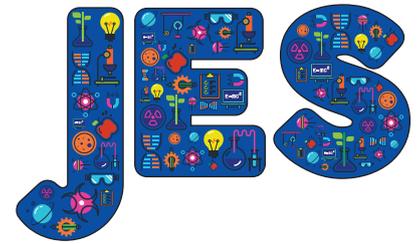


Developing understanding of science skills in Northern Ireland through co-teaching between pre- and in-service teachers



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Abstract

The Teacher Assessment in Primary Science for Northern Ireland (TAPS-NI) project (2017-19) worked collaboratively with pre- and in-service teachers to consider progression and assessment of science skills within the context of the World Around Us strand of the National Curriculum. Co-teaching, where two teachers work together on phases of co-planning, co-practice and co-evaluation, was employed to find out if such an approach could be fruitful in terms of both practice and curriculum development. Project data included participant questionnaires and semi-structured interviews. All participants reported increased understanding of science skills and their progression, and all contributed to the development of activity plans that contained a focused skill within the context of a whole investigation. The outcomes of the project indicate that co-teaching can be an effective form of pedagogy at both pre- and in-service phases of teacher education, supporting reflection and agency.

Keywords: Primary science, assessment, co-teaching, science skills

Introduction

The Teacher Assessment in Primary Science (TAPS) project is based at Bath Spa University and is funded by the Primary Science Teaching Trust (PSTT). TAPS has been working collaboratively with teachers across the UK since 2013 to develop support for valid, reliable and manageable assessment (Davies *et al*, 2017; Earle *et al*, 2017). One of the key findings from the TAPS project is that, in order for assessment to support teaching and learning, there needs to be a shared understanding regarding both the purposes of assessment and progression in the subject being

assessed. This provides a challenge for professional learning, which needs to consider both teacher assessment literacy and teacher understanding of the subject content. In order for a summative assessment of primary science to be valid, it should sample as wide a range of the construct as possible, which includes a consideration of science enquiry skills.

The process of enquiry broadly relates to: '*identifying investigable questions, designing investigations, obtaining evidence, interpreting evidence in terms of the question addressed in the inquiry, and communicating the investigation process*' (Harlen, 1999, p.129). This is not enquiry in isolation, but combines the development of both ideas and enquiry skills. Despite this general consensus in regard to the nature of scientific enquiry, there is no definitive list of science enquiry skills or enquiry types; they are '*not well-defined constructs*' (Millar, 2010, p.127). This poses potential difficulties when it comes to assessment, since there is a lack of agreement regarding the scope and criteria. An '*ill-defined construct*' is problematic in assessment terms; it is difficult to set assessment criteria for achievement of something that cannot be precisely described. In addition, the diversity of skills within the subject means that the '*assessment capabilities required by science teachers are wide ranging and complex*' (Edwards, 2013, p.212). A shared understanding of science enquiry skills is important for both the validity and reliability of assessments, since validity concerns whether it assesses what it is supposed to, and reliability concerns whether others would agree.

An area of debate, particularly pertinent to research on assessment, is whether it is possible, or indeed advisable, to separate science into component parts, teaching atomistically rather than holistically. Some educators separate



'knowledge', which is seen as factual information, and 'understanding', which is linked more with explanation, criticising that the drilling of facts does not lead to connected in-depth understanding (Davis, 1998). This is not to say that facts are not important, but that making links between the facts via thinking and experience is needed to develop learning for understanding (Harlen, 2018, p.33). The teaching and assessment of enquiry skills takes place in a context, so any enquiry will draw upon science conceptual content, for example, when making predictions or drawing conclusions. It is questioned whether it is possible to teach transferable skills in isolation (Standish, 2007) and that skills are '*strongly content dependent*' (Millar, 2010). Ollerenshaw and Ritchie (1993) argue for a holistic view of primary science, suggesting that practitioners should be '*wary of fragmenting children's learning in science into arbitrary compartmentalised skills*' (p.150). Harlen (2006) suggests that any description of separate skills is a '*convenience rather than an attempt to describe reality...We look at the components so as to help children develop skill in all aspects of enquiry*' (p.96). McMahan and Davies (2003) suggest that a 'focused teaching' model could '*bridge the gap between atomism and holism*' (p.37), with specific teaching for component skills, which are then applied in the context of a real investigation, as proposed by the TAPS Focused Assessment approach.

