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Master Teachers in Computing: What have we achieved?

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ABSTRACT

Recent changes to the teaching of Computing in all schools in England have been profound and wide-ranging, changing the subject from one focussed on the use of ICT products to one focussed on the understanding and creation of computing systems. This change in the curriculum has created a strong demand for professional development of in-service teachers, to develop their skills and expertise to deliver this new curriculum.

One approach to developing in-service teachers to deliver the new computing curriculum has been through the Computing At School Master Teacher programme, appointing and training experienced in-service teachers to deliver continual professional development (CPD) peer-to-peer. However, many potential Master Teachers require additional training before they can take up this role.

In this paper, we describe how we have trained two cohorts of Master Teachers in two successive years. Evaluation of the first cohort informed revisions to the second cohort's training. The diverse needs of the individual trainees, identified through semi-structured interviews and analysis of completed tasks, led to a variety of CPD being delivered, but almost all required training and practice with programming.

Before and during the programme, the trainers shared resources and had online meetings to discuss their work. This was useful in terms of establishing and maintaining consistency between different providers. The use of many teaching strategies that provided collaborative working and discussion opportunities were highly rated by the trainees.

The first cohort of teachers has already delivered a significant amount of CPD in their first year after training. The second cohort are well placed to start their CPD delivery,

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with a better appreciation of where they need to develop their own skills.

CCS Concepts

•Social and professional topics → Computational thinking; K-12 education; *Computer science education*;

Keywords

Computer science education, Curriculum change, Master teachers, Teacher education, professional development

1. INTRODUCTION

Recent changes to the teaching of Computing in all schools in England have been profound and wide-ranging, changing the subject from one focussed on the use of ICT products to one focussed on the understanding and creation of computing systems. Algorithmic thinking and programming are now at the centre of the subject, which is compulsory from age 6 to age 16. This change in the curriculum has created a strong demand for professional development of in-service teachers, to develop their skills and expertise to deliver this new curriculum.

While some schools have already offered programming opportunities, in many cases this has been limited to after school clubs mostly run by enthusiastic volunteer teachers. Preparing the whole school to meet this new demand may therefore present challenges. Budget cuts in the UK have impacted on the level of training services provided by local education authorities and 'City Learning Centres' which were established to offer ICT-based learning opportunities for schools and for the wider community.

CAS (Computing At School) is a grass-roots organisation in the UK that has had a profound influence on these changes. CAS exists to provide leadership and strategic guidance to all those involved in computing education in schools in the UK. It is currently concentrating on the computer science theme within the wider computing curriculum, as this is the largest change from the previous curriculum and the area where both new and in-service teachers require most support and development.

Many teachers are keen to offer the full range of the new computing curriculum, but a lack of subject-specific knowl-

edge, a lack of training opportunities, and technical barriers with overly-controlled school IT environments are all barriers to effective computing teaching.

One approach to developing in-service teachers to deliver the new computing curriculum has been through the CAS Master Teacher programme [12]. Master Teachers are experienced teachers who work with around 40 other teachers in their local area, supporting their teaching of computing. The Master Teachers are available to give advice for their supported teachers, but the Master Teachers are primarily expected to support their local teachers through offering low-cost continual professional development (CPD) sessions on a variety of topics. The locally-responsive, peer-to-peer CPD has been shown to be highly effective in other contexts [7].

Master Teachers are recruited onto the programme on the basis of teaching experience, extent of subject knowledge, and possible prior experience of delivering CPD. However, they may not have the skills or confidence across all aspects of the computing curriculum, and the development and delivery of CPD, to automatically step into the Master Teacher role. Therefore, CAS provide training for potential Master Teachers to provide the CPD required for peer-to-peer support of other teachers.

The Master Teacher initiative does not cover initial teacher training. There is a developing provision of specialist computing training for trainee teachers, which is being offered in many centres and with additional funding to make the specialism attractive. However, the Master Teacher programme is complementary to this initial teacher training, as Master Teachers are experienced teachers who can draw on that experience when identifying the CPD needs of other teachers.

