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How well does action learning work to support pre-service science teachers' development? An evaluative case study

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ABSTRACT

Collaboration is helpful for teacher development, and action learning (AL), including structured peer discussion (AL sets), has been used extensively with experienced teachers. This case study aims to evaluate AL as an innovative teaching approach for pre-service science teachers. The author carried out an intervention with 38 pre-service science teachers (postgraduate students) in one university, with eight volunteering as research participants. Data collected included audio recordings of AL sets, participants' action plans and action plan reviews, reflective journals, critical incident analyses and school-based mentors' reports of participants' teaching. The author carried out an evaluative analysis using Bell and Gilbert's model of science teacher development. Participants benefited from sharing teaching experiences, which provided both support and challenge. They developed better understandings of their teaching issues and created solutions. However, participants did not collect feedback systematically nor question assumptions. The research contributes to knowledge about how to use AL in teacher education.

Introduction

Background

When starting the research, I was a lecturer at Green University,[1] supporting pre-service teachers (PSTs) in completing a one-year university/school partnership postgraduate certificate in education (PGCE). My motivation was long-term physics teacher shortages in England and other Western countries (Gatsby 2015; Meltzer 2021; Soares and Lock 2007).

Prior to the research taking place, the Office for Standards in Education (Ofsted), the inspectorate for initial teacher education (ITE) in England, recommended that Green University:

> further improve the recruitment and selection process, so that a greater proportion of trainees are recruited with the potential to become outstanding teachers, especially in science and mathematics. (Office for Standards in Education Ofsted 2014, 12)

Ofsted's recommendation does not suggest how recruitment and selection might be improved, because there are few, if any, examples of effective practice in this regard. We must, instead, look at how people who wish to become physics teachers can be supported during training, so that they are more likely to succeed.

Whilst PGCE courses are a collaboration between schools and universities, there are differences in support available to PSTs in different schools. Owing to teacher shortages, some mentors are less experienced teachers, and due to workload pressures, insufficient time may be allocated for mentoring. Whilst mentoring can be beneficial to PSTs, weaknesses have been identified, including, for example, that feedback often focuses on classroom management rather than pedagogy and that it may not be sufficiently subject-specific, particularly where the mentor's science specialism (biology, chemistry or physics) differs from the PST's (Soares and Lock 2007). Unsurprisingly, therefore, PSTs' experiences of mentoring are not always positive (Izadinia 2015).

I introduced a strategy designed to support PSTs' development – action learning (AL), designing and implementing a teaching intervention in the academic year 2016–17. AL appeared to have the potential to address differences in support available to PSTs, since it relies on peer coaching rather than relying mainly on mentors. I carried out a case study, and in this article, I report on the evaluative aspect of the research.

Whilst my initial motivation was supporting Physics PSTs, the project also included Biology and Chemistry PSTs to attract sufficient research participants. Using AL to support novice science teachers was innovative, since it has been used elsewhere with experienced managers (Revans 2017) and experienced teachers (Aubusson, Ewing, and Hoban 2009). Within higher education (HE), AL has been widely used in leadership development, both for professional development of university leaders and teachers and with students (see, e.g. Sanyal, Hartog, and Haddock-Millar 2024). My aim was to determine whether AL could be adopted with PSTs in other settings, as a pedagogical approach to teacher education. Whilst there are a few examples of AL being used in ITE (Dolapcioglu 2020; Penney and Leggett 2005), AL has not been studied with science PSTs, in the context of practitioner research, and hence, I contribute to the literature. Additionally, a need has been identified for research including PSTs as participants (Loughran 2014) and to uncover their perspectives on learning to teach (Davis, Petish, and Smithey 2006), and hence, I contribute to knowledge in the field.

In the following section, I discuss AL, including for teacher development, comparing processes by which teacher learning occurs with a model of science teacher development produced by the Learning in Science Project (Bell and Gilbert 1996).

Models of teacher education

In this section, I introduce approaches to teacher education, describing how those adopted in ITE courses in England have changed over time. Because I researched my own practice, I refer to theories most influential in my work, which include those as a lecturer in university settings and as a professional development lead in the charity sector.

Common models of teacher education are shown in Table 1 (Brooks, McIntyre, and Mutton 2023). The authors characterise these models as knowledge-first because they envisage learning to teach involving knowledge acquisition. They contrast these models

Table 1. Common models of teacher education (Brooks, McIntyre, and Mutton 2023, 4).

Model of teacher education	Key features
Stage theory	Pre-service teachers go through a series of stages related to their concerns about teaching.
Theory into practice	University provide theory that, it has been decided, beginning teachers require. Schools provide opportunities to apply this theory to practice.
Apprenticeship	Teaching is . . . learnt through practice, supervised by an experienced practitioner.
Clinical practice	Development of processes by which beginning teachers develop abilities to teach effectively through experiences of, and engagement with, practice.
Core practices or practice-based teacher education	Appropriation of, and rehearsal of, practices.

with people-first approaches, e.g. reflective practice and communities of practice, which focus on personal transformation.

In the twentieth century, ITE in the United Kingdom moved predominantly into universities, rather than being apprenticeships in schools. Courses adopted theory into practice approaches, emphasising material from four foundational disciplines of psychology, sociology, philosophy and history of education (Wilkin 1996). Weaknesses included concerns about PSTs' preparedness for teaching, reduced emphasis on experienced teachers' knowledge, lack of consensus about propositional knowledge to be learned and PSTs' perceptions that much theory was irrelevant (Hagger and McIntyre 2006). In response, ITE courses have progressively included more time in schools, and different development models have been implemented, as I discuss.

