

Review of Network of Teaching Excellence in Computer Science 2013-2015

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Between September 2013 and April 2015 the Department for Education has funded Computing At School¹ to run a professional development programme for teachers of Computing, both primary and secondary: The Network of Teaching Excellence in Computer Science(NoE)².

The move towards the inclusion of computer science in the school curriculum has led to concerns about how teachers will manage this change and how sufficient teachers can be found. Teachers have a need for new subject knowledge in computer science, but also importantly, they need to gain confidence in their abilities to teach the new subject. The NoE was introduced to address these challenges building on the existing CAS community.

This report summarises the impact of the first phase of the programme and points to required changes for the second phase based on data from an independent evaluation, feedback from participants gathered by CAS and the annual CAS survey.

Summary of Recommendations

- Expand the role of Regional Coordinator into a Regional Centre
- Strengthen the connection between the Master Teacher and the local hub as well as other CAS and NoE activity
- Encourage Master Teachers to develop more mentoring and coaching CPD alongside training
- Provide resources for both Master Teachers and Hubs
- Review the “Master Teacher” role and other designations.
- Seek additional resource/funding to promote its activity and develop greater recognition of CAS initiatives.
- Expand face-to-face CPD and develop on-line support for specific training and consider the extent to which the offer made locally should vary from place to place.
- Explore links with other subjects to support computing in primary schools

¹<http://computingatschool.org.uk>

²<http://www.computingatschool.org.uk/index.php?id=noe>

- Strengthen the connection with the “Teaching School Alliance” network both to promote its work but also because Teaching Schools are effective Lead Schools or hosts for Hubs
- Consider mapping patterns of engagement and identify ‘cold spots’ to target areas for development.
- Identify the intended impacts of activity on teachers, teacher networks, schools, and pupils.
- Consider lessons to be learnt from evaluation of comparator organisations.
- Consider the extent to which independent evaluation is a priority and seek funding for this, as appropriate.

Computing At School

Computing At School (CAS) was established in 2009 by members from schools, higher education and the computing industry³. CAS emerged in response to concerns about the relative marginalisation of computing in schools and the consequent lack of take up of computing at A level and at Universities. The scope of computing includes programming (and computational thinking that supports this), an understanding of computer systems and networks, understanding of human computer interaction and knowledge of how computers work⁴. CAS contributed to debates about the place of computing in the school curriculum. These debates led to significant policy changes with the introduction of a new computing curriculum at both Primary and Secondary phases from September 2014 and attendant changes to GCSEs.

Computing At School has continued to develop as a membership organisation supporting members and other teachers to develop the school computing curriculum. A significant aspect of CAS’s work is enabling professional development of teachers to meet the challenges of recent curriculum changes. The Network of Teaching Excellence in Computer Science (NoE) is funded and supported by direct grant from the Department for Education (DfE). It is the main professional development project for the CAS Community in England and builds on the grass roots ethos which is central to CAS. The NoE brings many of the community building strands of CAS together in a formalised system of relationships and activity.

³Bradshaw, P. & Woodward, J. (2012). Computing At School: an emergent community of practice for a re-emergent subject. In International Conference on ICT in Education, 5-7 July 2012, Rhodes Greece.

⁴Peyton Jones, S. (2009). Computing at School: The state of the Nation: A report of the Computing At School Working Group for the UK Computing Research Committee.

The Network of Teaching Excellence in Computer Science (NoE)

The Network is both a network of professionals working together and a wide-reaching programme of professional development, including many more aspects than simple provision of training courses. The heart of the programme is to build a high-quality, sustainable CPD infrastructure at low cost, achieved by nurturing long-term, bottom-up collaboration between teachers, schools, universities.

