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## Building 'Science Capital' in the Classroom

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An introduction to the concept of 'science capital' and its implementation in science teaching practice

## Abstract

In this article we share insights from our ongoing research on the concept of 'science capital' – a term that refers to an individual's science-related resources and dispositions. We have been working in collaboration with secondary teachers in England to explore the applications of the concept in science teaching practice. Underpinned by a social justice agenda, our aim is to meaningfully engage students from diverse backgrounds with science. We present our developing work as an orientation point for science capital informed approaches in the classroom that include eliciting, valuing and linking students' own experiences and interests, embedding science capital dimensions, and reflecting on the 'field' of the science classroom.

## Introduction

"Science – what's the point?" This teenager's exasperated comment, made during their school science lesson, will sadly be familiar to many science teachers. It often stems from student disidentification with science and feeling that science is not relevant to their lives. In this article, we elaborate on the potential of the concept of 'science capital' (outlined below) to inform science teaching in ways that can help to reduce student antipathy and engage more students with science. This science capital informed approach to science teaching emphasises the relevance of science to students' lives and actively seeks to broaden what 'counts' as science in the classroom. By anchoring the epistemic base of school science to the wider arena of everyday, lived experiences, the science capital approach aims at a more inclusive science teaching practice.

We present findings from a series of research partnerships developed with science teachers in London, York, Leeds and Newcastle. Drawing on the concept of science capital, and through year-long programmes of professional development we, together with the partner teachers, have identified a number of strategies aimed at enhancing student engagement. The strategies were all readily implemented within existing schemes of work and lesson plans, and focussed on helping more students from more diverse backgrounds feel that science could be 'for them.'

Our research in this area is ongoing: we continue to work with teachers and explore ways of developing more socially just approaches to science education (Archer et al., under review). We have also developed a conceptual framework for defining student engagement with science (Godec et al. under review). Here, we seek to share our emerging ideas relating to science capital teaching practices. We present this article as an orientation point for science capital informed approaches in the classroom. Moreover, we welcome conversations about how these approaches may be further developed and refined. To illustrate the nature and impact of our approach, we share elements of our evidence base, comprising classroom observations, teacher interviews, and data outlining changes in student perceptions.

**Science Capital**
'Science capital' is becoming an increasingly familiar term in STEM education research, policy, and practice (e.g. Edwards et al. 2015; House of Commons 2017). Deriving from the sociology of Pierre Bourdieu, the idea of science capital was developed by Professor Louise Archer and colleagues as a conceptual device to capture an individual's science-related resources and dispositions, or lack thereof (Archer et al. 2015).

The concept can be explained by using the analogy of a 'bag' or holdall of resources and experiences that an individual carries around (see figure 1). The bag may be regularly topped up by experiences at home or school; equally, the bag may appear 'depleted' due to a lack of recognised resources. Those with a full bag have resources to hand which they can use in science lessons, or other science contexts. Those who do not possess the same level of 'high status' science-related resources, and/or those whose science resources are not recognised by society as being legitimate or the 'right sort' of resource, may have little to make use of: they do not have the capital to exchange and thus 'get on' in the 'game' of science learning. Indeed, analysis of large-scale survey data and longitudinal interviews with parents and students conducted as part of the ASPIRES project (2013) has shown that the more science capital a young person has, the more likely they are to express a 'science identity' (to see themselves and to be recognized by others as being a 'science person'), and the more likely they are continue with science post-16 (Archer et al. 2012, Archer et al. 2014). The contents of the bag (capital) can be grouped into different types, or 'compartments' - what you know, how you think, what you do, who you know - that correspond to science related forms of cultural, social and symbolic capital (Archer et al. 2015, King et al. 2015).

[Insert figure 1 about here] Caption : Science capital 'holdall' analogy. Illustration © Cognitive 2015

**Science capital research**
The strategies and approaches for use in the classroom have been developed collaboratively by our research team and partner teachers under the auspices of the Enterprising Science project, funded by BP. Over the course of four years, we have run four cycles of teacher professional development with secondary science teachers in London and the North of England (Archer et al. under review; King et al., 2015; King and Nomikou in press). Each cycle has involved between nine and 15 teachers.

