Teaching A-level in Early Career

Cathy Smith and Jennie Golding

UCL Institute of Education

Teachers in England typically begin their substantive posts with little experience of teaching advanced mathematics. This project investigates the question 'How, and with what effects, are early career teachers inducted into teaching A-level mathematics?' through five longitudinal case studies. Data has been collected over two years from lesson observations and interviews with teachers and department heads. Early thematic analysis suggests that A-level teaching in early career is viewed as an incentive over core teaching, a contrast that offers motivation and relief through its change of work conditions. Participants report distinct demands in preparation but also that they develop insights into the complexities of teaching and learning, and gain from rehearsing complex activities. Development of A-level teaching relies on key messages and informal teacher conversations, often more focused on managerial aspects than mathematics pedagogy.

Keywords: mathematics; A-level; initial teacher education

Mathematics is compulsory in England until age 16, with a quarter of the university-track cohort continuing to study for Advanced-level (A-level) mathematics qualifications. This research project is concerned with the role of A-level teaching within teacher education, and whether it requires distinctive pedagogic knowledge. The national ITE regulations in England require trainees to be prepared and assessed as competent for two successive key stages (KS), normally taken as KS3 (11-14 years old) and KS4 (14-16) in secondary. Schools vary considerably (and regionally) in their post-16 teaching and it would be impractical to *require* A-level experience across all partnerships; schools are also cautious of giving examination classes to unqualified teachers. The result is that initial teacher education (ITE) for secondary mathematics is typically focused on the compulsory age group. The inference is that A-level teaching is not distinctive in its requirements, merely requiring appropriate knowledge of the mathematics involved. England offers a variety of routes into teaching: Higher Education-led routes such as the PostGraduate certificate of Education (PGCE) require over half the course based in schools and, increasingly, government policy has encouraged an apprenticeship model of preparation, implementing bespoke training as clusters of schools or in liaison with charities such as Teach First. The unqualified teachers on these latter routes are often salaried and take nearly a full teaching load. Whether and how any of these routes involves A-level teaching is usually for the school to decide.

We investigate the research question 'How, and with what effects, are early career teachers inducted into teaching A-level mathematics?' Of course this problematizes how we conceptualise such an induction, and whether/how it complements preparation for teaching mathematics to younger students. Although there is a wealth of research on pedagogic approaches to particular A-level content such as calculus, we have found little literature that deals explicitly with teacher

education in this area. Livingston and Borko (1990) studied teachers in an analytic geometry/calculus context and characterise advanced mathematics teaching as a complex cognitive skill which includes sophisticated improvisational performances (and hence contingent knowledge) and demands depth and robustness of subject and subject pedagogical knowledge of a different kind to that employed with younger students or less densely-connected material. A European approach has been to foster teachers' understanding by focussing on 'big ideas' that have mathematical and pedagogic power across all age ranges. Kunste et al. (2011) found that pre-service teachers struggle to identify school mathematics topics exemplifying the 'big ideas' of infinity and proof, two themes that they note are particularly relevant to A-level teaching. For us this suggests that making connections between A-level teaching and other mathematics should indeed be considered part of the specialist knowledge of teachers, and not simply an extension guaranteed by knowledge of mathematics.

Method

Theory in this area is thus relatively sparse, and offers no clear framing of A-level preparation within teacher education. This led us to adopt a multiple case-study approach, in which we produce an "intensive, thick description and interpretation of the phenomenon" aiming to generate hypotheses about the role of A-level preparation (Merriam, 1985, p207) in beginner teachers' development. Each case is a teacher who has some sole responsibility for an A-level class in their first year of qualified teaching. (A-level mathematics classes usually have two teachers, with the content shared formally, by module, or ad hoc). The five teachers were chosen to represent different routes into teaching as described above: two with PGCEs, two from Teach First and one from a salaried school route. We recruited from alumni of our own institution for ease of identification and also because the longitudinal nature of the study, combined with their relative inexperience, could put pressure on participants. The data collection plan involves four interviews, (one with the Head of Department) and three lesson observations over 20 months, interspersed with two analysis periods. Data was collected over time in order to capture participants' changing reflections on A-level teaching and development in their classroom practice. It is already clear that participating in the research is having an effect on the teachers' thinking about A-level teaching, in part because there are limited other opportunities to do so. Our cases are not typical but offer illustrations of how A-level teaching can develop in early career.

