

Towards the Nature of Geography for Geography Education: an exploratory account, learning from work on the Nature of Science

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This paper offers an exploratory account of the Nature of Geography (NOG) for geography education. The proposed NOG framework describes geography through the theoretical offerings of the family resemblance approach across the dimensions of: aims and values; knowledge; methods and methodological rules; practices; and geography as a social-institutional system. In science education, the recontextualised family resemblance approach has stimulated fruitful contributions to research, including its applications as an analytical methodological tool for curriculum research and development, and to inform teacher education. Rather than seeking to describe the essence of geography through an illusive shared epistemological object of study, the family resemblance approach offers a framework shown to be robust in science education (Erduran & Dagher, 2014; Kaya et al., 2019) with space for multiple foci and flexibility to hold unresolved questions in tension. Our argument is that integration of the NOG framework into geography education would introduce students to a more holistic understanding of the different ways in which aims and values, knowledge, methods, practices, and social-institutional dimensions interact in the construction and constitution of geography. We suggest possibilities for NOG across teaching resources, curriculum research, and teacher education.

Keywords: nature of geography; nature of science; family resemblance approach

Introduction

This paper offers an exploratory conceptualisation of the Nature of Geography (NOG), by drawing on pathways carved from Nature of Science (NOS) research, particularly through the theoretical offerings of the family resemblance approach. Our purpose is to propose NOG as a solution to interconnected problems with which

geography education research has been wrestling: what is geography (Harvey, 2008; Peet, 1998; Puttick et al., 2018; Walford, 1996)? What should be taught in geography education (Firth, 2011; Lambert, 2011; Maude, 2020; Stoltman et al., 2014; Walford, 1982)? Addressing these questions is challenging, particularly because of the diversity of topics, traditions, and assumptions about knowledge within geography. In the example of David Harvey's work this problem motivated substantial attempts at unification, employing a wide range of perspectives from logical deduction to Marxian dialectics. This diversity is not unique to geography, but is shared in discussions about the nature of science which is "so varied that there seems to be no set of features that is common to all of them and shared by all of them" (Irzik & Nola, 2011, p. 251). Irzik and Nola respond to the apparent lack of shared features by employing a Wittgensteinian notion of family resemblance to identify the dimensions through which the nature of science might be identified, described, and taught about.

Frameworks of NOS have been applied widely in science education, including; as analytical methodological tools for curriculum analysis and development (Bybee, 2014; Erduran & Dagher, 2014); to inform science curricula internationally (Olson, 2018; NGSS, 2013); and to enhance teacher education (Kaya et al., 2019; Lederman, 1992). Sophisticated understandings about NOS are believed to be "a critical component of scientific literacy" which, among other things, support "an understanding of science from philosophical and historical perspectives" (Dagher & Erduran, 2016, p. 148). Dagher and Erduran's expansion of Irzik and Nola's account of NOS resulted in the Recontextualised Family Resemblance Approach to NOS (RFN), representing scientific practices, methodologies, aims and values, social norms, and knowledge. There are few equivalents in geography education research, and developing work on NOG offers potential to address enduring and interconnected problems in geography education:

what is geography? What should be taught in geography education?

What is geography?

Geography education research's consideration of the question *what is geography?* has been informed from two interrelated directions; wrestling in the discipline over its 'permanent identity crisis' (Peet, 1998), and empirical accounts of students' and teachers' conceptions of what geography is (Catling, 2004, 2013; Morley, 2012; Puttick et al., 2018; Walford, 1996). The former is a substantive challenge for the discipline to define what it is, and the other is a pedagogical challenge for geography education to support the teaching of broader, more holistic accounts about what geography is. The analysis of students' and teachers' conceptions of geography has focused on the limited nature of their understandings of geography, with papers often calling for subject-specific professional development.

What should be taught in geography education?