In the initial years of the project, we ran a series of twilight evening professional development sessions focussing on the concept of science capital and its implementation potential. The sessions also featured the creation of teams comprising three or four teachers and a researcher. The aim was to facilitate idea sharing between practitioners and provide concrete support on how to develop teaching practices. In years 1 and 2 of the programme, we approached science capital 'building' through the development of lesson starters, plenaries and homework activities that addressed the different dimension of science capital (see below). We observed teachers' attempts to incorporate these in their lessons and discussed their efficacy. We assessed these activities as steps in the right direction (King et al. 2015), but realized that we needed a more substantial leap in order to fully develop a science capital building approach.

This led to a refinement of our ideas, and the understanding that whilst many of the activities were useful tools and props, success would require a change in the teachers' overarching practice. Such a change did not involve an overt change to lessons. Instead, it involved implementing 'tweaks' to one's practice and organization of the learning environment. In other words- the approach we were proposing was not 'in addition to' existing work – like adding a missing ingredient that would increase science capital. Rather, by applying a science capital 'lens' to existing practice, it embodied a change of emphasis and shift of pedagogical mindset.

Accordingly, in years 3 and 4 of the programme, we focused on 'tweaking' existing lesson plans and schemes of work, and also reflected on ways in which interactions between teacher and students were conducted and how student contributions were encouraged and managed. In each year, we held two day-long workshops – one at the beginning and one in the middle of the school year – in which we discussed the concept and shared insights from previous years. We observed lessons fortnightly and held regular feedback sessions with each teacher in which we discussed the changes and their results. We also conducted focus groups with students to triangulate our observations. As a consequence of the regular interactions, close teacher-researcher relationships were developed which permitted us the opportunity to examine the effects of the implemented changes to practice in rich detail. We discuss these below.

**Science Capital in the Classroom**

**1. Elicit, value, link**

In recognizing the value of science capital as a construct for identifying the potential trajectories of science learners and, on a day-to-day level, students' engagement in science classrooms, our project aimed at exploring how best teachers could 'build' student science capital. However, to build science capital, it is necessary to know what foundations are already in place. Put simply, what sorts of capital might students already hold? In considering this question, we found the concept of 'funds of knowledge' developed by Moll et at. (1992) to be particularly useful. The term was originally devised as a concept to help counter deficit views regarding the cultural resources of Latino families in the USA. The term embodies the various sources of knowledge, skills and resources that non-dominant and under-represented communities possess which, in most instances, will be separate to the canonical knowledge required in the classroom (e.g. Zipin 2009). In recognizing that the different experiences and 'non-legitimate' capital of students is often undervalued or ignored, we sought to develop teaching strategies that would address this inequity. Thus we explored ways of identifying student funds of knowledge and thereafter valuing these varied experiences as legitimate resources. Finally we examined ways of making connections between student experiences and the science content of the classroom. This was simplified into the following mantra, or *aide memoire*: elict, value, link.

**Elicit**. The notion of elicit refers to efforts to draw out students' personal, family and culturally-specific knowledge, experience and interests. This often took the form of asking students what they knew at the start of each topic. However, this was not necessarily as simple as it sounds. Care was needed to frame questions in ways that invited students to share their individual experiences and tacit understandings (developed through out-of-school experiences), rather than document their prior (school-based) knowledge. Moreover, teachers needed to reflect on the likely areas of interest relevant to the class. Such interests varied with the age, ethnicity and gender of the students, and were inevitably shaped by the locality of the school including the socio-economic status of the community served and the nature of the surrounding environs. For example, discussions featuring aspects of farming worked well in encouraging student participation for our teachers in rural settings. Not surprisingly, the farming of vegetable crops resonated less with our inner city students. However, determined to build on student experiences, one creative urban teacher was successful in using a plant example: she led a discussion on how to keep salad fresh in a kebab shop as a way in to introducing leaf wilting and the role of transpiration.

In order to learn more about their students' lives, several teachers across the project worked with students to develop short questionnaires asking about home interests at the beginning of the year and thereafter used this information to help them identify aspects within a topic that would potentially resonate with students. Some classes involved students designing surveys which they conducted with their families, to capture wider knowledges, interests and what is important to local communities. Teachers then used this information when seeking to highlight the relevance of science by eliciting and encouraging students to share personal stories in which they had applied their science learning. For example, Miss de Luca frequently drew on one of her Y8 students' experiences in rugby to illustrate parts of the lesson. One boy, Riley, aged 13, had explicitly expressed that he found no point in science and was often rather disruptive in class. Once Miss de Luca started asking Riley to share examples from his sports training in several biology lessons, he clearly became more involved in the classroom.

