Towards a topological re-assemblage of education policy? Observing the implementation of performance data infrastructures and 'centers of calculation' in Germany

Sigrid Hartong

Published online: 08 Nov 2017.

Submit your article to this journal

Article views: 992

View related articles

View Crossmark data

Citing articles: 21 View citing articles

Routledge
Taylor & Francis Group

Towards a topological re-assemblage of education policy? Observing the implementation of performance data infrastructures and 'centers of calculation' in Germany

Sigrid Hartong

Department of Education, Faculty of Humanities and Social Sciences, Helmut-Schmidt-University, Hamburg, Germany

ABSTRACT
The ongoing trend towards educational globalisation has brought about various dynamics of education policy 'rescaling', resulting in a growing number of governmental arrangements, which are operating across traditional scales, levels or sectors of policy. This contribution takes up the conceptual frameworks of topological spatialisation and assemblage theory to better understand the pivotal role of new information technologies, data infrastructures and also the increasing power of 'centers of calculation' within education policy reforms that have been implemented in Germany after the launch of the *Programme for International Student Assessment*.

Introduction

The past decades have witnessed a progressive increase of research in the field of education policy globalisation, including a growing awareness for what has been described as 'fast policy mobilities' between countries, regions or cities (Peck and Theodore 2015; Steiner-Khamsi and Waldow 2012). Such policy mobilities also include the expansion of standardisation instruments, new monitoring and assessment strategies, or the enhancement of competition and (quasi) market structures (Verger, Lubienski, and Steiner-Khamsi 2016).

At the same time, an essential marker for the heterogeneous and also contradictory transformations related to globalisation has been found in a constantly rising level of governance complexity, which particularly results from higher numbers of intergovernmental and interagency relationships and powers (Savage 2016) and also from an increasing amount of involved actors and stakeholders between global to local policy contexts. In other words, globalisation articulates in a diversification of actors forming a 'social infrastructure' (Künkel 2015b, 8) of transfer agents, who

> […] sprung up around 'best practices' codification, practitioner conferences, learning exchanges, knowledge transfer, and communities of practice. (Peck and Theodore 2015, xv; see also Hartong 2016a)

This rising involvement of such 'intermediary' actors has been fuelled by a broad policy 'turn' towards (digital) data and numbers (Grek 2009; Ozga 2009), which includes a growing influence of large-scale and longitudinal educational data production, data mediation or technology-related consultancy practices (Hartong 2016b). Hence, in many education-related contexts, the implementation of new information and communication technologies (ICT) has been forming both an object

---

CONTACT Sigrid Hartong ✉ hartongs@hsu-hh.de

and subject of (globalising) policy mobilities and reform (Clarke 2015, 129; Mok and Leung 2012; Ruppert 2012; Stambach and Malekela 2006): while ICT have become translated into the field of education, they simultaneously act as a core medium through which new actors have become authorised as key players to shape output- and accountability-based policy and practice.

Particularly within orthodox neo-institutionalist trajectories of research, education policy globalisation has often been focused on the question of policy *convergence* between nation-states (Lingard and Grek 2007, 11), triggered by increasing coercion, normative pressure or imitation (often named policy 'learning'), which altogether produce 'isomorphism' (DiMaggio and Powell 1983) towards a common 'world polity' (Meyer et al. 1997; Meyer, Krücken, and Kuchler 2005). One particular strength of the world polity approach certainly lies in its emphasis on rational principles as constructivist moments of globalisation, which form new 'globalised' frames of reference for national or local policy-making. Moreover, the approach has excited fervent debates on new supra-national 'arenas of standardisation and educational governance' (Leuze, Rusconi, and Martens 2007), particularly international organisations or transnational networks, who have been increasingly operating as 'teachers of norms' (Finnemore 1993), ultimately fuelling worldwide policy alignment.

Still, over the past decade, the world polity's emphasis of top-down transformation, its identification of fixed policy 'objects' or 'indicators' of policy transfer as well as its narrowed focus on results (convergence) has evoked an increasing number of critics (for a summary see Adick 2009). Such critique saw too little attention paid to the influence of local 'path-dependencies' (Levin 1997; Pierson 2000), to policy mobility processes *beyond* national systems or state actors (Dale and Robertson 2012; Künkel 2015b, 11; Steiner-Khamsi 2012), while it simultaneously began to question classical, often taken-for-granted geographic images of scale and territory (one early example is Latour 1996).

Consequently, considerable efforts have been made in recent years to examine policy mobilities as more complex, distinct and also continuously changing relations *between* the global and the local (e.g., Brenner 2004; Carney 2009; DeLanda 2006; Hartong and Nikolai 2017; Herod and Wright 2002; Howitt 2002; Peck and Theodore 2015; Robertson and Dale 2015). While policy scales are more 'critically considered as a narrative device, a measure of distance and a technique of governmentalities' (Legg 2009, 235), such approaches also more strongly accentuate ambivalences and dynamics of simultaneously deterritorialised and 're-bordered'/territorialised policy mobilities (Milana 2016, 207).

This does not mean, however, that scales such as the transnational, national or subnational have become obsolete (Legg 2009), but rather that they are understood as parts of multiple scalar and (also de-)territorial transformations, in which governmental power is constantly created or (de-)stablised. At the same time, such an understanding is not limited to the distinct influence of human agents, but instead more strongly takes into account the various relations between humans and non-human agents, which, through their ongoing interaction, are equally co-producing policy mobility. As this article seeks to demonstrate, such approaches are particularly useful when observing the implementation of ICT within new governmental complexes in education policy, which are increasingly reaching beyond and across traditional policy 'entities', scales and geographies, while simultaneously transforming those entities (and also the individuals within) when being enacted.

In that context, this contribution will take up the conceptual framework of *policy assemblages* (as applied i.a. by Clarke et al. 2015; Peck and Theodore 2015 or DeLanda 2006) and, within that conceptual framework, draw upon the idea of *topological spatialisation* (as used by Allen and Cochrane 2010; Ruppert 2012; Lewis and Lingard 2015; Allen 2011 or Ball 2016) to better understand how new data infrastructures of educational performance monitoring (as part of ICT) have recently affected global–local policy mobilities (Anagnostopoulos, Rutledge, and Jacobsen 2013). The term 'data' hereby stands for quantified and digitalised educational information, which is stored and processed by computers, and which is enacted by software and algorithmic code.[1] 'Data infrastructures' then means networks of objects (the data itself, hard- and software, but also policy 'fragments', such as educational standards or funding formulas) and subjects (technicians, administrators, school actors, intermediary agents, etc.) assembled around these data and around its socio-technical de- and

recontextualisation practices. In other words, data infrastructures are understood as (the transformation of) governmental constellations constituted by (digital) data flows that, however, are more than computer-based hard- and software, but networks of people, technologies and policies (Anagnostopoulos, Rutledge, and Jacobsen 2013, 8). Whilst such data infrastructures seem increasingly essential for 'soft governance' by producing, transferring and mediating governing *as* topological knowledge (see also Lawn 2013), they still appear as a 'hidden', underexplored facet of policy rescaling in education. Following Anagnostopoulos, Rutledge, and Jacobsen (2013, 3),

> […] the contours and consequences of […] [data] infrastructure[s] remain only vaguely understood. Questions of how it is being built, the new technologies and actors it gives rise to, how it redistributes power and influence across and beyond the formal educational system, and how it shapes what and who counts […] have not been addressed in a comprehensive way.

This is particularly true for the German case, where hardly any (performance) monitoring infrastructures had been in place in the field of education until Germany participated in the *Programme for International Student Assessment* (PISA) in the year 2000. Then, within a decade, Germany underwent a radical shift towards 'output-orientation', assessments and monitoring infrastructures across all scales of the education system (which, however, is still in its initial stage). Despite this tremendous policy change, which has been flanked by most controversial political and public debates, the shifting geographies of power through these new 'data infrastructuralisation', at least so far, have been poorly examined.