Data was gathered by both authors, and ongoing joint analysis consisted of reviewing individual case summaries, making and testing cross-case comparisons. These descriptions and interpretations will be offered to participants at an upcoming validation seminar. In this paper we present the case of Anna (a pseudonym) because in many ways this exemplifies the commonalities between the five cases: a presumption against A-level teaching during ITE, effects on professional identity, workload and pedagogy, and co-teacher support that emphasises managerial aspects.

The case of 'Anna'

Anna studied mathematics at A-level and in her joint-honours degree. After considering other careers briefly, she found she was missing mathematics. Her mother is a teacher, which gave her incentives and reservations about the lifestyle, but after a year's work as a teaching assistant she felt "I really do want to teach" and completed the secondary mathematics PGCE. At the start of the study Anna was a newly

qualified teacher (NQT) employed in the school where she had done her first PGCE placement. She conveyed an ongoing commitment to teaching mathematics; there have been shocks and worries but she builds on these and "really, really enjoys it".

Anna's school has single-sex education to 16 and then co-educational teaching for A-level Mathematics and Further Mathematics. In her first year she taught the introductory module Decision 1 to a further mathematics group of 11 students, followed in the summer by a few weeks of advanced pure mathematics; in the next year she taught Decision 2 to the same group (now only 4 students). Her PGCE A-Level preparation had been predominantly university-based, comprising a full week of peer-taught seminars on A-level topics, with just a few visits to A-level lessons in the school placement. As an unqualified teacher, Anna's new classes had been observed daily so she was conscious of the contrast of starting A-level without anyone "actually watching me teach", but she weighed this omission against remembering the pressures of the PGCE year where she had indeed wanted to concentrate on KS3 and 4. In fact she had taught no exam classes during her training, which is usual in our experience.

The rationale for including A-level teaching in early career

The range of classes Anna would teach in early career was not a factor in her job decisions, but she was pleased when offered A-level teaching for her first year. In interview 1 the reactions she recalled were unreflective: pleasure in being deemed competent, in being able to meet the department's needs, and having a variety in class types (including teaching boys). Although she had studied decision mathematics herself, her second response was to spend "a good part of my summer working on it". At that stage she drew a distinction between KS4 and A-level mathematics subject knowledge: in the former she felt she would be '"fine" attempting any student's question even if she had not seen the problem before, while for A-level she initially felt she "would not have a clue", although once refreshed "really it was still there". In the following year, she still felt that she must prepare the mathematics more thoroughly for A-level content than for other areas.

Anna's Head of Department (HoD) would not normally put an "untested" teacher with an A-level class, expressing concerns both about the effect on students, who are quick to react if teaching does not go well, and about the pressure on the new teacher of taking an examination class. The school usually has competition for A-level teaching but on this occasion timetabling was difficult and, on consulting senior leadership, they felt their knowledge of Anna made it a low risk decision. Without any knowledge of her A-level teaching, they justified their faith in Anna's potential on the grounds of her subject qualifications, time and willingness to prepare and proven strength in teaching younger students. Thus, given the pre-requisite subject knowledge, A-level teaching was viewed as an extension of other mathematics teaching, perhaps more stressful and time-consuming for inexperienced teachers but not distinctive. Both the HoD and Anna emphasised the main message that A-level students are just "overgrown" younger students, requiring the same engagement, monitoring and assessment. This particular message featured for other participants and was repeated over time. It appeared to act as a "reform artifact" expressing a provisionally-agreed set of department values (about independence and support) around which new teachers could experiment with local meanings (Horn, 2005).