TAPS for Northern Ireland (TAPS-NI) began in 2017, based in the Ballyclare PSTT cluster together with local Primary Science Quality Mark (PSQM) schools. The group found that the Northern Ireland Curriculum (CEA, 2007), which placed science within the World Around Us alongside history, geography and technology, lacked detail about science content. The curriculum provided schools with the freedom to personalise their teaching and make cross-curricular links, but this made assessment for learning or summarising difficult because there was no shared criterion-referenced scale upon which to make judgements or plan next steps. Early in the TAPS-NI project, the Council for the Curriculum, Examinations & Assessment (CCEA) published a progression document (CCEA, 2018) which outlined suggested lines of progression for scientific and technological knowledge and skills. This document provided a starting point for the TAPS-NI group to develop a shared understanding of attainment expectations

in science, but the development of focused activities and exemplification was needed to relate this to classroom practice. In order to widen the working group and draw on Stranmillis University College's expertise in co-teaching, pre-service teachers were invited to join the TAPS-NI project.

Co-teaching

Co-teaching is where two or more teachers work together to meet the needs of a class of pupils and, at the same time, develop and extend their own practice. The co-teaching pairs can comprise two pre-service teachers, two in-service teachers or, as in the case of the TAPS-NI project, a pre-service and an in-service teacher. It has been shown to be a highly effective form of pedagogy within initial teacher education (Murphy *et al*, 2014) as a model for continuing professional development (CPD) and as a strategy for enhancing pupils' attainment and their enjoyment of primary science (Murphy & Beggs, 2005). During co-teaching, both parties share responsibility for planning, teaching and evaluating. The close physical and intellectual collaboration resulting from two professionals sharing ideas, classroom practices and post-lesson analyses provides a learning experience that can transform the future practice of both parties. While co-teaching involves the sharing of expertise – in this case the science specialist knowledge of the pre-service teachers and the situated pedagogical knowledge of the in-service teachers – the project sought to benefit from the synergy to tackle the challenging area of skills progression. It was hoped that employing co-teaching within the TAPS-NI project would both enhance the practice of the pre- and in-service teachers and give rise to new TAPS-NI activities and supporting resources for future use by other teachers in Northern Ireland.

Research methods

TAPS employs a Design-Based Research approach whereby researchers and teachers collaborate in iterative cycles of development, alternating development days and trialling of approaches in school, to develop theoretical and practical products (Anderson & Shattuck, 2012; Davies *et al*, 2017). The TAPS-NI project extended the research team to include pre-service teachers. This novel use of the co-teaching model led to the following research questions (RQs):



RQ1. What affordances can a co-teaching model provide for pre- and in-service teachers during a curriculum development project?

RQ2. What is the impact on pre- and in-service teachers participating in the TAPS-NI project and how might this inform the pedagogy of teacher education?

Six pre-service teachers, in their third year of an undergraduate degree, were geographically matched with six in-service teachers. The project spanned a full school year, with the planning and co-teaching taking place from September to December and the revising and drafting of new resources carried out from January to June. It took place in three phases. In the first, planning, phase, a series of seminars allowed the co-teachers to come together to develop their understanding of science skills and to explore the challenges and opportunities that co-teaching might present as they tried out the TAPS-NI activities. The pre-service teachers visited the co-teachers' schools, observed lessons and planned alongside their partner teacher.

The next phase, co-practice, involved co-teaching and evaluating a series of four weekly science lessons, beginning with pre-existing TAPS activities, then devising new ones. The final evaluation phase involved all participants coming together to share their classroom experiences and allowed for an audit of skill assessments.

