabilised (Dussauge, Helgesson & Lee, 2015; Helgesson, 2016). The study shows how the lack of reading books is enacted as a public health problem requiring prevention and the intervention of children’s healthcare, and how this obscures the political and ideological negotiations behind the settlement of truths about reading books. Using ANT vocabulary to describe this process shows that ‘problematization’ is a key strategy in mobilising energy and interest around ideas. If enough actors can be made to be interested in a particular action, then resources can be mobilised and action enabled.

Technology and society

A number of early STS studies focused on the relationship between technology and society (e.g., Law, 1991). Today, with a new wave of technologies – social media, wearable technologies, ‘nudge’ technologies and other intimate and increasingly intrusive technologies circulating amongst us (Williamson, 2019), there is renewed

interest in STS on technologies and societies. Ethan Chang's paper (this issue) *Beyond workforce preparation: Contested visions of 'twenty-first century' education reform* is based on an ethnographic study of the work done by non-profit actors in California, and their use of digital technology to invent and materialize not only contrasting but competing sociotechnical visions of desirable educational futures. Chang explores the political values and interests inscribed in two different edutechnologies, which aim to strengthen, respectively, individual student achievements and local community participation. Making analytical use of the concept 'sociotechnical imaginaries' (Jasanoff & Kim, 2013) the study contributes a sharp problematization of the values and interests that influence imagined futures, who benefits from them, and how technology is intertwined in the enactment of these futures.

This focus on the consequences of socio-technical imaginaries and the deployment of socio-technical devices links with the very influential forms of knowledge generated in education today through large-scale comparisons, standardisation, benchmarking and other forms of quantification (Gorur, 2017). STS has inspired the study of the hugely significant work of statisticians, psychometricians, and economists in developing indicators, benchmarks and standards, and the ways in which instruments and surveys produce 'calculable worlds'. The established body of work on the sociology of quantification includes the examinations of university rankings by Espeland and her colleagues (for example, Espeland & Stevens, 2009); the work on globalisation and Europeanisation by Landri (2018); international comparisons and assessment and comparative education (e.g., Addey, 2018, Gorur 2011b, Piattoeva, Klutas & Souminen, 2019). There is now also a growing body of work in the area of digital methods, social media, platformisation, and computer-based assessments including the paper by Laura Høvsgaard in this issue.

Learning practices

Although STS does not directly address theories of learning and cognition, its focus on materiality, affect, controversy, innovation and the ways in which technologies are encountered and adopted offer unique insights into classroom and school settings. There is, therefore, an emerging possibility for using STS, so to speak, 'in reverse'. That is, the focus on knowledge-making practices can easily be directed towards 'learning practices'. An influential example of this is Helen Verran's (2001) work on mathematics classrooms in Nigeria, where Australian understandings of how mathematics should be taught encountered 'African logic'. This encounter provided the impetus for her work on Indigenous knowledge practices and more generally in post-colonial STS. Estrid Sørensen's (2009) work on the materiality of learning pushed beyond cognitive notions of learning to generate powerful socio-material descriptions.

The work of scholars like Fenwick, Nerland and Jensen (2012) on informal learning and professional learning extend sites of learning beyond the classroom. In these explorations, the material, embodied and affective nature of learning are highlighted. The papers in this Special Issue, too, take up this theme. For example, in *Pedagogical affect and its politics*, Dianne Mulcahy (this issue) studies learning at museums from a post-constructivist perspective where materials' effects on the learners is especially highlighted. Mulcahy makes use of the Deleuzian (1988) concept of 'affect' that she understands as 'changes in bodily capacity, which emerge

through encounters ... These changes both affect other entities and are affected by them'. In a museum ... context, Mulcahy notices how school visitors come upon exhibits that exert force upon them and move them, and 'make a material impression on them and influence them to learn in a particular way – intensively/affectively'. Thinking and learning here involve cognitive, social and material relations woven together. When affected, the learner also reacts to the content – in this case, an exhibition dealing with identity issues – and can potentially affect others with their reactions. There is, in the way the museum is assembled, a clear state of micropolitics through which knowledges are made, Mulcahy argues, since 'pedagogic affect incites learning and ethical action'.