Across our cases, this HoD reasoned most strongly *against* giving A-level classes to NQTs, although in practice he felt it had worked well for Anna. Our wider

experience suggests this caution is a fairly typical school reaction, although here our selection of cases obviously favoured HoDs who were driven by necessity and/or who argued that advantages outweighed the extra pressures and risks. These advantages were seen primarily in the dual light of motivation (for the teacher) and retention (for the school). HoDs proposed that new teachers, and particularly those with strong mathematics, would soon be bored by an allocation of "middle sets, middle age groups". A-level teaching was motivating both in itself and because of its status - teachers would feel valued when given responsibility. In this construction, boredom and feeling unvalued (rather than workload) are seen as threats to retaining mathematics teachers (which is a cause of concern in all these London schools) and A-level teaching is an aspect of the job that can mitigate these.

All sample HoDs were A-level teachers themselves and felt that the experience built up their breadth of pedagogic knowledge about teaching and young people. A-level shows the ultimate purpose of some KS3/4 content, and provides a useful perspective for making decisions in planning and teaching. They also valued within a school day having a variety of intellectual challenge and of relationships with adolescents. For some, including Anna's HoD, these opportunities for deeper professional thinking were valuable reasons for teaching A-level eventually, but they came *after* learning the basic teacher role – they were not *part of* learning that role. A-level teaching was viewed primarily as a privilege for future development, possibly behind a queue of other aspiring teachers. In Anna's case, although she continued beyond her first year as Decision specialist, one experienced teacher normally taught pure mathematics to all three A-level classes, and four other teachers negotiated for the applied teaching, so that she did not see how her A-level role would develop.

Reflections on learning to teach A-level

Over the interviews we asked Anna what she had gained by teaching A-level, what she found challenging, and how it was similar to or different from other teaching. Throughout the interviews the major benefit reported by Anna has been being respected as a 'real' teacher by colleagues and the students, and also by herself. She feels A-level teaching gives "the whole big picture" – academically, of where mathematics ends up and, socially, where adolescents end up. With the status of being an A-level teacher, she feels that her professional experience is fully trusted by students and colleagues in the school. A-level teaching also offers Anna heightened autonomy in the classroom: there is a difference between the relative freedom she has an A-level teacher to "bounce off the students" and enjoy mathematics with them, and some of the aspects of managing younger students that "pull on the teaching, make it less enjoyable for everyone". Anna is a good classroom manager, but she welcomes the respite from having to consider divergent student behaviours, and it helps her feel successful. In this respects, A-level teaching brings Anna closer to what she knows is an 'idealised' view of teaching where behaviour management is invisible and teaching appears to be only about students learning mathematics.

The persistent challenge for Anna from teaching A-level has been the heavy workload (or as she says "time invested") in reviewing her own subject knowledge, selecting resources, planning lessons and monitoring students' work. She has been tempted to cut down on A-level preparation time because "you can probably get away with it" but not succumbed. This is not only due to her professionalism, but also because detailed preparation protects her from a fear of becoming stuck or confused in front of the students. She discussed this fear in later interviews, describing it at that

distance as an inexperienced belief that instant responses were critical to teacher–student relationships. Nonetheless this was a concern for her and other participants. By the end of the year Anna had developed a more confident overall strategy in handling difficult mathematical tasks in the A-level classroom, that she describes as letting students get stuck, posing questions that make them think, and helping them argue it out. She purposefully selected group resources that encouraged student discussion in order to make uncertainties public. This progress matches Livingston and Borko's (1990) finding that expert teachers are more able to extemporise in lessons than novices. We note that Anna reports no less preparation time for this approach, but greater satisfaction as it aligns with her mathematics education beliefs.

We asked Anna to reflect on connections between her A-level teaching and other teaching. In the early interviews she considered that she was developing different skills. For A-level teaching she was much more aware of the choices made in planning and delivering her exposition, examples and questions. There was more "space" for her to assess students' responses during the lesson and adapt accordingly. For other teaching, managing the group's behaviour consumed her main attention. Later, she reflected that the A-level experience of questioning helped to frame suitable questions for younger students. She also used the A-level classroom as a rehearsal space for introducing unfamiliar structures of student activities and resources.

