

Introduction: Reclaiming and Renewing Actor Network Theory for Educational Research

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Actor-network theory (ANT) continues to enjoy a lively trajectory in the social sciences since its emergence in the early 1980s at the Centre de Sociologie de l'Innovation (CSI) of the École nationale supérieure des mines de Paris. Largely associated with its progenitors in science and technology studies including Bruno Latour, John Law and Michael Callon, ANT has contributed an important series of analytic approaches and considerations that rupture certain central assumptions about knowledge, subjectivity, the real and the social. The focus is on the socio-material—and how minute relations among objects bring about the world. Analyses drawing upon ANT trace how different human and nonhuman entities come to be assembled, to associate and exercise force, and to persist or decline over time. Nothing is given or anterior, including 'the human', 'the social', 'subjectivity', 'mind', 'the local', 'structures' and other categories common in educational analyses. Throughout the 1980s and 1990s, ANT figured prominently in studies published in sociology, technology, feminism, cultural geography, organization and management, environmental planning, and health care. With a few limited exceptions, however, educational research in the main has not demonstrated a similar enthusiasm in the uptake of ANT.

We are among those who believe that ANT offers truly important insights about the processes and objects of education. This is in spite of, or actually partly because of, its mutations in the past two decades into a highly diffuse, diverse and contested set of framings and practices. Its own key commentators refuse to call it a 'theory' as though ANT were some coherent explanatory device. It may be more accurate to think of ANT as a virtual 'cloud', continually moving, shrinking and stretching, dissolving in any attempt to grasp it firmly. ANT is not 'applied' like a theoretical technology, but is more like a sensibility, a way to sense and draw (nearer to) a phenomenon. For educational researchers, as we argue in Fenwick & Edwards (2010) and Fenwick, et al. (2011), ANT's language can open new questions and its approaches can sense phenomena in rich ways that discern the difficult ambivalences, messes, multiplicities and contradictions that are embedded in so many educational issues.

This book is an experiment, intended to engage readers in the question: What work can ANT do in educational research? To bring some focus to the book, we called for chapters addressing issues of educational change or reform. The authors employ a range of ANT constructs to explore and perform educational change in highly diverse manifestations: integration of new technology, a large-scale school improvement initiative, everyday curriculum enactments, development of international standardized tests, introduction of teacher evaluation systems, and implementation of a literacy program. Each author argues for the unique analysis that ANT approaches enable, yielding overall an important expansion of how we engage with educational change. While one object of each chapter is to show an ANT sensibility at work with a particular researcher in a particular environment of concerns, each also focuses, as ANT studies are expected to do, on tracing the rich material details of the actual actors and their story being followed by the researcher. The remainder of this introduction outlines ANT for those who may be newcomers to its ideas and approaches, and offers a glimpse of the chapters.

About Actor-Network Theory

The risk in explaining ANT is distorting and domesticating it. Its ideas are practices for understanding, not a totalizing theory of the world and its problems. Jan Nesper puts it well in his chapter when he describes ANT ideas as 'ontological acids undermining reductive explanations and pushing us towards engagements with evidence'. The more well-known ANT ideas that authors have taken up are described here briefly, including symmetry, translation, network ontology, network effects, (im)mutable mobiles, obligatory points of passage, and scale play. We also introduce selected critiques of ANT and certain 'after-ANT' conceptions such as multiple ontologies. We hope to avoid the trap of re-establishing and imposing a purity of ANT-ness that Law (1999, p. 10) has warned of: 'Only dead theories and dead practices celebrate their identity'.