Recent consideration of this question in school geography has focused on the concept of powerful knowledge (Maude, 2020). In the discipline, and emerging in school geography, responses have argued that knowledge reaching beyond an established (White) canon (Esson & Last, 2020) should be taught, asking critical questions such as: why is my curriculum so white? (Stanek, 2019) and seeking to decolonise geographical knowledge (Noxolo, 2017). Similarly, developments in teaching Critical Physical Geography (Malone, 2020) and climate change (Cross & Congreve, 2020) have called for more expansive conceptions of the subject to inform curriculum and pedagogy. The school subject's focus on 'powerful knowledge', which also underpins the 'Geocapabilities' approach, shares similarities with some dimensions and aims of NOS, in particular: calls for students to be given greater access to understandings about

knowledge production (Firth, 2011) and ‘attention to both the products of geographical knowledge production, including properties such as its systematicity, and the procedures and processes involved in its creation, including the adjudication of its theories and principles’ (Lambert et al., 2015, p. 726). This brief list of properties, procedures and processes strongly echoes some dimensions of NOS, yet despite considerable attention to ‘powerful knowledge’, there seems to have been little progress towards giving students access to understanding beyond content knowledge: it remains a ‘blind spot’ (Hoadley et al., 2019). Where the concept of ‘powerful knowledge’ is also limited by theoretical weakness (Alderson, 2020; White, 2019), NOG offers potential through its coherent, theoretically rich, and practically useful framework to help progress these debates and stimulate fruitful lines of research that will improve our understandings of geography and geography education. The following section introduces NOS through a brief historical account.

Nature of Science in science education

NOS emerged as a topic of discussion in science education in the 1960s with seminal works by Conant (1961) and Klopfer (1969). The inclusion of NOS in science curricula has been advocated by science educationalists for many years and is commonly stated in objectives for science education (AAAS, 1989; Kimball, 1968; Lederman, 2007).

Saunders (1955) described understanding NOS as the most important purpose of science teaching, and potential benefits for pupils have been argued to include; (a) understanding the process of science, (b) making informed decisions on socio-scientific issues, (c) appreciating science as a central element to contemporary culture and society, (d) being made more aware of the norms of the scientific community, and (e) learning science content more in depth (Driver et al., 1996; Erduran & Dagher, 2014). Several accounts of NOS have been developed, each with different philosophical

underpinnings. Over the past 30 years, one of the most researched account of NOS is that which is commonly referred to as the *consensus view*. The consensus view presents several guiding statements or tenets which many consider as agreed-upon normative aspects of science which can be taught in schools (Bazzul, 2017). Lederman *et al.* (2002) present seven tenets, covering scientific knowledge's nature as: tentative; theory-laden; creative and imaginative; social and cultural embeddedness; the role of observation and inference; and the myth of The Scientific Method.

These tenets have shaped how NOS is presented at all educational levels (Lederman, 2007), but there are growing criticisms of the consensus view, particularly focused on the fragmented and narrow view of science that it is argued to represent (Allchin, 2017; Erduran & Dagher, 2014; Hodson & Wong, 2017; Matthews, 2012). Alternative approaches to NOS have emerged to address these weaknesses, including; Whole Science (Allchin, 2011), Features of Science (Matthews, 2012), the Family Resemblance Approach (FRA) (Irzik & Nola, 2014) and the Reconceptualised Family Resemblance Approach (RFN) (Erduran & Dagher, 2014; Kaya & Erduran, 2016). Within science education there is agreement on the need to teach NOS, and disagreement on the particular NOS that should be used. In the case of geography, a consensus view seems untenable because of the way in which each major 'turn' in the discipline (Taylor, 2009) foregrounds quite different – even contradictory - aims and values, which the school subject, to a greater or lesser extent, recontextualises, refracts and reflects in various ways and in relation to other competing forces shaping the curriculum (Puttick, 2015). The Wittgensteinian notion of family resemblance developed in RFN through a flexible framework of interacting dimensions has the capacity to hold conflicting positions in tension and give both analytical and practical assistance in teaching about the nature of geography.

