Destabilising data: The use of creative data visualisation to generate professional dialogue

BURNETT, Cathy <http://orcid.org/0000-0001-6087-244X>, MERCHANT, Guy <http://orcid.org/0000-0001-8436-7675> and GUEST, Ian <http://orcid.org/0000-0002-0228-4006>

Destabilising data:
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Cathy Burnett, Guy Merchant, Ian Guest

Abstract
Whilst there is plenty of debate on the nature and role of data in social science research, data in schools tend to be understood in terms of numbers and used in limited ways linked primarily to attainment. The 'data-fication' of schooling has been strongly critiqued for its powerful impacts on policy and practice, pupils' experience, the curriculum, teaching and learning, and – as is particularly relevant to this article – teachers' professional and personal lives. There is a need therefore to expand what count as data in schools, to think creatively about how data are communicated, and to consider what data do when inserted differently into professional dialogue. In exploring such possibilities and speaking to the field of critical data studies, this article reports on a project that set out to 'do data differently' by inviting teachers to create, visualise and share their own data on what mattered to them in their everyday literacy teaching using a postcard format. Characteristics of teachers' response to this project are explored, linked to: impressionism, imperfection and subjectivity in data collection; complexity and opacity of visualisation; and professional discussion as drift. Rooted in a sociomaterial perspective and drawing on Latour's ideas about immutable mobiles, it is argued that shifting the focus, visualisation and sharing of data can have 'complicating effects' which – through foregrounding the instability and partiality of data – can produce generative spaces for teachers' professional dialogue.

Key words: data, literacy, professional dialogue, teacher, data visualisation

Introduction
Notwithstanding ongoing debates about the nature and role of data in social science research (see for example Denzin & Giardina, 2016), data in schools are understood predominantly in terms of numbers (Pratt, 2016), referred to in the singular (data 'is' not 'are'), and used in limited ways – mainly linked to attainment. Since the late 1990s, the analysis and comparison of attainment data across pupils, schools and localities has been central to the enactment of school improvement in England and elsewhere. Fuelled by changing patterns of educational organisation and governance, an enthusiasm for a 'data-driven system' has been amplified through digitisation that enables the rapid manipulation, aggregation and communication of data (Landri, 2018). Readings of data can be problematic- in England, for example, critique has been levelled at school league tables, both for the (in)appropriateness of measures used and the insufficient recognition given to statistical uncertainty (Leckie and Goldstein, 2011; 2017). Despite this, as researchers in the field of critical data studies have explored, the 'datafication' (Williamson, 2016; Mayer-Schönberger & Cukier, 2013, p.78) of schooling has had pervasive effects, associated with the reproduction of inequalities, the intensification of managerialism, threats to personal privacy and security, and reductionist manifestations of 'what counts' as 'education' (Grant, 2017; Selwyn, 2015). Such work highlights how data do not sit outside practice but help to produce it in particular ways (Beer & Burrows, 2013; Jarke & Breiter, 2019), making some things visible rendering others – not least the processes and assumptions underpinning data production itself – invisible (Lawn, 2011). These effects are

achieved as data combine with other phenomena such as 'evidence-informed' practice, accountability systems, benchmarking, school improvement plans, testing regimes, academisation, PISA tables and technologies of governance that work through shifting assemblages of corporate, quasi–public and non-governmental organisations across national boundaries (Hamilton et al., 2015). In schools then, data are not neutral or objective but *do* things– they are, as Bradbury and Roberts-Holmes (2018) argue, a 'productive force'. This is evident particularly in the case of literacy education, where an emphasis on statistical analysis foregrounds cause-effect relationships between interventions and attainment and side-lines important dimensions of teachers' and pupils' experiences of literacies by focusing on narrow and measurable indicators of progress (Hayes, et al., 2017). A consequence of datafication has been the prioritisation of activities likely to impact attainment as measured through standardised testing (Hayes et al., 2017; Davis & Willson, 2015) often with negative impacts on teaching and learning, the breadth and depth of curricula, and teacher and pupil wellbeing (Ball, 2003; von der Embse et al., 2017).

Importantly, it is not just data that are significant to what happens in schools but how they are visualised and disseminated (typically through graphs and spreadsheets). As Williamson (2016) explores, data visualisations promulgate certain kinds of understandings linked for example to the variables designed into them by those who produced or commissioned them. In education, visualisations help sustain the authority and apparent objectivity of data through seemingly straightforward correlations – between levels of attainment and classes or schools, for example – and through clean layouts, linear representation and geometric shapes (Grant, 2017). These undoubtedly ease interpretation but, in doing so, lead to simplification, abstraction and de-contextualisation (Lemke, 1998; O'Halloran, 2008). Concerns about overly simplistic data visualisations have prompted some innovation, such as Leckie, Charlton & Goldstein's dynamic representations of attainment data which foreground statistical uncertainty in value added scores (Leckie, Charlton & Goldstein, 2016). Such visualisations however, as far as we are aware, have yet to take hold in schools and other possibilities for visualisation remain underexplored in educational contexts.

In this article we report on a British Academy funded project, *Doing Data Differently,* that aimed to contribute to emerging work in data visualisation and to critical data studies by involving primary teachers in collecting, visualising and sharing their own data. Working from a sociomaterial perspective, we were interested both in what teachers did with this opportunity and in the kind of professional dialogue generated by such data. In what follows, we contextualise this project with reference to other research which has explored the effects of datafication on teachers' professional lives and position our work in relation to critical data studies. We then draw on Latour's concept of immutable mobiles in order to introduce the sociomaterial perspective that informs this work, and consider how developments in data visualisation helped shape this project. After outlining the study, we explore characteristics of teachers' response to our approach which we suggest were associated with destabilising the meanings of educational data and that, as such, opened out valuable opportunities for professional dialogue.