Practical theorising underpinned my own teacher preparation (see, for example, Burn, Mutton, and Thompson 2023). This approach is relevant because teachers' beliefs are influenced by how they were taught themselves, i.e. it might influence my own research and teaching. The practical theorising model was adopted by the Oxford PGCE programme – the internship scheme – which was developed collaboratively between university tutors and experienced teachers, with the aim of developing greater coherence between university-based and school-based elements of the course.

The practical theorising model intends that PSTs develop their abilities to evaluate suggestions for practice learned in university (propositional knowledge) in their school context and to evaluate ideas for practice from school against criteria for quality suggested by research (Burn, Mutton, and Thompson 2023; Hayward 1996). Since it emphasises critical evaluation, its approach to professional learning has some features of reflective practice, within a clinical practice model (Brooks, McIntyre, and Mutton 2023).

Many other courses adopted reflective practice, broadly based on Deweyian or Schönian models (Furlong and Maynard 1995), to overcome weaknesses of the theory into practice. Reflective practice typically involves cycles of developing hypotheses and testing them by experience (see, for example, Argyris and Schön 1974). 'Reflection-on-action' is thinking about events afterwards (Schön 1987, 26). Reflection enables professionals to uncover theories they might infer and underpin their actions, based on their behaviour. Change in practice happens through examining and modifying these theories. Additionally, some reflective models incorporate an affective component, not just rational thought (Korthagen and Vasalos 2005; Tripp 1995). For example, Tripp draws upon Dewey, stating that 'reflection is . . . the term we should use for our processing of emotion' (Dewey 1944, cited in Tripp 1995, xii). Korthagen and Vasalos (2005) envisage teacher educators leading

reflective conversations with PSTs, to enable them to overcome difficulties as they develop as teachers by reflecting more deeply, for example, considering their motivation and self-concept.

In my experience, ITE courses have some features of reflective practice, e.g. PSTs must write evaluations of their lessons, an example of reflection-on-action. Working as a Teach First Tutor (2011–13), all PSTs wrote a reflective journal assignment, focusing sequentially on classroom and behaviour management, assessment for learning (AfL) and children's learning. This sequencing may show awareness of Furlong and Maynard's (1995) stage model of teacher development – initially overcoming challenges with classroom and behaviour management, before considering teaching and learning.

Reflective practice has several weaknesses. It:

- Is often viewed as an individual activity (see, for example, Sellars 2017), leading to 'reinforcing existing views' (Aubusson, Ewing, and Hoban 2009, 43).
- May overburden PSTs owing to a lack of coherence between school-based and university-based elements of courses (Hayward 1996).
- May underemphasise propositional knowledge, where many agree there is a body of knowledge that could inform teachers' practices (e.g. McIntyre 2003; Osborne and Dillon 2010).

To overcome the disadvantages of reflecting individually, ITE courses may include collaborative activities, such as paired teaching, group analysis workshops and group enquiry (Rudduck 1992). Teach First (2019–22) included a collaborative development module. Groups of PSTs held regular remote calls, agreeing on an aspect of teaching to develop, discussing the design and implementation of a classroom intervention and evaluating its impact. Discussions were structured with a tuning protocol, which has been used elsewhere for teacher educator development (Walsh 2007). In my experience, university/school partnership courses included paired teaching, where possible, and there were more frequent, less structured peer discussions. Discussions incorporated evaluation of practices from schools, similar to that element of practical theorising, although this activity was perhaps more informal.

I have also found that courses include a lot of propositional knowledge, not relying solely on reflective practice. Courses now place greater emphasis on research-informed practices, e.g. AfL (Black et al. 2004), with less material about foundational disciplines (Edwards, Gilroy, and Hartley 2002). Students commonly write enquiry assignments, applying ideas from the literature to practice and critically evaluating their implementation, similar to practical theorising in that PSTs evaluate propositional knowledge from universities in school contexts.

Stenhouse (2012) views school-based research, carried out collaboratively by teachers and researchers, focusing on improving learning, as action research. Various types of action research exist, with common features including cycles of planning, acting, observing and reflecting (Zuber-Skerritt and Wood 2019). PSTs' enquiry projects are rarely cyclical, however, and are usually modest, whereas action research is often more critical, collaborative and emancipatory (Rudduck 1992; Zuber-Skerritt and Wood 2019). Hence, the types of enquiry usually carried out in ITE might instead be positioned as clinical practice (Brooks, McIntyre, and Mutton 2023) or practitioner research (Rudduck 1992).

The difficulties this type of enquiry presents are: The one-off nature of assignments may suggest to PSTs that the process is only for universities, rather than intended to continuously improve practice throughout a career (Hagger and McIntyre 2006). Secondly, projects may engage too little with wider social and political influences, limiting the extent to which they challenge existing practices (Rudduck 1992). Thirdly, my experience has been that projects are short and significant impacts on children's learning are therefore unlikely. PSTs may conclude that research-informed practices are ineffective, and it may be difficult for them to attain a good understanding of social research. So, what else might we do?

AL came to my attention because Green University piloted it with PSTs in the 2015–16 academic year. Because AL includes enquiry cycles, incorporating collaborative reflection, I became interested in its potential for developing teaching, although there are few examples of the literature about its use with PSTs. In the following section, I introduce the technique.

What is action learning?

AL was originally developed in industry, its aim being to develop managers to bring about improvements to systems or processes (Revans 2017). It typically involves participants meeting regularly in small groups (AL sets), collaboratively diagnosing and solving work-based problems.