Family resemblance was originally described by Wittgenstein in 1958 in response to his critique of language. In 2011, Irzik and Nola applied the basic idea of Family Resemblance to NOS, which likens science to the ways that members of a family each resemble one another in some details, if not in others, adapting Wittgenstein's generic definition to describe and represent science through two aspects: cognitive-epistemic, and social-institutional, with each aspect having its own distinct categories. Their perspective characterises fields of science as sets of broad categories addressing a diverse group of features which are common across all the sciences. In 2014, Erduran and Dagher reconceptualised Irzik and Nola's view by adding three additional categories and applying it to science education. Three different definitions of the Family Resemblance then existed: in philosophy (Wittgenstein), philosophy of science (Izik and Nola) and science education (Erduran and Dagher). To clarify the definition of FRA for science education purposes, Kaya and Erduran changed the name in 2016, with their reconceptualised model becoming known as RFN (Reconceptualised Family Resemblance Approach to NOS).

Reconceptualised Family Resemblance Approach to NOS (RFN)

The RFN is a theoretical framing that sees science defined by a combination of related features. RFN offers a systematic approach, providing a novel way of capturing the unity of science while doing justice to its diversity. The FRA wheel (**Error! Reference source not found.**) identifies science as a cognitive-epistemic and social-institutional system that encompasses a number of components. Science as a cognitive-epistemic system occupies a space divided into four quadrants representing categories. This circle floats within a larger concentric one also divided into four quadrants, relating to the four components of science as a social-institutional system. The boundaries between the two

circles (or spaces) and their individual compartments are perforated, indicating the non-compartmentalised nature of the components and ideas: they are interwoven, allowing fluid movement across and between. The distinctive yet interrelated representation of components aims to depict science as a holistic, dynamic, and interactive system, subject and relating to multiple influences. Although the representation uses divisions to illustrate the various components, the notion that the cognitive-epistemic and social-institutional components co-exist provides a departure from representations of science only in relation to discrete ideas expressed through lists of propositions. The RFN model is generative, and a growing body of research is making productive use of its interactive, visual and holistic account (Erduran et al., 2019; Kaya et al., 2019).

