One year on – science capital in primary PGCE students: Factors influencing its...

• David Jones • Sally Spicer

...development and its impact on science teaching

Abstract

A second year of research on science capital in primary PGCE trainees in two universities corroborates previous results. Science capital differences in gender are evident and the trainees' own school science experiences continue to be a big influence on attitudes towards and confidence in teaching the subject. With the COVID-19 pandemic curtailing school placements, continued engagement with science during lockdown was explored. Development of subject knowledge, science capital and the impact on confidence to teach the subject during this latter and unique stage of the PGCE were examined, with a view to inform our planning for next year's cohorts.

Introduction and rationale

Our pilot research study on science capital in primary PGCE students was reported last year (Jones & Spicer, 2019). The collaboration between our two initial teacher education (ITE) departments has considered if the science capital of our trainee generalist primary teachers, most of whom are non-science specialists, influences their attitudes to science, and subsequently impacts on their confidence to teach the subject. The ASPIRES report identified that the majority of children have made up their minds about science by age 10, with science-related attitudes, values and dispositions being one factor found to have an impact (Archer *et al,* 2013, 2015).

Teachers' attitudes are key in influencing their classroom practice (Jones & Carter, 2007, cited in Ucar, 2012, p.255), therefore our trainees, as future primary science educators, will play a vital role in shaping children's developing views of science.

Our rationale is that the science capital of the teacher plays a more significant role in primary than secondary due to the more generalist nature of primary teachers. Our hypothesis is that the higher a trainee's science capital, the greater their confidence in teaching the subject, leading to better teaching and consequently better outcomes for the children. The continuation of the study was to determine if general trends identified in the pilot were repeated.

Questions for the second year of the study remained:

- What are the levels of primary PGCE students' science capital?
- What factors influence the development of primary PGCE students' science capital during the PGCE course?
- How does a primary PGCE student's level of science capital impact on their teaching of science?
- How can science capital be developed more effectively through the Primary PGCE programmes?

Methodology

Participants for the second year of the study, 2019/20, were again drawn from the primary PGCE cohorts at the University of East Anglia (UEA) and the University of Warwick (see Table 1). The cohorts reflected the usual majority female composition, which was also mirrored in the respondents to the questionnaires used in this study (see Table 2).

• David Jones • Sally Spicer

...development and its impact on science teaching

Table 1. Questionnaire response rates.

Number of respondents	2019-20	2018-19
Questionnaire 1	67	85
Questionnaire 2	44	50
Questionnaire 3	39	34

Table 2. Response rate by gender.

	2019-20		2018-19	
Average response rate over 3 questionnaires (%)	Overall average from combined UEA and Warwick cohorts	Questionnaire	Overall average from combined UEA and Warwick cohorts	Questionnaire
Male	17%	13%	16%	17%
Female	83%	87%	84%	83%

** Much lower responses from male trainees on Questionnaires 2 and 3.*

Data were collected via three online questionnaires over the course of the academic year, as in the pilot study, with some refinement to questions and scoring.

Questionnaires contained both quantitative Likert scale and qualitative free response questions. Questionnaire 1, at the beginning of the course in the autumn term, was based on the Student Science Capital Survey used by Archer *et al* (2015) and was used to ascertain an initial benchmarking of students' science capital. An additional set of questions exploring 'Pedagogical Confidence' was also included. These explored aspects such as science subject knowledge, confidence to teach science at different key stages, and in answering children's questions. A points system based loosely on that used by Archer *et al* (2015), involving assigning numerical values to responses, was then used to calculate a science capital 'score'.

The focus of Questionnaires 2 and 3 (mid-point and end of course) was to identify students' development of subject knowledge, pedagogical

...development and its impact on science teaching

confidence and what factors influenced these, as it was felt that their science capital would not change to an easily measurable degree and that it would be these factors that would have the biggest influence on the quality of teaching. Questionnaire 3, however, was adapted following school closures due to COVID-19 in March 2020 and the cancellation of the summer term placements. It instead aimed to capture the impact of the lockdown on the development of trainees' views of science, their subject knowledge and confidence to teach the subject.

Unlike the pilot study, participant names were collected to enable follow-up individual interviews or focus groups. Focus groups and individual interviews were carried out after the course completion of the PGCE, in early July, with 7 of the 2019/20 cohort (4 from Warwick, 3 from UEA).

Findings

Although refinements to the scoring system mean that direct comparison of the science capital scores cannot be made at this point, analysis of the initial science capital scores for the cohorts over the two years compared by age and gender indicated a general trend showing that males usually have a greater science capital score. The lowest score each year was that for females in the 26-30 age range. An obvious limitation is the small sample size, particularly for males and those in age groups above 25 years. Therefore, no specific correlations can be inferred due to this and the self-selecting voluntary participation.