The NoE is based on striving for quality in teaching through a community of practice that involves (a) local, (b) face-to-face, and (c) peer-to-peer delivery. In days of online delivery and time-poverty, CAS maintain that professional development is not a mechanical process but human based on professional relationships and confidence levels of the people involved and supports different forms of professional learning: cascade, training, classroom enquiry, accreditation, and mentor/coaching. The emphasis is on teacher leadership of professional development within communities of practice/professional learning communities. CAS supports a Network of Excellence consisting of Hubs, Hub Leaders, Lead Schools and Master Teachers, linked with supporting stakeholders such as industry and Universities.

The Network came into being through direct funding from The Department For Education in September 2012. The first phase provided funding until the end of March 2015. The purpose of the programme has been to promote Computing in both primary and secondary schools by establishing a network of member schools and lead schools, and to provide local, face to face professional development for Computing teachers.

The CAS CPD premise is that good professional relationships between supportive peers underlie the best and most effective teacher professional development and thus will impact on teacher practice in the classroom improving both student motivation and student achievement. The NoE has built on the principles of local, face-to-face support using mentoring, peer to peer support and cascade of subject knowledge via accessible role models, namely the CAS Master Teachers. This has been supported through the pre-existing online CAS community site and local hub networks and now teachers can access a variety of professional development opportunities including:

- Attending a local hub meeting
- Attending a session run by a local CAS Master Teacher
- Other communication with, and support from, a local CAS Master Teacher
- Attending a session run by their local university
- Carrying out a classroom research project/investigation in their school.
- Discussions with other teachers on CAS Online
- Passing on what they have learned within their department/school

- Working towards the BCS/CAS Certificate of Computer Science teaching
- Sharing and collaborating on classroom resources

CAS Master Teachers

The professional development model of the Network of Excellence is founded on the concept of the “CAS Master Teacher”. It subsumes the ideas of cascading good practice, working within a supportive community and empowering professionals. CAS Master Teachers are classroom-based experts, who have undergone specific training with CAS to undertake the role. CAS Master Teachers can be designated as Level 1, Level 2 or Level 3 depending on the degree of their experience and training:

- Level 1: experienced classroom teachers with Good or Outstanding OFSTED rating but who need further subject knowledge in Computing and Computer Science
- Level 2: experienced classroom teachers with Good or Outstanding OFSTED rating and whose subject knowledge in Computing and Computer Science is good
- Level 3: (Regional Coordinator) An experienced Level 2 who takes further responsibility for a team of Level 2 Master Teachers in their area.

The Regional Coordinators were introduced in the last year of phase 1 as the number of Master Teachers grew and it became impossible to manage them all centrally. The Regional Coordinator’s employer received a grant from the DfE to release them from other duties to monitor, manage and train their team of Master Teachers. It was a very important step but difficult for many teachers to meet the demands required by the Master Teachers in their area. The equivalent of one day a week was not sufficient to support their team and ensure they were delivering CPD in their area. Furthermore a disconnect emerged in some areas between the NoE and other CAS activity. The two were viewed as separate organisations and this aspect needs to be addressed in the future.

Throughout the duration of the NoE Phase 1 membership in CAS, and associated CAS activity, has grown significantly. In Sept 2012 there were just over 1000 members, by March 2015 there were approximately 17,000! With this growth the management need has become intense. For the next phase of the project it is recommended that the existing Regional Coordinator role be changed to create a number of CAS Regional Centres, which would provide increased time for coordination and facilitation of local activity for Master Teachers, Lead Schools and others in their region.

RECOMMENDATION: Expand the role of Regional Coordinator and establish a number of CAS Regional Centres, which encompass all CAS activity, including NoE

RECOMMENDATION: Strengthen the connection between the Master Teacher and the local hub as well as other CAS and NoE activity

The CAS Master Teacher has been enabled to provide local CPD through a modest grant paid to their school to free them up from other duties for the equivalent of an afternoon a week. It’s important to note that a new CAS Master Teacher is not chosen for the role

because they are already a 'master' teacher; rather, by their participation in the programme they grow to become a specialist lead in their locality offering support to other teachers wishing to develop their own professional skills and subject knowledge. This is one of the issues with the title 'Master Teacher' – see below.