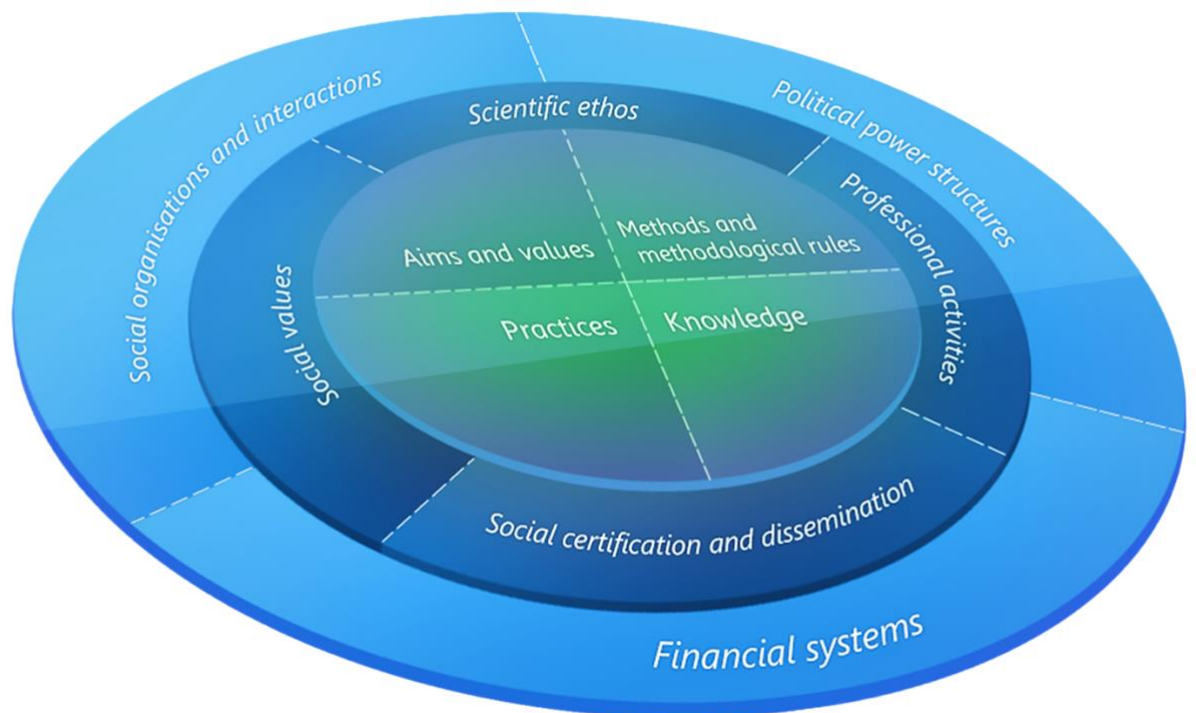


Figure 1. FRA Wheel: science as a cognitive-epistemic and social-institutional system (Erduran & Dagher, 2014, p.28)

The RFN categories represented on Figure 1 (aims and values; knowledge; methods and

methodological rules; practices; science as a social-institutional system) are now briefly introduced, followed by a recent application in science teaching, and then discussion of the dimensions in relation to geography.

Aims and values

The RFN framework (Figure 1) employs a broad notion of aims and values, including epistemic, cognitive, socio-political, and cultural dimensions. The RFN contention is that ignoring a set of aims and values, practices, methodologies, or social norms embodied in NOS will lead to a limited understanding of how science is conducted. If not explicitly shown, disconnects are likely to emerge between pupils' thinking about what scientists aim to do, how they do it and the context in which they undertake and communicate science. The RFN category deals with components of scientific aims and values often depicted by philosophers of science, with the focus on epistemic and cognitive values in science. Epistemic values described by Irzik and Nola (2014) are those that direct the pursuit and methods of science, and cultural values that enter science through the work of individual scientists. The cognitive aims and values are aspects of reasoning and cut across epistemic, cognitive, socio-political and cultural values related to science. Epistemic and cognitive values govern the knowledge generation and evaluation practices of science, and include; consistency, simplicity, objectivity, empirical adequacy and novelty. Social values relate to shared norms that include inductive bias, honesty, applicability to human needs and decentralisation of power with respect to race and gender. The explicit identification of social aims and values highlights the ways in which scientific organisations influence scientific knowledge production.

Knowledge

The category of *Knowledge* addresses the contribution of theories, laws and models to our scientific understanding and educational applications of these ideas. Often these ideas are taught by teaching the products of science in a disconnected fashion without giving the learners a sense of the relationship between different forms of scientific knowledge, how knowledge grows and what criteria and standards (heuristics) drive the growth of scientific knowledge. Theories, Laws and Models (TLMs) are forms of scientific knowledge that work together to generate and/or validate new knowledge (Kuhn, 1970). They are products of scientific enterprise (Popper, 1972). Science instruction in schools is dominated by theories, laws and models, but this is often characterised as disparate content knowledge, with little activity building pupils' understanding of connections across and between them (Erduran & Dagher, 2014).

Methods and methodological rules

The category of methods addresses how scientists conduct science to produce knowledge, which has involved highlighting the myth of *The Scientific Method* and going on to illustrate the variety of methods that scientists employ (Wong & Hodson, 2009). Science is an organised activity that is governed by several methods and principles that include constructing hypotheses that are testable, avoiding *ad hoc* changes to theories, choosing theories according to their explanatory power, rejecting inconsistent theories, accepting new theories only if they offer better explanations, using controlled experiments to test casual hypotheses, and using blinded procedures when experimenting on human subjects (Irzik & Nola, 2014).

Practices

The category of practices explores the variety of activities that scientists do to produce knowledge, beyond the implementation of the particular methods discussed above.

Scientific practices; (a) are a set of interactions between the data, models, explanations and predictions that underlie the characterisations of phenomena occurring in the real world, and (b) integrate social-institutional and cognitive processes that mediate such interactions through discursive practices like argumentation as well as norms such as social certification (Erduran & Dagher, 2014). These understandings highlight the way in which social dimensions of knowledge production are made explicit, for example, through the RFN category of “political power structures” as “the dynamics of power that exist between scientists and within science cultures”, and its keywords; “political power, research team, team leader, team members, researcher, gender, ethnicity, race, nationality” (Kaya & Erduran, 2016, p. 1123).