All were fully briefed on the scope of the project and were asked for permission at each data collection point, in line with informed consent procedures (BERA, 2018). The following research data were gathered and anonymised:

- ❑ Each teacher and trainee completed questionnaires regarding their experience of the project;
- ❑ Semi-structured interviews were carried out with 4 teachers and 5 trainees;
- ❑ Co-teaching lesson plans and evaluations; and
- ❑ Field notes and observations made by researchers throughout all phases of the project.

An interpretive stance was taken as we sought to capture any consensus across the reported experience of participants from a range of practice

settings, thus enhancing the authenticity and transferability of our findings. The interviews were transcribed and, as with the questionnaires, thematically analysed for recurrent themes and perspectives.

Outcomes and findings

RQ1. What affordances can a co-teaching model provide for pre- and in-service teachers during a curriculum development project?

All participants reported, via questionnaire or interview, that co-teaching developed their appreciation and understanding of the place of science skills within the Northern Ireland Curriculum, together with enhancing their confidence and ability to promote progression of skills within their science lessons.

Co-teaching was considered to have been instrumental in developing each aspect of practice:

❑ Co-planning:

- More ideas from the fresh perspective of the other practitioner.
- The opportunity to critique and identify weaknesses in plans as they emerge during joint planning.
- Having to plan and choreograph individual roles allowed each partner to reflect more deeply on the role of the teacher throughout a lesson and how it evolves.
- Pre-service teachers benefitted greatly from their partner's insight into the individual needs of pupils and abilities of groups and could modify their plans.
- In-service teachers valued the enthusiasm and creativity of the in-service teachers.

❑ Co-practice:

- The additional teacher allowed each teacher to work more closely with particular groups of pupils and to therefore make more accurate assessments of both the effectiveness of the activities and the pupils' acquisition of skills.
- The opportunity to add in or qualify something their partner said or omitted to clarify.



- Raising questions for each other or engaging in scripted dialogue to promote the narrative of the lesson and scaffold pupil thinking.
- The opportunity to 'observe from within' a lesson and, whilst teaching, smoothly modify or change their approach based on hearing or seeing their partner's progress.
- Pre-service teachers felt being closer to 'the action' made it easier to acquire the physical attributes of classroom management and assimilate them into their own future practice.

□ Co-evaluation:

- The post-lesson discussion based on a shared experience was probably the most frequently cited merit of co-teaching.
- The extra set of eyes and ears when evaluating.
- The experience of another professional to challenge or confirm their personal opinions.
- The moral support when things didn't go well!
- A focus on successes and exploration of effective practice can be overlooked when evaluating independently.

Of course, it should be acknowledged that, in an interview with a tutor who leads on co-teaching, the participants may be more likely to focus on the positive aspects of the project. In addition, in both the anonymous questionnaires and in one of the interviews, participants reported the need for more time together, particularly for collaborative planning and evaluation. Even within co-teaching, the demands on practitioners' time can be a challenge.

RQ2. What is the impact on pre- and in-service teachers participating in the TAPS-NI project and how might this inform the pedagogy of teacher education?

Questionnaires completed at the end of a co-teaching section (November 2018) included the following comments from the pre-service teachers, which have been selected to represent the range of ideas in this exploratory study:

'I found myself realising the importance of assessment throughout science lessons and strategies to do so...Thinking about assessment in general – got me better at it' (Pre-4).

'We usually just do this [assess] based on the concept...I learnt how to question children more effectively in order to assess their understanding... The project helped us to focus on science skills' (Pre-1).

'Limiting the planning of the lesson to focus on one science skill, e.g. observation, made it easier to plan for and made a feasible and achievable outcome' (Pre-2).

The comments from pre-service teachers indicate thinking around both assessment and science skills. It could be that 'realising the importance of assessment' (Pre-4) represents more a raising of awareness rather than development of understanding, but the building of teacher assessment literacy is a career-long endeavour, not something that can be mastered quickly (DeLuca & Johnson, 2017). The TAPS Focused Assessment approach, where one skill is chosen for the focus of the lesson, within the context of a whole investigation, is present in the pre-service teacher comments above, with manageability noted as an advantage of the approach (Pre-2).