In this paper, we describe how we have trained two cohorts of Master Teachers in two successive years. Lessons learnt from the first cohort were successfully applied to improve the training of the second cohort.

1.1 Master Teachers

Master Teachers are trained in two stages. The first stage, level 1 training, concentrates on subject-specific knowledge and expertise across the computing curriculum. The second stage, level 2 training, is one day solely about how to deliver effective CPD to teachers. In this paper, we only consider level 1 training.

Primary school teachers (teaching children aged 5-11) have five days of level 1 training; secondary school teachers (teaching children aged 11-18) have an additional five days of training. This reflects the greater subject specific requirements of secondary teachers. Each Master Teacher training centre had approximately five primary and five secondary teachers. In most centres, all teachers attended five days' training, with the secondary teachers attending five separate days. The combination of geographically widely-spread teachers for a centre, and the difficulties of arranging lesson cover, meant that most centres offered the training as ten separate days.

In between training days, the Master Teacher trainees are required to engage with additional learning resources and to apply what they have learnt in their own classrooms and through delivering some initial CPD to other teachers in their school and local area.

2. MASTER TEACHER TRAINING PROGRAMME

After a small pilot training programme in 2012-3, the Master Teacher training programme has run for two years (2013-14 and 2014-5), with the second year drawing to a close at the time of submission of this paper. Level 1 training took place between September and April, leaving the summer term for the one-day Level 2 training.

The first full cohort consisted of 80 teachers in 8 centres, the second cohort was 120 teachers in 12 centres. The teachers were split evenly between primary and secondary teachers, with each centre taking five of each. The primary teachers were 80% women; the secondary teachers were 60% women.

2.1 Pedagogic approach

Defining the theoretical foundations of CAS CPD model is challenging as it adopts a flexible and personalized approach to professional learning and development. Caena [3] suggests that there are five core features of effective teacher and learning development; content focus, active learning, coherence, duration and collective participation. Kennedy [10] discusses nine different categories of CPD and groups them into three types: transmissional, transitional and transformative:

- Transmissional: training, award-bearing, deficit, cascade.
- Transitional: standards-bearing, coaching/mentoring, community of practice.
- Transformative: action research, transformative.

Sentance *et al.* [11] propose a holistic model of professional development in the area of CS based on Kennedy's nine categories. They focus on four types of professional development: Cascade, Training, Mentoring and Community of Practice. This model suggests that teachers may be motivated by giving them the opportunity to gain a professional qualification (which may help their professional development). Sentance *et al.* also found that teachers are interested in action research; including this element within the CPD offers a space for teachers to apply their knowledge and understanding.

The CAS CPD model was designed to promote active learning where the participants were encouraged to actively involve in constructing their own knowledge and understanding through collaborative learning activities, which plays an important role in changing the cultures and practices of teachers.

2.2 Preparation

Each training centre tailored their own programme to the suit their individual circumstances. Prior to the start of training, the trainers at each centre contacted all their trainees to ask about their existing skills and experience, and any areas of weakness they could identify that they would like covered in the training. The trainees also completed an online questionnaire to assess their levels of prior knowledge. Based on these evaluations, the trainers tailored their programme of training to the specific strengths and weaknesses of their trainees.

As expected, this pre-training evaluation of the teachers' abilities indicated that programming ability was a significant

concern for most teachers. This was expected as programming was the significant new addition to the school curriculum. Many teachers also expressed that they were unfamiliar with the more technical aspects of computing hardware and networking, including concepts such as the IP stack.

Based on this evaluation, and feedback from the first cohort, programming was a constant theme throughout all the training for the the second cohort of trainee teachers. The content of subsequent sessions was altered throughout the year. By having Master Teacher training structured over a year rather than in one day, learners were given the opportunity critically to reflect on what they learned and implement the collaboratively-developed ideas in their own school.