Although Anna spoke of wanting to see the big picture in mathematics, she made few explicit connections between learning mathematics at younger ages and what or how students learnt at A-level. She mentioned this herself, and ascribed it to teaching decision mathematics which is completely new content for students. In contrast, her short summer experience of teaching pure mathematics had made her realise the algebraic fluency needed for A-level. She felt there were more such insights to be gained when she could teach more pure mathematics. She compares this to KS3 and KS4 teaching where she does now see "where all the links happen. And I need to make those in A-level". Her perception of connections in content is a strength, but there are connections with decision mathematics at the level of over-arching forms of reasoning (e.g. working with diagrams, proving, reasoning systematically) and the fact that she misses these shows some of her inexperience as a teacher.

Support and mentoring

As a newly qualified teacher Anna has a regular support timetabled session with a mentor teacher. She also has an experienced department around her. Although she is the only teacher of decision mathematics, there are two teachers in the school who have taught it before. This level of potential support was a factor in the HoD's allocation of A-level teaching, and in Anna's confidence in accepting it. In practice, she has found that her mentor session is devoted to other issues and although teachers around her are "basically supportive, they just don't have a lot of time." No doubt this light-touch support reflects the assessment that Anna's A-level teaching is sound. Nevertheless it shows that teachers in early career can be developing an important aspect of their teaching in isolation, and this was reflected in our other cases.

The kind of interactions Anna describes around her A-level teaching are those that occur because teachers share the same students rather than because she is inexperienced. These interactions are primarily organisational and concerned with standardising practice and reporting; they include comparisons of student attitudes, attainment and behaviour, scheduling of teaching and tests. Anna makes the point that

for KS3 and 4 there are many experienced teachers around her and that she finds she can seek help informally and gain a range of perspectives on pedagogic issues at that level. Horn (2010) suggests that interactions with colleagues support teachers' informal learning through rehearsals and reinterpretations of classroom events. Some of our other participants note that such occasional informal conversations about 'how I teach x' are their main way of developing as A-level teachers, but that they happen infrequently if at all. To balance this, Anna has made use of online resources and enrolled for an online Teaching Further Mathematics course.

Final Thoughts

Our initial question concerned, first, how teachers are inducted into A-level teaching. For most of our cases, including Anna, class allocation was a serendipitous decision based on weighing the risks of high-pressure examination teaching against mathematical qualifications and the perception that A-level will motivate 'good mathematicians'. Subsequent teaching development was largely in isolation, although certainly monitored through co-teaching arrangements. Initial orientation came in the form of two key messages echoed by Anna (and other cases): the importance of thorough preparation and the warning that A-level students, although apparently mature, needed the same engagement and monitoring as younger students. Despite the wealth of department experience, informal teacher interactions did not crystallise into support for her to establish local meanings for these messages. This raises questions about the development of early career teachers as they widen their experience.

The effects of teaching A-level were unquestionably positive for Anna, giving her status, self-belief and enjoyment. She reframed the demands on her workload as an investment for her future career *and* for her other teaching. From considering A-level teaching as a completely different skill set, Anna has started to deploy strategies developed at A-level purposefully in her other teaching. Our future work for this project will explore whether and how A-level teaching requires developing distinctive pedagogic strategies, or is perhaps distinctively useful in developing general knowledge for teaching.

References

Horn, I. S. (2005). Learning on the Job: A Situated Account of Teacher Learning in High School Mathematics Departments. *Cognition and Instruction*, *23*(2), 207–236.

Horn, I. S. (2010). Teaching Replays, Teaching Rehearsals, and Re-Visions of Practice: Learning from Colleagues in a Mathematics Teacher Community. *Teachers College Record*, *112*(1), 225–259.

Kuntze, S., Lerman, S., Murphy, B., Kurz-Milcke, E., Siller, H.-S., & Winbourne, P. (2011). Professional knowledge related to big ideas in mathematics – an empirical study with pre-service teachers. In *Proceedings of CERME7*. Rzeszow.

Livingston, C., & Borko, H. (1990). High School Mathematics Review Lessons: Expert-Novice Distinctions. *Journal for Research in Mathematics Education*, *21*(5), 372.

Merriam, S. B. (1985). The case study in educational research: a review of selected literature. *The Journal of Educational Thought (JET) / Revue de La Pensée Éducative*, *19*(3), 204–217.