ANT examines the interconnections of human and nonhuman entities based upon an anti-foundationalist approach in which nothing exists prior to its performance or enactment. Human intention and action are therefore decentred in this approach. The objective is to understand how these things come together—and manage to hold together—to assemble collectives or 'networks' that produce force and other effects: knowledge, identities, routines, behaviours, policies, curricula, innovations, oppressions, reforms, illnesses and on and on. ANT thus helps us to ask: What are the different kinds of connections and associations created among things? What different kinds and qualities of networks are produced through these connections? What different ends are served through these networks? A key assumption is that humans are not treated any differently from nonhumans in ANT analyses. This assumption, elaborated by Bruno Latour (1987), is called 'symmetry'. Everyday objects and parts of objects, memories, intentions, technologies, bacteria, texts, furniture, bodies, chemicals, plants ... all things are assumed to be capable of exerting force and joining together, changing and being changed by each other. The networks thus formed can keep expanding to extend across broad spaces, long distances or time periods. Of course, networks can also break down, or dissolve, or become abandoned. ANT analyses show how things are attracted into or excluded from these networks, how some linkages work and others do not, and how connections are bolstered to make themselves stable and durable by linking to other networks and things. In particular, ANT analyses focus on the minute negotiations that go on at the points of connection. Things persuade, coerce, seduce, resist, and compromise each other as they come together. They may connect with other things in ways that gather them into a particular collective, or they may pretend to connect, partially connect, or feel disconnected and excluded even when they are connected.

Latour (1999) fights any ontological separation between materiality and meaning as a rupture between the thing and its sign that are part of each object. He considers a central problem to be the 'circulating reference' between words and world that attempts to transform matter, the objects of knowledge, into representations, as though there were justifiable a priori distinctions between mind/matter or object/sign. He, like Ian Hacking (2000) and Deborah Barad (2007), is therefore critical of social constructivists as well as realists in assuming that materiality and representation are separate realms. The important point is that ANT focuses not on what texts and other objects mean, but on what they do. And what they do is always in connection with other human and nonhuman things. Some of these connections link together to form an identifiable entity or assemblage, which is referred to as an 'actor' that can exert force. 'Playground', for example, represents a continuous collaboration of bats and balls, swing installations, fences, grassy hills, sand pits, children's bodies

and their capacities, game discourses, supervisory gazes, safety rules, and so on. This playground is both a moving assemblage or network of things that have become connected in a particular way, and an actor that can produce fears, policies, pedagogies, forms of play and resistances to these forms—hence, actor-network. And the objects that have become part of this actor-network are themselves effects, produced by particular interactions with one another.

ANT analyses try to faithfully trace all of these negotiations and their effects. In the process, they show how the entities that we commonly work with in educational research— classrooms, teaching, students, knowledge generation, curriculum, policy, standardized testing, inequities, school reform—are in fact assemblies or gatherings of myriad things that order and govern educational practices. Yet, these assemblies are often precarious networks that require a great deal of ongoing work to sustain their linkages. So, such analyses can show how such assemblages can be unmade as well as made, and how counter-networks or alternative forms and spaces take shape and develop strength. The focus is on how things are enacted rather than attempting to explain why they are the way they are.

Those familiar with ANT debates will know that many speak of ‘after-ANT’ or ‘post-ANT’. Some avoid using explicit ANT terminology, characterizing their work as complexity, socio-materiality, material semiotics, or STS (science and technology studies). The frustration expressed by the most prominent ANT commentators is that many early ANT studies reified concepts such as networks, solidified particular models of analysis, and colonized their objects of inquiry in representational ways that ANT approaches were intended to disrupt. A landmark volume of essays entitled *Actor Network Theory and After* (Law, 1999) was premised on the assumption that ANT ideas proliferating throughout the 1990s had largely run into an impasse. At that time Law (1999), for example, worried that ANT’s topological assumptions had come to homogenize the possibilities of understanding complexity in spatial and relational socio-material events. Other authors, representing leading scholars associated with ANT at that time, declared various approaches forward that included eliminating or replacing certain naturalized ANT language and models, delimiting ANT’s claims and opening its conceptual scope.

At the time of this writing, thirteen years on from the publication of *Actor Network Theory and After*, there has been a remarkable profusion of ANT studies, critiques and hybrid theoretical blends as ANT has travelled across disciplines ranging from feminist technology studies to cyber-punk semiotics to environmental activism. Some authors have argued for ANT’s particular value in educational research (e.g. see Edwards, 2002; Nespor, 2002; McGregor, 2004; Waltz, 2006; Mulcahy, 2007; Harmon, 2007; Fenwick and Edwards, 2010). These explorations have each helped to extend and reconfigure ANT ideas, opening challenging questions and ways of thinking for educational researchers. We believe that it is more helpful to use one term ‘actor-network theory’ to refer to this constellation of ideas that have associated themselves with ‘ANT’ at some point, rather than to attempt problematic periodizations of early-ANT, after-ANT, ANT-diaspora and so forth. We employ ANT as a marker— understood to be a contingent and conflicted signifier—for approaches that share notions of symmetry, network broadly conceived, and translation in multiple and shifting formulations.