At the end of the second year of TAPS-NI (May 2019), the in-service teachers were asked about the impact of the project on their schools:

'More willingness to do science and more science evident across the school. Move away from fear of "need to know"' (T4).

'Promoted science. When teachers have tried a lesson they are asking for more that are available. > Increase in diversity of science' (T1).

'Greater awareness of science skills...Better understanding of progression in skills from FS to KS2 (and what this looks like in reality)' (T5).

'Pupils know and understand skills...Use of scientific language and knowledge. Buzz about science... parent feedback: "children love science"' (T3).

For the in-service teachers, promoting science across the school and developing understanding of science

skills were at the forefront. There was little mention of assessment, indicating that, for this sample of in-service teachers in Northern Ireland, teacher assessment literacy is not a priority for development. Interestingly, the in-service teachers' preference for the term 'progression of skills' rather than 'assessment' also might reflect a more summative than formative conceptualisation of assessment.

Discussion

Previously at Stranmillis, the success of primary science co-teaching had been in programmes between pre-service science specialists and in-service non-science specialist teachers, meaning that the pre-service teacher had a clear contribution to the partnership. In this project, both parties had expertise in primary science and so it was not at all clear whether the partnerships would be equally effective, hence this initial study. Our findings that both pre- and in-service teachers described the co-teaching experience as very fruitful suggest that the benefits of co-teaching extend to pairings where both partners have comparable levels of competence in the focus area. This is consistent with our studies of co-teaching between pairs of pre-service teachers and point to a conceptualisation of co-teaching as the joint exploration and creation of new practice (McCullagh & Doherty, 2018). Since pre- and in-service teachers were collaborating on a challenging curriculum project, there was a shared goal: to develop activities and examples that could be used to support teaching and assessment of science skills.

The outcomes of the project indicate that co-teaching is an effective form of pedagogy at both pre- and in-service phases of teacher education. For the pre-service teachers, the experience was very different from their block placement, where the schools' strong curricular focus on numeracy and literacy restricted the time for teaching science. Where there is an opportunity to teach science, it can often consist of a one-off lesson and rarely enables pre-service teachers to follow through a series of lessons with a complete cycle of reflection for science (Jones, 2008). The fact that, during co-teaching, the pre-service teachers are not being assessed on their classroom teaching allows them to be more ambitious and frees them up to adopt a more enquiry-based stance in their approach. It accommodates a collaborative

approach to action research in line with Carter's (2015) call for student teachers to develop their own teaching '*in an environment where they are able to trial techniques and strategies and evaluate the outcomes*' (p.21). Co-teaching presents reflection as manageable, valuable and powerful. We have noticed that students who have experienced co-teaching usually attain higher grades during their subsequent school placements.

For the in-service teachers, co-teaching addresses many of the weaknesses traditionally associated with a course-led model for professional development (Craft, 2000). In contrast, CPD that is based within the classroom provides the teacher with greater agency for change and allows for the influence of the school itself and the day-to-day activities of teachers and pupils. The merits of co-teaching in our study are in line with those identified by Kerr (2010):

- Active participation;
- Collaboration;
- Addressing specific needs; and
- Sustainability.