Critical orientations to the workings of data in teachers' professional lives
Our starting point for this project was concern about the effects of datafication on teachers' professional lives (Lewis & Holloway, 2019). One such effect is marginalisation: teachers can be left out of the frame as data generation is initiated by others, data-sets are difficult to interpret or access, and there is a lack of transparency about how data are applied (Selwyn, 2015). This is perhaps most evident in systems that bypass teachers through using digitised data to shortcut feedback loops, through computer adaptive testing, learner analytics and

personalisation, for example (Thompson, 2017; Thompson & Cook, 2017). Such developments reflect and bolster neoliberal education systems, arguably reconfiguring what it means to teach, to learn and to belong (Thompson & Cook, 2017). However these effects are also evident in more mundane engagements with data (Ratner et al., 2019). Bradbury and Roberts-Holmes, for example, explored how some early years teachers' data collection for assessment purposes seemed to sidestep professional judgement, an approach characterised as 'no reflection, no thinking, no dialogue' (p.58). They note how this cultivated an idea of teaching as an individual rather than shared endeavour, one in which teachers felt they had little control and in which they were positioned as data collectors rather than professional decision makers. In response to such concerns, critics have called for greater use of qualitative data to inform educational decision-making, data that illuminate the complexities of classroom literacy provision and the diverse experiences of teachers and learners in local sites (Moss, 2012). Indeed in England, there is increasing recognition by policy-makers and officials of the negative impact of an over-emphasis on measurement – Ofsted has now reduced the emphasis on attainment data as a source of evidence in determining inspection outcomes (Ofsted, 2019). Such changes may lead to more organic approaches to educational development, informed by a greater variety of data generated through teacher-led enquiry and driven by local knowledge, drawing on the long tradition of teacher research and reflective practice (e.g. Cochran-Smith & Lytle, 2009; Mason, 2001). However, analyses of attainment data have become so deeply engrained in educational processes that they may continue to generate disproportionate effects. Given this, there is a pressing need to support teachers to engage with data in ways that are professionally empowering, and to explore alternative ways in which data might interface with practice.

To these ends, some researchers have argued for more to be done to develop teachers' critical data literacy to support understanding of the power dynamics of data, perhaps using techniques developed for exploring digital data in other contexts (Selwyn & Pangrazio, 2018). In addition to making space for more productive or critical orientations to existing data-types, however, we suggest there is a need to work proactively to revisit the focus of data collection and the ways that data are visualised and shared. This orientation to critique is in line with a sociomaterial perspective which informs our ongoing work (Burnett & Merchant, 2020), and which is found in the work of Latour and Massumi. Latour, for example, advocates paying attention to 'matters of concern' rather than simply to 'matters of fact' (Latour, 2004, p231). In this arena matters of concern might focus on what counts as data and who decides on what counts in the first place, rather than the matters of fact of published data on something like literacy attainment. Latour is also suspicious of the critical conceit of trying to show people what is *really* going on - matters that they were previously unaware of – and how they have been 'naïve believers' (p. 246) suggesting that it is more important to focus on generating new ideas instead. Massumi (2015) arrives in a similar place albeit from a different starting point. He argues that critique helps to hold things in place, 'separates something out, attributes set characteristics to it' (p.14) thus leading to its reification. This process, according to Massumi, solidifies existing arrangements and inhibits other practices from emerging because, 'it doesn't allow for these seeds of change, connections in the making that might not be activated or obvious at the moment.' (p.15).

In line with this thinking *Doing Data Differently* was designed to move away from existing data-types and their representations towards teacher-generated data and visualisations in the hope that new connections might be made and different aspects of literacy teaching brought to light. In doing so it sidestepped debates about the digitisation of data and rapid data flows that have been such a strong focus for critical data studies, and focused instead on prompting more direct and personalised engagements with data by teachers. In approaching this work,

we drew on Latour's notion of immutable mobiles to account for the workings of data in schools and subsequently to support our theorisation of teachers' response to our project. This concept is particularly relevant to our work as it speaks to concerns around visualisation.

Datafication, data representation and immutable mobiles
In a detailed exploration of the power of visualisation, Latour (1986) relates the development of knowledge practices to the increasing sophistication of our ability to justify particular perspectives or understandings using tools of representation and inscription. He draws attention to 'simple modifications in the way in which groups of people argue with one another using paper, signs, prints and diagrams' (p.3). These modifications or inscriptions are used to persuade others of the veracity of particular facts, particular ways of seeing the world and particular ways of being. Latour describes such inscriptions as 'immutable mobiles' (p.7) because they capture and aggregate data gathered from local sites in the form of representations that are constant (hence immutable) which can then be spread across different populations without substantive change (hence mobile). In this way 'Immutability is ensured by the process of printing many identical copies; mobility by the number of copies, the paper and the movable type' (p.10).

Latour's idea of immutable mobiles has considerable explanatory power for thinking about the visualisation of attainment data. These data, in the form of charts, graphs and so on, are aggregated in what Latour would refer to as 'centres of calculation' (p.29) that produce visualisations based on comparisons, fluctuations in attainment and so on. Importantly, in the current educational milieu, mobility is accelerated because it is no longer constrained by the capacity to produce paper copies, and data visualisations spread rapidly through digital media remaining immutable through their 'optical consistency' (p.7) when viewed on screen, pasted into a document, or presented to an audience on PowerPoint. Importantly this process involves chains of inscription - as pupils' outcomes are translated as scores and/or cemented as grades, then aggregated in different ways using spreadsheets and other calculating devices, to produce visualisations based on specific comparisons (over time, between cohorts and across different demographics). Latour's argument is that the inscriptions themselves – in our case, the visualisation and presentation of attainment data – are significant to what happens in practice, and to the power associated with particular ways of knowing.