AL may be defined:

> Learning from and through action or concrete experience, and through reflecting on this experience and taking action as a result of this learning. It is learning from and with each other in action learning 'sets' to address a major, complex, practical problem in the workplace, organisation, community or other site of collective activity. (Zuber-Skerritt and Wood 2019, 4)

However, AL models differ in whether they deal with major workplace problems or with the personal development of individuals. AL is generally used to tackle problems where various possible actions could be taken and the solution is unknown. Alternatively, participants may know what to do, but need to work out how to do it (Zuber-Skerritt and Wood 2019). AL sets are typically made up of 'about six people' (Pedler, Burgoyne, and Brook 2005, 49).

Whilst AL has distinct schools, questioning is commonly emphasised (Adams 2010). Revans (2017) argues that we cannot rely on knowledge alone to solve novel problems in workplaces. Instead, work-based learning (L) occurs by taking programmed knowledge (P) and applying insightful questioning and reflection (Q), where 'programmed knowledge' refers to content taught in traditional settings, as well as to process knowledge of the AL method itself (Coghlan and Coughlan 2010):

$L = P + Q$ (Revans 2017, 2–3).

Questioning encourages participants to examine problems critically. It supports diagnosis of problems, identifying barriers to achieving them and developing courses of action. Furthermore, it may uncover participants' values and beliefs, helping them to understand themselves better in relation to problems, leading to personal growth (Adams 2010). Having planned possible courses of action, participants return to workplaces,

carrying out interventions to deal with them and returning regularly to AL sets for review. Whilst there are few examples of AL being used with PSTs, 'the HE context is now a significant one for action learning [being] the second most popular locus for action learning after the business sector' (Brook and Pedler 2020, 2). AL differs from traditional university teaching, which is often didactic, in that it is a type of experiential learning, based on enquiry. There is a wide variety of AL practice, with different strands, such as:

- Critical AL, which considers the influence of power relations
- AL research, which has a greater emphasis on knowledge creation and dissemination
- Online learning using discussion forums, rather than face-to-face AL sets.

Some core principles are 'action as the source of learning; learning from reflection upon action and addressing problems that resist simple solution' (Brook and Pedler 2020, 2).

Whilst my professional experience suggests that some ITE courses include regular opportunities for PSTs to discuss teaching with peers and individual reflection and/or enquiry, AL differs by including cycles of structured group discussion, with reflective questioning, followed by planning, implementing and observing (Aubusson et al. 2007). Additionally, typically, school-based mentors and tutors lead target-setting on ITE courses, whereas participants lead the process in AL, in discussion with peers, although academic partners or other facilitators may participate (Aubusson, Ewing, and Hoban 2009; Pedler, Burgoyne, and Brook 2005). There is debate about the extent to which facilitators/ academic partners should keep control when working with students in HE, with research pointing to the need to hand over responsibility to learners (Brook and Pedler 2020).

AL for teacher development

In this section, I introduce the Learning in Science project model of science teacher development (Bell and Gilbert 1996), comparing the learning processes involved with the learning processes in AL for school teachers' development (Aubusson, Ewing, and Hoban 2009). Could, I wondered, AL support science teacher development?

Bell and Gilbert's (1996) model has been highly influential in science teacher education and development, arising from the Learning in Science Project. This research project is considered trustworthy because it studied 48 science teachers' development, in depth, over a three-year period. The project involved teacher collaboration to support changes in teaching methods. It is suggested that science teacher development has personal, social and professional dimensions, occurring in three phases – a stage model (Table 2).

Bell and Gilbert (1996) suggest the learning processes involved in science teacher development are support, reflection and feedback. Using AL extensively for experienced school teachers' development in Australia, Aubusson, Ewing, and Hoban (2009) identify remarkably similar processes: reflection, community, action and feedback, as I explain below.

Reflection. Since AL involves cycles of reflecting on observations of work-based problems through critical questioning, leading to a provisional hypothesis, in a cycle including trialling, auditing and reviewing (Revans 2017), it is similar to enquiry cycles found in reflective models. Reflective questioning provides opportunities for reflection-on-action. In the Learning in Science Project, reflection also involved both critical enquiry and critical

Table 2. Learning in Science project model (adapted from Bell and Gilbert 1996; Gilbert 2010).

Phase	Personal development	Social development	Professional development
1 – Entry into ITE	Accepting an aspect of teaching as problematic, e.g. realising the ways they were taught may be incompatible with today's classrooms.	Seeing isolation as problematic; valuing opportunities to discuss teaching with peers.	Being introduced to new theoretical ideas, trying them out in classrooms.
			Coming to terms with struggles of putting new ideas into practice.
2 – First working in full-time employment	Dealing with restraints, e.g. tensions between curriculum coverage and developing students' understanding.	Valuing collaborative ways of working and reconstructing what it means to be a science teacher.	Developing coherence between theoretical underpinnings and classroom practice.
			Increasing reflectivity, responding to pupil feedback.
3 – After several years' work in different contexts	Feeling empowered to take charge of own development.	Initiating collaborative ways of working, within and external to school.	Initiating development activities; anticipating change proactively.

analysis (Bell and Pearson 1991). Using AL with PSTs in Turkey, Dolapcioglu (2020) suggests that reflection and critical questioning enabled PSTs to put theory into practice to support the development of children's critical thinking.

Community. Relationships with others are considered fundamental to AL, with various benefits of working together, including that:

- Participants' views may differ, leading to reflection (Zuber-Skerritt and Wood 2019).
- Participants challenge one another's assumptions and learn from one another's contributions (Aubusson, Ewing, and Hoban 2009).