Science as a social-institutional system

Social-institutional dimensions examine how science exists in financial and political spheres, where the dynamic in institutions and organisations such as universities and research institutes contribute to how science is conducted and reported (Wong & Hodson, 2010). This aspect of the RFN framework addresses the aims and values of science; here, through the social, political and cultural aims and values. This dimension of the RFN framework contains seven categories: (1) professional activities, (2) scientific ethos, (3) social values, (4) social certification and dissemination, (5) political power structures, (6) social organisation and interactions and (7) financial systems.

Practical example from the NOS classroom

Recent work, such as Erduran *et al.* (2020) has contextualised NOS for science education through exemplar teaching resources explicitly designed around the RFN framework and its application for the science curricula. One example is the activity ‘Conservation At Work - The Bengal Tiger’ which tells the story of how the conservation of tigers in the Corbett Reserve in North India impacted local villages: the rise in tiger numbers resulting from conservation efforts led to increased encounters between humans and tigers and a number of human deaths. The resource supports the development of conversations between different stakeholders, and there are many parallels between the activity and resources that will be familiar to geography educators. The development in the resource, informed by the NOS approach, is in making particular dimensions of the NOS explicit, such as framing the stakeholder discussion in a way that foregrounds aims and values including: ‘objectivity...empirical adequacy...critical examination...addressing human needs...and taking opposition to own ideas seriously’ (p.381). Speech bubbles from scientists make these aims and values explicit: “it is very important that scientists consider...” and “it is very important that scientists aim to be...” Similarly, the facilitation of the discussion through argumentation is designed to engage with the NOS dimension of practices, making subject-specific aspects of these discussions explicit in ways that improve students’ understandings of NOS, moving beyond more generic ‘critical thinking’ or ‘discussion’ skills. For geography education this example illustrates the ways in which existing approaches might be tweaked to make the NOG – here, geographical aims, values and practices – more explicit, enlarging and refining students’ conceptions of geography.

Towards the Nature of Geography (NOG)

We now take each of the dimensions of the RFN framework for the NOS to begin

opening a discussion about the ways in which each area might align with and stimulate fruitful lines of enquiry for geography education. We have engaged particularly with Harvey's work in this discussion to illustrate the ways in which attention to the NOG might contribute to greater coherence in conceptualisations of geography, and to illuminate the dimensions through which geographical knowledge is produced and enacted. Harvey's work is, among many other things, a substantial attempt to grapple with questions about the nature of geography. Although potentially any work could have been chosen, the wide range of theoretical stances he has adopted is particularly interesting for this exploratory discussion of NOG. The span of his work includes systems theory and positivism in *Explanation in Geography* (1969), structuralism in *Social Justice and the City* (1973), as a Marxist in *The Urbanization of Capital* (1985) and in dialectic with Marx's critique in *Spaces of Capital* (2001). Across each dimension of NOG we highlight some of the ways in which this framework might contribute to geography education.

NOG: Aims and values

Across all dimensions of NOG, we might ask historical questions about what has been the case, alongside consideration of the different positions currently taken in relation to the dimension of NOG. Considering the aims and values that have driven geography highlights common themes and points of tension while making a more general point about the non-neutrality of geographers and geography (Harvey, 1984). Geographers are driven by certain values, working towards particular aims which may be more or less explicit and open to critique. Obvious tensions might be illustrated by contrasting Mackinder's geography – in which control and domination are central aims, and loyalty to Empire is a key value (Kearns, 2009) – against the current Halford Mackinder chair

of Human Geography's argument that *kindness* should be the value driving geography: 'what was once the core subject of imperial domination can and should be turned inside-out and upside-down' (Dorling, 2019, p. 7). Similarly, work prioritising decolonisation (Legg, 2017) as an aim of geography makes anti-racism explicit as an underpinning value.