Qualitative data from free responses indicated that the factors influencing trainees' views of science were consistent over the two years. Key positive factors were the opportunity to teach science in school, coupled with the engagement of the children, the passion of the university tutors and school mentors, and university-taught sessions. Some additional ones were identified from the 2019/20 cohort, specifically related to the period of lockdown when students would normally have been completing their summer term placements (see Table 3).

Over both years of the study, the most commonly cited factor influencing trainees' views of science was their experience of the subject in secondary school (see Table 3). The percentage of participants reporting positive experiences of science in secondary is seen to drop significantly (49% in 2018/19 and 50% in 2019/20, compared to those reporting positive experiences in primary (72% in 2018/19 and 84% in 2019/20). Research shows that past experiences influence not only a person's attitudes, personal theories, and beliefs regarding the teaching of science, but also their self-efficacy, their opinions of ability and capability to teach the subject effectively (Bandura, 1997, cited in Poulou, 2007, p.191; Thomas & Pederson, 2003; Hancock & Gallard, 2004). Our results not only add further weight to that argument but also to the link between science capital and self-efficacy with regards to teaching the subject. The results also indicate how long-lasting formal science education experience potentially is, and consequently how important it is, as a teacher's confidence in their own ability is a characteristic that reliably predicts both their practice and student outcomes (Poulou, 2007).

The positive impact we have as primary teacher educators in ITE is indicated in comments captured via our questionnaires and end-of-course evaluations. This supports the view that a growth mindset in STEM university tutors impacts on their students' motivation and attainment (Canning *et al,* 2019). By engaging trainees with the subject in both knowledge and specific pedagogy through our university taught programmes, we play an

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...development and its impact on science teaching

Table 3. Factors influencing trainees' views of science.

Positive influences:

- Teaching science in school and children's engagement.
- University taught science sessions.
- University tutors – passion and for some also that of the class teacher / mentor.

Mentioned less frequently, and only in 2019/20:

- Twitter.
- Ideas shared by peers.
- Making STEM accessible for girls; admitting own stereotype.

Negative influences:

- Own secondary school experience.
- Lack of time and priority given to primary. science teaching in placement schools.
- Lack of opportunity to teach science (2019/20).
- Others' views of science (2018/19).
- Own subject knowledge (2019/20).

important role in developing our trainees' attitudes to science, including by facilitating their self-reflection and reflexivity (Warin *et al,* 2006).

Continued engagement with science and science education during the lockdown was facilitated by tutors at both HEIs. Trainee responses indicated some additional positive outcomes of the lockdown, which were both interesting and unexpected (see Table 4).

Table 4. Trainees' continued engagement with science in the March to July 2020 lockdown period.

Positives:

- 85% of respondents engaged with university-directed science learning – a mix of synchronous and asynchronous – and these were positively valued overall.
- Some appreciated the increased professional autonomy and the opportunity to take responsibility for their own learning.
- Self-identification of gaps in subject knowledge and addressed via self-study.

Negatives:

- Missed practical element of university sessions.
- Less interaction/engagement with peers.
- Felt less able to ask questions via the online platform, compared to face-to-face science seminars.

A positive was the extra time available to trainees when they would have normally been on school placements. Some trainees made use of this to specifically address their own science subject knowledge gaps and take responsibility for their learning. A few trainees struggled with the virtual teaching platforms and were uncomfortable with asking questions, audibly or via the chat functions, whereas they would have felt able to ask when in a small group within a 'normal' face-to-face seminar of up to 36 of their peers.

Despite the cancellation of school placements, some opportunities to teach primary science during lockdown were available to approximately half the 39 respondents to Questionnaire 3.

...development and its impact on science teaching

The context for this is shown in Table 5.

Table 5. Teaching primary science opportunities during lockdown.

Setting	% participating (of 39 respondents)
Online teaching via school VLE	21%
Face-to-face in school	8%
Own or wider family's children	28%

Table 6. Science subject knowledge development and impact of not teaching during lockdown (39 responses).

Strategies used for science subject knowledge development:

- 51% accessed online science CPD.
- 38% CPD via ASE, Future Learn & Reach Out.
- 41% expressed positive impact via own reading.
- 5% positive impact through engagement with local environment.

Impact of missed opportunities to teach the subject due to the cancelled summer placement:

- 21% felt negative impact due to missed opportunities to develop subject knowledge through teaching.
- 18% reported negative/lack of subject knowledge development for other reasons.

The vast majority of the respondents across both cohort years considered that their personal science subject knowledge impacted on their ability to effectively deliver science in school. Development of science subject knowledge during the lockdown was continued by some trainees through various strategies, including reading and accessing online professional development opportunities (see Table 6). Of note were two respondents indicating a specific impact on subject knowledge through engaging with the local environment. This was explored in more detail via focus group discussion, which revealed a heightened awareness of nature observed when taking permitted walks, followed up by seeking answers to questions that arose, for example about species identification.