**Value**. Our notion of valuing refers to the importance of recognizing and acknowledging students' existing knowledge and ways of being. In affording symbolic recognition in this way, and taking students' backgrounds, experiences and identities seriously, science learning can become more democratized. More students are given a voice and space in the science learning environment. It is important to note here the difference between valuing and giving praise. Praise – the recognition of a job well done – has its place in supporting student morale. Valuing – the recognition of other ways of knowing – helps to broaden perceptions of what counts in science. In this sense, valuing plays a role in reshuffling power dynamics. In reviewing our data, we noted moments when the teachers afforded only superficial value, often expressed with one word or interjection: we labelled such instances 'thin' valuing. We acknowledge that it may not be possible for teachers to value every contribution, and that one-word responses may be inevitable in a busy classroom. However, we also identified instances in which the teachers had genuinely taken a student's contribution on board – these we termed 'thick' valuing. The more teachers practiced and reflected on the elicit, value, link technique, the more able they were to do 'thick' valuing. In the excerpt from our fieldnotes of a lesson below. Mr. Okello values the contribution of Tolek, an Eastern European boy, who would normally be very quiet or not pay any attention:

> Mr. Okello shows students a picture of a surveyor using a theodolite and asks them: 'Has anyone seen anything like this, anyone using one of these contraptions around London?' Lots of students put their hands up and some are shouting 'Yes sir!'.
>
> Mr. Okello: 'But do you know what they are actually doing? Do you know anyone who works on a constrauction site?' [elicits student contributions]
>
> Tolek: 'My grandad does'
>
> Mr. Okello: 'Ok. And has he ever told you about what he's done on his work?' [values contribution by inviting Tolek to share further information]
>
> Tolek: 'He's building a block of houses at the moment. He works with surveyors and they are making sure the land is good enough to build on.'
>
> Mr. Okello then thanks Tolek for his contribution and repeatedly refers back to Tolek's grandad in other examples he uses in that lesson.

By eliciting and 'thickly' valuing such contribuitons, Mr Okello was able tap into Tolek's personal experience and highlight the relevance of such experiences to science learning.

**Link.** By linking, we mean the act of connecting students' contributions and ways of knowing to more accepted or canonical knowledge. It involves wrapping the science content of the lesson around the personal interests and experiences that students bring with them. A common criticism of many education systems relates to the highly abstract knowledge that students are expected to make sense of. In emphasising 'linking', the onus is on the teacher, rather than the student, to find ways of making abstract knowledge connect with the students' understanding.

The *elicit, value, link* approach emphasises and values students' experiences and enables teachers to find an accessible starting point that is not necessarily based on prior subject knowledge. It structures a teaching approach that is personalised and localised (we note that many examples in textbooks whilst nominally providing a context to an abstract idea still fail to resonate with students' lived experiences). It offers more students a way in to the new topic, and affords more students an opportunity to participate in science lessons:

> It's almost like adding an emotional side to science. When students wonder why are we learning this? We can say because it is relevant to people, to your parents …and I need to make it relevant to you. (Mr. Hobbes, mid-year workshop)

**2. Embedding science capital dimensions**

Returning to the bag analogy, the idea of a science capital approach is to utilize resources that are already in the bag, and eventually 'fill' all four compartments. The content of these compartments can be further refined into eight distinct dimensions of science capital. These dimensions were identified from data from a survey conducted in England with over 3,600 students aged 11–15 years (Archer et al. 2015; DeWitt et al. 2016). They are:

1. Scientific literacy (conceptualised broadly as scientific knowledge, skills and an understanding of how science 'works', and the ability to use and apply these capabilities in daily life for personal and social benefit);
2. Scientific-related dispositions/preferences (such as the valuing of science in society);
3. Symbolic knowledge about the transferability of science in the labour market (knowledge about the extrinsic value and transferability of science qualifications);
4. Consumption of science-related media (including tv, books, and online content);
5. Participation in out-of-school science-learning contexts (e.g. visiting science museums, zoos/aquaria, going to science clubs);
6. Family/parental scientific knowledge and qualifications;
7. Knowing people who work in science-related jobs;
8. Talking to others (outside school) in everyday life about science.