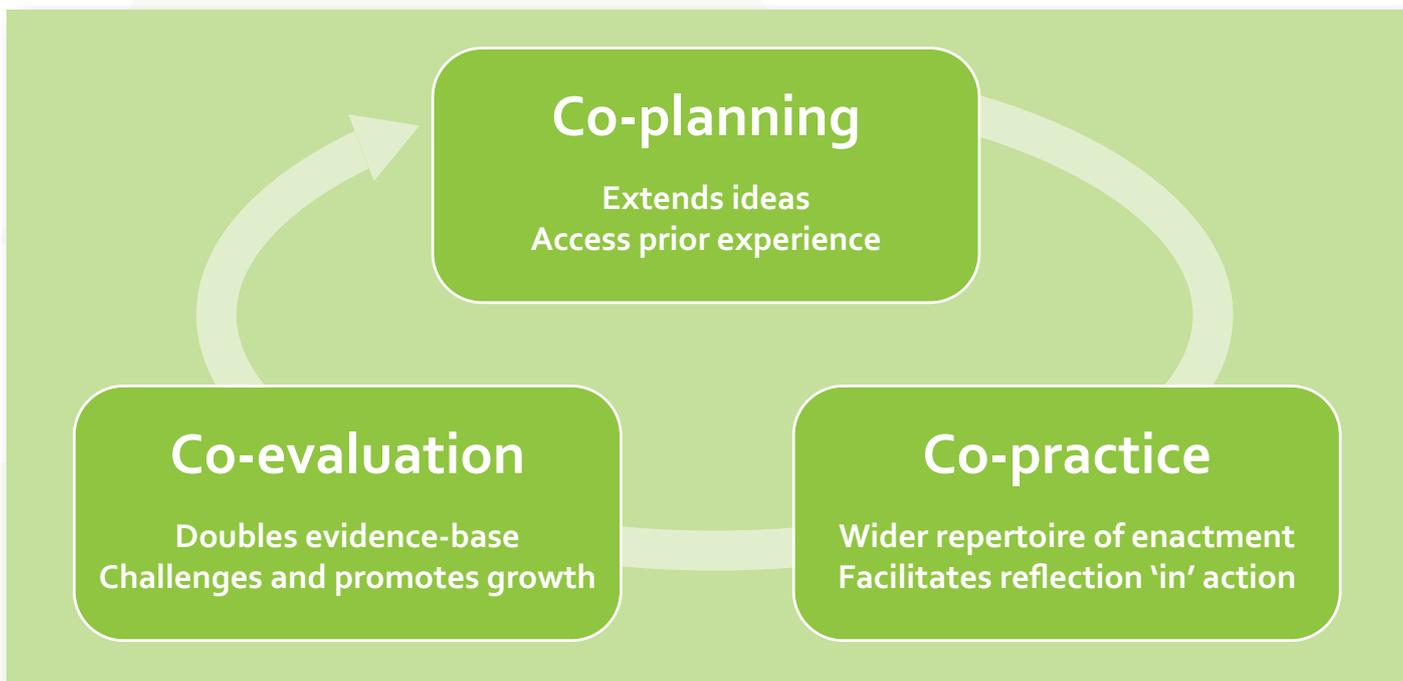
By facilitating dialogue and collaboration, the transformative impact of co-teaching need not end with the individual teacher, but could help nurture communities of practice.

Figure 1 provides a summary of our identified affordances of co-teaching, highlighting the benefits of practitioners working together to transform their individual and collective practice, and are consistent with Vygotskian-based theoretical frameworks (Murphy, 2016).

Our findings also show that co-teaching is productive for curriculum development. When both parties are equal partners, co-teaching can lead to the creation of new practice. This provides a very different learning dynamic to the traditional school-based placement where the student is considered to be the 'novice' and expected to conform and replicate the current practices of the 'expert' host teacher. The Northern Ireland Department of Education's publication *Learning Leaders: A Strategy For Teacher Professional Development* calls for a focus on 'next' as well as 'current' practice (2016, p.8).



Figure 1. The affordances of each aspect of co-teaching.



Co-teaching allowed for the refinement and the creation of new classroom guidance and activities for assessment and progression (TAPS-NI, 2019). For example, the TAPS-NI skills flower (Figure 2) was created to display in classrooms to support discussion and coverage of the seven skills.

Professional development in science education can be enhanced by more meaningful and productive partnerships between schools and ITE institutions. In light of this study, we propose that co-teaching can play a significant role across the continuum of teacher education and in the area of curriculum development.



Figure 2. The TAPS-NI skills flower showing the seven science skills specified within the Northern Ireland Primary Curriculum.