Harvey (1984, p. 7) includes striving 'towards scientific rigour, integrity and honesty' as important values for geographers, which might be expanded to consider the ways in which, across Harvey's work, constants (such as non-neutrality) and variables (such as interpretations of 'scientific rigour') vary across materialist, Marxist, structuralist, and post-positivist accounts. More broadly, the frequency with which values underpinning knowledge claims are unacknowledged (Jones & Merritt, 1999) supports calls for them to be made more explicit. The NOG framework raises these questions and highlights aims and values as an important dimension of geography, rather than prescribing certain aims and values (such as the propositions in a professional code) around which a consensus might be sought. Questions about values also permeate and underpin debates around knowledge (Alderson, 2020).

NOG: Knowledge

Knowledge in geography education has received increased attention, often revolving around questions about what constitutes 'powerful knowledge' (Maude, 2020).

Critiques of powerful knowledge have highlighted the tensions between this sociological framework and distinctly geographical epistemologies. For example, Catling and Martin's (2011) discussion of children's ethno-geographies, and Roberts' (2014) focus on geographical analyses of cities both suggest that these geographical knowledges do not map onto dichotomies between 'everyday' and 'powerful'

knowledges. The NOG approach asks different questions about knowledge to foreground theories, laws and models. Potential differences in the relationships between theories, laws and models developed in science and geography might be expected: ‘given the nature of geographic concepts, the development of formal theory in geography appears to be a very restricted possibility’ (Harvey, 1969, p. 130). Harvey’s early thought encouraged a geography characterised by hypothetico-deductive process through which theory might be tested and accepted or rejected using deductive-predictive arguments. More recently, he described *Explanation in Geography* as being a response to geography’s assumed exceptionalism: “the established doctrine was that the knowledge yielded by geographical enquiry is different from any other kind. You can’t generalize about it, you can’t be systematic about it. There are no geographical laws...” (Harvey, 2000). From different perspectives, including systems theory, post-positivism, structuralism, and Marxism, Harvey has sought to address this exceptionalism, including through appeals to the unity of science, and beliefs about the objectivity of laws across natural and social dimensions:

in the same way that the laws of fluid dynamics are invariant in every river in the world, so the laws of capital circulation are consistent from one supermarket to another, from one labour market to another, from one commodity production system to another (Harvey, 1969, p. 132)

The shift from laws to theory ‘grasp[ing] the most significant relationships at work’ (1982, p. 450) is one aspect of the different ways in which geographical knowledge might be understood. The dimension of knowledge in NOG avoids the weaknesses over debate about what constitutes ‘powerful knowledge’ by instead fostering multifaceted engagement with geographical knowledge including through theory, laws, models, and their relationships across other dimensions of the NOG.

NOG: Methods and methodological rules

An important dimension of NOG related to knowledge often raised in debates about knowledge in geography education research is methodological: the processes of knowledge production (Firth, 2011). This might be summarised as the challenge of not simply presenting students with “decontextualized facts that obscure science’s epistemic foundations” (Kloser, 2013, p. 1233). Within the discipline of geography there have also been calls to make discussion of methods more consistently explicit (Hitchings & Latham, 2019). Emphasis on these issues has the potential to facilitate greater understandings of how geographical knowledge is produced that move beyond simplistic notions of ‘collecting data’. Here, developments from across the discipline offer particularly interesting stimulus, including (among others) discussion of methodologies for questioning belief (Brown, 2004), and philosophical discussion of methodological issues through Critical Physical Geography (Lane, 2019; Lave et al., 2018) to update the relatively simplistic ways in which methods are often introduced in the school subject as only an aspect of fieldwork. For example, in England the subject content for GCSE Geography mentions ‘methods’ only twice, both of which are in relation to data collected during fieldwork (DfE, 2014): the implication being that methods are not integral to understanding knowledge and its production in other areas of the subject. In Kloser’s terms, these other areas risk being reduced to decontextualised facts.