Teachers commonly feel isolated (Aubusson et al. 2007; Plauborg 2009), with AL overcoming isolation as group members develop trusting relationships (Aubusson, Ewing, and Hoban 2009; Hoban et al. 1997; Stark 2006). A more recent AL project designed to develop teachers' pedagogical content knowledge suggests collegial support led to significant improvement (Alimuddin et al. 2021). Similarly, in a project implementing mobile learning, teachers valued structured collaborative discussion of practice (Maher and Schuck 2020). In this study, I planned for PSTs to work in AL sets of four to eight, discussing areas for development in their teaching in a structured way.

Research suggests that factors supporting the building of community include maintaining stability in AL sets and carrying them out sufficiently close together, e.g. every 2–3 weeks (Aubusson, Ewing, and Hoban 2009; Dolapcioglu 2020) or 4–6 weeks (Hoban et al. 1997; Stark 2006). Equally, work commitments sometimes constrain their frequency (Stark 2006). In this study, I planned to keep the same participants working together to allow relationships to develop and to carry out AL sets each time PSTs returned to the university from school placements.

In addition to communities within AL sets, Revans' model involved wider teams within workplaces (Revans 2017). In school-based AL projects, participants are commonly

accountable to school leaders and, as in industry, leaders' support facilitates change (Dilworth 2010; Maher and Schuck 2020). Some AL models include academic partners or consultants providing support, e.g. helping AL groups to choose foci and to plan actions, suggesting relevant research and offering critical insights (Aubusson, Ewing, and Hoban 2009; Stark 2006). In this study, I planned to take the academic partner role.

In the Learning in Science project model, interaction with peers provides support, enabling participants to socially construct understandings of being a science teacher. Because working in an AL community also provides support to participants, I treat community/support as synonymous.

Action and feedback. Some suggest that Dewey places an emphasis on thinking, rather than action (Sellars 2017), whereas action is fundamental in AL (Revans 2017). Perhaps the place of action within Dewey's model is underestimated, however. Since Dewey (1997, 87) states, 'the consequences of action must be carefully and discriminatingly observed,' it is clear that action must occur and that observations are made. Because the Learning in Science Project involved teachers implementing new teaching approaches, action is implicit in this model. In this study, I planned for PSTs to write action plans after each AL set, returning to school placements to implement their plans.

Feedback is another common feature of AL models, where feedback information is gathered to provide evidence of the effects of action (Aubusson, Ewing, and Hoban 2009; Willis 2010; Zuber-Skerritt and Wood 2019). In AL, feedback may emphasise what participants have learned, rather than systematic data collection (Willis 2010; Zuber-Skerritt and Wood 2019). However, Aubusson, Ewing, and Hoban (2009) list a range of data, overlapping with those used in social research, e.g. school test data, observations, field notes, journals and pupil feedback. Similarly, Bell and Gilbert (1996) interpret feedback broadly, including both informal methods (e.g. comments from pupils, parents and colleagues) and formal methods (e.g. lesson observations or research data from surveys and interviews).

Using AL with final-year undergraduate PSTs in Australia, Penney and Leggett (2005, 160) suggest potential challenges to data collection for feedback purposes, however: 'Having identified a personal professional issue as a focus for their projects, some students … struggled to see how they may "research it" in the required systematic, structured way, collecting specific "evidence" or "data".'

In this project, I planned to suggest to PST the types of data they could collect in schools.

Thus, we could see AL and action research as existing on a continuum, with projects with more anecdotal data at one end and more methodologically rigorous projects at the other (Zuber-Skerritt and Wood 2019). A difference between AL and action research is whether outcomes are made public, with AL being more private. This project has some features of action research owing to adopting more painstaking methods of data collection and analysis and publishing outcomes.

I hypothesise that AL may support science teacher development because learning processes identified by researchers are similar: reflection, community/support, action and feedback. Hence, I explore AL's potential to support PSTs' development. My research question is:

- How well does a teaching intervention using AL work to support participants' development?

A sub-question is:
- How does AL support science PSTs' development?

Materials and methods

Case studies often consider contemporary issues, looking in-depth at the experiences of a small group of people, in multivariate and complex organisational contexts (Yin 2014). Hence, a case study is an appropriate design because I researched an aspect of my practice, working with students in my workplace.

The teaching intervention

I designed and carried out an intervention during the 2016–17 academic year with the cohort of 38 science PSTs at Green University, with eight volunteering as research participants. Table 3 gives an overview of participants.

The programme concerned ran from September to June. PSTs attended university in two blocks (September–October and January–February) and undertook block teaching placements in two schools (October–January and February–June). Figure 1 shows a timeline.

I introduced science PSTs to AL in a seminar in October, which included encouraging them to write reflective journals. In December, PSTs selected issues from their journals as the basis for critical incident analysis, which is a type of reflective writing (Tripp 1995) and for discussion in AL sets of four to eight participants. Issues could be any challenge PSTs perceived in relation to learning to teach.

In AL sets, each participant:

- Presented their teaching issue.
- Other group members then asked open questions to encourage further reflection upon their issue.
- The presenter then reflected on any conclusions and identified actions they planned to take in their school placement over the next few weeks/months.

PSTs then wrote action plans about how to overcome their issues, identifying areas for development, success criteria, actions to be taken, support needed and how progress would be monitored. PSTs were encouraged to implement these actions in schools.

Table 3. Participants' teaching subjects.