References

- Anderson, T. & Shattuck, J. (2012) 'Design-based research: a decade of progress in education research?', *Educational Researcher*, **41**, (1), 16–25
- BERA (2018) *Ethical guidelines for educational research* (4th Edition). London: BERA
- Carter, A. (2015) *Carter Review of Initial Teacher Training*. London: Department for Education. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/399957/Carter_Review.pdf
- Council for the Curriculum, Examinations & Assessment (CCEA) (2007) *The Northern Ireland Curriculum: Primary*. Belfast: CCEA
- Council for the Curriculum, Examinations & Assessment (CCEA) (2018) *Science and Technology within The World Around Us: Progression Guidance*. Belfast: CCEA
- Craft, A. (2000) *Continuing professional development: a practical guide for teachers and schools*. London & New York: The Open University



- Davies, D., Earle, S., McMahon, K., Howe, A. & Collier, C. (2017) 'Development and exemplification of a model for Teacher Assessment in Primary Science', *International Journal of Science Education*, **39**, (14), 1869–1890
- Davis, A. (1998) *The Limits of Educational Assessment*. Oxford: Blackwell
- Department of Education (2016) *Learning Leaders: A Strategy for Teacher Professional Learning*. Bangor: Department of Education
- DeLuca, C. & Johnson, S. (2017) 'Developing assessment capable teachers in this age of accountability', *Assessment in Education: Principles, Policy & Practice*, **24**, (2), 121–126
- Earle, S., McMahon, K., Collier, C., Howe, A. & Davies, D. (2017) *The Teacher Assessment in Primary Science (TAPS) school self-evaluation tool*. Bristol: Primary Science Teaching Trust
- Edwards, F. (2013) 'Quality assessment by science teachers: Five focus areas', *Science Education International*, **24**, (2), 212–226
- Harlen, W. (1999) 'Purposes and procedures for assessing science process skills', *Assessment in Education*, **6**, (1), 129–144
- Harlen, W. (2006) *Teaching, learning and assessing science 5-12* (4th Edition). London: Sage
- Harlen, W. (2018) 'Learning and teaching science through inquiry'. In: *ASE Guide to Primary Science Education*, 4th edition, Serret, N. & Earle, S. (Eds.). Hatfield: Association for Science Education
- Jones, M.M. (2008) 'Collaborative Partnerships: A model for science teacher education and professional development', *Australian Journal of Education*, **33**, (3), 61–76
- Kerr, K. (2010) "It certainly taught us how to change our minds on teaching science": co-teaching in continuing professional development'. In: *Co-teaching in international contexts*, Murphy, C. & Scantlebury, K. (Eds.), pps.147–167. London & New York: Springer
- McCullagh, J.F. & Doherty, A. (2018) 'Lights, Camera, Science! How digital storytelling can support enquiry', *Primary Science*, (151), 21–24
- McMahon, K. & Davies, D. (2003) 'Assessment for inquiry: supporting teaching and learning in primary science', *Science Education International*, **14**, (4), 29–39
- Millar R. (2010) 'Practical work'. In: *Good practice in science teaching: what research has to say*, Osborne, J. & Dillon, J. (Eds.). Maidenhead: Open University Press
- Murphy, C. & Beggs, J. (2005) 'Co-teaching as an approach to Enhance Science Learning and Teaching in Primary Schools'. In: *Teaching Together, Learning Together*, Roth, W-M. & Tobin, K. (Eds.), pps. 207–2031. New York: Peter Lang
- Murphy, C., McCullagh, J. & Doherty, A. (2014) *Piloting a model for co-teaching in preservice teacher education school placements based on Vygotsky's zone of proximal development*. AERA proceedings, available from: <http://www.aera.net/Publications/OnlinePaperRepository/AERAOnlinePaperRepository/tabid/12720/Owner/941006/Default.aspx>
- Murphy, C. (2016) *Co-teaching in Teacher Education*. St Albans: Critical Publishing
- Ollerenshaw, C. & Ritchie, R. (1993) *Primary science: making it work*. London: David Fulton Publishers
- Standish, P. (2007) 'Rival conceptions of the philosophy of education', *Ethics and Education*, **2**, (2), 159–171
- TAPS-NI (2019) *TAPS-NI Progression in Science: Teacher Assessment in Primary Science (TAPS) for Northern Ireland*. Bristol: Primary Science Teaching Trust

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