These ideas about immutable mobiles, inscription and power offer a sociomaterial account of how data take hold in educational contexts: how data, rather than working to serve the community, act on it, operating to sustain ways of seeing and knowing the world (Gray et al., 2016). Because numbers are transportable, they perform objectivity, a process which relies on and helps to substantiate the idea of standardisation of performance. As the complex messy experience of what children do at school is captured in numbers and transformed into spreadsheets and charts, however, much of that experience (and its possible value) is written out. 'Cascades' of school attainment data are amalgamated with data from other schools, regions, countries, etc., and they become increasingly distant from the practices in which they were generated and, as a result, increasingly difficult to challenge or problematise. Moreover as systems for data management and analysis become ever faster and more agile, these movements are condensed and rendered invisible, collapsing centres of calculation and existing within 'data infrastructures' of databases, platforms, packaging, coding, algorithms run by data analysts, visualisers and so on, and administered through companies and institutions that have their own ways of doing things (Williamson, 2016).

These ideas explain how datafication extracts data from localised contexts. As this happens, the knowledge practices underpinning these inscriptions (e.g. those that shape tests taken or frame curriculum subjects such as literacy), are treated unproblematically and further entrenched as data are shared (Hamilton, 2012). As inscriptions enter relations with people, places and things – as attainment data are moderated by teachers, reviewed by policymakers or used to justify certain educational approaches, for example – they further sediment their authority. Through inscription, data themselves become the focus of attention, and the aims of education are recalibrated in terms of impact on data rather than impact on experience or practice (Grant, 2017). Improvement is thereby reduced to achievement on a narrow band of indicators, and teachers are both responsible for administering the tasks that generate data and held to account for their results, often with detrimental effects on feelings of efficacy, agency or worth (Ball, 2003). In this way 'data' – as a way of knowing education – gain power through layers of inscription, fixing ideas about practice and narrowing possible avenues for improvement. To be clear, our point here is not that attainment data (or quantified data more broadly) cannot make positive contributions to educational research or practice, but rather to highlight the relational effects that may be produced as data (through inscription) assemble with other educational policies and practices.

Importantly for our project, while this analysis highlights the role that inscriptions of data play in generating a certain kind of educational reality, it also suggests how that reality might be unsettled. The relational configurations that perform the stability of data, and that in turn sustain certain kinds of educational realities, do not in and of themselves represent a stable set of relations: they are neither permanent nor inevitable. This suggests that other kinds of data and other kinds of inscriptions might achieve something different in relation with educational practice. An interest in such possibilities led us to explore ways of 'doing data' with teachers that might generate new kinds of connections. Innovations in the field of data visualisation offered inspiration here.

Data Visualisation

In an age when communication is increasingly visual (Kress, 2010) and information must compete hard for attention it is unsurprising that there has been a growth of interest in data visualisation. Research has explored the affordances, politics and reception of different approaches (Kennedy et al., 2016; Engebretsen & Kennedy, 2020) and sources of guidance and inspiration are widely available (e.g. Berton, 2009; Lankow et al., 2012; Mollerup, 2015).Data visualisations often represent relationships between two variables: such as activity and duration, levels of population and year, or amounts of waste per nation state, and various forms have evolved to represent these relationships, e.g. line graphs to represent growth over time or bar charts to indicate relative size or quantity. Data visualisation can however be highly creative: information designers have, for example, combined familiar forms of graphic representation with visual metaphors (e.g. McCandless, 2012) and experimented with different media and with three dimensional and animated forms (e.g. www. gapminder.org).

Given our argument that inscriptions are significant to what data do in relation with practice, we were interested in how different kinds of data might combine with alternative forms of visualisation, particularly in exploring possibilities for quantification. As Lemke (2003) explores, visual-graphical representations of quantifications can be used to capture diverse aspects of experience such as size, intensity, loudness, duration and speed, and we wanted to explore how such modalities could be used to capture teachers' personal experiences.

Lupi and Posavec's *Dear Data* provides one compelling example of how quantification can be applied to everyday experience. *Dear Data* (Lupi & Posavec, 2016) documents a year-long postcard exchange through which Lupi and Posavec, two information designers working in different cities, collected data on their feelings, interactions, relationships and everyday occurrences and explored ways of representing these on postcards they then sent to each other. Their work combines quantification with visualisation techniques that capture the intimate minutiae of everyday life – moments of swearing, smiling and saying thank you, for example, or smells smelled, people encountered and products used. They show how data visualisation techniques can be used to represent personal experience and complexity. Their approach to producing and interpreting what Lupi (2016) calls 'small' data takes time - data are logged and visualised by hand, and 'reading' postcards involves frequent references to keys. Rather than using data to 'become more efficient', they use data 'slow things down' (Lupi 2016) - 'to become more human and to connect with ourselves and others at a deeper level' (Lupi & Posavec, 2016). Lupi (2016) argues that such approaches allow designers to acknowledge context, and require readers to work harder at interpretation prompting deeper reflection. Their postcards exemplify how quantitative data can be translated into 'dense and unconventional data representations' (Lupi, 2016, p.78) that do not just represent but participate in everyday life in ways that matter to those that produce them. As such their approach aligned with our ambition to explore teacher-generated data and visualisations that would allow new connections between teachers, data and experience and bring different aspects of literacy teaching to light.