Pseudonym	Science specialism
CM	Physics with mathematics
Connor	Biology
Dean	Chemistry
Emily	Biology
Kathryn	Chemistry
Paul	Chemistry
Rachael	Physics
Zoe	Biology
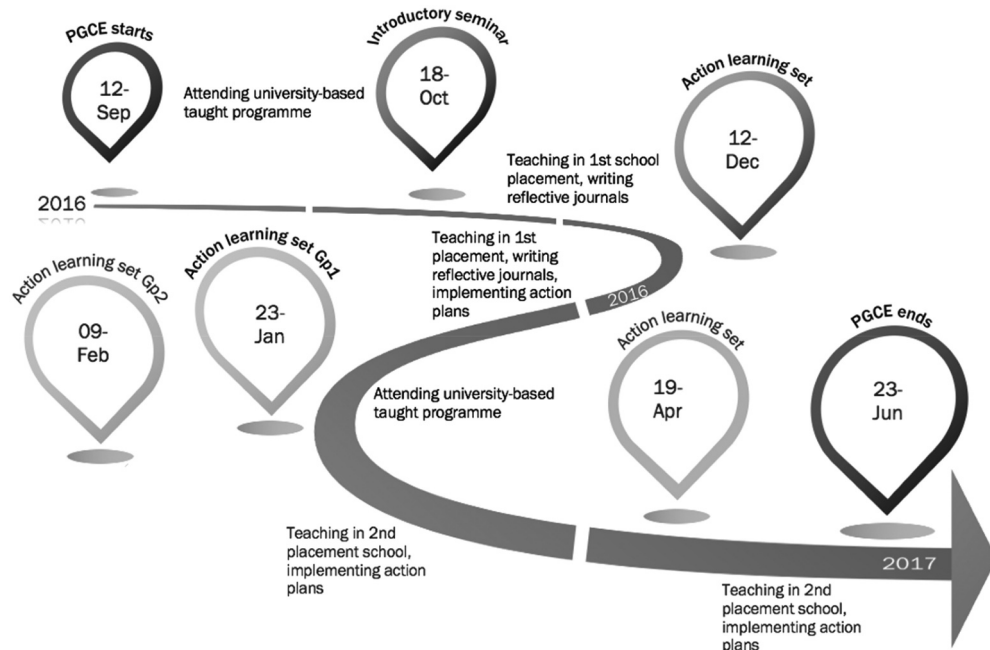
Figure 1. Intervention timeline (Gourlay 2019, 84).

When participants returned to the university, action plans were reviewed, further critical incident analyses were written and further AL sets were carried out. Two full AL cycles were completed.

Research tools and analyses

Data collected included some documents routinely used, such as participants' application forms and school-based mentors' teaching reviews and reports. Others were written for the intervention, including reflective journals, critical incident analyses and action plans. AL sets were audio-recorded. Participants were encouraged to collect data in their school placements, so materials were provided to seek headteachers', children's and parents' consent.

Owing to the amount of material in audio recordings, I first wrote overviews rather than verbatim accounts. Throughout data analysis, I re-read written material and re-listened to audio recordings to familiarise myself with the data. This process included returning to audio recordings to make full transcriptions of some elements, in order to check participants' meanings.

I carried out content analysis – an appropriate approach for large data sets (Grbich 2007), looking for professional, personal and social development occurring through reflection, community/support, action and feedback (Aubusson, Ewing, and Hoban 2009; Bell and Gilbert 1996). Table 4 shows examples of descriptors used to categorise data:

Academic rigour was sought through the use of various sources, including:

Table 4. Descriptors used to categorise data.

		Learning process			
		Reflection	Community/support	Action	Feedback
Type of development	Personal	Participant identifies area for development. Questioning clarifies participant's thinking.	Group discussion leads to participant apparently overcoming difficult emotions or understanding themselves better.	Classroom action reveals an aspect of teaching that is problematic.	Data collected by participant leads to participant seeing themselves differently in relation to the problem.
	Social	Group discussion reveals different views. Participants challenge one another's assumptions.	Group discussion enables participant to overcome a restraint. Discussion makes participant feel less isolated. Discussion provides reassurance or challenge.	Action taken can be linked to challenge from other participants.	Group discussion of data collected by participant enables participant to consider different views.
	Professional	Questioning reveals underpinning educational principles.	Group discussion includes advice taken up by a participant in their plan to solve teaching issue.	Implementing new teaching approaches, or advice from other participants.	Consideration of data collected by participant leads to development of ideas.

- Multiple types of data from participants, which tend to tell similar stories.
- My views as a course tutor and researcher.
- Mentors' views, through reviews and reports about participants' teaching.

Green University gave ethical approval. The main risk to participants was disclosing something calling into question their suitability to be awarded a professional teaching qualification. Hence, they were warned, both orally and in writing (in an information sheet), not to say/write anything that might be deemed unprofessional. Participants completed consent forms.

Results and discussion

Results are presented and discussed as narrative accounts evaluating AL for supporting science PSTs' development.

Finding 1: AL communities supported participants' development

Professional development took place through obtaining one another's advice
Initially, participants valued opportunities to discuss their teaching with peers, rather than reflection initiated by questioning. Although I encouraged open-ended questioning, as suggested in the literature, highlighting the importance of critical questioning (e.g. Adams 2010), participants often gave advice, which they said they preferred, particularly earlier in the programme. Even when participants asked questions, they were inclined to suggest courses of action. For example, when Emily wished to develop her classroom and behaviour management practice, Kathryn asked, 'Could you do role-play with anyone?'

Participants frequently adopted others' advice. For example, in December, Paul's issue was having too many targets for improvement. Paul adopted Dean's suggestion, choosing one focus and asking his mentor for feedback on that one thing. This example might also show overcoming a restraint – that it was impossible for Paul to attend to multiple targets. Overcoming restraints lies in Phase 2 of personal development (Bell and Gilbert 1996).