Translation—How Change Occurs

In some early formulations, ANT has been described as a 'sociology of translation'. Translation is the term used by Latour (1987) to describe what happens when entities, human and nonhuman, come together and connect, changing one other to form links. At each of these connections, one entity has worked upon another to translate or change it to become part of a network of coordinated things and actions. 'Entity' is a loose way to refer to various things that can be human and nonhuman, including different kinds of material objects and immaterial (conceptual, moral, virtual) objects and actions, that are not pre-given, essentialized and defined. As Law (1999) tries to explain, an entity is more than one and less than many, not a multiplicity of bits nor a plurality, a division into two or more others. In traditional ANT language, while the working entity is called an 'actor', the worked-upon entity is referred to as an 'actant'. In other words according to Latour (1999, p. 18), when the actant becomes translated to become a performing part of the network, the actant behaves with what appears to be particular intentions, morals, even consciousness and subjectivity. In other words, when translation has succeeded, the entity that is being worked upon is mobilized to assume a particular role and perform knowledge in a particular way. It performs as an actor.

Translation is neither deterministic nor linear, for what entities do when they come together is probable but unpredictable. They negotiate their connections, using persuasion, force, mechanical logic, seduction, resistance, pretence, and subterfuge. Connections take different forms, some more elastic, tenuous, or long-lasting than others. Translations may be incremental, or delayed across space and time. Entities may only peripherally allow themselves to be translated by the network. In Latour's (2005) ontology, entities undergo myriad negotiations throughout the process of translation. For Harmon (2007), this is an important contribution of ANT to education: tracing exactly how entities are not just effects of their interactions with others, but are also always acting on others, subjugating others and making things possible. All are fragile, and all are powerful, held in balance with their interactions. None is inherently strong or weak, but only becomes strong by assembling other allies.

Eventually these dynamic attempts by actors to translate one another can appear to become stabilized: the network can settle into a stable process or object that maintains itself. Like a black box, it appears naturalized, purified, immutable and inevitable, while concealing all the negotiations that brought it into existence. Examples would be a mandated list of teaching competencies, or an 'evidence-based' educational practice accepted as 'gold standard'. Each entity also belongs to other networks in which it is called to act differently, taking on different shapes and capacities. A teaching contract, for example, is a technology that embeds knowledge, both from networks that produced it and networks that have established its use, possibilities and constraints. In any employment arrangement, the contract can be ignored, manipulated in various ways, or ascribed different forms of power. Thus, no agent or knowledge has an essential existence outside a given network: nothing is given in the order of things, but performs itself into existence. And however stable and entrenched it may appear, no network is immutable. Counter-networks are constantly springing up to challenge existing networks. Continuous effort is required to hold networks together, to bolster the breakages and counter the subterfuges.

Networks

If translation is what happens at the nodes of a network, where one entity successfully acts upon another, how does a network actually grow? One suggestion was offered in ANT's early years by

Callon (1986), in a much-cited and critiqued conception of networks assembling and extending themselves through 'moments' of translation. The critiques have centred on problematic applications of Callon's ideas as a fixed model which tends to distort the complexity it was intended to liberate. This is undoubtedly as true in educational research as it has been in other fields of social science. However, there also exist educational studies showing the utility of Callon's moments of translation in illuminating how some networks become so durable and apparently powerful in education, exerting influence across far-flung geographic spaces and time periods. Callon (1986) proposed that some types of network begin with problematisation where something tries to establish itself as an 'obligatory passage point' that frames an idea, intermediary or problem and related entities in particular ways. The translations whereby separate entities are somehow attracted or invited to this framing and where they negotiate their connection and role in the emerging network Callon called *interessement*, which not only selects those entities to be included but also importantly those to be excluded. Those entities to be included experience enrolment in the network relations, the process whereby they become engaged in new identities and behaviours and increasingly translated in particular directions. When the network becomes sufficiently durable its translations are extended to other locations and domains through a process of mobilization.