In fact, as this contribution indicates, the German case clearly demonstrates how the turn towards assessments and monitoring has given rise to new intermediary actors who are programming, collecting, visualising or mediating data into politics, research, administration or school practice (Hartong 2016b; Koyama 2011; Mayer-Schönberger and Cukier 2013; Williamson 2015b). Such actors not only support a more effective or efficient use of data, but simultaneously, and together with the data, co-create new policy assemblages, including new visibilities, geographies and modes of (topological) governmentality.

Conceptual framework

A growing number of research in the field of education policy mobility has identified complex and dynamic interactions between policy levels, sectors, actors or policy 'fragments' when approaching globalisation processes, rather than unilateral policy transfer or binary zero-sum games (Peck and Theodore 2015, 6). Consequently, over the past years, increasing attention has been devoted to more *relational* approaches of 'local globalism' and 'global localism' (de Sousa Santos 2006), to geopolitical ambivalences, to the role of (path-dependent) institutional settings (e.g., Powell, Edelstein, and Blanck 2016), to the ongoing fragmentation of policy 'objects' and also to implicit power relations *within* structures of policy learning or policy transfer (e.g., Peck and Theodore 2015, 22ff.).

A concept, which has become increasingly used in policy mobility research, is Carney's (2009) approach of 'global policy scapes', which addresses national reforms and their subnational manifestations as the result of complex and disjunctive global–local policy flows (see also Savage and O'Connor 2015, 613). Similar to this idea, Robertson and Dale (2015) use the term 'education ensembles' to describe globalised policy spaces, which are made up '[…] of various layers of structures and generative mechanisms' (Robertson and Dale 2015, 150). Sheppard (2002), in turn, introduces the term 'positionality' as a power-oriented, relational construct of global policy rescaling through perception and sense-making, which he traces back historically to Captain James Cook's exploration of Hawai'i in 1778, as a radical restructuring of '[…] the space/time vectors connecting Hawai'i with London' (Sheppard 2002, 307). In that regard, Sheppard understands positionality as being

> […] continually enacted in ways that both reproduce and challenge its preexisting configuration. (Sheppard 2002, 318)

Others have introduced more 'vertical case study'-approaches (e.g., Bartlett and Vavrus 2014) as well as policy field approaches derived directly or more indirectly from Bourdieu's critical sociology (e.g., Fligstein and McAdam 2012; Hartong and Nikolai 2017; Fourcade 2006 or Mangez and Hilgers 2012).

All these contributions share a notion to go beyond the question how global trends impact on nation-states, and instead explore how global and national forces continuously interact with subnational or local processes, institutions, actors, objects (or fragments of objects) and polities, often causing unevenness, frictions, or different timelines of policy adaptation as well as particular possibilities for reform (Ball 2016, 550; Clarke et al. 2015, 35; Dale 2005; Ozga et al. 2011; Savage and O'Connor 2015, 611).

Within this trajectory of research, this contribution takes up two concepts, which are seen as particularly powerful for understanding global–local mobilities enacted through the implementation and expansion of performance data infrastructures in education. These are the concept of *policy assemblages* (as used by Clarke et al. 2015; Peck and Theodore 2015 or DeLanda 2006) and, within that conceptual framework, the idea of *topological spatialisation* (as used by Allen and Cochrane 2010; Ruppert 2012; Lewis and Lingard 2015; Allen 2011 or Ball 2016).

Observing data infrastructures through the lens of topological assemblages

Roots of assemblage theory go back to the work of the French philosophers Deleuze and Guattari, who defined assemblages as

> number[s] of disparate and heterogeneous elements convoked together into a single discernible formation that displays some form of consistency and regularity while it remains open to transformative change through the addition or subtraction of elements or reorganization of the relations between them. (Bureš 2015, 14)

In other words, assemblage theory focuses on simultaneities, tensions and heterogeneities, but also on the fixity of social constellations (Mattissek and Wiertz 2014, 3; Peck and Theodore 2015, xvii), which are observed as historically and structurally contingent. In that view, single parts of particular assemblages (in this contribution: particular data, technologies or data-mediating actors) can always play different roles within different assemblages (DeLanda 2006, 18ff.), while assemblages themselves are composed by a heterogeneity of human and non-human elements that 'go into making policy' (Clarke et al. 2015, 31).

Among others, Ong and Collier (2005) used assemblage theory to explicitly trace the 'global shape' of particular policy subjects. For them,

> 'global assemblages' integrate '*global* [which] implies broadly encompassing, seamless, and mobile, [and] *assemblage* [which] implies heterogeneous, contingent, unstable, partial, and situated'. (Ong and Collier 2005, 12, italics by author)

Hence, following Clarke et al. (2015, 49), the core question of assemblage research in the context of global–local policy mobility focuses on different ways in which specific assemblages may, or may not, become (temporarily and territorially) stabilised.

Within the conceptual framework of assemblage theory, different scholars then have developed new perspectives on relational rescaling by applying a more *topological* notion of power and governmentality. Instead of observing horizontal or vertical forms of power distribution, such topological perspectives mainly focus on the reach and proximity of influence, which however are not simply spatial, territorial extension, but rather

> […] play across one another in a variety of intensive ways to bridge the gap erected by the physical barriers of distance. (Allen and Cochrane 2010, 1075; see also Ruppert 2012, 121)

In education policy, such topological understandings of globalisation have been applied, among others, by Ball (2016), Savage and Lewis (2016) or Lewis and Lingard (2015). Lewis and Lingard's

(2015) contribution is of particular interest here, because they use the concept of topological globalisation to describe the influence of the Organisation of Economic Co-operation and Development (OECD) on nations, states, cities and schools through PISA-based data governance. As they show, the OECD has successfully established topological spaces of data-related practices (such as particular narratives, but also instruments such as rankings and reports), which enable the OECD to be physically absent and yet still (locally) present in terms of policy reach and influence (Lewis and Lingard 2015, 625).

While there has been a growing body of research focusing on the 'governance by numbers' exercised by international organisations (Leuze, Rusconi, and Martens 2007; Milana 2016), such research often led to an understanding of education being increasingly 'governed at a distance' (Rose 1999), which, however, mainly referred to the geographical distance of international actors. Topological understandings of governmentality see such a geographically based diagnosis as potentially misguiding (Clarke et al. 2015, 26), given that

> topographical distance between actors can be elided by the global being topologically 'folded' into local spaces. In effect, territorial distance – as measured in kilometres or miles – becomes less reflective of near and far, of place and space, than does the topological notion of 'closeness' as expressed through relationality and connectedness. (Lewis and Lingard 2015, 623; building on Allen 2011)

Building on these ideas, I argue that the worldwide mobilisation of educational performance monitoring can be identified as an effect of international assessments such as PISA, which triggered a 'turn' towards comparative 'what works'-knowledge, and, as a consequence, towards a topological (re-)assemblage of education policy through performance data infrastructures. Hereby, objects (data, technology and other policy 'fragments') and subjects (technicians, administrators, school actors or intermediary agents) become '(re-)assembled together' (Koyama 2011, 706) around new governmental constellations that are constituted by (digital) data flows and that create various new linkages and spaces between the global and the local (also Sassen 2002, 365).

Within such new policy assemblages, data mediators and also data managers have become powerful change agents, because they transfer data between digital spheres, territories and traditional governmental spaces in education, which in turn increasingly rely on successful data mediation (Hartong 2016b). For instance, data mediators and data managers apply practices of data visualisation or data services around the production and usage of assessment results or information platforms, ultimately operating at the heart of data de- and recontextualisation. One example is the complex network of institutional partnerships and data service contractors assembled around the OECD, who collaboratively produce and process PISA data (Bloem 2016), exemplarily for the online platform *Education GPS* (http://gpseducation.oecd.org, 24 July 2017),[2] but who have rarely been the subject of in-depth analysis (see also Hartong 2016b, 524).