Loughran (2014) argues that science teachers need to move from wanting to be told how to teach, to wanting to learn how to teach, hence wanting advice might be a weakness. However, some AL models allow the introduction of new ideas (Aubusson, Ewing, and Hoban 2009), and Gilbert (2010) notes that new teachers need to develop their repertoire, so I adapted the AL protocol, incorporating an advice-giving step. Anecdotal feedback suggested that participants appreciated this change.

Personal development occurred through discussion with peers

Discussion may have helped participants to come to terms with their feelings about learning to teach. For example, in December, Dean expressed strong feelings, writing, 'I hate two of my classes'. In the AL set, he further explained that several students in his Year 11 group (age 15–16) were being disruptive. He recounted a concerning incident:

> I was doing a practical on the halogens. I didn't give a good enough example, demonstration and safety briefing at the beginning . . . But I had a student that had taken a whiff of some chlorine, or bromine. . . So, he was coughing, and he needed to go outside. I sent him outside, carried on looking round the class, realizing that at this point everything was going slightly wrong. So, during that, I went to go to the door to see if the student was okay, because I sent him outside just to get some fresh air, and I'd opened some of the windows to get some of the chlorine and bromine smell out of the room . . . open ventilation, which is what you're supposed to do in that situation. While I was doing that, I turned around and the teacher that's in the lesson is pretty much dragging another student over to the sink to wash off their arm. During this case . . . a student had got some bromine water in a pipette, stuck it to a student's arm, pretended like an injection, and squeezed it against this student's arm. So, I didn't see this because I was dealing with another student.

During the discussion of other participants' classroom and behaviour management issues, Dean gave advice about what to do. He expressed frustration about not implementing it himself. The group listened to Dean's ideas and suggested additional actions. His subsequent written action plan suggested he now realised it was unhelpful to be too self-critical, and he should 'follow through with [the school's] behaviour policy' and 'work on telling students off'.

The strong feelings, i.e. hate and frustration, are similar to those observed by Furlong and Maynard (1995), and the fact that Dean was able to identify more effective teacher behaviours might be something commonly achieved in reflection. However, since he realised that his self-criticism might be a barrier to development, perhaps he also learned something about himself (Adams 2010; Korthagen and Vasalos 2005).

Social development took place through comparing experiences

The AL community enabled participants to feel less alone. For example, Dean said (January):

> It makes me feel better hearing that everyone is having similar issues. It's nice to know that I'm not the only one that's having behavioural issues, or interaction issues with your class, or the hesitancy to own that class.

Similarly, in April, CM said the discussion was therapeutic, which Rachael echoed, saying, 'I feel like I've grown closer to you all and this [AL set] is the highlight of my day'. CM referred to a 'Schadenfreude type of thing' since participants felt better 'because of hearing about other people's misfortune'.

These observations agree with previous research, e.g. Aubusson et al. (2007, 14) noted, 'even "sharing and discussing failures proved to be of a valuable nature"'. Participants felt less isolated when working together (Alimuddin et al. 2021; Bell and Gilbert 1996; Plauborg 2009), and trusting relationships developed (Aubusson, Ewing, and Hoban 2009; Stark 2006).

If Gilbert (2010) is correct that valuing collaboration happens in Phase 2 (early career), then AL sets may have accelerated participants' development in this regard. Alternatively, it may demonstrate that social support is also valued during Phase 1.

Social development took place when AL sets provided reassurance or challenge

An example of reassurance came in Connor's January AL set, which discussed two girls who were arguing and refusing to work together, causing disruption across the school. CM asked, 'What could you do to try to help that, or is it beyond your control?', inferring that Connor could not control the situation. Connor replied that an experienced teacher had attempted to resolve it, without success. Paul followed up, 'What could you do in terms of your lesson, without addressing the whole situation going on, make it successful?', focusing Connor on what was achievable. Dean asked, 'Do they sit near each other?', revealing that Connor had separated them. Zoe interjected, 'Are there other people who could help you with this?', leading Connor to realise that the Head of Year could provide support. He concluded:

> I shouldn't worry too much about the problem as a whole as it's quite difficult and it is something that will happen occasionally, and the only thing that will fix it is time. But to resolve it in lessons and make sure that the lessons continue going on the way they should, moving them is a good idea.

This discussion seemed to reassure Connor, and he focused on action within his lesson, which was to assign groups for practical work with friendship difficulties in mind.

Stark (2006) noted group members were mutually supportive but were reticent about challenging each other. Was there evidence of a challenge in this study?

In December, Kathryn was struggling with classroom and behaviour management with a Year 10 class (aged 14–15). Kathryn's approach to getting quiet was 'hollering at them and being grumpy, moving them when they're not responding'. Emily asked whether pupils were receptive to hollering and about any follow-through. Kathryn admitted:

> So far, I haven't given any of them detentions or any sanctions whatsoever in Year 10. I haven't felt it necessary to do as yet. I can get them back. I can get them so they are silent.

Questioning continued, 'Would it not waste less time in the lesson if you gave some detentions?' and further asked what Kathryn wanted to achieve. She responded that she

would like a little more respect. The follow-up was, 'Why do you think you have not established that respect?'. This questioning seems robust in prompting Kathryn to take action. In answer to, 'What are you going to do now?', Kathryn responded, 'be more firm. In an ideal world re-do a seating plan . . . Be more on top of their behaviour. Move them if they are insolent. Give out detention for that student.'

These observations suggest participants were able to take part in 'mutual critically supportive dialogue,' which, again, might usually be associated with Phase 2 (Gilbert 2010, 278).