2.3 Training provision

Training was a blend of face-to-face training with groups of students, one-to-one training to support individual trainees (generally performed by teleconference), and application of skills learnt by the trainees in authentic practice by teaching children or delivering CPD to peers.

Each centre arranged their own training timetable and the content of the training. However, all centres followed the same overall pattern. All trainees attended five training days, which generally concentrated on primary provision and transitions from primary to secondary schools. The secondary teachers attended an additional five days, interspersed throughout the training programme, that concentrated on the more technical requirements of teaching computing in secondary schools.

Importantly, the training was not intended to improve the teachers' ability to teach: all the Master Teacher trainees were competent teachers before embarking on the Master Teacher training and were expected to use their existing professional expertise to develop engaging and appropriate lessons to communicate the concepts and knowledge required for the curriculum. The training was intended to ensure that the teachers had the requisite knowledge and expertise to develop these lessons.

This training programme, combined with the amount of material that needed to be covered, necessitated a blended learning approach, combining face-to-face training, independent study, individual support, and authentic practice. The face-to-face sessions were the main driver of the training. In these sessions, the trainers gave assignments to each trainee for completion before the next face-to-face session. Many of these were practical, involving delivering classroom teaching and CPD. After the first face-to-face session, subsequent sessions typically started with a "teach back" session where teachers shared their experiences and reflections on the tasks they had performed and swapped ideas on how to improve. The materials generated for these tasks, and reflective commentary on them, were captured electronically and shared among the teaching group, typically via a shared blog or wiki space (e.g. [6]).

2.4 Reflection

After the Level 1 training was completed, we interviewed the teachers to understand how valuable they found the training and how prepared they felt about both teaching the new computing curriculum in the classroom, and delivering CPD to other computing teachers. Our results broadly align with earlier reports on Master Teacher training [12]. Teachers started the level 1 training feeling not confident in their

ability to deliver the new computing curriculum, but ended it by reporting greatly increased levels of confidence in both their subject knowledge and confidence in their ability to deliver that knowledge to their students and peers.

The teachers found the face-to-face sessions the most valuable and most enjoyable. In particular, they enjoyed the collaborative sharing and discussion of their practice of classroom and CPD tasks performed between the sessions. In particular, they found valuable the sharing of ideas of alternative ways of presenting ideas and techniques in the new curriculum, by using either a wider range of technology to illustrate the ideas, or using non-technological approaches such as CS Unplugged [2] or CS4FN [8].

The individual one-to-one support was not taken up well. This was mainly due to the busy schedule of practicing teachers, who often had a number of pressing tasks which precluded the scheduling of videoconference sessions. They found the fixed, and more significant time requirements, of the face-to-face sessions easier to devote time to. Based on the much greater value of the face-to-face sessions, several centres used the time allocated to one-to-one support to and additional face-to-face session at the end of the summer term.

Many Master Teacher trainees, including those from the second cohort who have not completed their training, have already successfully delivered CPD and professional peer support to their colleagues as a result of the training. CAS has surveyed all Master Teachers from the first and second cohort [5] and gained their evaluation of the training. Over 80% of teachers said the training had at least a moderate impact on their knowledge, with 40% reporting significant impact. These figures were approximately the same for the two years of training. However, the effects on the training on class room practice improve markedly in the second year of delivery (see Figure 1). The training in 2014–5 had substantially more impact on classroom practice and therefore pupils than the training in the previous year. This shows that the lessons learnt from the 2013–4 training were successfully applied in the second year. The adoption of a trainee-centred approach to training, where the training sessions focused much more on what the trainees needed, translated into better results for the children in the classroom.