Science and democracy

The relationship between science and the citizen has also been an enduring STS topic. In recent decades STS scholars have taken up the challenge of studying how uncertainties of the world are encountered, ordered and distributed, focusing on the anxieties and challenges unleashed by such events as mad cow disease (Hinchcliffe, 2001) and avian flu (Chien, 2013), global warming (Urry, 2015), antibiotic resistance (Gröndal, 2018) and genetically modified foods (Goodman, 2008). These events turned the world itself into a laboratory, and challenged notions of scientific expertise as well as democracy. When science is no longer confined to the laboratory, and when the consequences of actions are not known, people must have a say in 'scientific decisions'. But do ordinary citizens have the ability to participate in this decision-making? This crisis of democracy and scientific expertise has implications for education.

To participate effectively in contributing to debates and decisions on such urgent and controversial issues, citizens need to be aware both of the substantive matters and, more broadly, of how to evaluate truth claims. Teaching controversy mapping (a kind of technology based version of ANT) is one way in which some schools are beginning to respond to this project. In their article *Socioscientific issues via controversy mapping: Bringing actor-network theory into the science classroom with digital technology*, Mark Elam, Anne Solli and Åsa Mäkitalo (this issue) follow the fortunes of one such effort to introduce controversy mapping in a Swedish classroom. The idea was to use digital tools for controversy mapping to transport interdisciplinary scientific controversies into the classroom so that students could immerse themselves in and experience such disagreements as part of the school curriculum, rather than just having controversies presented them. In the article, this way of teaching is seen as a form of citizen education leading to what Dewey termed 'social intelligence' – a kind of democratic skill acquired 'through interaction with, and direct participation in, matters of shared concern' (Dewey, 1909). However, in this event, the focus shifted to mastering the technology and away from interdisciplinary engagement with the 'science' of the controversy. Focusing on the dynamics within schools and classrooms, this paper demonstrates the ability of ANT to provide nuanced accounts of how classrooms operate. The paper shows how mapping real scientific controversies is an authentic way to participate in democratic life itself. By doing this, the authors have also been able to show that the world-making of education is indeed a matter of politics by other means.

Metrics, politics and scientific objectivity

Practices with and of digital technologies, algorithms and datafication are areas of emphasis within STS and are urgent issues for education. Currently, the rise of digital technologies and big data that not only ‘read’ but also ‘make’ societies (Ruppert, 2011) are becoming increasingly common as research objects within many fields, including education. STS is admirably suited to the study of these new phenomena.

In *Adapting to the test: Performing algorithmic adaptivity in Danish schools* Laura Høvsgaard (this issue) focuses on small and mundane practices within the complex infrastructures of Danish education, namely the generation and calculation of student test results through adaptive testing. The study is a telling illustration of the STS logic that the world and the means with which we measure it are constructed simultaneously and that the making of measurable worlds involves always situated, but nevertheless powerful, practices. The study shows how, when the students do not easily fit into the frames with which they are measured, teachers are faced with a new task in making the students adaptable to the algorithm.

And then there is politics. STS scholars linked the rationality and objectivity that was promoted in claims about scientific knowledge construction to the liberal democratic culture in western societies. The neo-liberal claim of evidence-based policy which is unemotional and untainted by bias or ideology – a politics without the political – and its focus on efficiency and productivity are linked to science’s claim of apolitical rationality. The model of impersonal, depoliticised science provided the imaginary for a technical, instrumental, rational set of administrative processes in a liberal democracy (Hackett et al., 2008).

This ‘scientisation’ and ‘technicisation’ of policy is a topic of key interest in education. Education scholars have focused on various aspects of ‘evidence-based policy’ in the neo-liberal pursuit of efficiency, productivity and outcomes. STS can offer interesting concepts to scholars in education researching bureaucratic regimes and their effects, and of practices promoted by New Public Management and audit cultures (Strathern, 2000; 2003). With the enormous and growing influence of institutions like the OECD, the World Bank and UNESCO, and the international indicators and benchmarks they have created, these institutions have been increasingly the focus of many researchers in education. These institutions set norms for everything from teachers’ salaries and qualifications to class size and the percentage of GDP that should be spent on education. The current discourses of a global crisis in education – one that can, it is argued, only be solved by mobilising global data-generating mechanisms – is another case where STS topics overlap with topics of interest to education scholars. A related topic is the involvement of citizens in accountability through becoming ‘informed consumers’ and exercisers of choice in the quasi-markets of education (Gorur, 2018).