Taking up Clarke's (2015) analysis of what he calls the global management assemblage, which over the past years has been entering and transforming universities, I consequently argue that data management itself can be described as a global phenomenon, which forms both an object of translation and a core medium of catalysing re-assembling processes. In other words, data management in many fields of education has become a hidden transcript, which is pushing actors towards 'finding things [here: data] to manage' (Clarke 2015, 118, 130), to engage with codes and software (Manovich 2013; Williamson 2016b) and to focus on translating 'things' into data and back.

Against this backdrop, observing performance data infrastructures in education through the lens of topological assemblages seems promising for several reasons:

(1) Assemblage theory understands itself as a rather open heuristic for explorative empirical research, which seems particularly appropriate for the analysis of the still very opaque, distinct shapes of datafication (meaning the quantification of things) and digitalisation (meaning the conversion of analogue information into a binary computer code) in education (Mayer-Schönberger and Cukier 2013, 78). In understanding objects of analysis as constantly processing and

changing (Künkel 2015b, 9), the approach provokes dense empirical descriptions, a more ethnographic gaze, and also a stronger awareness for details, rather than taking them for granted (Bureš 2015; DeLanda 2006).

(2) While assemblage theory has often been applied in ethnographic single-case studies, it also offers multiple options for international, comparative research. For instance, understanding the path-dependent recontextualisation of global trends as different assemblage-'landscapes', might shed new light on current policy transformations within particular geographical(ly constructed) settings, such as nation-states. Within the empirical focus of this contribution on Germany, the same seems true for transformations *within* multi-level, federal systems, that reveal additional dynamics, repercussions or subnational varieties of reform when responding to global trends.

(3) Many scholars have pointed out the close relation between assemblage theory and concepts of governmentality, which pay particular attention to asymmetries of power within processes of (re-)assemblage and policy mobility (Legg 2009, 239; Mattissek and Wiertz 2014, 2). Such power relations are contingent in the sense of ongoing (potential) struggle and power, which determine what may, or may not, be translated in a particular way (Clarke et al. 2015, 40ff.). Related to data infrastructures and data mobility, such power asymmetries are not only reflected in the crucial stages of software programming, data selection/data processing, data distribution or data visualisation, but also in the growing emergence of infrastructural 'centers of calculation' (Ruppert 2012; Sheppard 2002, 316). Within such technical zones of human-data interaction, material infrastructures are co-created with specific rules, norms and values, ultimately bringing about a new 'digital economy of scale' within 'cybergeographies' (Goodchild 2004; Ong and Collier 2005, 11).

(4) Consequently, topological assemblage thinking takes up various ideas of *Actor Network Theory*, as substantiated by Latour, Woolgar or Callon (Bousquet 2013; Bureš 2015, 15; Färber 2014, 95; Piattoeva 2016). In particular, assemblages are not understood as solely 'including' individuals, but rather, through the establishment of particular topologies and visibilities, as 'creating' them. In line with that idea, Ruppert (2012) showed how the recent expansion of database devices by the new UK Labour government has brought about new topologies, which materialise and advance new, distinctly defined individualities of subjects, ultimately resulting in a 'technocratic infrastructure for knowing subjects and populations' (Ruppert 2012, 119).

(5) Topological assemblages address the emergence of new spatialities, but also transformations of temporalities (Peck and Theodore 2015, xxii), thus pointing to a still underexplored facet in policy mobility research (Clarke et al. 2015, 20; DeLanda 2006, 40; Sassen 2002), which, however, seems the more important when observing datafication and digitalisation. While the infrastructuralisation of data is commonly associated with an overall acceleration of knowledge mobility, I argue that particular assemblages around programming, (human) data processing and data mediation have created entirely new regimes of temporality. As an example, the 'fixed' schedule of long-term performance assessments (such as PISA, which must be published within three-year cycles) has brought about new temporal forces (Bloem 2016), which are constantly guiding potential data-human interaction, while, at particular points in time (which is the publication of new results), continuously opening up possibilities for policy re-assemblage.

(6) Understanding parts and their functioning in a different manner within different assemblages can facilitate the classification of data/data management in education, which in one context might serve as an automated learning or teaching device, in a second as information for administrative requirement planning, in a third as accountability measure, and in a fourth as a (global) market product. In other words, datafication in education evokes numerous (re-)assemblage processes, including distinct 'things' that are actually moving (Künkel 2015a, 82), e.g., codes or algorithms, programmes, data mediators or visualised data products (such as monitoring reports or rankings). Consequently, what assemblage theory describes as an ongoing interplay between deterritorialisation and re-bordering/territorialisation (DeLanda 2006, 12), might

also inform a broader and also more critical observation of data de- and recontextualisation processes.

Despite this illustrated strengths of the topological assemblage approach for observing data infrastructures in education, scholars have also pointed to particular weaknesses of the concept. Such weaknesses are mainly related to the empirical challenge of simultaneously embracing local depth and transnational reach of assemblage processes (Künkel 2015a, 77; Peck and Theodore 2015, 37) without ending up in endless deconstruction. Similarly, understanding assemblages as being in constant motion also complicates an actual 'mapping out' of relations (Bureš 2015, 19). Considering these concerns, this contribution understands assemblage theory primarily as a new way to approach the globalisation (here: datafication and digitalisation) of knowledge, power and politics (Clarke et al. 2015, 52) and, consequently, as a flexible, yet broad guideline for empirical research (Bureš 2015, 20).

The (global) expansion of performance data infrastructures in education and the particular case of Germany

Over the past two decades, an increasing global fabrication of educational data through new ICT can be observed, designed to improve and to accelerate the application of educational knowledge through numbers and statistics (see also Lingard, Creagh, and Vass 2012). Central in this development are international organisations such as the OECD, who have implemented complex global–local infrastructures of data production, databases, data-related policy products, data experts and mediators, as well as data-related norms, values and ideas.

Particularly over the last decade, the OECD (but also actors such as the *European Union* or the *World Bank*) have increasingly focused on becoming data experts, by using survey data for policy consultancy and services, by expanding the scope of their instruments (e.g., PISA for schools) to 'reach into' nations, cities or schools (Bloem 2016; Lewis and Lingard 2015; Sellar and Lingard 2013), and by promoting the digitalisation of educational governance. Promoters of data infrastructuralisation hereby regularly pointed to an 'intolerable' situation for policy-makers, teachers and parents who were supposedly forced to make meaningful decisions on the basis of either poor (e.g., fragmented) data or 'opinion' (as Andreas Schleicher, head of the OECD's PISA division, recently stated). Consequently, through triggering a growing orientation towards large-scale, small-scale, 'big' and 'thick' data (Boyd and Crawford 2012; Mayer-Schönberger and Cukier 2013), such actors prompted governments, but also a growing number of private firms or philanthropies, to invest in the creation and expansion of data infrastructures, educational monitoring and e-learning/e-governance.

In many parts of the world, yet in varied extent and scope, this turn towards (better) data stands in close relation to standards-based reform initiatives as well as to a growing orientation towards educational output and accountability (Hartong 2015). Applying the idea of topological assemblages, while there occurs an overall rise of new assemblages and topologies through the implementation of performance data infrastructures and new 'centers of calculation', the shape of these assemblages, the functionality of single pieces within (e.g., the role and scope of PISA), and also the internal relation between pieces may look very different. Reasons certainly lie in varying legal regulations within the politically constructed boundaries of nation-states, but also in path-dependent options for data mediators' influence, as well as in the cultural 'likeliness' to trust in numbers (e.g., rather than in judgements of the teaching profession).