There was probably an increased awareness in the general UK population, over this time of restricted movement, that being outdoors and connecting with nature is good for everyone's mental health and wellbeing (Mind, 2018). An unintended consequence of this may have been a contribution to science capital development by more people simply taking greater and less-rushed time out in

...development and its impact on science teaching

their local environments. How the trainee respondents engaged with the natural environment is shown in Table 7.

Following up on this in the focus groups and interviews, it was apparent that some trainees had developed a passion for nature and a new-found curiosity and sense of awe and wonder about the world, inspired by the ITE science tutors. The lockdown situation simply afforded them time to engage in this. The potential longer-term impact of this engagement was indicated by responses regarding the overall impact of lockdown on trainees' confidence to teach science, with 15% feeling more confident and intending to make greater use of outdoor learning and 21% feeling increased confidence through improved subject knowledge. The clear negative impact on confidence to teach science was the missed opportunities to teach the subject, reported by 38% of respondents.

Focus group and interview recordings will be fully transcribed and analysed over the coming months. However, two things were revealed during initial analysis that we had not considered in our collection of data over the two years. The first was highlighted by one female interviewee, who attended an all-girls school. She stated that, within her school, science was not seen as an historical male preserve and, as a result, she felt that her experiences and views of science were much more positive. This raises the question of how attending a single-sex or co-educational secondary school potentially impacts a person's experiences and views of science. Secondly, although a trainee may have a high science capital score in relation to them having family members or a partner in science-related employment, the question takes no account of how they have engaged with those family members. We had wrongly assumed that parental/partner high science capital automatically conferred capital on the trainee. However, as one interviewee indicated, they had

Table 7. How trainees engaged with the natural environment during lockdown.

Activity	% participating (of 39 respondents)
Bird watching	10%
Citizen Science	5%
Gardening	26%
Nature walks	41%
All of the above	8%
Did all frequently prior to lockdown	3%
None	5%
Didn't feel they have engaged	3%

...development and its impact on science teaching

only started to engage in discussions about science with their family and partner during their PGCE year, as it had stimulated their own curiosity with regards to the subject. Prior to that, they had actually felt (as a child and young adult) rather in awe of and intimidated by the perceived 'cleverness' in the other people, so had shied away from asking questions. Therefore, our assumptions that this factor automatically leads to greater science capital may be incorrect.

Future implications

As we face the start of the next academic year, continuing to teach our PGCE primary science modules via online platforms, the responses to Questionnaire 3 have highlighted additional considerations that need to be taken into account with the loss of face-to-face university teaching. This includes the value afforded to live question and answer sessions following directed science self-study.

For one respondent, a synchronous lecture-style session was actually preferred to a physical lecture theatre environment because they were put in random discussion groups, which made them talk to different people rather than only talking to the person sitting next to them. This might be the same for individuals in our next cohort.

Conversely, from other responses, we need to be aware that some trainees may struggle to ask questions due to their perceptions of being under greater scrutiny when in a live virtual learning environment. Therefore, it is imperative that we build relationships with our new cohorts and develop practice that facilitates their confidence in feeling able to ask questions to support their knowledge, confidence and science capital.

As there will be a continued emphasis on trainees' professional autonomy next year, we need to continue to incorporate opportunities for them to take control of their own learning, such as identifying and addressing their individual subject knowledge gaps, or signposting varied support structures and platforms. However, although this has the potential to be very empowering for the trainees, as we will not have face-to-face sessions there is also a need for us to monitor this engagement carefully in order to quickly identify and support those who require further intervention.

There is a great opportunity to build on the heightened awareness of engaging with nature and the outside learning environment and to develop knowledge and science capital through this. Creative course planning to facilitate this will be needed, perhaps through the use of videos or directed tasks involving scientific enquiry and aspects of the working scientifically curriculum objectives, such as close observation and classification of living things found in trainees' local green spaces (DfE, 2013).

Finally, the reduced opportunity to experience teaching science for most of the 2019/20 primary PGCE cohort resulted, understandably, in some having reduced confidence when it comes to teaching it as an NQT. This needs to be considered by university tutors responsible for supporting NQTs, alongside the school NQT mentors, in the year ahead.

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...development and its impact on science teaching

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David Jones, Lecturer in Primary Education, University of East Anglia.
E-mail: **David.J.Jones@uea.ac.uk**
Sally Spicer, Senior Teaching Fellow in the Centre for Teacher Education, University of Warwick.
E-mail: **S.L.Spicer@warwick.ac.uk**