Studying educational science

Early STS work was preoccupied with studying science in practice, as in Latour and Woolgar’s seminal work *Laboratory Life: The Construction of Scientific Facts* (Latour & Woolgar, 1979). In this Special Issue Antti Saari and Esko Harni, draw on these roots in their article *Out of the Box: Behaviourism and the Mangle of Practice*,

where they take us back to the mid-twentieth century and the rise of behaviourism and its influence on education. Saari and Harni argue, with notions borrowed from Andrew Pickering, that behaviourism was a performative science whose processes were very much ‘mangled’ into its outcome, i.e. they are an example of “‘machinic” operations in science and technology, where human and material elements are “tuned” to each other to operate as a whole’. Saari and Harni then demonstrate in detail how these processes resulted in specific ideas on animal and human behaviour, and secondly, how these ideas managed to dissolve into learning and education strategies. In their conclusions, Saari and Harni direct our attention, in relation to the current discourse on ‘evidence’ in education, to the prevalent ‘politics of experimentation’ (Pickering, 2008, p. 13) – and ‘the way research practices and their applications are opening up and delimiting a set of possible forms of agency and developing their interplay’ (Saari & Harni, this issue). Their contribution shows the important continuities of behaviourism within the current datafication of student activities in the classroom.

Another way to conduct studies of science is to analyse and reconstruct ‘naturalised’ concepts. In their article *Performing Mundane Materiality*, Alfredo Salomão Filho and Annelies Kamp (this issue) challenge the Bourdieusian approach to social capital with an STS perspective, giving more room for symmetrical human/non-human relations, in what they call ‘social capital actor-networks’. Following 12 mobile students in Dublin in assemblages with non-human actors, their article offers consideration to issues of performativity and the relevance of materiality for empirical investigations into social capital. Filho and Kamp show that despite well-documented incompatibilities between Latourian and Bourdieusian approaches (Kale-Lostuvali, 2016; Schinkel, 2007), their common concern with the relational offers a fruitful space for theoretical connections. Not least, they argue that associating the teachings of ANT with social capital ‘creates a hybrid theoretical blend that embraces all the actors that demonstrate agential capacity’. Their data offers a good illustration of how an assemblage of reference letters, transcripts, policy documents, personal contacts and so on interplay to constitute the mobile students’ social capital.

Conclusion: STS and research in education

The knowledge practices and political practices of education provide good grounds for STS and ANT analyses. In this Special Issue, we present articles that explore the different ways STS and ANT concepts and sensibilities can be deployed in the field of education and education policy. The wide-ranging topics include education reform practices; regulation; context; innovation; standardisation; scientisation; evidence; the establishment of new disciplines; interdisciplinarity; knowledge-making; studies of educational institutions and their practices; the mobility of knowledge, people and technologies; material-semiotic studies of learning; classroom practices; and classroom research.

This growing diversity of STS work in education is an echo of the expansion of the scope and range of STS studies. Writing recently to commemorate 30 years of its existence, the Editor of the journal *Science & Technology Studies* recounts the wide variety of topics of the Special Issues that they have had over the years, including knowledge infrastructures, university-society relations, standardisation and social structure as well as numbers and numbering. This bodes well for the expansion of

STS research in education, as well as for exciting interdisciplinary engagement across different fields.

A key to STS and especially ANT is to take the material (or rather, the socio-material) seriously. As we have argued, education is made up of material conditions and preconditions, but still much educational theorising and analysis is built on a distancing of research from the material. That is, language, culture, subjectivity, discourse, norms, values, and social constructions are all issues that are addressed as something separated and different from the material. By advocating STS-sensibilities as relevant approaches in educational research, this special issue highlights the importance of the material and explicates the material and productive forces constituted through mixtures of human and non-human actors.

More broadly, this Special Issue engages with the making and unmaking of controversies in education and knowledge-making and the exploration of the ambiguities, multiplicities and mess that are intrinsic to apparently clear and stable routines. It promotes understandings of the performativity of mundane practices, the mechanics of power and the politics of everyday life (Woolgar & Neyland, 2013).

While educational practices cannot simply be reduced to power, they do offer another means to exercise it. As Mathias Decuyper describes in his afterword to this Special Issue, STS and ANT provide us with tools to ‘show how’ rather than ‘tell that’ this happens. He also distinguishes between those studies in educational research that use STS in a way that helps us in ‘making, remaking and unmaking’ education, and those that conceptualise STS as a form of education in and of itself, one that challenges traditional practices of teaching and learning.