In ANT terms, a network is an assemblage or gathering of materials brought together and linked through processes of translation, that together perform a particular enactment. A textbook or an educational article, for example, each bring together, frame, select and freeze in one form a whole series of meetings, voices, explorations, conflicts, possibilities explored and discarded. Yet these inscriptions appear seamless and given, concealing the many negotiations of the network that produced it. And a textbook or article can circulate across vast spaces and times, gathering allies, shaping thoughts and actions and thus creating new networks. The more allies and connections, the stronger the network becomes. Law (1999, p. 7) explains that in a network 'elements retain their spatial integrity by virtue of their position in a set of links or relations. Object integrity, then is not about a volume within a large Euclidean volume. It is rather about holding patterns of links stable'.

ANT's network ontology is particularly useful for enabling rich analyses of contexts, which have become increasingly important in educational analyses of pedagogy, curriculum and educational change (Edwards, et al. 2009). Contexts such as schools, lecture halls and workplaces are created and continually shaped through social and material processes. These folds and overlaps of practises are very much about network relations. In fact, human geographers have long worked with ANT, using its ideas, critiquing and extending them, to understand social space as a multiplicity of entities engaged in fluid, simultaneous, multiple networks of relations (see Murdoch, 2006, for a review). Power is central to any understanding of space and context as produced through networks of socio-material relations. ANT analyses can also trace how assemblages may solidify certain relations of power in ways that continue to affect movements and identities. For example, the sedimentation of power relations in educational spaces and their continuing effects are ubiquitous. Nespor's (1994) oft-cited study of the differences in social behaviour and curricula between physics and business students at a university examines the ways that architecture interacts with particular codified knowledge to order flows of action, people and objects, constituting space in fundamentally different ways.

In ANT's early years the notion of network was employed to suggest both flow and clear points of connection among the heterogeneous entities that became assembled to perform particular

practices and processes. However, with the proliferation of technological network systems and the ubiquity of the network metaphor to represent such phenomena as globalization and social capital, the term has problematically suggested flat linear chains, enclosed pipelines and ossified tracks. Frankham (2006) points out how educators have particular reason for caution when networks are everywhere invoked to represent idealized learning communities that are homogenous and a-political. ANT-associated writings have explored alternate metaphors of regions and fluid spaces (Mol & Law, 1994) to approach the complexity of socio-material events and avoid imposing a linear network model on the ineffable and imminent. Some have explored ways of retaining notions of network by refusing pipeline associations and showing diverse shapes and forms that a network can assume. Some networks are provisional and divergent, while others are tightly ordered, stable and prescriptive.

One problem with this network conception is what and where one should focus in conducting educational research. Miettinen (1999) makes this point in his critique of ANT, arguing that the network ontology is infinite and therefore unworkable for researchers. Indeed 'cutting the network' (Strathern, 1996) has always been deemed a necessary aspect of using ANT in research, but being explicit about how that enacts the effects of research in certain ways. Wherever one marks boundaries around a particular phenomenon to trace its network relations, there is a danger of both privileging that network and rendering invisible its multiple supports. Critiques of ANT studies have noted their fondness for examining powerful, visible networks, and their tendency to reproduce network participants' views of their reality (Hassard et al., 1999). Representations of networks are themselves concrete, implying the realities to be far more stable and durable than imminent, precarious shifting socio-material relations ever can be.

Familiar issues of reflexivity are no less problematic in ANT accounts, which can objectify networks as something produced solely in the eye of the researcher, and simultaneously forget to paint the researcher's representations into the portrayal of network translations, thereby leaving the entire analysis in control of the researchers. This not only turns a supposedly heterogeneous, symmetrical perspective into a decidedly human-centred one, but also pretends to honour uncertainty and messiness in what is in effect a pre-determined account. In choosing a focus for study, ANT researchers confront McLean and Hassard's (2004, p. 516) challenge:

... to produce accounts that are sophisticated yet robust enough to negate the twin charges of symmetrical absence or symmetrical absurdity [and] to understand the paradoxical situations in which ANT researchers find themselves in conducting field studies and producing accounts, notably in respect of notions of power, orderings and distributions.

This is what the contributors to this book have attempted.