The project: Doing Data Differently
Inspired by Lupi and Posavec's postcard exchange, *Doing Data Different*ly involved teachers in collecting, visualising and discussing *their own* data on aspects of *their* experience that mattered *to them* in everyday literacy teaching, and examined what such data might do – to teachers and to teachers' discussions about practice – if used as the focus for professional dialogue. Importantly the emphasis here was not on analysis of pupil learning, or indeed on developing teachers' data literacy as others have done (e.g. Cowie & Cooper. 2017). Instead we wanted to explore the potential for teacher-generated data to produce insights into aspects of classroom literacy teaching that are commonly disregarded in statistical accounts, insights that might be informative and illuminating for those outside the profession, and that might be valuable for teachers to share amongst themselves. We were particularly interested in the possible value to teachers of alternative applications and visualisations of quantifying phenomena other than attainment and representing these creatively. It is worth noting here that the project did not aim to evaluate the impact of this process on teachers' practice or their understandings of data per se. In line with our sociomaterial perspective – we were interested in what teachers did with the opportunity, in what data seemed to do as they entered teachers' professional dialogue and, in turn, what 'data' became.

Over a single academic year (2018-2019), seven primary teachers were invited to generate data on their everyday experiences of classroom literacy and represent these on postcards shared with other participants at half-termly meetings. We chose literacy because we ourselves were literacy specialists and because literacy has been a key focus for the generation of attainment data. Teachers were recruited through widely distributed invitations across the South Yorkshire region. All those interested were invited to a briefing on the project, following which seven agreed to participate. Our sample was not designed to be representative of the wider teaching population: the teachers were self-selected, worked at six different schools with different age groups (6-11 year-olds) and had various levels of responsibility for English and literacy (three were subject leaders while others were not).

Moreover, by opting for a project called *Doing Data Differently*, they were individuals who may well have been frustrated by, or critical of current uses of data and interested in what else might be possible. Five attended an introductory workshop on data visualisation in July 2018, during which they looked at examples of data visualisation, experimented with collecting and representing data, and considered aspects of their experience of teaching literacy that could be counted or measured. The other two (unable to attend the workshop) attended a meeting to explore similar ideas, examples and approaches. All were given coloured felt pens, a postcard template and a copy of *Dear Data* as inspiration. Participants were also offered a second workshop part-way through the project to explore diverse forms of visualisation, which two attended.

Participants were asked to create postcards which were shared at six meetings scheduled at regular intervals across the year. If unable to attend they were invited to arrange alternative times to discuss their postcards (although this was only possible on one occasion due to their other time commitments). As a group participants agreed a brief for each postcard, which included: logging 'reactions to' a chosen phenomenon; charting where certain people or items travelled; focusing on an aspect of creativity and literacy; capturing 'teachers' experience' of a chosen focus; mapping time spent on activities against feelings; and a free choice. During meetings, they introduced their postcards by outlining their focus, describing how they had collected and visualised data, and what they thought their postcards showed. This process in effect allowed participants to 'hold the floor'. Open-ended discussion followed, led mainly by questions and comments from others in the group. They discussed thoughts and experiences prompted by one another's visualisations, considered implications for classroom practice and their lives as teachers, and reflected on the challenges and possibilities of creating postcards. As researchers we joined in conversations, sometimes asking for clarification, sometimes holding back to allow others to drive the discussion. We occasionally offered comments or perspectives from our own experience, but did not attempt to direct the conversation (although our comments may have had this effect). A further session was held to review and reflect further on the process and value, if any, of making and sharing postcards in this way. During this meeting, participants often drew on their experience of data in other contexts to help them describe how this project was different. As such we gained some limited insights into their views on more typical applications of data in school.

All participants gave consent for their postcards and anonymised transcripts of discussions to be shared publicly as part of the project and to support this research. They were given opportunities to withdraw postcards or parts of the transcribed discussion and some chose to do so. As researchers, in line with our ethical framework, we also withdrew postcards or excerpts of transcripts that might lead to breaches of confidentiality with respect to institutions, members of staff or pupils. The final data set included 34 postcards and 12 hours 54 minutes of audio recordings of participants' reflective discussions from the initial workshop, half-termly and final review sessions. Selected postcards and excerpts from transcripts were curated as a virtual exhibition (https://blogs.shu.ac.uk/doingdatadifferently/). Analysis combined: a) thematic analysis of transcripts, focusing on: the aspects of classroom literacy provision foregrounded by teachers, and their perspectives on the value of generating and sharing data in this way; b) analysis of the range of data visualisation styles used; and c) mappings of the movement of dialogue in response to eight of the postcards (e.g. Figures 3 and 4).

Elsewhere we explore the aspects of literacy provision teachers represented in their postcards (Burnett et al., under review1) and describe how their data visualisations were produced for

different reasons: to demonstrate aspects of professional experience to others, to enquire into aspects of teaching and learning, and to reflect on aspects of their professional life (Burnett et al., under review2). Here however we explore aspects of their engagements with data through this project that they told us were different to those they were used to in school, and which in turn opened out possibilities for professional dialogue that they found valuable. Reflecting back to Latour's notion of immutable mobiles, we draw on our analysis to comment on how participants took up the invitation to 'do' data in this way, and on what data – as collected, visualised and shared on postcards – seemed to do to professional dialogue. We describe a number of emerging characteristics of the interplay between teachers, data generation, data visualisation and data sharing in our work, which we group as follows:

1. Impressionism, imperfection and subjectivity in data generation;
2. Visualising complexity/opaque visualisation;
3. Professional discussion as drift.