The development of studies in education drawing on ANT or other STS approaches has not been along a straight or singular route. Being anti-essentialist and anti-foundationalist, ANT has invited researchers to be disloyal to the approach itself, and in this Special Issue we see how educational research has moved from quite traditional uses of ANT to include a variety of broader STS logics. We detect a lively confidence in the varied use of STS, and we see this as evidence of a certain maturity and development of the field. As this body of work gains momentum there will be new debates, new thinking and new and interesting intersections with other theories, which are much needed to engage with the many interesting – and often somewhat terrifying – issues that confront us in the field of education.

Notes

- ¹ The European Association for the Study of Science and Technology (EASST) and the Society for the Social Studies of Science (4S) host a joint conference every four years.
- ² Prominent examples are the journals *Social Studies of Science*, since 1970; *Science, Technology and Human Values*, since 1976; *Science, Technology and Society*, since 1996; and *Science and Technology Studies*, since 2012.
- ³ This origin story is disputed by Jasanoff (2012), who argues that STS has its roots in controversy studies, and points us to the work of the US-based scholar Dorothy Nelkin, and particularly *Controversy* (Nelkin, 1979), a textbook used in the STS course Nelkin taught at Cornell University.

References

- Addey, C. (2018). Assembling literacy as global: The danger of a single story. In M. Milana, S. Webb, J. Holford, R. Waller, & P. Jarvis (Eds.), *The Palgrave international handbook on adult and lifelong education and learning* (pp. 315–335). London: Palgrave Macmillan.

- Asdal, K. (2011). The office: The weakness of numbers and the production of non-authority. *Accounting Organizations and Society*, 36(1), 1–9. doi:10.1016/j.aos.2011.01.001
- Bijker, W. E. (1995). Sociohistorical technology studies. In S. Jasanoff, G. E. Markle, J. C. Petersen, & T. Pinch (Eds.), *Handbook of science and technology studies, Third edition* (pp. 229–256). Thousand Oaks, CA: Sage.
- Bijker, W. E., & Law, J. (1992). *Shaping technology/building society: Studies in sociotechnical change*. Cambridge, Mass.: MIT Press.
- Bowker, G. C., & Star, S. L. (2000). *Sorting things out: Classification and its consequences*. Cambridge, London: MIT Press.
- Callon, M. (1986). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuç Bay. In J. Law (Ed.), *Power, action, belief: A new sociology of knowledge* (pp. 196–233). London: Routledge.
- Callon, M., Lascoumes, P., & Barthe, Y. (2009). *Acting in an uncertain world: An essay on technical democracy*. Cambridge, Mass.: MIT Press.
- Callon, M., Law, J., & Rip, A. (1986). *Mapping the dynamics of science and technology: Sociology of science in the real world*. Basingstoke: Macmillan.
- Callon, M., & Muniesa, F. (2005). Economic markets as calculative collective devices. *Organization Studies*, 26(8), 1229–1250. doi:10.1177/0170840605056393.
- Camic, C., Gross, N., & Lamont, M. (Eds.) (2011). *Social knowledge in the making*. Chicago: University of Chicago Press.
- Chien, Y.-J. (2013). How did international agencies perceive the avian influenza problem? The adoption and manufacture of the ‘One World, One Health’ framework. *Sociology of Health & Illness*, 35(2), 213–226.
- Deleuze, G. (1988). *Spinoza, practical philosophy* (R. Hurley, Trans.). San Francisco: City Lights Books.
- Dewey, J. (1909). *Moral principles in education*. Boston: Houghton Mifflin Company.
- Dussauge, I., Helgesson, C.-F., & Lee, F. (Eds.) (2015). *Value practices in the life sciences and medicine*. Oxford: Oxford University Press.
- Espeland, W., & Stevens, M. (2009). A sociology of quantification. *Archives Europeennes de Sociologie*, 49(3), 401–436.
- Felt, U., Fouché, R., Miller, C. A., & Smith–Doerr, L. (2016). *The handbook of science and technology studies, Fourth edition*. Cambridge, Massachusetts, London, England: The MIT Press.
- Fenwick, T., & Edwards, R. (2010). *Actor-Network Theory in education*. London and New York: Routledge.
- Fenwick, T., Nerland, M., & Jensen, K. (2012). Sociomaterial approaches to conceptualising professional learning and practice. *Journal of Education and Work*, 25(1), 1–13.
- Fuller, S. (2006). *The philosophy of science and technology studies*. London: Routledge.
- Goodman, D. (2008). Agro-food studies in the ‘age of ecology’: Nature, corporeality, bio-politics. In R. Munton (Ed.), *The rural: Critical essays in human geography* (pp. 127–149). London: Routledge.
- Gorur, R. (2011a). ANT on the PISA trail: Following the statistical pursuit of certainty. *Educational Philosophy and Theory*, 43(S1), 76–93.
- Gorur, R. (2011b). Policy as assemblage. *European Educational Research Journal*, 10(4), 611–622.
- Gorur, R. (2017). Towards productive critique of large-scale comparisons in education. *Critical Studies in Education*, 58(3), 341–355. doi:10.1080/17508487.2017.1327876