Against this backdrop and in contrast to other countries, Germany is still in its initial stage of turning to datafication and especially to digitalisation in terms of educational performance monitoring. In this regard, it crucially differs from countries which have already created extensive (centralised) data infrastructures and systems of e-governance, such as the United Kingdom (Ruppert 2012), but also federations such as the United States or Australia (Hogan, Sellar, and Lingard 2016; Koyama 2011; Williamson 2015b, 2016a, 2016b).

For example, in Australia, a national school reform agenda after 2008 led to the implementation of a centralised *Australian Curriculum, Assessment and Reporting Authority* (ACARA), a national census testing of literacy and numeracy (NAPLAN), and a new national online platform, which publicly and interactively compares school performance data (the *MySchool* website).

The United States appear as even further developed in terms of top-down, test- and accountability-driven data infrastructuralisation (see also Lingard and Lewis 2016). Here, key driving forces included the federal *No Child Left Behind* (NCLB)- and *Race to the Top* (RttT)-resolutions, established between 2001 and 2010, but also the extensive involvement of non-governmental, often for-profit actors, who early created a powerful market for data, digitalisation, and 'smart' education governance products. Simultaneously, problems of data (policy) fragmentation between the American states and districts were addressed with nation-wide initiatives such as the *Data Quality Campaign*, which recommended the states to adopt common standards, to implement (centralised, standardised) performance data management structures, and to build on (automated) ICT.

But also many non-western countries, such as the Russian Federation, have radically intensified the datafication and digitalisation of education policy, which in the case of Russia led to a complex surveillance regime, including an intensified production of 'data on data production' (Piattoeva 2016).

Interestingly, some of today's most developed 'smart' educational monitoring and assessment systems are located in Estonia and Cambodia.[3] The *Estonian Education Information System* (EEIS, www.eeis.ee) not only automatically collects, processes and evaluates individual educational data, but at the same time links that data to international surveys such as PISA, to various research surveys, and also to (constantly adjusted) assessment-building processes. Data access is hereby monitored via individual ID-cards. In Cambodia, the *Ministry of Education, Youth, and Sport* (MoEYS) tremendously reformed the educational system with the support of the non-profit organisation *World Education, Inc.* (http://www.worlded.org, 9 December 2016), which not only fostered a turn towards learning apps and digital classroom environments, but also towards continuous cross-level assessment and evaluation. Therefore, *World Education* developed the *TEST app assessment*, which automatically collects student performance data in a nationally/globally accessible cloud system (https://wecambodia.exposure.co/learning-to-read, 9 December 2016), which can then be used for administrative, accountability or teacher training purposes.

The German 'turn' towards data infrastructuralisation after PISA[4]

Germany as a system where the different states (*Länder*) hold almost all responsibility for educational governance (and more or less only for that policy field) is a good example of how the global trend of performance data infrastructuralisation in education evoked very ambivalent policy (re-)assemblage processes. In Germany, a combination of different factors in the past resulted in a strong resistance against large-scale reform, particularly against supra-state control or incisive (performance, data-based) accountability measures (Hartong 2015). One factor is a fairly high level of teacher professionalism/autonomy within a state-controlled input system, which exerted

> […] weak control and evaluation of the processes and almost no external control of the outcomes [such as performance data] of schooling. (Hopmann 2003, 472)

Another is a school structure which segregates different school tracks (Powell, Edelstein, and Blanck 2016), while the actual composition of that segregation again varies a lot between the states and the different political constellations, ultimately resulting in a juxtaposition of very heterogeneous subnational 'path-dependencies' (Pierson 2000) (and policy assemblages).

The high level of state-centralised school authority, however, not only limited federal influence on school policy, but also the range of autonomy for districts and communities (*Kommunen*). Regularly, this led to extended debates about a systematic ineffectiveness of the system, which – despite the heterogeneity of the states – was (too) often 'governed from a distance'.

Against this backdrop, the recent turn towards performance data and (digital) data infrastructures in German education policy can only be understood as the result of complex interactions between 'catalysing' events and power shifts among policy actors at transnational, national and subnational scales around the turn to the twenty-first century (see for similar findings in the Australian standardisation movement Savage and Lewis 2016). Unsurprisingly, one of the most important 'catalysers' was the PISA-'shock' in 2001, whose wide-ranging effects have been examined within a large body of research (e.g., Hartong 2012; Niemann 2010; Tillmann et al. 2008). With regard to data infrastructures, the PISA-shock reflected the growing topological influence of international large-scale databases and comparative educational monitoring instruments, which, by that time, had also been intensively promoted by the European Union (e.g., the *European Qualification Framework* or the *Europass*). The emergence of PISA and other international large-scale monitoring system ultimately provoked a substantial transformation within the German field of educational research (Aljets 2015), which opened up a unique opportunity for particular empirical research institutions (which also served as the German PISA-consortium) to become core leaders in the post-PISA policy agenda (Hartong 2015), including the implementation and expansion of performance data infrastructures.

At the centre of this data infrastructuralisation stood an output-oriented *national* education monitoring strategy, which included the creation of nationally centralised standards and assessments (Tillmann et al. 2008), and which was led by the *Standing Conference of the Ministers of Education of the German States* (Kultusministerkonferenz, KMK 2006). However, by that time, the KMK, which traditionally formed a rather slow-reacting national arena for the coordination of state policies, stood under enormous pressure by the *Federal Ministry of Education* (BMBF) to accelerate reform activities, to improve the overall educational performance, to close student achievement gaps and to more effectively govern districts and communities. Consequently, the national reform agenda, which formed up between 2002 and 2008, also included a range of federal (BMBF-) programmes to foster local autonomy-building and reform empowerment, also in the field of monitoring and accountability (see below).

At the same time, the BMBF initiated large funding programmes to strengthen and to stabilise empirical research networks in the field of large-scale data surveys. One example was the establishment of the *National Educational Panel Study* (NEPS) in 2009, funded by the BMBF and nested within a network of more than 20 large German research institutions. Different from PISA, NEPS was designed as a longitudinal educational survey, which tracks individual competency development from *Kindergarten* (pre-elementary sector) to adult education. Six starting cohorts of over 60,000 persons, who to date have been repeatedly interviewed, were sampled through the years 2009–2012. Eventually, in 2013,

> […] NEPS turned from a temporary research project into an infrastructure facility permanently financed under the funding agreement between the German Federal and State Governments. (www.neps-data.de, 14 December 2016)

Moreover, in 2003, the KMK passed a resolution, which for the first time in German history obliged the states to record a defined amount of nationally standardised, individualised data (e.g., school, student or teacher data, yet *excluding* test performance data) (KMK 2003). Over the following years, the states, though in varying speed and extent, responded to that resolution by centralising and standardising their monitoring and reporting practices (see below).

Simultaneously, the national agenda brought more attention to profound data from 'the local level' (districts/*Kommunen*). Particularly promoted by the BMBF's *Local Learning*-programme (Wilkoszewski and Sundby 2014, 19), districts were addressed to become more strongly activated in educational monitoring, including the regular production of locally adjusted monitoring reports (Döbert and Weishaupt 2012; Ratermann and Stöbe-Blossey 2012). Hereby, the *Local Learning*-programme funded the creation of partnerships between districts and philanthropies, who, as experts in

education reform, should guide the local policy transformation (e.g., towards data-based policy-making) and enhance transparency between districts and cities (e.g., through data exchange).

In sum, tremendous re-assemblage processes became initiated in Germany after PISA, which included the implementation, expansion, standardisation and centralisation of performance data infrastructures and platforms, as well as a new influence of data mediators. Such infrastructures and actors became assembled together with (or around) governmental actors (such as the KMK, the state or district departments), including the creation of new 'centers of calculation'. Two examples of such infrastructural 'centers of calculation' will be closer illustrated in the following sections.

The Institute for Educational Quality Improvement

In 2004, the KMK founded the *Institute for Educational Quality Improvement* (IQB) to support, coordinate and to inform the implementation of educational standards and also the development of standards-aligned assessments/tests on the national and state level.