It is important to emphasise here that these characteristics were not designed into the project, but emerged as teachers took up the invitation to collect, visualise and share data. Below we explore these in turn referring back to ideas about immutable mobiles to highlight key dimensions of what happened.

1   Impressionism, imperfection and subjectivity in data generation

As explored earlier, in exploring the effects of immutable mobiles, Latour (1986) considers the role of centres of calculation that work at a distance from the sites that generate primary data. He describes processes in which cascades of data gathered locally are compiled, aggregated, decontextualised and then reconfigured. Such processes depend upon and also help produce a stable focus for data generation. In contrast our project was designed to leave the focus and processes of data generation – quantification, visualisation and dissemination – in the hands of teachers, and no attempts were made to aggregate findings. This approach led to a tendency for impressionistic data collection and repeated acknowledgement by the teachers of the imperfections of their processes and the inherent subjectivity of their approach to generating data. These tendencies had implications for the nature and focus of discussion which led us to consider the possibilities associated with 'imperfect' data.

Firstly, participants' plans for gathering data often had to be modified. We predicted that teachers would have difficulty finding time to generate data and this was indeed the case. Some planned to monitor phenomena repeatedly over a series of lessons or days but found this unsustainable due to other professional demands. For these reasons, quantifications frequently drew on estimates derived from a general sense of what happened rather than a rigorous record. Much of what they presented was therefore impressionistic. Participant 4, for example, created a postcard using mushrooms on a tree to represent the amount of time spent marking books (See Figures 1a&b). In explaining how a total time was calculated, they explain:

> I picked up a girl's book, English book, and I went through it and in it there were 46 pieces of work that I'd marked and so what I did was I tried to approximate how much time it took to mark each piece of work. So the big toadstools are extended pieces of writing that would have taken 20 minutes or more to mark and there were six of those. […] The mushrooms growing on the tree, they were ten minutes or more and there was 20 of those per child roughly. There was 20 in this particular book anyway, and then the small mushrooms are less than ten minutes and there was about 20 of those as well.

So after I'd looked at this one book I sort of extrapolated that and said it must be pretty much the same for every book. So I'd looked at the numbers of pieces of work marked, I'd estimated how long it took and then I multiplied the time it took to mark them by the number of pieces of work by the number of children and it came to approximately 97 hours of marking.

While the approach taken was systematic, it relied on a *sense* of time spent rather than measurement.

[Insert *Figure 1a: 'Marking as Mushrooms' postcard* about here.]
[Insert *Figure 1b 'Marking as Mushrooms' postcard key* about here.]

Secondly, in nearly all cases, participants highlighted imperfections in their postcards and their data collection processes, prefacing explanations with apologies. As well as apologising for relying too much on memory or impressions or being 'haphazard', they apologised for: not focusing on literacy; not using a postcard template; the quality of their artwork; 'copying' from *Dear Data*; being too 'wacky' or not creative enough; or not being 'scientific' or 'influencing the data'. Sometimes they told us they were unsure about our expectations or whether they had addressed the brief, or that they thought their postcard was too complex or too negative. All of this had implications for what we could learn from the project about the possibilities of quantification and visualisation and about what matters to teachers about literacy teaching. As the project progressed, however, we became less interested in alternative applications of quantification and more interested in what happened as postcards were shared. We began to see the imperfect, impressionistic quality of the data as significant in itself. Participants' references to imperfection were, we felt, interesting partly because they seemed to be infused by existing expectations of what data should be. However the shared apologies and reassurances they gave one another also seemed to build a sense of community in which experimentation was encouraged and anything was acceptable. This was underlined by phatic dimensions of the dialogue: the frequent laughter and exclamations of appreciation at one another's postcards- 'Wow', 'Ooh', 'Oh my word', 'Whoa'. Participants told us that the supportive atmosphere and sense that anything was acceptable generated conversations that were of a different quality to discussions about attainment data:

> 2: I think we massively expect to be judged but I know walking in to this room anything I've said I've never thought, oh my goodness, I daren't say that and I've never looked through the transcript and thought can I take that out? Because actually it's about being open and honest and it's just being the vehicle that's allowed us to do that I think.
> 3: Yeah. Again, it goes back to those professional discussions doesn't it of non-judgemental and just opening it up for it to be picked apart and something we discussed as well isn't it how great it would be if you had a little buddy in school that you could have these conversations with all the time.

Counterintuitively perhaps, imperfection, impressionism and objectivity were associated with authenticity. As discussed above, data inscriptions that work as immutable mobiles are also contingent on subjectivities, slippages and ambiguities (albeit in different ways) but, as they move, these 'imperfections' are erased and data become sedimented as truths. In this project, while data collection was often far from rigorous, participants suggested that their data had an integrity that could be lacking in attainment data. At one meeting, for example, participants discussed how the common practice of comparing attainment between year groups

encouraged grade inflation. They stated that the postcard 'data', while incomplete and subjective, provided more honest reflections of what they noticed or felt about what happened:

> 7: I think there's an honesty though that's come out of the postcards as well. No one's falsified any data because there's no need to whereas, you know, there are schools that do that for end of Key Stage assessments and because one class teacher has, then it's an inflated view of what that class do going up to the next teacher. […]
> 5: Because they're under pressure. [Murmurs of agreement.]