- Gorur, R. (2018). Standards: Normative, interpretive and performative. In S. Lindblad, D. Pettersson, & T. S. Popkewitz (Eds.), *Numbers, education and the making of society: International assessments and its expertise* (pp. 92–109). New York: Routledge.
- Gröndal, H. (2018). *Unpacking rational use of antibiotics. Policy in medical practice and the medical debate*. Uppsala: Acta Universitatis Upsaliensis.
- Hackett, E. J., Amsterdamska, O., Lynch, M., & Wajcman, J. (2008). Introduction. In E. J. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), *The handbook of science and technology studies, Third Edition*. Cambridge, Massachusetts, London, England: The MIT Press.
- Hamilton, M. (2001). Privileged literacies: Policy, institutional process and the life of the IALS. *Language and Education*, 15(2–3), 178–196.
- Hamilton, M., Maddox, B., & Addey, C. (Eds.). (2015). *Literacy as numbers: Researching the politics and practices of international literacy assessment*. Cambridge University Press.
- Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies*, 14(3), 575–599.
- Helgesson, C.-F. (2016). Folded valuations? *Valuation Studies*, 4(2), 93–102.
- Hinchliffe, S. (2001). Indeterminacy in-decisions: Science, policy and politics in the BSE (Bovine Spongiform Encephalopathy) crisis. *Transactions of the Institute of British Geographers*, 26(2), 182–204.
- Jasanoff, S. (2004). The idiom of co-production. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and social order* (pp. 1–12). London, New York: Routledge.
- Jasanoff, S. (2005). *Designs on nature: Science and democracy in Europe and the United States*. Princeton, N.J.: Princeton University Press.
- Jasanoff, S. (2012). Genealogies of STS. *Social Studies of Science*, 42(3), 435–441.
- Jasanoff, S., & Kim, S. H. (2013). Sociotechnical imaginaries and national energy policies. *Science as Culture*, 22(2), 189–196. doi:10.1080/09505431.2013.786990
- Jasanoff, S., Markle, G. E., Peterson, J. C., & Pinch, T. (1995). *Handbook of science and technology studies*. Thousand Oaks, California: SAGE Publication, Inc.
- Kale-Lostuvali, E. (2016). Two sociologies of science in search of truth: Bourdieu versus Latour. *Social Epistemology*, 30(3), 273–296.
- Kuhn, T. S. (1962/2012). *The structure of scientific revolutions*. Chicago & London: The University of Chicago Press.
- Knorr-Cetina, K. (1999). *Epistemic cultures: How the sciences make knowledge*. Cambridge, Mass: Harvard University Press.
- Lampland, M. & Star, S. L. (Eds.) (2009). *Standards and their stories: How quantifying, classifying, and formalizing practices shape everyday life*. Ithaca, NY: Cornell University Press.
- Landri, P. (2018). *Digital governance of education. Technology, standards and Europeanization*. London: Bloomsbury.
- Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Cambridge, Massachusetts: Harvard University Press.
- Latour, B. (1988). *The pasteurization of France*. Cambridge, Massachusetts: Harvard University Press.
- Latour, B. (1992). Where are the missing masses? The sociology of a few mundane artifacts. In W. E. Bijker, & J. Law (Eds.), *Shaping technology/building society: Studies in sociotechnical change* (pp. 225–258). Cambridge: MIT Press.
- Latour, B. (2005). *Reassembling the social: An introduction to Actor-Network Theory*. Oxford: Oxford University Press.