In Germany, the PISA-study was from the beginning managed by a consortia of empirical research institutions (now integrated in the ZIB, the *Centre for International Student Assessment*), which, between 2000 and 2006, conducted an additional survey (PISA-E) for generating a significant PISA-sample of the German states. After 2006, this additional survey became transformed into 'PISA-BS' and re-designed to monitor the states' achievement of the national education standards (BS), which had been developed by the KMK between 2002 and 2006 for both primary (fourth grade) and secondary education (year of graduation, either ninth, tenth or 12/13th grade, depending on the school track). The IQB became assigned with further processing PISA-BS into a state comparison study at 'national' scale, including the development and supervision of assessment frameworks, test items and reporting instruments, for both primary (fourth grade) and secondary (ninth grade) education. Hence, after 2008, the IQB-test circle gradually developed an own self-dynamic and infrastructure, which was officially decoupled from PISA and instead (re)assembled around the development and monitoring of the national education standards.

On the one hand, the KMK explicitly accentuated this dissociation (here: dis-assemblage) of the national performance monitoring from the OECD and PISA, which was justified by referring to 'necessary cultural adjustments'. On the other hand, since the development of both the national standards and the national comparison study had gradually emerged (also) from PISA (also Waldow 2012, 169), the KMK, by that time, had already opted for a close alignment of the assessment designs, which was also repeatedly manifested within the KMK monitoring resolutions (latest KMK 2015, 5, 11). In other words, while different institutions became assigned with separately coordinating international (ZIB), and national (IQB) assessments as well as longitudinal monitoring (NEPS), the KMK and also the BMBF still fostered a close alignment and maximal exchange of data, exemplarily regarding the performance indicators, surveyed student/teacher background information (KMK 2015, 11), and also integrated databases within the IQB's data centre (see below, see also http://zib.education/en/about-zib.html, 24 July 2017).

A similar ambivalence between official assessment structure dissociation and simultaneous processes of standardisation/integration can be observed in terms of the internal state comparison tests (*Vergleichsarbeiten*, VERA), which are not sample-based but '[…] determine achievement levels of all students at a certain grade' (IQB 2016), thus providing much more detailed information about the

> […] strengths and weaknesses of [individual] […] students[classes and schools] with regard to the educational standards. (IQB 2016)

VERA initially started as a subnational assessment harmonisation of seven German states in 2004, coordinated by a university in southern Germany. Each of the states then used VERA data individually (there was no comparison between the states) to monitor student performance and to use that data for teaching improvement.

Triggered by the national reform agenda and the monitoring strategy of the KMK, however, the number of states participating in VERA gradually expanded after 2004, until the IQB once again took over the meta-governance and coordination of test development and piloting for all VERA tests. Again, the purpose was to better align VERA with the national standards. Consequently, the IQB started to develop standards-aligned learning tasks for teachers to support test preparation and test-related skill achievement. The tasks are accessible through a digital platform, which simultaneously collects and distributes particularly 'framed' (standards-aligned) data, ultimately linking the IQB directly to classroom practice.

At the same time, the states have remained responsible for administering VERA and for mediating the test data between schools and administration individually (while they are legally prohibited to use the test results for school or student rankings, KMK 2012). Indeed, at least to date, the administration of VERA in the states (e.g., the distribution of responsibilities, the degree of test obligation, the usage of test results either for school support or accountability purposes), and also the role VERA plays compared to other state-level evaluation processes, varies a lot.

In other words, on the one hand the states officially retain the authority for all total educational performance surveys, which has also been repeatedly clarified in the KMK monitoring strategies (see latest KMK 2015). On the other hand, the IQB as a new, cross-scale data-mediating agency is increasingly designing these tests and hereby produces detailed datapools, which link local, state-related, national and also international data within new topological spatialisation. Consequently, while public rankings of schools or individuals have remained prohibited (for now), the data and infrastructure for such rankings is increasingly existent (see Figure 1).

Similar to the OECD, the IQB has not only acquired an enormous database for student performance data and background information through its own assessments, but simultaneously integrates these database with other (e.g., the PISA-) datasets within an IQB in-house research data centre (*Forschungsdatenzentrum*, FDZ), which documents the data and then makes it available for re- and secondary analysis.

> […] The FDZ also offers a broad variety of training seminars, such as workshops on specific data sets and their appropriate analysis. Moreover, the FDZ organizes academies on advanced methodological issues in educational research and aims to promote the general infrastructure of research data in the field of education. (IQB 2016)
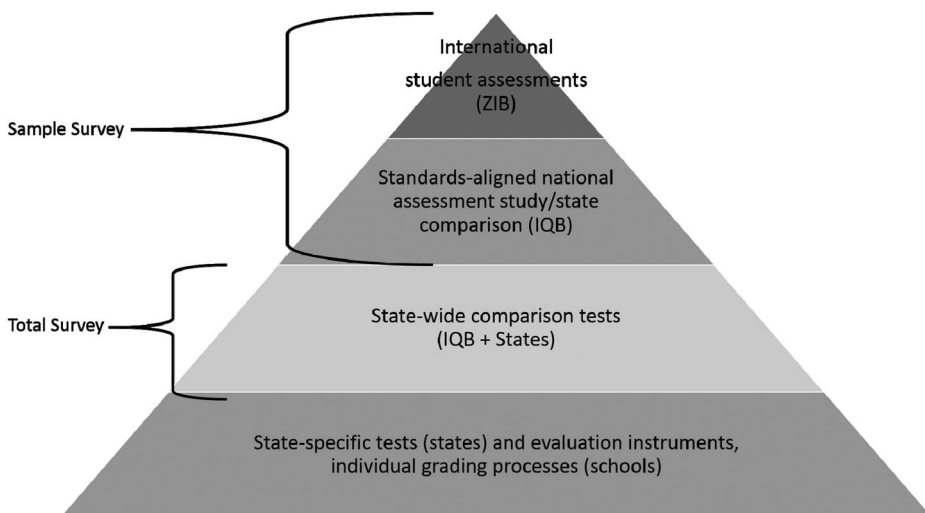

Figure 1. Standardised performance assessments in Germany.

In sum, the establishment of the IQB appears as a significant catalyser within monitoring-oriented re-assemblage processes in German education policy. The IQB (yet together with other research institutions) has contributed to the implementation of large-scale performance data infrastructures, which, particularly through the activities of the FDZ, are gradually integrating international (e.g., PISA), national (the state comparison study) and state-level data (e.g., VERA), while simultaneously mediating large parts of that data back into research for further (aligned) data production. In other words, even though the IQB was itself officially de-coupled from PISA (which was instead transferred to the ZIB), the PISA data is still part of the IQB- (and particularly ZIB-) practices.

At the same time, from the beginning, the IQB data production has been coupled to (here: assembled together with) national standardisation policies, particularly to the evaluation and promotion of the national education standards, which mark a core element of all IQB-assessments. Consequently, with the recent 'takeover' of the VERA test development, state-level monitoring activities became partly dis-assembled from decentralised state authority, while the test administration and also the disaggregated test results have, at least so far, remained with the states.

Still, the IQB has been fostering national and subnational standardisation processes, which are increasingly 'reaching into' the states, into classroom activities and also into educational research practices. In other words, even though the states' educational authority (so far) still brings a large amount of fragmentation into the assessment of educational performance, the IQB exercises increasing topological power (Hartong 2014) by operating as a main supervisor for (further) standards development, as a coordinator for standards-aligned data infrastructuralisation, and as a key host for performance data, ultimately creating new visibilities for knowing subjects (Ruppert 2012).