Talking about their small data seemed to generate opportunities for participants to share experiences of classroom life. As such the postcards did not carry meaning very far – they had limited mobility – but were infused with meaning through the process of composition (as explored further in the next section), and then again when shared in the group. Like Lupi and Posavec's postcards they encouraged reflection on aspects of experience, sometimes provoking an affective response as the following extract illustrates:

> 2: I just think this is such a positive message, even though sometimes there are more negative elements. […] I still think just the way they're presented, you look at it and you smile on most of the postcards, even if they do have negative elements whereas, again, coming back to my point I made earlier, I think the way that data tends to be presented, just sheets of numbers of graphs, it's just wrong.

This drew our attention to the emotional significance of data which at times appeared to be generated through participants' personal connection with the data and the work of the group, and which contrasted with the negative feelings often associated with more conventional school data (Bradbury & Roberts-Homes, 2018).

2 Visualising complexity/opaque visualisations

As explored earlier the extent to which inscriptions are mobile depends partly on how successful they are in clearly transmitting information or relations between variables. This involves simplification - the complexity of lived experience is inevitably ironed out or reduced. When data become mobile, such simplifications sediment as truths, performing certainty and objectivity. In designing this project, we anticipated that teachers' postcards might generate alternative truths – truths that would work to dispel some of the deficit discourses about teachers and some of the reductivist ideas about literacy education that circulate in the media and policy announcements (Hayes et al., 2017). At the start of our project, we hoped that such alternative truths might be propelled and instantiated as they were shared in our virtual exhibition and disseminated via formal and informal networks. In a sense, we hoped that they would become more mobile. However, while the postcards sometimes gained a life outside the project – being shared with governors, head teachers or colleagues – more typically their trajectories were much shorter. While they certainly generated alternative insights, many involved a complexity of design and a density of information that made rapid interpretation – and hence mobility – difficult. Our second characteristic therefore relates to some interesting effects of visualising complexity and sharing opaque visualisations.

Given that participants rarely had much time for generating data or making postcards, postcards were often hastily created prior to meetings and decisions about visualisation were sometimes pragmatic or apparently random rather than designed. For instance, they sometimes told us they could not remember their reasons for design choices or that they were

just driven by an urge to experiment, make something attractive, or use what was readily available. They did however draw on a range of forms, some of which aligned with quite conventional representations – charts, graphs, diagrams and maps – while others were more experimental. One for example used images taken from a catalogue to represent sources of inspiration in the classroom, while others used techniques they had seen in *Dear Data* or that were discussed during the workshops. Some participants used visual metaphors to convey their sense of the essence of a phenomenon. For example one drew a layered cake to represent time spent on elements of literacy, while two others used a hamburger image to show the ingredients of a good literacy lesson. Participant 4, who created the marking-as-mushrooms postcard (Figures 1a&b), stated that they

> …chose mushrooms because we were doing something in science, and we were talking about how mushrooms and fungus were like a completely different classification of living thing all to themselves and I kind of feel like that about marking. […] It's just a thing unto itself and it's unruly and it kind of has this weird way of reproducing itself. I don't know. You write one big comment and then get in to a habit of it.

Data visualisation in the public sphere aims for clarity, often as a route to persuasiveness, and this clarity, as explored earlier, contributes to its mobility. Some of participants' data visualisations met this criterion – the marking-as-mushrooms postcard for example was subsequently shared by the participant with their head teacher. However, other postcards were more opaque and took time to decipher, with interpretation relying heavily on participants' explanations. This was perhaps partly because participants were new to data visualisation and less confident in designing visualisations to convey data effectively. However, the opacity of visualisations was also a product of the complexity of experience represented. Participants regularly conveyed relations between multiple sets of variables, for example between noise, activity and teacher emotion, or books chosen, place of reading and how children sat. In doing so, they often hybridised data visualisation techniques, combining charts with maps or over-layering complex sets of symbols to represent different dimensions. These hybrid forms could be interpreted with careful use of a key, but at times had to be mediated by the creator. Figure 2, for example, was produced by Participant 7 to represent a teaching sequence on Ancient Greece. It involves concentric circles that map different activities in terms of levels of 'depth of learning' (linked to Bloom's taxonomy – see Bloom et al., 1956). It is also annotated with numbers indicating levels of teacher satisfaction and dots to indicate moments when activities were shared with other teachers, students or family members. Dotted lines across the circles signify links between activities, where one thing led to another. The postcard thereby combines an analysis of one set of relationships (learning and activity) with other variables and dimensions of the experience – emotional engagement as a teacher, the significance of a wider community within and beyond school, and chronology in planning. This was achieved through a hybrid form of representation that is hard to interpret in isolation but came alive with Participant 7's commentary.

[Insert *Figure 2: 'Ancient Greeks' postcard* about here.]

It is also worth noting that, perhaps because of the complexity of visualisations, meanings were not fixed. Postcards often accrued meanings as they were shared and others sought to understand better what was represented. As Participant 2 commented:

> … it was really interesting to hear other people's perceptions of your postcard. So when we were having the discussions I started off explaining a couple a couple of times and

then somebody said, oh, I thought that referred to this and actually it's kind of an unintended outcome but obviously it came across still to other people and I thought that was really interesting, that actually even though I'd not intended to get that message across, that obviously likeminded people could pick that out.

Meanings then were provisional and emergent. The contrast between such inscriptions and Latour's immutable mobiles is significant here. Latour suggests that the knowledge practices he addresses do not concern 'inscription per se, but the *cascade* of ever simplified inscriptions that allow harder facts to be produced' (1986, p.16). In this project, participants – rather than tending towards simplification – often produced complex representations with mutable or negotiable meanings. This is a point we discuss further in the next section where we explore our third characteristic, which concerns the fluidity of teachers' discussions.