Effects of Networks— Agency, Power, Identity and Knowledge

The over-riding insight of ANT views of the world is that all objects, as well as all persons, knowledge, and locations, are relational effects. The teacher is an effect of the timetable that places her in a particular room with particular students, in a class designated as Social Studies 6, amongst textbooks, class plans and bulletin boards and stacks of graded papers with which she interacts, teaching ideas and readings she has accumulated in particular relationships that have emerged with this year's class of children. In the pedagogical practices of her work, she is a 'knowing location'. In

one example, McGregor (2004, p. 366) traces how the teacher as knowing location is produced in Science classrooms through:

... the laboratory, with its electricity points, water and gas lines. The Bunsen burners and flasks set up by the technicians, who have also ordered and prepared the necessary chemicals according to the requisition sheet, the textbooks and worksheets that the students are using. Mobilized also are the teacher's experience and education.

These are further affected by networks of activity that composed and timetabled the student group in a particular way and allocated the teaching assistants. These things that act at a distance—buzzer, database, textbooks—are what Latour (1987) originally called immutable mobiles. Immutable mobiles are only visible within a particular network of relations. They can be silent, ignored, or overridden by other active objects. However, they have developed enough solidity to be able to move about and still hold their relations in place. In effect, they function as the delegates of these other networks, extending their power by moving into different spaces and working to translate entities to behave in particular ways. Law and Singleton (2005) explain that whether an object is more or less abstract (a pedagogical idea compared to an instrument) is less the point, because the key feature is that it is identified, has material effects, in particular networks of historical, cultural, behavioural relations that make it visible.

But many immutable mobiles are not at all immutable: they break and shift, grow and adapt and mutate as they travel. Returning to the teacher as a knowing location, what of her agency and subjectivity? She is planning lessons, choosing particular pedagogical approaches, deciding whether to solve the myriad classroom problems that emerge in this way or that. How does ANT avoid casting her as determined and recognize her own force exercised through her pedagogical participation? How does ANT understand the sources and effects of her intentions, her desires, and the meanings she makes of her pedagogical encounters with students? Certain critiques of ANT have accused it of failing to appreciate what is fundamentally human and subjective in flows of action, suggesting that perhaps it ought to modify its stance of radical symmetry to admit that humans are different because they make symbolic meaning of events and exert intentional action (Murdoch, 1998).

However, ANT's ontology of folding and unfolding networks is incommensurate with any agency/structure dualism. Nor does ANT conceptualize agency as an individuated source of empowerment rooted in conscious intentions that mobilize action. Instead, ANT focuses on the circulating forces that get things done through a network of elements acting upon one another.

Action is not done under the full control of consciousness; action should rather be felt as a node, a knot, and a conglomerate of many surprising sets of agencies that have to be slowly disentangled. It is this venerable source of uncertainty that we wish to render vivid again in the odd expression of actor-network. (Latour, 2005, p. 44)

What appears to be the teacher's agency is an effect of different forces including actions, desires, capacities and connections that move through her, as well as the forces exerted by the texts and technologies in all educational encounters. While networks and other flows circulate through the teacher's practices, her own actions, desires and so on are not determined by the network, but emerge through the myriad translations that are negotiated among all the movements, talk, materials, emotions and discourses making up the classroom's everyday encounters.

Pondering ANT's utility in overcoming the limitations of inter-subjective or humanist conceptions of agency in education, Leander and Lovvorn (2006, p. 301) warn that 'removing the agency of texts and tools in formalizing movements risks romanticizing the practices as well as the humans in them; focusing uniquely on the texts and tools lapses into naïve formalism or technocentrism'. Agency is directly related to the heterogeneity of actors in networked relations. These are not actors plus fields of forces or context, but actants which can only proceed to action by association with others who may surprise or exceed. As McGregor (2004, p. 367) concludes from her study of teachers in science education, 'knowing is a relational effect where pedagogy is a collective accomplishment and learning a situated activity'.

Some immutable mobiles become what Latour (1987) has called obligatory points of passage, central assemblages through which all relations in the network must flow at some time. A teacher's mathematics curriculum guide, for example, functions as an obligatory point of passage. Her lesson plans, her choice of texts and assignments must all at least appear to be aligned with it, and are at least partially translated by its prescriptions. Thus this teacher's knowledge and activity, along with all the other mathematics teachers and classes, those that assist them, the administrators that supervise them and the textbook publishers preparing materials for them, must pass through this obligatory point, this curriculum guide, to form their own networks.