New digital monitoring systems at the state and local level

Before PISA, the German states widely governed education by centrally providing input 'resources' (such as learning material or teachers) to the schools, and by distributing these resources based on long-term requirement planning. The very broad data basis (school statistics) was delivered regularly by the schools, which, however, often used different systems, and sometimes only provided fragmented data. At the same time, school (let alone student or teacher) performance data had been excluded from those statistics.

As described above, the national monitoring strategy then categorically shifted the focus towards the performance output of the German education system, which also demanded more detailed reporting of what was happening/achieved inside the different states, districts and schools.

While in the initial years of reform, the states and districts mainly developed fragmented pilot initiatives and sporadic reporting, the amount of cross-state and cross-district coordination regarding reform exchange, and also the amount of standardisation, grew significantly after 2006. Crucial here were the aforementioned funding and framework-setting initiatives from the federal ministry (BMBF), but also the increasing involvement of intermediary actors (such as consultants, philanthropies or research institutions), who successfully 'transferred' knowledge and built reform infrastructures between the states and districts.

One example of such transfer activities has been the integration of reports or 'extracted' data (e.g., particular graphs or distribution curves) into new digital platforms. One of many examples is the website *bildungsbericht.de*, hosted by the *German Institute for International Educational Research* (DIPF), which is also the producer of the national educational monitoring report, and which has served as a member of the former PISA-consortia (now the ZIB). The website collects information on the educational monitoring reports of all German states and (where available) districts. Some states (such as Bavaria or North Rhine-Westphalia) also started to centralise district data into common formats (e.g., standardised data forms or particular types of visualisation), which, as 'data profiles' are now quickly available online.

However, while the monitoring reports and data profiles may include aggregated student performance data (such as generated through the IQB-assessments), such data has so far been

widely limited, given the aforementioned legal prohibition to publicly compare school-based performance or individual test results. Instead, the data mainly include school statistics, such as number of schools/teachers/students, distribution of minority groups, graduation or drop-out rates, which more indirectly provide information about (comparable) performance. This fairly high level of data protection is also reflected in extensive restrictions of public access to the databases.

Apart from the massive expansion of monitoring reports and their gradual integration into public data platforms, a range of private firms has responded to the rising demand of data management by developing new IT-solutions for the states and districts to better harmonise different data infrastructures. In many states, these new system solutions explicitly go beyond requirement planning purposes, but (so far very vaguely) promise to effectively use both *dis*aggregated and comparative performance data for output-based decision-making (e.g., http://www.svp-rlp.de/projektinform ationen/hintergrund.html, 23 June 2016). It remains to be seen how this rising market will be developing in the upcoming years.

Conclusion and outlook

In Germany, the ongoing expansion of data infrastructures for performance monitoring has particularly been triggered by the PISA-study and the following national reform agenda. While this agenda was led by the governmental body of the KMK, the resulting performance data infrastructures are constituted by a complex assemblage, in which particular data mediators have turned into cross-scalar 'centers of calculation'. Such actors increasingly exert what has been conceptualised as 'governance by numbers' or topological spatialisation, and which is currently 'working through' the multi-level policy architectures and institutional structures of the German federal system. At the same time, such topological spatialisation increasingly works as a mode of 'close' governmentality, which is simultaneously (meta-)governed from the physical absent (e.g., by IT-providers or global/national networks of data analysts).

In other words, while the KMK's national monitoring strategy in the beginning evoked a hotchpotch of fragmented data production and reporting, it was soon followed by a period of infrastructuralisation and topologisation. In that regard, digital technologies triggered the expansion of interface-development and data dashboarding (e.g., 'data sheets'), which are simultaneously embedded within transforming legal regulations of the KMK, the BMBF and the states. Hereby, new policy assemblages have been created around objects and subjects, which are increasingly constituted by (digital) data flows, resulting in new topological spatialisations and temporalities (such as survey/assessment schedules) between the global and the local (also Sassen 2002, 365). New data mediators (such as the IQB or the state-system providers) hereby link (digital) technologies and data with different policy 'levels' (international, national, state, district) and sectors (politics, research, school practice, for-profit market), while continuously making decisions regarding assessment design, ways of data processing or institutional network-building. Particularly because such actors and digital platforms are usually operating in the background of policy-making or are taken for granted, it seems the more important to pay more attention to their role and influence within new policy assemblages.

While this contribution mainly presented initial findings from the German case, the worldwide implementation and fast expansion of highly mobile, but still very opaque data infrastructures offers new challenges also for international/comparative research. Assemblage theory and the concept of topological spatialisation might offer new ways of comparatively rethinking the globalisation of path-dependent localities, and to more closely observe (power-related) mechanisms of assemblage creation, stabilisation, or (de)territorialisation. Such comparisons might not only map out varying scopes of databases, data mediators or assessments, but also their actual relation (to each other or to governmental bodies) as well as their centrality within the different sectors of education policy.

Notes

1. For an elaborated description and also critical reflection on what is commonly understood as 'big data', see Boyd and Crawford (2012).
2. *Education GPS* operates through interactive data processing, which offers users a flexible, individual and automated combination and visualisation of data generated from large databases such as PISA (Williamson 2015a). While *Education GPS* is officially hosted by the OECD, the visualisation technology as the core service of the platform has been developed and is operated by the companies *NComVA* and *TTangs*.
3. I would like to thank Sam Sellar for calling my attention to this.
4. The following insights are related to an ongoing project, funded by the *German Research Foundation* (DFG, project number HA 7367/2-1), which seeks to improve the understanding of digital-era governance and the role of data management in education within the German federal context and also from an international comparative perspective (using the United States as a contrasting case). The project includes analyses of (1) policy material, such as monitoring regulations, resolutions or digitalisation/datafication programmes (ongoing), (2) the actors and institutions involved in performance data management at national and state level (ongoing), (3) the performance data infrastructures and their modes of operation in three selected states per country (scheduled for 2018), as well as (4) interviews with national and state-level policy actors, technicians, administrators and data system companies (scheduled for 2018). This article presents findings from an initial round of policy material/actor analysis for the German case, complemented by secondary literature.

Disclosure statement

Funding

References

Adick, C. 2009. "World Polity – ein Forschungsprogramm und Theorierahmen zur Erklärung weltweiter Bildungsentwicklungen." [World Polity – a Research Agenda and Theoretical Framework for the Explanation of Global Educational Transformations.] In *Neo-Institutionalismus in der Erziehungswissenschaft* [Neo-Institutionalism in Educational Research], edited by S. Koch and M. Schemmann, 258–291. Wiesbaden: VS Verlag.

Aljets, E. 2015. *Der Aufstieg der Empirischen Bildungsforschung. Ein Beitrag zur institutionalistischen Wissenschaftssoziologie* [The Rise of Empirical Educational Research]. Wiesbaden: VS Verlag.

Allen, J. 2011. "Topological Twists: Power's Shifting Geographies." *Dialogues in Human Geography* 1 (3): 283–298.

Allen, J., and A. Cochrane. 2010. "Assemblages of State Power: Topological Shifts in the Organization of Government and Politics." *Antipode* 42 (5): 1071–1089.

Anagnostopoulos, D., S. A. Rutledge, and R. Jacobsen, eds. 2013. *The Infrastructure of Accountability. Data Use and the Transformation of American Education*. Cambridge, MA: Harvard University Press.

Ball, S. J. 2016. "Following Policy: Networks, Network Ethnography and Education Policy Mobilities." *Journal of Education Policy* 31 (5): 549–566.

Bartlett, L., and F. Vavrus. 2014. "Transversing the Vertical Case Study: A Methodological Approach to Studies of Educational Policy as Practice." *Anthropology & Education Quarterly* 45 (2): 131–147.

Bloem, S. 2016. *Die PISA-Strategie der OECD. Zur Bildungspolitik eines globalen Akteurs* [The PISA-Strategy of the OECD]. Weinheim: Juventa.