3   Professional discussion as drift

Latour's analysis of immutable mobiles explains how certain kinds of knowledge perpetuate. A set of 'truths' are established through inscription which gain credence as they move away from the complex social and cultural realities in which they were produced. Such decontextualisation becomes problematic in education when 'truths' are used as the basis for developing practice, as happens when analysis of attainment data leads to activities designed to make an impact on future data (e.g. through targeted interventions), narrowing the focus of professional learning and activity. This channelling effect has become a key feature of school improvement in many jurisdictions in recent years (Burnett & colleague, under review). However, our project invited participants to think beyond the usual foci for data analysis in schools. As stated earlier, they engaged with data for different purposes and the focus of discussions ranged widely, addressing classroom life, planning, the curriculum, feelings, people, places, resources, and the permeability of their personal and professional lives (Burnett et al., under review 2). Direct comparisons with other data-driven discussions are difficult to make – and indeed we made no attempt at comparison. However it appeared that this broad focus allowed considerable scope for thinking about professional practice through allowing connections to be made across multiple aspects of experience.

As described earlier, the process of sharing postcards ensured that all had the opportunity to 'take the floor', and postcards could be held up or passed round as this happened. Participant 2 stated that 'it was useful us having a postcard to keep referring back to because I know I for one sometimes struggle to stay on the conversation at hand'. Our mappings of the movement of dialogue, however, showed how conversations often drifted as participants moved from 'the conversation at hand' to other, broader or linked themes. Often, it seemed, postcards were not the anchor for reflection – the evidence that formed the basis for action – but rather the springboard for discussion. For example, after Participant 5 shared the postcard representing the 'literacy layer cake' described above, the discussion drifted from the Great British Bake Off to a consideration of books on the United Kingdom Literacy Association book prize shortlist, to different ways of structuring children's writing (see Figure 3), and on to the topic of shared responsibility for teaching a class and finally to a broader discussion of feelings about children's achievements:

> Sometimes you're that immersed yourself you don't realise the quality the children are producing, and it just takes someone else to come in and say 'okay, have you seen these stories?' You're like, fresh eyes. Yeah it's a lovely feeling when that happens. (Participant 6)

It seemed to us that one of the benefits of this drift was that it provided opportunities to open up new avenues of discussion. Whilst school data might prompt discussions about levels of attainment and how to raise these, discussion around the layered literacy cake focused not just on classroom practice but on what might be called professional pride.

[Insert *Figure 3: 'Literacy Layer Cake' discussion map* about here.]

Another conversation about a postcard depicting where children go to read in class (Figure 4) touched on resources provided by teachers themselves and the sedentary nature of children's life in classrooms and then moved to teachers' different experiences of professional development including a poetry workshop and what they had done for National Poetry Day.

[Insert *Figure 4: 'Where children go to read in class' discussion map* about here.]

Again this drift seemed to allow for making connections across different aspects of professional experience, and for looking more broadly at practice. Discussion of each topic was meshed with multiple practices, values and perspectives.

Discussions like this might be criticised for lacking focus, rigour or challenge. It seemed to us, however, that they took participants towards aspects of practice that are flattened out or marginalised through the reductive processes of datafication. Much of what was shared in our meetings could be described as anecdotal and subjective. As discussed above – data were often impressionistic rather than systematically generated, and participants did not challenge or contradict one another, although they did ask questions that probed what others did and thought. It is beyond the scope of this study to judge whether these conversations impacted on professional learning, thinking or practice, but participants did tell us that they valued these loose discussions. Participant 3, for example, commented that the project was valuable not just because it allowed discussion of pedagogical possibilities but because it provided a forum for sharing and reaffirming professional commitments:

> as a bit of CPD of what we wanted to do, how we can improve our own work, but also it was really good to have that professional chat that, you know, we're all likeminded otherwise we wouldn't have come together to do this in the first place but I think it's nice to know that your choices are validated. Yeah. It's not all about postcards.

From this perspective the 'professional chat' was as important as the postcards themselves, and data became part of a process rather than a fixed outcome. This is a final point of contrast with the idea of immutable mobiles, which are associated in Latour's account with settling disputes, winning arguments and ultimately with exerting power and influence. The postcards in this project provoked discussion and exploration allowing participants to drift across a range of professional concerns and topics.

Discussion

The starting point for our study was a particular problem - the positioning of teachers through the uses of attainment data in the educational system in England, particularly in the context of literacy education. We were interested in whether alternative approaches to 'doing data' might generate more empowering opportunities for professional dialogue. We recognise that the same project with different participants may well have had different effects, that there is more to be done to explore alternative possibilities for quantification and visualisation, and that the possible benefits of involving teachers in data collection go far beyond those

discussed here (see Cochran-Smith & Lytle; Mason, 2001). However, we do suggest that this project – and the sociomaterial perspective that shaped it – provided valuable insights into the new connections that can be generated through reworking what counts as data, and in visualising and sharing data in new ways. It is this focus on generating new connections, and the relational effects of these connections, that we want to emphasise here.

If, as explored earlier, attainment data produce effects through assembling with other phenomena such as 'evidence-informed' practice, accountability systems, benchmarking, school improvement plans, testing regimes and so forth, then the data in this project produced different effects as they assembled with postcards, coloured pens, creative visualisations, a supportive group of colleagues, a room at a university, research funding and academics keen to open things up. Of course accountability systems, testing regimes and so on were still present. They surfaced during discussions and in some of the postcards and perhaps inflected the scope of what teachers felt able to do and discuss. Nevertheless, the teachers' data did appear to have particular effects as they combined with the social and material configurations of this project. Specifically, we suggest that the characteristics identified above – impressionism, imperfection and subjectivity in data collection; complexity and opacity of visualisation; and professional discussion as drift – are significant in thinking about what data can and do become in school.