Finding 2: Reflection in AL sets supported participants' development in some ways but not in others

Personal development supported participants to identify and clarify areas for development and to formulate plans to overcome them

Most participants were able to identify areas for development in their teaching, corresponding to Phase 1 of personal development (Bell and Gilbert 1996). However, this was not always true since Emily chose to talk about classroom and behaviour management when she had no difficulty with it, owing to challenging behaviours being a rarity in her school (December and January). Understandably, she perceived this absence as a deficit compared to peers' opportunity, but her development would have been better supported by focusing on something relevant to her placement.

When open-ended questioning took place, it served two purposes. Firstly, it revealed more about presenters' thinking to the group and to themselves. For example, Dean's January issue concerned a quiet group who would not respond to oral questioning. Dean described the lack of response 'killing the pace' of lessons. However, when CM asked him, 'How important is this to you?' he responded:

> It's getting some kind of feeling of engagement. 'How is my lesson going? Are you understanding what I'm talking about?' Because, other than that, it ends up my just looking at their books, where either they've just copied something off the board, which obviously they're going to get right, and all I can write is 'good notes', or it's questions that I've asked them, and then gone through, and they've written the correct answers. And I can't see how much they've been able to do themselves. I've got no kind of knowledge of where they are until they do a test, and either they do really well, or they don't. . . I don't know if we're going to be doing assessment again at a later date, but there was no way of me telling where they are and if they understand during this lesson because there was no interaction at all.

This comment revealed Dean's concern was about obtaining feedback about pupils' learning, rather than 'pace' or 'engagement' – an attitude consistent with course material about AfL (Black et al. 2004).

Secondly, open-ended questioning helped participants to develop solutions. For example, in February, Kathryn's issue was teaching GCSE Physics. Whilst she had taught several physics topics in lower secondary (age 11–14), she thought GCSE Physics (age 15–16) might be 'scary'. Whilst she liked Maths, she thought she might get caught out and did not want to appear 'a bumbling fool'. She was nervous about admitting to school colleagues 'how rubbish at physics [she was]' until getting to know them. She felt like 'physics is a bit of an alien thing'.

Prompted by open-ended questions, such as, 'how could you overcome the fact that physics feels alien to you?', she developed a plan. She said would like to find some crossover with chemistry. She planned to observe physics lessons, discuss practical work with technicians and revise using textbooks, revision guides and BBC Bitesize (an online revision site). So, whilst participants initially appeared to prefer getting advice, there was some evidence that questioning supported their work-based learning (Revans 2017).

Social development sometimes revealed different views

In December, CM discussed difficulty dealing with a pupil who persistently talked out of turn and answered back. Dean asked, 'Have you fiddled with the seating plan?'. CM replied:

> I'd like to do that in the New Year, but cos we're only there for two and a half weeks [before the placement ended]. But, yeah, it is my classroom. I would put him separately, sit him on his own.

They revisited this suggestion when Dean discussed his halogen practical. Dean was aware he needed to change his seating plan, but CM disagreed, 'It's too late to do one now' (because the placement was soon ending). Connor, however, expressed a different view: 'Think of placement A as a chance to experiment. Try out being "the really mean teacher" with them and after a few weeks you're done, and you can walk away and not have to deal with them anymore.'

Perhaps, group reflection is better than reflecting individually because alternatives are suggested, in agreement with Aubusson, Ewing, and Hoban (2009). Thus, AL sets could provide the conditions for Phase 2 of social development, in which teachers reconstruct their ideas about teaching.

However, there was little evidence of participants challenging one another's underlying assumptions. Several assumptions went unchallenged, notably about the reasons for pupils' unwanted behaviours and their 'abilities'. Participants tended to suggest external factors (such as parents' lack of interest in education) as reasons for children's misbehaviour and regularly framed questions around whether classes were 'top set'. This outlook may have protected them from adapting their teaching, since parents' attitudes and pupils' abilities may be beyond their control. Thus, their discussions lacked the criticality needed to challenge the status quo (Rudduck 1992) and suggests the need for an academic partner/consultant in AL sets.

Professional development took place when participants looked to underpinning principles

Open-ended questioning may have encouraged participants to consider educational principles. For example, in April, Rachael's teaching issue was developing her questioning. Zoe asked, 'If you take more risks, what's the worst thing that might happen?' Rachael responded:

> The worst thing that could happen is that it doesn't work and I don't use that strategy again. And maybe I need to do options as well, give them – we can do it this way or we can do that way. But I think having the questions written down, and looking up AfL strategies as well in

books, and remind myself of the PD [professional development] sessions we went to before . . .

Open-ended question may have stimulated Rachael to consider theoretical ideas taught earlier in the programme, i.e. she began to think about the educational issues involved, corresponding to Phase 2 of professional development. Of course, this development might have taken place without the AL intervention. However, Rachael appeared to find both reflective discussion and action planning helpful, saying in response to the evaluative question 'How did we learn?', in the AL set, 'I think this process of discussion and reflecting for me is really useful' and:

> Actually, we've got [different ideas] in our head, but sort of formalising them and writing them down, so we need to go over them and do something about them, so that we're actually taking them forward into the next placement . . .

Thus, participants may have relied on advice less as they progressed, suggesting that there are development stages.

So, how helpful were the action and feedback processes, overall?