NOG: Practices

Work in geography provides a rich source of insight into practices that produce knowledge taught in geography education, particularly around climate modelling (Mahony & Hulme, 2016, 2018) and Critical Physical Geographies (Lave et al., 2018;

Tadaki et al., 2014). The introduction to *Social Justice and the City* (Harvey, 1973) captures some sense of this: “the biographical details of how this book came to be written are relevant to reading it since they serve to explain features in its construction that might otherwise appear peculiar” (p. 9). One set of peculiarities are associated with the change in the perspective and arguments made, and there is an important sense in which Harvey’s work might be understood in relation to the particular space-times of the English and US cities in which he lived and worked (Barnes, 2006).

The alignment between the vision for the potential contribution of NOG in giving students’ access to knowledge production – to the ‘rules of the game’ – is particularly clear in Lane’s (2019) second and third tenets of CPG (after the first which is: critique of the lack of attention given to less ‘pristine’ environments in physical geography). The second tenet, drawing on science and technology studies, holds that “some of the assumptions made of and by scientists, which are integral to giving science predominance in decision-making, do not hold” (p. 50). These assumptions include the role that scientists’ subjective, positioned and situated decision making is influenced by a range of factors including government and industry priorities and funding, and “the power to influence what a scientist does is not distributed equally between people and organisations” (p. 50). Our argument is that consideration of the NOG offers robust support for these aims.

NOG: Geography as a social-institutional system

The dimension of the social-institutional system foregrounds Lane’s questions about organisations, offering potential for more systematic reflection on social-institutional issues. For example, in addressing Castree’s (2006) critique about Harvey’s limited attention to the “political and moral economy of Western university life” (p.268)

and its bearing on the shape of his work. Similarly, Massey's (1990) stark critique of the style, construction and "assumption of universals which are in fact particulars" (p.31) in *The Condition of Postmodernity* (Harvey, 1990) highlight the ways in which geography as a social-institutional system produces and celebrates particular kinds of work.

Distinctions between 'powerful knowledge' and 'knowledge of the powerful' (Young & Muller, 2013) might also be pushed and explored a little more deeply through the NOG challenge to analyse the ways in which knowledge production works through particular social-institutional systems in particular space-times. Geographical research on social-institutional systems offers a rich body of work on which to draw, for example, through geographies of the social-institutional dimensions of knowledge about climate change through the IPCC (Mahony & Hulme, 2016, 2018), which has highlighted the ways in which:

...this 'global' knowledge has distinctive geographies, shaped by histories of exploration and colonialism, by diverse epistemic and material cultures of knowledge-making, and by the often messy processes of linking scientific knowledge to decision-making within different polities. (Mahony & Hulme, 2018, p.395)

The dimension of social-institutional systems makes these messy processes explicit to students and teachers, moving to contextualise and situate knowledge claims. This speaks to anti-racist efforts to decolonise geography curricula by bringing critical attention to structural issues (Esson et al., 2017; Puttick & Murrey, 2020) about geography's "racist and colonial tendencies", ongoing "white space-making practices" (Hamilton, 2020, p. 300), and what continues to be a lack of diversity in its social-institutional composition (Dorling, 2019). Making the spatialized nature of geography's disciplinary activity more explicit is an early step along the process of generating broader debate that "must include voices, ideas, scholarship, and places in the world

that have been under-represented in geography's publication venues over the years” (Daley et al., 2017, p. 3).

Possibilities for NOG

We now briefly expand on three possibilities for engaging with NOG in the contexts of: teaching resources, curriculum research and teacher education.

Teaching resources

Particularly in the context of school geography, applying the NOG framework to the construction of teaching resources offers concrete suggestions to expand the depth with which geography is encountered and taught. In addition to the content a resource aims to communicate, dimensions of NOG could also be incorporated. At the most basic level this could involve all data being clearly referenced (in England, examination board resources presenting data are routinely not attributed), which might be extended at times to (even briefly) note the ways in which the knowledge was produced, using what methods, by whom, in what context, driven by what values, towards what aims, and in what socio-institutional context, and funded by what bodies. Embedding NOG dimensions in the construction of teaching resources would also help to address the problems Knight (2007) and others have highlighted about outdated understandings being presented as timeless, decontextualised truths. Encouraging the development of teaching resources that introduce students to geographers (that is, examples beyond TV personalities) and their theories and models, may also help to engage students beyond decontextualised facts and give deeper understanding of what geography is.