Since the start of the NoE 380 Master Teachers have been recruited (Primary: 195, Secondary: 167). At the end of Phase 1 there were 302 Master Teachers still active (Primary: 159, Secondary: 143) and both extending this number and consolidating their expertise remains a priority for the future development of the NoE.

The work done by the Network of Excellence has already seen the emergence of some inspirational teachers who not only excel within their own classrooms, but are willing to make significant contributions to the wider community of Computer Science teachers within CAS and beyond. Each Master Teacher is embedded in their local region with connections to other CAS members in schools, universities and in industry.

To facilitate payment schedules and requirements Master Teachers were asked to plan and deliver three CPD events. Whilst there is nothing intrinsically wrong with this goal it placed the emphasis on one form of CPD to the detriment of other forms. Many encountered difficulty in recruitment and reported lower than expected attendance at their events. There was no discernible pattern to this and different regions had different reasons. Despite this many had informal contact with a significant number of teachers and were much in demand for advice, consultations and conferences. This spread of 'other activity' has been invaluable for those receiving this level of support and in the next phase the reliance on three events should be removed in order to encourage other forms of CPD, especially mentoring and coaching. It should also be possible for CAS Central, or a Regional Centre to provide (a) more administrative support, (b) marketing materials and (c) training resource packs. For the latter, this would save the Master Teachers a significant amount of time. Rather than having to generate their own workshop material they can use those centrally prepared and spend their preparation time considering how best to deliver the material for this audience.

RECOMMENDATION: Encourage CAS Master Teachers to develop more mentoring and coaching CPD alongside training

RECOMMENDATION: Provide training materials and resources for both CAS Master Teachers and CAS Regional Hubs

NoE Member and Lead Schools

All schools (primary or secondary) in England are welcome to join the Network as an institution. By doing so the school is making a public statement that the subject of Computing is important for their pupils. When registering as a member of the NoE each school can self-designate as a **Lead School** which means taking a lead for computing and computer science education by supporting other schools. At the end of each academic year Lead Schools are required to complete an activity audit in order to maintain their status as

a Lead School in the NoE. The audit consists of a number of 'yes'/'no' questions and an opportunity to expand in free form on why their school should be a Lead School. Over time, it will be important to raise the rigour in the audit and ensure that the institutional support provided by schools in an area conforms to the latest research⁵.

Lead Schools are expected to:

- recognise that Computing as a subject is important, and it is part of the school development plan.
- be developing or have developed a broad and balanced computing curriculum that shows clear, planned progression
- offer support to other schools in their local community through sharing good practise e.g, team teaching, lesson observations, shared schemes of work or running joint planning sessions, helping colleagues set up a Code Club in a local school or run Computing focused transition days etc.

In July 2015 there are over 1472 registered schools (Primary: 539; Secondary: 975) of which 543 are Lead Schools (Primary: 241; Secondary 339).

University Partners

University faculty staff (both Computer science and Education departments) are central to the success of the Network. There is a need for both subject knowledge and pedagogical knowledge development and university colleagues are encouraged to forge links with the primary and secondary schools in their area, find out what they need, work with Master Teachers in the area to design and deliver SKE courses, find ways of utilising undergraduates or post-graduates to support both curricular and extra-curricular activities with the schools or just be at the end of a friendly email stream to help answer questions from the teachers.

Several universities received funding to train the Level 1 Master Teachers (primary or secondary) to enhance their subject knowledge and ensure they were ready to become Level 2 Master Teachers. Funds were also made available to the Level 1 Master Teachers to attend this training. This was highly attractive to many teachers and a very important part of their process in upskilling both for their own classroom practice but also in the first step to become a Level 2 Master Teacher. Primary teachers accessed 5 days of training; Secondary teachers accessed 10 days of training.