To help build science capital, teachers can support students in the areas described by the eight dimensions. Addressing student science literacy (dimension 1) is part of regular professional practice: this is what science teachers typically do during a lesson. Teachers also regularly model a positive attitude towards science, as well as the disposition that 'science is everywhere' and therefore relevant (dimension 2). However, the other dimensions (3-8) tend to be addressed less consistently, and our teachers reported struggling to incorporate them in their lessons regularly (King et al., 2015). Over time, we developed tweaks to lesson plans and related activities that explicitly sought to build capital in dimensions 3 – 8. For example, homeworks were set that required students to look for science in the media, including non traditional science media outlets such as those presented by 'Youtubers' (dimension 4). Some teachers set up social media resources with diverse science content linked to classes' out of school interests (dimension 5). We encouraged talk with parents and community conversations about science, focussing on issues that mattered most to families and communities (dimension 8). The idea was to promote science talk as normal, and something that everyone can engage in – it's not just for scientists or the 'brainy' students.

We also stressed the importance of conveying the transferability of science skills and qualifications (dimension 3). This dimension seems to be one most closely related to anticipated future participation and identity in science (DeWitt et al. 2016). Our partner teachers unanimously reported this to be the most challenging dimension to address. They felt that they were not adequately equipped to offer career information and guidance, which echoes teachers' concerns about career education more broadly (Moote and Archer 2017). A technique commonly used by our partner teachers was to ask students to think of jobs that use science skills or the science content of the lesson. Two teachers, Ms Smith and

Miss de Luca, asked students to interview school staff (caretaker, catering staff, Physical Education teacher) about how they use science in their work.

### 3. Reflecting on the 'field'

Embedding a science capital informed approach to teaching involves reflecting on one's own and the wider school's practice. During the joint sessions, we discussed ways in which the role of the 'field' – power relations and the 'rules of the game' within the science class, as shaped by both teacher and students (and also parents and the education system) – affects what happens in the class. We encouraged teachers to reflect on their lessons and think about who is valued or celebrated and whose behaviour 'counts' as engagement. This led to increasing recognition of such patterns in subsequent lessons, with teachers making an effort to pay closer attention to and include more students.

The practice of reflection also led to many rich discussions identifying the factors affecting science teaching, from school culture to challenges specific to year groups and the pressures of performativity more broadly (King and Nomikou, in press). We continue to explore this area and examine ways in which changes in the field can be created and enabled despite constraining factors.

## Closing remarks

As mentioned above, our research is ongoing, but our preliminary results point to a number of positive outcomes. All teachers report students being more engaged and less disruptive during lessons. Some also see a connection between increased engagement and academic progress, like Ms. Arkwright:

> It's opened their eyes quite a lot, I think they're much more engaged with the science they are learning… It facilitates their progress further. (Ms Arkwright, post intervention interview)

In terms of teacher practice, we identified growth in teachers' agency with developed sense of purpose, mastery, reflexivity and autonomy (King and Nomikou, in press).

By framing topics with reference to students' prior experiences (at home, in local community and outside of school), science becomes more personally relevant. By valuing and linking students' contributions to the science content, students will come to see themselves as more 'science-y', and that future study/career in science is a possibility. By addressing more dimensions of science capital throughout lessons – e.g. encouraging talk about the topic outside of lessons; promoting science media resources – we can help students to see that science is not 'other', but instead an important, intrinsic part of life and, possibly, part of their own identity.

We believe that a science capital informed practice is not only beneficial to students, it also works for teachers and their overstretched timetables. The science capital building approach is not onerous and time consuming, nor does it add to existing workloads. It is more a change in pedagogical mindset, whereby the same lessons can be delivered but simply tweaked to allow more student contributions. In enhancing student engagement, behavioural issues are reduced creating additional time for student contributions, and discussions exploring the everyday relevance of science. In fostering opportunities for engagement, the approach begets more opportunities for student participation. Ultimately, teaching with what students 'bring' with them in the classroom becomes an inclusive practice that works and one which students appreciate:

> It's more enjoyable but it's also a better way of learning, cos you can actually understand it. (Adam aged 14, Y10 focus group).

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