Curriculum research

Helping to address questions about what should be taught in geography education, the NOG framework offers a useful lens through which curricular representations of

geography might be analysed: To what extent is NOG already included in geography curricula? What areas are included? What is omitted? In what ways does attention to different dimensions of NOG vary nationally and internationally? What might be learnt from international comparative analyses of curricula through NOG? The dimensions of NOG discussed above provide a concrete response to the more general concern raised by discussions around powerful knowledge. Moving beyond the broader ‘does this curriculum give students access to powerful knowledge’, NOG research might instead ask to what extent does the curriculum include geography’s: aims and values? Knowledge? Methodologies and methodological rules? Practices? Social-institutional dimensions? Research might ask how relationships across NOG dimensions are represented, and within dimensions, sub-questions might explore: how social-institutional dimensions shed light on geography’s institutional and political past; what particular methodological approaches are foregrounded; what epistemological assumptions are included, and which are excluded; at what phases of education different dimensions of NOG are prioritised, and how students’ progress in understanding the NOG might be conceptualised.

Teacher education

The narrow or limited conceptions of geography that are reported to be held by beginning teachers has been a stubborn issue repeatedly found across multiple studies conducted against the background of very different National Curriculums (Puttick et al., 2018). Giving attention to NOG during initial teacher education provides a rich set of subject-specific questions to support beginning teachers’ development. Over the course of an initial teacher education programme, beginning teachers might be supported to reflect on and expand their own conceptions of geography by engaging with and critically exploring the NOG. The NOG framework might also be used to review and

develop teaching resources, lesson plans, and schemes of work, leading to subtle tweaks (such as greater inclusion of source, background and methodological information in specific resources) and enhancement of individual lessons: by focusing on particular dimensions of the NOG for particular lessons teachers might consider how resources, pedagogical approaches, explanations and activities might be used to more effectively introduce students to this dimension of NOG. Over the medium term attention to the NOG might support more substantial shifts in curriculum making, including giving greater attention to the people, cultures and contexts involved in the production of geographical knowledge to enlarge students' understandings about geography: not only the content it has produced, but more deeply what it *is*.

Conclusions

NOG, through a family resemblance approach, has the potential to contribute to ongoing discussions in geography education by making more expansive conceptions of geography more explicit and more accessible to students. Analysis of the work of particular geographers or schools of thought provides one way of exploring what geography is, such as through the engagement with Harvey's work that we have introduced in relation to NOG. A NOG approach to school geography holds promise for doing this more often and more routinely; introducing students to more situated, contextualised and richer understandings of geography and geographers. Part of our argument in the current paper is that the framework for NOG that we have presented offers a tool to systematically explore the dimensions through which these different geographies might be understood, compared, appreciated, and critiqued. Rather than seeking to describe the essence of geography through an illusive shared epistemological object of study, we have presented the family resemblance approach as a framework with space for multiple foci and flexibility to hold unresolved questions in tension. Big

unresolved questions include ‘what is geography?’ and ‘what should be taught in geography education?’ In both cases, NOG brings together multiple interacting dimensions through which the questions might be explored more deeply. Of particular importance for geography education is the way in which NOG holds promise for moving beyond problematic questions about what counts as ‘powerful knowledge’ to make progress on the issues raised by these knowledge debates: what are the ‘rules of the game’? How can students be given access to understandings about knowledge production? Integration of the NOG model into geography education would introduce students to a more holistic understanding of the different ways in which aims and values, knowledge, methodologies and methodological rules, practices, and social-institutional dimensions interact in the constitution of geography. These more expansive understandings of NOG would also enable substantial progress to be made on the long-standing critique of beginning teachers’ limited conceptions of geography. Across teaching resources, curriculum research, and teacher education, we hope the possibilities outlined in this exploratory account provide useful directions for future work.

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Figures

Figure 1. RFN Wheel: science as a cognitive-epistemic and social-institutional system (Erduran & Dagher, 2014, p. 28).