Bousquet, A. 2013. "Welcome to the Machine: Rethinking Technology and Society Through Assemblage Theory." In *Reassembling International Theory: Assemblage Thinking and International Relations*, edited by M. Acuto and S. Curtis, 91–97. London: Palgrave Pivot.

Boyd, D., and K. Crawford. 2012. "Critical Questions for Big Data." *Information, Communication & Society* 15 (5): 662–679.

Brenner, N. 2004. *New State Spaces*. Oxford: Oxford University Press.

Bureš, O. 2015. *Global Security Assemblages: Enhancing Assemblage Thinking with Bourdieu's Sociology*. London: Palgrave.

Carney, S. 2009. "Negotiating Policy in an Age of Globalization: Exploring Educational 'Policyscapes' in Denmark, Nepal, and China." *Comparative Education Review* 53 (1): 63–88.

Clarke, J. 2015. "The Managerialised University: Translating and Assembling the Right to Manage." In *Making Policy Move: Towards a Politics of Translation and Assemblage*, edited by J. Clarke, D. Bainton, N. Lendvai, and P. Stubbs, 95–150. Chicago, IL: Policy Press.

Clarke, J., D. Bainton, N. Lendvai, and P. Stubbs, eds. 2015. *Making Policy Move: Towards a Politics of Translation and Assemblage*. Chicago, IL: Policy Press.

Dale, R. 2005. "Globalisation, Knowledge Economy and Comparative Education." *Comparative Education* 41 (2): 117–149.

Dale, R., and S. L. Robertson. 2012. "Towards a Critical Grammar of Education Policy Movements." In *Policy Borrowing and Lending in Education. World Yearbook of Education*, edited by G. Steiner-Khamsi and F. Waldow, 21–40. London: Routledge.

DeLanda, M. 2006. *A New Philosophy of Society. Assemblage Theory and Social Complexity*. London: Bloomsbury.

de Sousa Santos, B. 2006. "Globalizations." *Theory, Culture & Society* 23: 2–3.

DiMaggio, P. J., and W. W. Powell. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality." *American Sociological Review* 48 (2): 147–160.

Döbert, H., and H. Weishaupt. 2012. "Bildungsmonitoring." [Educational Monitoring.] In *Schul- und Unterrichtsreform durch ergebnisorientierte Steuerung. Empirische Befunde und forschungs methodische Implikationen* [School Reform Through Output-Oriented Governance], edited by A. Wacker, U. Maier, and J. Wissinger, 155–173. Wiesbaden: VS Verlag.

Färber, A. 2014. "Potenziale freisetzen: Akteur-Netzwerk-Theorie und Assemblageforschung in der interdisziplinären kritischen Stadtforschung." [Setting Free Potentials: Actor-Network-Theory and Assemblage Research in Interdisciplinary Critical Urban Studies.]*Suburban* 2 (1): 95–103.

Finnemore, M. 1993. "International Organizations as Teachers of Norms: The United Nations Educational, Scientific, and Cultural Organization and Science Policy." *International Organization* 47 (4): 565–597.

Fligstein, N., and D. McAdam. 2012. *A Theory of Fields*. Oxford: Oxford University Press.

Fourcade, M. 2006. "The Construction of a Global Profession: The Transnationalization of Economics." *American Journal of Sociology* 112 (1): 145–194.

Goodchild, M. F. 2004. "Scales of Cybergeography." In *Scale and Geographic Inquiry Nature, Society, and Method*, edited by E. Sheppard and R. B. McMaster, 154–169. Oxford: Blackwell.

Grek, S. 2009. "Governing by Numbers: The PISA 'Effect' in Europe." *Journal of Education Policy* 24 (1): 23–37.

Hartong, S. 2012. *Basiskompetenzen statt Bildung? Wie PISA die deutschen Schulen verändert hat* [Basic Competencies Instead of Education? How PISA Changed the German Schools]. Frankfurt/Main: Campus Verlag.

Hartong, S. 2014. "Neue Bildungsregulierung im Zeitalter der 'Governance by Numbers'. Das Beispiel standardbasierter Bildungsreform in Deutschland und den USA." [New Educational Regulation in Times of 'Governance by Numbers'.]*Leviathan* 42 (4): 1–29.

Hartong, S. 2015. "Global Policy Convergence Through 'Distributed Governance'? The Emergence of 'National' Education Standards in the US and Germany." *Journal of International and Comparative Social Policy* 31 (1): 10–33.

Hartong, S. 2016a. "New Structures of Power and Regulation Within 'Distributed' Education Policy: The Example of the US Common Core State Standards Initiative." *Journal of Education Policy* 31 (2): 213–225.

Hartong, S. 2016b. "Between Assessments, Digital Technologies, and Big Data: The Growing Influence of 'Hidden' Data Mediators in Education." *European Educational Research Journal* 15 (5): 523–536.

Hartong, S., and R. Nikolai. 2017. "Observing the 'Local Globalness' of Policy Transfer in Education." *Comparative Education Review* 61 (3): 519–537.

Herod, A., and M. W. Wright. 2002. *Geographies of Power. Placing Scale*. Oxford: Blackwell.

Hogan, A., S. Sellar, and B. Lingard. 2016. "Commercialising Comparison: Pearson Puts the TLC in Soft Capitalism." *Journal of Education Policy* 31 (3): 243–258.

Hopmann, S. 2003. "On the Evaluation of Curriculum Reforms." *Curriculum Studies* 35 (4): 459–478.

Howitt, R. 2002. "Scale as Relation: Musical Metaphors of Geographical Scale." *Area* 30 (1): 49–58.

IQB. 2016. *Competence in Education. The Institute for Educational Quality Improvement*. Berlin: IQB.

KMK. 2003. *Kerndatensatz (KDS) für schulstatistische Individualakten der Länder. Beschluss der Kultusministerkonferenz vom 8. 5. 2003*. Berlin: KMK.

KMK. 2006. *Gesamtstrategie der Kultusministerkonferenz zum Bildungsmonitoring*. Luchterhand: KMK.

KMK. 2012. *Vereinbarung zur Weiterentwicklung von VERA*. Berlin: KMK.

KMK. 2015. *Gesamtstrategie der Kultusministerkonferenz zum Bildungsmonitoring*. Berlin: KMK.

Koyama, J. P. 2011. "Generating, Comparing, Manipulating, Categorizing: Reporting, and Sometimes Fabricating Data to Comply with the No Child Left Behind Mandates." *Journal of Education Policy* 26 (5): 701–720.

Künkel, J. 2015a. "Urban Policy Mobilities. Theoretische Grenzen und Rekonzeptualisierungen." [Urban Policy Mobilities. Theoretical Limits and Reconceptualizations.]*Suburban* 3 (3): 75–98.

Künkel, J. 2015b. "Urban policy mobilities versus policy transfer. Potenziale für die Analyse der Neuordnung des Städtischen." [Urban Policy Mobilities Versus Policy Transfer.]*Suburban* 3 (1): 7–24.

Latour, B. 1996. "On Actor-Network Theory: A Few Clarifications." *Soziale Welt* 47 (4): 369–81.

Lawn, M. 2013. *The Rise of Data in Education Systems*. Oxford: Symposium Books.

Legg, S. 2009. "Of Scales, Networks and Assemblages: The League of Nations Apparatus and the Scalar Sovereignty of the Government of India." *Transactions* 34 (2): 234–253.

Leuze, K., A. Rusconi, and K. Martens, eds. 2007. *New Arenas of Education Governance: The Impact of International Organizations and Markets on Educational Policy Making*. Houndmills: Palgrave Macmillan.

Levin, B. 1997. "The Lessons of International Education Reform." *Journal of Education Policy* 12 (4): 253–266.

Lewis, S., and B. Lingard. 2015. "The Multiple Effects of International Large-Scale Assessment on Education Policy and Research." *Discourse: Studies in the Cultural Politics of Education* 36 (5): 621–637.