- Latour, B., & Woolgar, S. (1979). *Laboratory life: The construction of scientific facts*. Princeton, NJ: Princeton University Press.
- Law, J. (1991). *A Sociology of monsters: Essays on power, technology, and domination*. London ; New York: Routledge.
- Law, J. (2009). Actor network theory and material semiotics. In B. S. Turner (Ed.), *The New Blackwell Companion to social theory* (pp. 141–158). Online: Wiley-Blackwell.
- Lundahl, C. (2014). The book of books: Encyclopaedic writing in the science of education in the 1980s. In A. Nordin, & D. Sundberg (Eds.), *Transnational policy flows in European education* (pp. 79–103). London: Symposion Books.
- Lynch, M. (1985). *Art and artifact in laboratory science: A study of shop work and shop talk in a research laboratory*. London: Routledge.
- Marres, N. (2015). Why map issues? On controversy analysis as a digital method. *Science, Technology & Human Values*, 40(5), 655–686.
- Mol, A. (2002). *The body multiple: Ontology in medical practice*. Durham: Duke University Press.
- Nespor, J. (1994). *Knowledge in motion. Space, time and curriculum in undergraduate physics and management*. Oxon: RoutledgeFalmer.
- Nelkin, D. (1979). *Controversy: Politics of technical decisions*. Beverly Hills: Sage.
- Ong, A. (2007). Neoliberalism as a mobile technology. *Transactions of the Institute for British Geographers*, NS 32, 3–8.
- Ong, A., & Collier, S. J. (2005). Global assemblages, anthropological problems. In A. Ong, & S. J. Collier (Eds.), *Global assemblages: Technology, politics, and ethics as anthropological problems* (pp. 3–22). Oxford, UK: Blackwell Publishing Ltd.
- Piattoeva, N., Klutas, A. & Souminen, O. (2019). Making and Mobilising Contexts in Policy and Research. In R. Gorur, S. Sellar, & G. Steiner-Khamsi (Eds), *World Yearbook of Education 2019: Comparative methodology in the era of big data and global networks* (pp. 1–9). London and New York: Routledge.
- Pickering, A. (2008). New ontologies. In A. Pickering, & K. Guzik (Eds.), *The mangle in practice: Science, society and becoming* (pp. 1–14). Durham: Duke University Press
- Porter, T. M. (1995). *Trust in numbers: The pursuit of objectivity in science and public life*. Princeton, N.J.: Princeton University Press.
- Ruppert, E. (2011). Population objects: Interpassive subjects. *Sociology*, 45(2), 218–233.
- Schinkel, W. (2007). Sociological discourse of the relational: The cases of Bourdieu & Latour. *The Sociological Review*, 55(4), 707–729.
- Strathern, M. (2000). The tyranny of transparency. *British Educational Research Journal*, 26(3), 309–321.
- Strathern, M. (2003). New accountabilities. In M. Strathern (Ed.), *Anthropological studies in accountability, ethics and the academy* (pp. 1–18). Florence: Taylor and Francis.
- Suchman, L. (2016). 4S President's message – September 2016. Retrieved from: http://www.4sonline.org/item/4s_presidents_message_september_2016
- Sundström Sjödin, E., & Wahlström N. (Forthcoming) The wing chair: Where is the critical in literacy? (Unpublished manuscript.)
- Sørensen, E. (2009). *The materiality of learning: Technology and knowledge in educational practice*. Cambridge: Cambridge University Press.
- Timmermans, S., & Berg, M. (2003). *The gold standard: The challenge of evidence-based medicine and standardization in health care*. Philadelphia: Temple University Press.

- Urry, J. (2015). Climate change and society. In J. Michie, & C. L. Cooper (Eds.), *Why the social sciences matter* (pp. 45–59). London: Palgrave Macmillan.
- Verran, H. (2001). *Science and an African logic*. Chicago: University of Chicago Press.
- Williamson, B. (2019). Intimate data infrastructures: Emerging comparative methods of predictive analytics and psycho-informatics. In R. Gorur, S. Sellar, & G. Steiner-Khamsi (Eds.), *World Yearbook of Education 2019: Comparative methodologies in the era of big data and global networks* (pp. 59–75). Oxon and New York: Routledge.
- Woolgar, S., & Neyland, D. (2013). *Mundane governance: Ontology and accountability*. Oxford: Oxford University Press.