The network effects that produce these immutable mobiles and obligatory points of passage are important dynamics in the power relations circumscribing education. The circulation and effects of these objects can assemble powerful centres that accumulate increasingly wider reaches of networks to hold them in place. Delegation, the ability to act at a distance through objects, is one way that power circulates through a network. How fast these immutable mobiles move, their fidelity or how immutable they really are as they move through diverse networks, and what entities they encounter or damage they sustain to their internal network relations, are questions worthy of exploration in different educational interests.

Scale is another important area for consideration. In fact, as Law and Hetherington (2003) note, if space is performed, if it is an effect of heterogeneous material relations, then distance is also performed. What makes near and far, here or there, is not a static separation between two points that is travelled by some object. Instead, these concepts of distance and location are created by relations that are always changing. When multiple points are linked together through actor-networks, the concepts of micro- and macro- do not hold. The teacher planning her morning class and the final meeting of the curriculum guide developers simply represent different parts of a network that has become extended though space as well as time. There do not exist as separated spaces of the 'local' and 'global', as though these are identifiable and distinct regions. Instead, these are scale effects produced through network relations. A series of intricate links runs among the different enactments of, for example, an educational policy whether visible in OECD documents, school district databases, parent discussions, or a teacher's correction of a student. ANT analyses upend and play with notions of scale, eschewing scale as ontologically distinct layers or regions, in ways that help to penetrate some of the more nuanced and multi-faceted circulations of power in educational practice and knowledge.

Similarly, macro notions of social structure are not comprehensible in ANT logic. When anyone speaks of a system or structure ANT asks: How has it been compiled? Where is it? Where can I find

it? What is holding it together? Soon one sees a number of sites and conduits, and the connections among them. While some have criticized ANT for supposedly failing to address broader macro social structures of capitalism, racism, class-gender relations and so forth in a preoccupation with the local and contingent, ANT commentators reject the dualism of the micro and macro. There are no suprastructural entities, explains Latour (1999, p. 18), because ‘big does not mean “really” big or “overall” or “overarching”, but connected, blind, local, mediated, related’.

As much as network relations are useful to trace in these dynamics of delegation, obligatory points of passage and scale play, the temptation to collapse all interactions and connections into networks needs to be avoided. While most entities and forces are usefully viewed as effects within an ANT-ish gaze, not all relations that contribute to producing these effects will be networks. There are other types of regions, other kinds of connections, other forms of space and foldings that work alongside and through networks, as Hetherington and Law (2000) describe. Indeed, argues Singleton (2005) in analysing the enactment of public policy, the relative stability of certain networks occurs not through their coherences but through their incoherences and ambivalences. An overly narrow preoccupation with network relations speaks to a bias that will inevitably banish from sight some of the more puzzling messiness of educational phenomena.

This is not to downplay the importance of understanding entities and forces as effects. It is to encourage more open and rich exploration of the multiple forms, lines and textures of materials that come together in different ways to produce these effects. Similarly, learning in ANT logic is not a matter of mental calculation or changes in consciousness. Instead, any changes we might describe as learning, such as new ideas, innovations, changes in behaviour, transformation, emerge through the effects of relational interactions that may be messy and incoherent, and spread across time and space. As Fox (2005) explains in analysing learning processes in higher education, competence or knowledge from an ANT perspective is not a latent attribute of any one element or individual, but a property of some actions rather than others as a network becomes enacted into being. The process of enactment, this interplay of force relations among technology, objects and changes in knowledge at every point in the network, is a continuing struggle. This struggle is learning. This conceptualization offers a way to think about education that steps outside of the ‘enculturation’ project that typifies pedagogies ranging from the emancipatory to the transmissive. Regardless of ideological persuasion or educative purpose, they claim that education imposes some future ideal on present human subjects and activities with the objective of developing learners’ potential to become knowledgeable, civic-minded, self-aware, and so forth.