3. THE WAY AHEAD

The Master Teacher programme is funded by the UK central government Department for Education, via the British Computer Society. Changes in the funding structure, and concomitant changes in the CAS structure, have led to a reduced number of centres offering Master Teacher training for 2015–6. In addition, the British Computer Society and CAS are now offering a Certificate in Computer Science Teaching, which is intended to show a teacher's competence across the new curriculum, especially programming. Acquiring this certificate should equip teachers with the basic technical skills required to teach the computing curriculum, which would allow the Master Teacher training programme to concentrate on the development of advanced skills and the differences in teaching approach needed to deliver CPD as opposed to classroom teaching.

4. CONCLUSION

In this paper, we have outlined the CAS Master Teacher

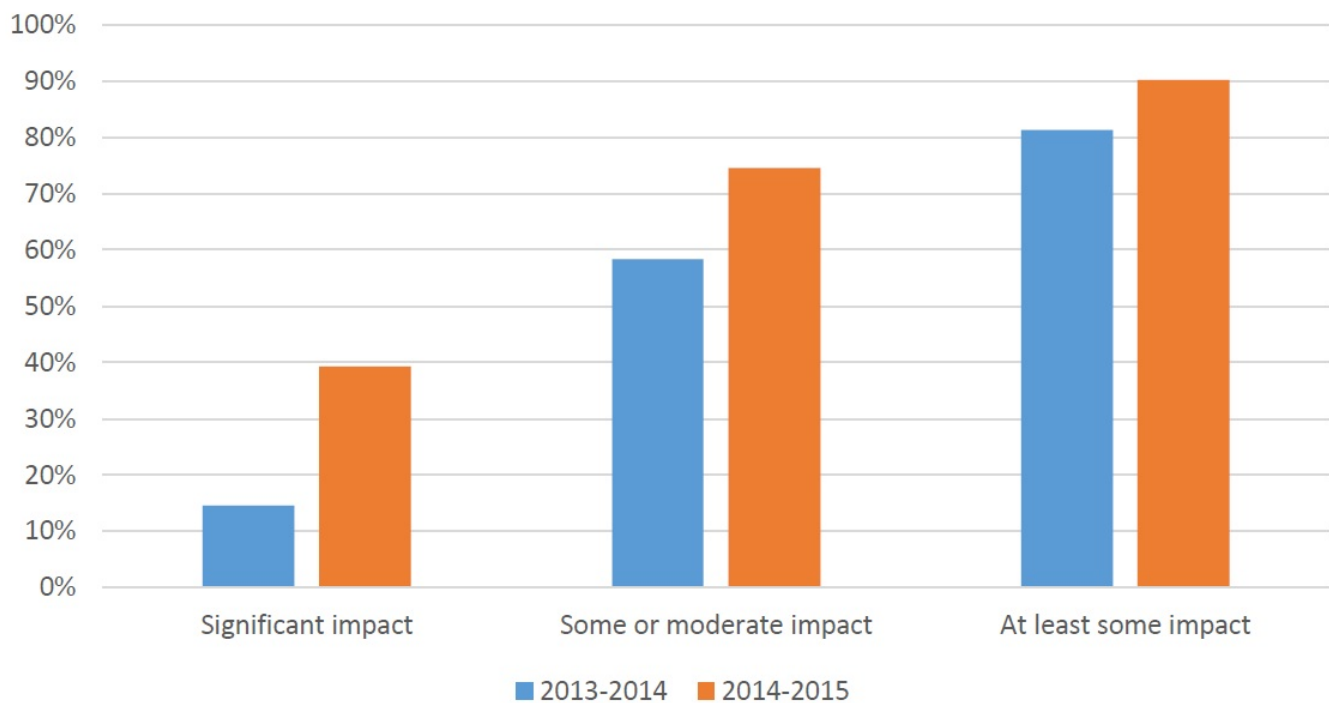


Figure 1: Master Teacher trainees' evaluation of training: answers to 'Impact of Master Teacher training on my students/pupils.'

Level 1 training programme. This training programme is for experienced, in-service teachers. The level 1 training equips these teachers with the skills and specialist knowledge required to deliver computing-related CPD to their peers. We have outlined the method of delivery used and shown that the training was successful.

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