Finding 3: Action and feedback have potential to support development but there were challenges

Participants often took action but were sometimes stuck

Difficulties with classroom and behaviour management were very common in December and January/February, and most participants improved during the year. For example, Kathryn established ground rules following peer questioning. In February, she had developed 'class-built expectations' with her Year 7 class (aged 11–12), i.e. she had adopted a democratic management style in which pupils participated in agreeing classroom rules. Similarly, in January, Zoe was concerned about pupils wandering during practical work and not completing work. By April, she adapted her teaching 'letting students take control of activities and learn independently'. Thus, she was now integrating pupil movement into planning. These examples could be social development, since issues had been discussed in the previous AL set, and Kathryn, in particular, had been challenged by others.

However, CM was stuck. In December, he was concerned about a student talking out of turn and answering back, but reticent about taking action because the placement was soon ending. By January, he still had classroom and behaviour management difficulties. He had taken action by excluding some pupils, but he lost enthusiasm for teaching when this happened. Connor asked what he could do to not let it get him down. In replying, CM expressed regret about wasting time trying to get classes quiet and feeling he had not taught them anything. In response to participants' feedback, I scheduled an additional seminar designed to support the development of classroom and behaviour management. However, in April, CM's difficulties were similar: 'My original incident was talking about trying to engage the students, and punishment, and when you send somebody out of the class you just lost that motivation, which was kind of what we talked about last time.'

He withdrew from the PGCE programme at this stage. Perhaps this result demonstrates a weakness of AL in supporting PSTs' development, since CM was a physics participant,

whom we needed to be successful to address the physics teacher shortage. Another possibility is that deeper questioning, uncovering barriers to progress, may have helped (Korthagen and Vasalos 2005). Alternatively, if people-first approaches emphasise personal transformation, perhaps we must accept that some PSTs do not become teachers (Aldridge 2015).

Feedback was limited

Most participant feedback was self-reported, orally in AL sets and/or through written action plan reviews. Not all documents were consistently completed or provided by participants and only CM obtained permission from a headteacher to collect data. Overall, little formal feedback was collected, similar to Penney and Leggett (2005). However, there was support for participants' claims about their progress from mentors' reports. For example, where Zoe had been working on classroom and behaviour management, when second placement ended her mentor wrote:

> Zoe has shown a huge improvement with behaviour this placement. It is important to note that there has never been anything more than low-level disruption … All of Zoe's lessons have been a pleasure to observe and there is always a safe and calm environment.

Overall, feedback was comparable with other AL studies (Willis 2010; Zuber-Skerritt and Wood 2019) with a greater emphasis on participants' learning than on collecting types of data used in social research. However, stronger feedback might provide greater impetus for participants' action, further supporting development, noting that Bell and Gilbert (1996) suggest that awareness of development needs is a prerequisite for teacher development and that Hoban et al. (1997) suggest that pupils' feedback was a catalyst for change.

This research had some limitations. Data about participants' views of AL were limited. In the future research, the data could be strengthened by carrying out semi-structured interviews with participants. Whilst interpretations of data were shared with critical readers (supervisors), rigour could be enhanced by involving a group of researchers in data analysis. Additionally, more could be achieved in assessing AL's impact in a longitudinal project, extending into the early career phase.

Conclusions

AL worked well for most participants in that they were able to identify teaching problems, and structured discussions enabled them to find/create solutions. For most, there was evidence of overcoming teaching issues, but unfortunately, not all participants made progress. Whilst we cannot be certain what would have happened without the teaching intervention, there was evidence that the community/support process was particularly successful.

AL had not been studied in ITE in England, and this paper contributes to knowledge by suggesting a structured discussion that supports PSTs' development. It also presents science PSTs' concerns as they learn to teach, which has been lacking previously (Davis, Petish, and Smithey 2006; Loughran 2014). I recommend AL to others working with PSTs because it positions enquiry as a process for ongoingly improving teaching, rather than as a one-off university assignment. If there are development stages, AL's strength is in meeting PSTs' needs at their current stage, e.g. allowing advice to be provided initially, and facilitating greater reflection later. Since the study was completed, there has been an

increasing emphasis on deliberate practice in ITE in England (a practice-based model) (see, for example, Bronkhorst et al. 2014), and I envisage it being possible to integrate practice into the stage where advice is given. Additionally, relevant theory could be provided by an academic partner (tutor or experienced mentor), when PSTs are ready, overcoming the perceived irrelevance of theory when taught up-front, and dealing with a weakness of reflective practice, that it pays too little attention to research findings. Academic mentors could also challenge PSTs' assumptions and encourage deeper questioning to support personal growth. AL could overcome shortages of specialist mentors, because academic partners could work with AL sets of four to eight PSTs, rather than courses relying on many mentors. Additionally, AL formalises peer support, which research participants valued.

Ideally, AL would be integrated into an ITE programme in a professional enquiry and development module. Greater leadership engagement (including mentors, schools and course leaders) with AL could make it more successful (Maher and Schuck 2020). More regular and frequent AL sets, in stable groups, may support even better collaborative relationships. This module could provide opportunity to strengthen participants' data collection and understanding of social research, providing impetus for development.

Note

1. The university has been anonymised.

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Notes on contributor

Dr Helen Gourlay is a Lecturer in Physics Education at the UCL Institute of Education (UCL IOE). She completed her undergraduate degree in Natural Sciences at the University of Cambridge and subsequently undertook a PGCE at the University of Oxford. Prior to working in higher education and teacher development, Helen was a successful and innovative science teacher. She taught science across the secondary age range for 17 years in comprehensive schools in London and Hertfordshire. Whilst working full-time as a teacher, she completed an MA in Science Education at UCL IOE. She completed her Doctorate in Education, specialising in science teacher preparation, at the University of East Anglia. Her research interests include science teacher development and children and young people's learning in science.

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Ethics statement

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