However, since ANT views all things as emerging through their interconnections in networks, where their nature and behaviours are never inherent but are produced through continuous interactions and negotiations, there can be no conception of ‘future potential’. This is a powerful counter-narrative to the conventional view of developmentalism that dominates the pedagogical gaze, positioning learners in continual deficit and learning activities as preparation for some imagined ideal. ANT’s ontology forces attention on all the work that is too easily swept away by such neat developmental teleologies.

Translation, Devices and Assemblages in Education

In the chapters collected here, authors consider various cases of educational change through the analytic approaches afforded by ANT. Using ANT implies that to theorize is to intervene and

experiment rather than to abstract and represent. Thus, the chapters attempt to enact ANT rather than simply, and as we have largely done in this introduction, enact about ANT. As Jan Nesper points out, ANT's focus on objects such as technological 'devices' can unsettle the ways we consider educational change: 'redrawing our understandings of the relations of globalizing and localizing processes, slow and fast networks—and of drawing attention to devices as relatively neglected elements of change processes'. In one case, Nesper follows the many translations enacted in setting up instructional television at one university during the 1970s, and its evolution in subsequent decades to interactive video. The translations link global networks such as the ITV device itself, broadcasts, visions for educational technology, etc. with local networks such as classrooms, curricula and the technology unit in the university. Nesper finds that some of these translations are reversible or short-lived, while others are 'irreversible' and persistent, just as some networks such as technological product development are 'speeded-up' while others such as behaviourist pedagogy are 'slow, congealed'.

He shows that the challenge for those entrusted with managing educational change is to articulate these different networks at play to bring them 'into sync' at appropriate times for different audiences such as professors, administrators, programmers, and the State Commission. Nesper contrasts this example with a moving narrative of developing assistive technology for a boy with severe cerebral palsy to enable him to take tests in school. The device emerged through translations such as physical 'tinkering' and experimenting, articulating with and attempting translations of other global networks such as administrative record-keeping and exclusionary practices of segregating special education students. In both cases, he shows how devices translate, how phenomena can be seen and produce major changes in their organizations. Yet the relative 'success' of the devices is ambiguous, and the devices themselves, their contexts of production and the changes they generate differ dramatically.

A fundamental and ubiquitous activity of educational change is the everyday implementation of prescribed curriculum. Drawing upon a case study developed elsewhere (Fenwick and Edwards, 2010), Richard Edwards employs the ANT conceptions of translation and token to examine how this implementation occurs—not as diffusion of the prescription, but as multiple enactments. His case studies, classes for vocational cooking skills in a local UK college and a UK school, reveal the diverse connections among conversations, tastings and objects ranging from students' iPods, white chef coats and textbooks to the cooking knives, pots and smells. Edwards traces the processes through which curriculum-making occurs as a series of network effects through the myriad objects that weave and glue together in classroom activity. As he follows these networks, some embedded in objects or trailed into the class activities from wider outside networks, and others emerging in the everyday entanglement of these entities, he shows how curriculum-making is necessarily multiple and heterogeneous. Enactment of the prescribed, standardized curriculum, therefore, is always a betrayal of the prescription, always a new series of surprising translations.

Over the years, Mary Hamilton has drawn upon ANT to explore how an international marker of educational standards, the International Adult Literacy Survey, both emerged but also how it is translated into policy and practice at different scales. Her chapter focuses in particular on the English Skills for Life policy. She draws upon the early concepts of the moments of translation through which to trace the ways in which the very notion of Skills for Life becomes stabilized as a policy discourse. The ways in which order is enacted in and through policy and in the process becomes taken for

granted or naturalized, while also to be found in ideology critique of policy, can only fully be materially traced through ANT.

The enactments of standards in education is the specific focus of the article by Dianne Mulcahy. She explores the ways in which professional standards for teachers are translated into particular forms of teacher work and identity, drawing upon what she refers to as the ontological turn in ANT at the end of the 1990's. Mulcahy is here referring to the moves by people such as Annemarie Mol and John Law to develop framings that focused specifically on the material and semiotic as integral to each other and on a multiple ontologies view. Much contemporary ANT analysis has moved from the one world/many perspectives view associated with phenomenology to a many worlds perspective (Mol, 2002). Mulcahy shows the diverse enactments of standards as both representations and as performances, sometimes simultaneously in different sites. For her, 'standards are primarily to be seen not in terms of the intrinsic capabilities or potentialities of teaching professionals, or in terms of an extrinsic language of practice, but rather performances of teaching and learning in networks of practice' (emphasis in original). She concludes that these very different performances ought not to be reconciled, but held together in tension.