Lingard, B., S. Creagh, and G. Vass. 2012. "Education Policy as Numbers: Data Categories and Two Australian Cases of Misrecognition." *Journal of Education Policy* 27 (3): 315–333.

Lingard, B., and S. Grek. 2007. *The OECD, Indicators and PISA: An Exploration of Events and Theoretical Perspectives*. Edinburgh: ESRC/ESF Research Project.

Lingard, B., and S. Lewis. 2016. "Globalization of the Anglo-American Approach to Top-Down, Test-Based Educational Accountability." In *Handbook of Human and Social Conditions in Assessment*, edited by G. T. L. Brown and L. R. Harris, 387–403. New York: Routledge.

Mangez, E., and M. Hilgers. 2012. "The Field of Knowledge and the Policy Field in Education: PISA and the Production of Knowledge for Policy." *European Educational Research Journal* 11 (2): 189–205.

Manovich, L. 2013. "Media After Software." *Journal of Visual Culture* 12 (1): 30–37.

Mattissek, A., and T. Wiertz. 2014. "Materialität und Macht im Spiegel der Assemblage-Theorie: Erkundungen am Beispiel der Waldpolitik in Thailand." [Materality and Power Observed Through the Mirror of Assemblage-Theory.]*Geographica Helvetica* 69 (3): 1–13.

Mayer-Schönberger, V., and K. Cukier. 2013. *Big Data. Die Revolution, die unser Leben verändern wird*. München: Redline. [Big Data. A Revolution which is Going to Change Our Life].

Meyer, J. W., J. Boli, G. M. Thomas, and F. O. Ramirez. 1997. "World Society and the Nation-State." *American Journal of Sociology* 103 (1): 144–181.

Meyer, J. W., G. Krücken, and B. Kuchler, eds. 2005. *Weltkultur: Wie die westlichen Prinzipien die Welt durchdringen* [World Culture and the Penetration of Western Principles]. Frankfurt/Main: Suhrkamp.

Milana, M. 2016. "Global Polity in Adult Education and UNESCO Landmarking, Brokering and Framing Policy." *Globalisation, Societies and Education* 14 (2): 203–226.

Mok, K. H., and D. Leung. 2012. "Digitalisation, Educational and Social Development in Greater China." *Globalisation, Societies and Education,* 10 (3): 271–294.

Niemann, D. 2010. "Turn of the Tide – New Horizons in German Education Policymaking Through IO Influence." In *Transformation of Education Policy*, edited by K. Martens, A.-K. Nagel, and M. Windzio, 77–104. Basingstoke: Palgrave Macmillan.

Ong, A., and S. J. Collier. 2005. *Global Assemblages: Technology, Politics, and Ethics as Anthropological Problems*. London: Blackwell.

Ozga, J. 2009. "Governing Education Through Data in England: From Regulation to Self-evaluation." *Journal of Education Policy* 24 (2): 149–162.

Ozga, J., P. Dahler-Larsen, C. Segerholm, and H. Simola. 2011. *Fabricating Quality in Education. Data and Governance in Europe*. London/New York: Routledge.

Peck, J., and N. Theodore. 2015. *Fast Policy: Experimental Statecraft at the Thresholds of Neoliberalism*. Minneapolis: University of Minnesota Press.

Piattoeva, N. 2016. "The Imperative to Protect Data and the Rise of Surveillance Cameras in Administering National Testing in Russia." *European Educational Research Journal* 15 (1): 82–98.

Pierson, P. 2000. "Increasing Returns, Path Dependence, and the Study of Politics." *American Political Science Review* 94 (2): 251–267.

Powell, J. J. W., B. Edelstein, and J. M. Blanck. 2016. "Awareness-Raising, Legitimation or Backlash? Effects of the UN Convention on the Rights of Persons with Disabilities on Education Systems in Germany." *Globalisation, Societies and Education* 14 (2): 227–250.

Ratermann, M., and S. Stöbe-Blossey. 2012. *Governance von Schul- und Elementarbildung. Vergleichende Betrachtungen und Ansätze der Vernetzung* [Governance of School and Elementary Education]. Wiesbaden: VS Verlag.

Robertson, S. L., and R. Dale. 2015. "Towards a 'Critical Cultural Political Economy' Account of the Globalising of Education." *Globalisation, Societies and Education* 13 (1): 149–170.

Rose, N. 1999. *Powers of Freedom: Reframing Political Thought*. Cambridge: Cambridge University Press.

Ruppert, E. 2012. "The Governmental Topologies of Database Devices." *Theory, Culture and Society* 29 (4/5): 116–136.

Sassen, S. 2002. "Towards a Sociology of Information Technology." *Current Sociology* 50 (2): 365–388.

Savage, G. C. 2016. "Who's Steering the Ship? National Curriculum Reform and the Re-shaping of Australian Federalism." *Journal of Education Policy* 31 (6): 833–850.

Savage, G., and S. Lewis. 2016. "The Phantom National? Assembling National Teaching Standards in Australia's Federal System." Conference Paper presented at the Australian Association for Research in Education Annual Conference 2016.

Savage, G. C., and K. O'Connor. 2015. "National Agendas in Global Times: Curriculum Reforms in Australia and the USA Since the 1980s." *Journal of Education Policy* 30 (5): 609–630.

Sellar, S., and B. Lingard. 2013. "PISA and the Expanding Role of the OECD in Global Educational Governance." In *PISA, Power, and Policy: the Emergence of Global Educational Governance*, edited by H. D. Meyer and A. Benavot, 185–206. Oxford: Symposium Books.

Sheppard, E. 2002. "The Spaces and Times of Globalization: Place, Scale, Networks, and Positionality." *Economic Geography* 78 (3): 307–330.

Stambach, A., and G. A. Malekela. 2006. "Education, Technology, and the 'New' Knowledge Economy: Views from Bongoland." *Globalisation Societies and Education* 4 (3): 321–336.

Steiner-Khamsi, G. 2012. "Understanding Policy Borrowing and Lending." In *Policy Borrowing and Lending in Education. World Yearbook of Education*, edited by G. Steiner-Khamsi and F. Waldow, 3–17. London: Routledge.

Steiner-Khamsi, G., and F. Waldow, eds. 2012. *Policy Borrowing and Lending in Education. World Yearbook of Education*. London: Routledge.

Tillmann, K.-J., K. Dedering, D. Kneuper, C. Kuhlmann, and I. Nessel. 2008. *PISA als bildungspolitisches Ereignis. Fallstudien in vier Bundesländern* [PISA as an Education Policy Event]. Wiesbaden: VS Verlag.

Verger, A., C. Lubienski, and G. Steiner-Khamsi. 2016. *World Yearbook of Education 2016: The Global Education Industry*. London: Routledge.

Waldow, F. 2012. "Taylorismus im Klassenzimmer." [Taylorism in the Classroom.]*Zeitschrift für Pädagogik* 58 (2): 159–175.

Wilkoszewski, H., and E. Sundby. 2014. "Steering from the Centre: New Modes of Governance in Multi-level Education Systems". OECD Education Working Papers, No. 109. OECD. doi:10.1787/5jxswcfs4s5g-en.

Williamson, B. 2015a. "Governing Software: Networks, Databases and Algorithmic Power in the Digital Governance of Public Education." *Learning, Media and Technology* 40 (1): 83–105.

Williamson, B. 2015b. "Governing Methods: Policy Innovation Labs, Design and Data Science in the Digital Governance of Education." *Journal of Educational Administration and History* 47 (3): 251–271.

Williamson, B. 2016a. "Digital Education Governance: An Introduction." *European Educational Research Journal* 15 (1): 3–13.

Williamson, B. 2016b. "Digital Education Governance: Data Visualization, Predictive Analytics, and 'Real-Time' Policy Instruments." *Journal of Education Policy* 31 (2): 123–141.