The university role here was pivotal and for many the relationships established through this process lasted beyond the training period. Many "tutors" and "students" invested a great deal above and beyond what was required and it was reported that many university teachers learned a great deal from their teacher students!

⁵ http://www.estyn.gov.wales/sites/default/files/documents/School-to-school_support_and_collaboration_-_June_2015.pdf

It will not be possible, long term, to maintain the level of funding required to provide the subject knowledge in this way so future phases of the NoE will need to consider how to address this, perhaps to remove the Level 1 and Level 2 designation and enable the proposed Regional Centres to be on the lookout for potential Master Teachers in their area and offer bespoke training and support to suit the individual circumstance drawing on expertise in their area.

The Community of Practice

All constituent members are part of a developing **Community of Practice** in their area which includes:

- Master Teachers
- Lead Schools
- University Partners
- Local CAS Hubs
- Regional Coordinators

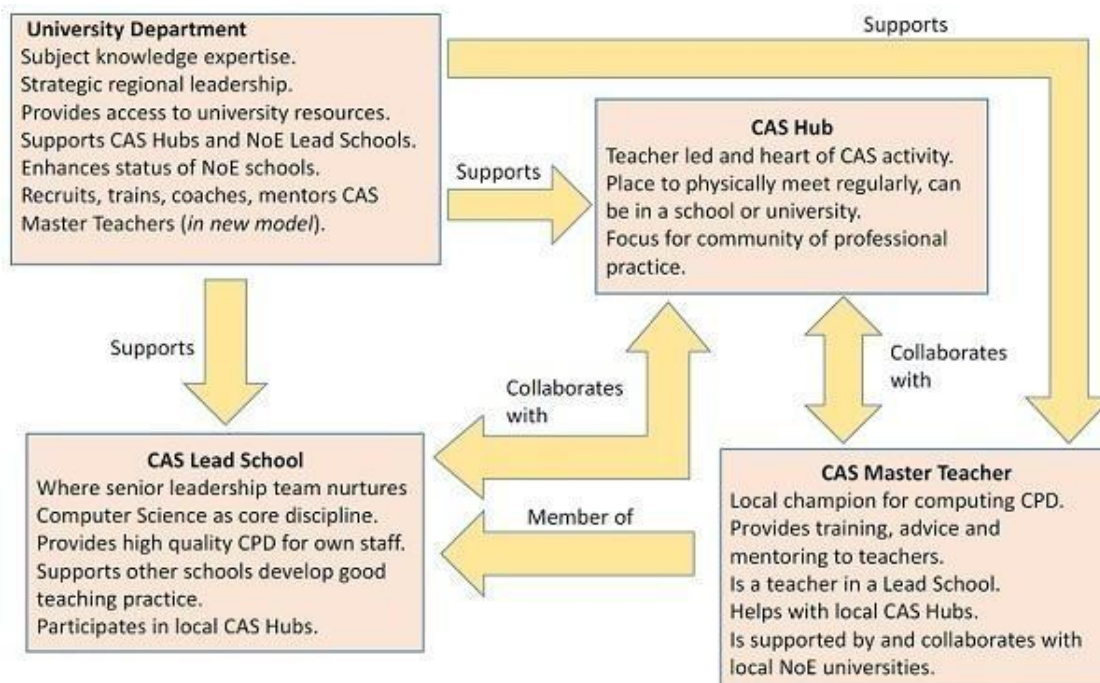


Figure 1: Structure of the Network of Excellence Phase 1

Wenger describes a community of practice as⁶:

"..groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly."

All NoE and CAS activity seeks to bring together teachers and other practitioners to share what they do and learn how to do it better through building relationships. This structure and approach is very important and one of the hallmarks of the success of the NoE, and CAS in general. Impact of the NoE

Data collection

As part of our own evaluation we collected data from a number of sources

- Feedback forms which tell us the level of satisfaction from a course immediately after it has taken place
- Impact forms which tell us the impact that the training has had 10 weeks following a session
- Broad-based surveys which capture how many of the general CAS membership are engaging with Master Teacher training

Feedback data is taken from teachers who attended Master Teacher training courses and a small number of universities who advertise their courses through the Network of Excellence systems.