Tara Fenwick is also interested in how ANT helps to elaborate the tensions and ambivalences in networked spaces and performances. Drawing upon previous explorations of this issue (Fenwick and Edwards, 2010), she contrasts two cases of educational reform, one a province-wide school improvement initiative in Alberta, Canada that becomes enacted through the enrolment of school districts, staff, parents, unions, etc. This long standing reform process to support school-based action research projects to enhance student achievement has been deemed a 'success' because of levels of participation and the outcomes achieved. Fenwick traces the diverse networks at play in this policy enactment, showing co-existing counter-networks, ambiguous connections, and translations that work in different ways at different points. These activities are all assembled together in varying degrees of tension that seem to be necessary to the overall reform. Fenwick therefore makes visible not only the emergence of the policy network and its effects but also the counter networks and alternative spatializations through which the reform is undermined, contested, ignored, etc.

As is the case for many educational researchers, Radhika Gorur shifts the focus to the supra-national, and is interested in how a particular entity of educational knowledge emerges in ways that can exercise fundamental change. She chooses as her case the OECD's Programme for International Student Assessment (PISA). Contemporary educational analysts (e.g. Grek, 2009) are increasingly concerned about how PISA is being used to govern education transnationally and to translate complex educational processes into static data. Gorur, however, is more interested in how PISA as a form of knowledge with apparent universal acceptance and impact came into being. She follows a method developed by Latour to trace how certain forms of scientific knowledge emerge and become powerful. Such knowledge achieves stabilization through everyday material practices that combine and align wide-ranging objects, ideas and behaviours. In her study of PISA's architects and decision-makers, Gorur adopts this ANT sensibility to examine how PISA knowledge is produced by assembling and connecting a vast array of information from diverse locations and contexts into a single spatio-temporal frame. PISA as an entity of knowledge is thus shown not only to be relational and continuously performative, but also precarious, held together through ongoing work that sustains its connections and productions—work that can be interrupted, weakened and even refused.

Conclusion

In its insistence on attending to these minute interactions, the precise ways in which they occur as well as their effects, ANT analyses challenge many assumptions underpinning certain educational conceptions of development and learning, agency, identity, knowledge and teaching, policy and practice. ANT analyses make visible the rich assortments of mundane things at play in educational events and how they are connected. The examination of the different processes and moments at work in translation, in particular, extends beyond a simple recognition that artifacts and humans are connected in social and cognitive activity. In Latour's (1999, p. 17) summation, ANT's main contribution is to 'transform the social from what was a surface, a territory, a province of reality, into a circulation', where time and space are understood to result from particular interactions of things. ANT's conception of symmetry unlocks a preoccupation with the human, the intersubjective and the meaning, and refuses a rigid separation between material and immaterial, human and nonhuman objects. In tracing what things do and how they came to be enacted, ANT analyses offer a method for picking apart assumed categories and structures in education, some of which appear to exert power across far-flung distances and temporal periods. For analyzing politics and policy in educational research, Nespor (2002, p. 376) argues that ANT raises important questions about 'how and in what forms people, representations and artifacts move, how they are combined, where they get accumulated, and what happens when they are hooked up with other networks already in motion'. ANT analyses not only can perform the shifting locus of power, how different actors are dominant at different times within different networks, but also show the nuances and ambivalences within this performance of power. Perhaps, as Neylund (2006, p. 45) puts it, ANT's most important contribution to education is providing an entry point to better understand 'mundane masses (the everyday and the humdrum that are frequently overlooked), assemblages (description of things holding together), materiality (that which does or does not endure), heterogeneity (achieved diversity within an assemblage), and flows/fluidity (movement without necessary stability)'. In attempting to enrol and mobilize ANT into educational research, we would expect parts of that research to become translated into something other than it now mostly is. There is the presumption that this other would also be better, because of, rather than in spite of, the messiness it enacts. Obviously any such translation is incomplete and fragile.

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