These characteristics are significant, we argue, in exemplifying what we describe as '*complicating effects*'. Here we refer back to Latour's argument that knowledge gains influence through inscriptions that help to produce simplifications, simplifications that accrue stability, mobility – and hence power – as they enter relations with people and practices. This argument, as we have explored, provides a compelling explanation of the datafication of schooling, a phenomenon which can be seen in terms of a series of simplifying effects produced through interactions between people, data inscriptions and other social and material actors. We refer to the emerging characteristics of our project as 'complicating effects' as they worked not to simplify but to complicate understandings of practice. We see them as effects of a relational shift between teachers, data and practice, a shift that worked to open out professional dialogue in ways that explored or at least acknowledged complexity.

Rather than representing fixed 'truths', data in this project were often characterised by instability, they were self-consciously imperfect, impressionistic and subjective. With the freedom to generate their own data, teachers brought multiple factors into play by focusing on a diversity of topics which were unlikely to resolve into the simple visualisations more typically associated with school data. The teachers' 'imperfect' data and complex visual designs prompted discussions that moved across and between different dimensions of practice, rather than drilling down into single aspects. In place of the simplified insights attempted by more usual data representations, their postcards evoked complex, multifaceted lives in which quotidian classroom events were interwoven with institutional norms and pressures, personal enthusiasms, private lives and much more. This instability and complexity meant that the meanings conveyed by postcards did not often travel far – they were stable enough to be transported to group discussions, but often shifted as they were taken up in these discussions. There was a 'liveliness' (Blackman, 2019, p. xxiii) to the data that seemed to open out diverse possibilities for professional conversations and accounts of experience therefore became more complicated as the postcards were discussed. Data, it seemed to us, were not approached as fixed sources of evidence but became participants in an ongoing project of reflection, or were side-lined altogether once a conversation gained momentum. Together these complicating effects avoided the kind of simplification which, as argued

above, is at the heart of the critique of datafication. We therefore argue that approaches to engaging data such as this, through surfacing complexity and contingency, may open out possibilities for professional dialogue that both amplify professional voice and generate opportunities for professional exchange and reflection.

In the light of this discussion, we might characterise the postcards the teachers produced as 'mutable immobiles' in contrast to the 'immutable mobiles' that Latour describes – see Table 1.

[Insert *Table 1: from immutable mobiles to mutable immobiles* about here.]

We recognise that pitting our approach against more typical applications of data in schools, and producing a table such as this one, itself risks oversimplification. Conversations about attainment data may well be more slippery and nuanced in practice than research on data in schools has suggested, and may well exhibit some of the drift we noted in this project. Moreover, some of our participants' postcards did achieve some mobility and gained influence – some showed their postcards to head teachers, governors or colleagues as a form of 'evidence', which they told us was persuasive in supporting calls for changes to practice, and the virtual exhibition provides another forum for disseminating the visualisations. However, our argument here is not so much that some data are stable and mobile and others are not. Rather, we suggest that our project invites us to consider *all* data as unstable, even if, in certain relational configurations – as happens through certain kinds of inscription – they perform stability. Moreover, while stability may well be key to power and dominance, domination is itself a temporary construction if, as Latour proposes, stability is performed rather than extant. As he argues: 'domination is not a given but a slow construction and it can be corroded, interrupted or destroyed if the records, files and figures are immobilized, made more mutable, less readable, less combinable or unclear when displayed.' (1986, p.27). As the negative impacts of a data-driven school system become more widely recognised, then doing data differently – in ways such as this – might prove fruitful in working with the instability of data to increase the range and diversity of professional dialogue, and help pave the way for re-positioning teachers as the experts on and chief investigators of their practice.

Conclusion

The work described in this article illustrates possibilities for working with data that exceed narrowly framed exercises in the analysis of attainment data. As such it speaks to the wider body of work emerging in critical data studies which works to unsettle overly simplistic analyses and applications of data for commercial, educational and societal purposes. Our project approached this not through taking a critical stance on existing data practices, but by exploring the kinds of possibilities that might be produced – and connections that might be made – by generating new ones. Working with 'small', 'slow' data in ways that foreground instability, as happened through this project, may create space for acknowledging professional practice as complex, contingent and dependent upon the human, material, relational dimensions of what happens in schools. The professional dialogue associated with this project did not focus on specific problems, outcomes or endpoints, but orientated to teaching as an ongoing endeavour, and approached professional knowledge and skills as inextricable from feeling and context.

While we do not know if this project had any lasting impact on participants, we do suggest that approaching data collection, visualisation and sharing differently can generate productive spaces for teacher dialogue in ways that embrace the instability and partiality of data.

Attempts to recalibrate relations between teachers, data and visualisations may open out professional dialogue to make space for teachers to voice and to explore what matters to them. It may even be that more nuanced conclusions would be drawn from attainment data if approached with the tentativeness and uncertainty with which these teachers approached their own data – by treating it in effect as less stable. Regardless of this, this project exemplifies how complicating effects may be produced through shifting the focus, form and dissemination of data, and these in turn may help generate contingent, reflective, layered and potentially fruitful professional dialogue, which builds on teachers' interests, experiences and concerns, than that more typically associated with the production, visualisation and application of data in schools. It illustrates why it is valuable to move beyond instrumental applications of data, and indeed beyond critique which assumes that data will always have similar effects. We end therefore by reiterating our argument for diversifying the range of ways in which data, visualisation and teachers come into relation, and call for more research that explores the diverse effects that are generated in practice as this occurs.

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