Quality of training at Master Teacher training events

We have undertaken a similar analysis to that produced in the July 2014 report and the feedback received is equally or more positive about Master Teacher events than at that point in time. 752 feedback forms have now been received of which 63 referred to events held at universities in the NOE; the remaining 689 referred to sessions held by one of 68 different Master Teachers.

- At the beginning of training the average confidence of teachers scored out of 10 was 4.1. After training the average confidence was 7.4. So on average the master teacher training raised teachers' confidence by 3.3 points on this scale (1-10)

⁶ <http://wenger-trayner.com/introduction-to-communities-of-practice/>

- 99% of respondents either agreed or strongly agreed that the trainer was well informed and well prepared
- 96% of teachers felt that they could now implement what they had learned and 98% of respondents felt the course would have an impact on their practice
- 98% then said they would recommend the training they had received to others
- 99.5% of respondents said they agreed or strongly agreed that the course was enjoyable
- 99% of respondents agreed or strongly agreed that the course was good value for money
- In addition 99% felt there was a good range of activities and that engagement/ direction was well-balanced

Contact with Master Teachers

We carried out surveys of CAS members in February 2014 and February 2015. Our wide scale survey is used for a number of different purposes to find out how teachers are interacting with CAS and what kinds of professional development they find useful.

We were able to extract just the data for teachers in England to find out how many are in contact with their local Master Teachers.

Table 1: Teachers in contact with CAS Master Teachers

	Feb 2014	Feb 2015
Number of teachers in England completing survey	864	981
% in contact with a Master Teacher	35.5%	41.6%
% attending more than 6 hours MT training	14%	21%
% attending > 1 hour MT training	34%	54%

The table above shows that more teachers are now in contact with a Master Teacher in the last 12 months, and a high percentage are attending Master Teacher training. 54% of the teachers in England who completed the survey had attended some Master Teacher training, which was an increase in 20% from the previous year. This shows that the increased numbers of Master Teachers are starting to make an impact.

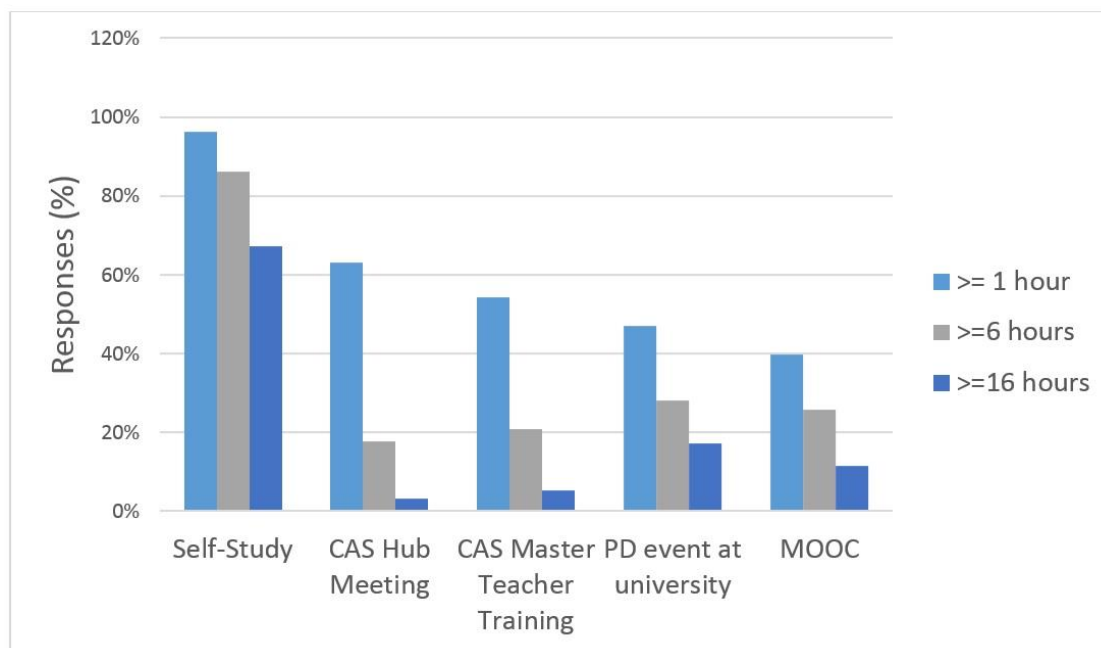


Figure 2: Type of professional development (PD) and number of hours undertaken

Figure 2 shows the number of hours the teachers participating in our survey said that they had spent on their professional development. We also asked about other types of event but the most attended were hub meetings, Master Teacher training and university NOE events. This was also reflected in how useful the teachers found the events (see Figure 3). The % of responses reporting that a type of Professional Development was useful or very useful is shown. Primary/Middle teachers and Secondary teachers are compared and also data from the previous years' survey. This shows that teachers are continuing to find Master Teacher training the most useful type of PD that they are involved with, even when compared to an increasing number of MOOCs that are available.

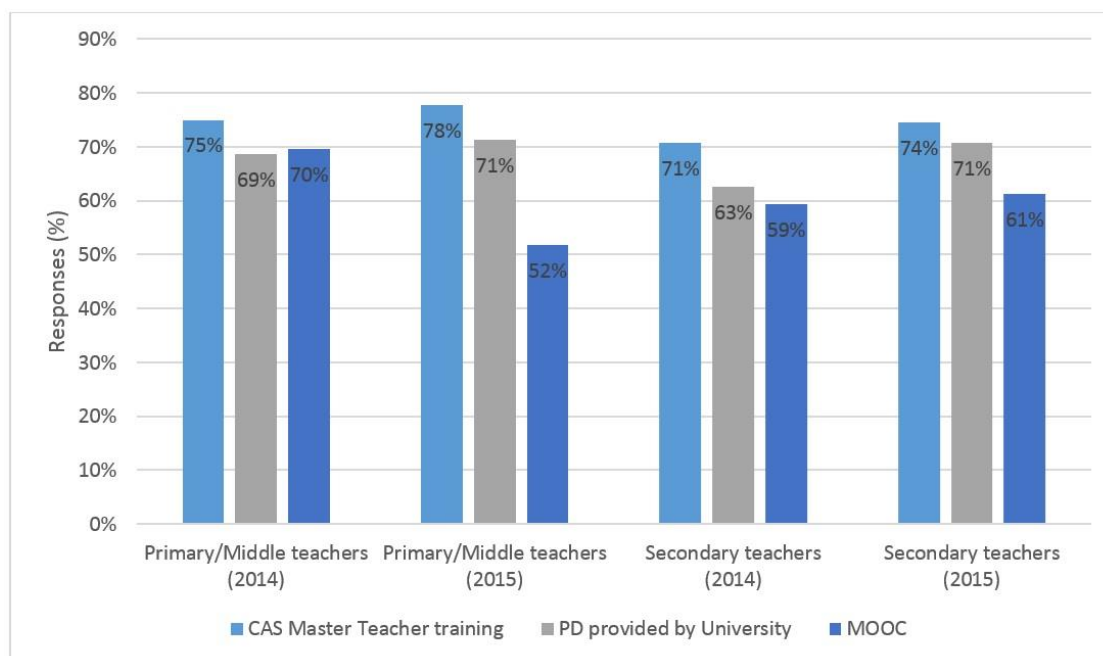


Figure 3: % teachers reporting PD type as useful/very useful

Overall 329 teachers out of 429 completing the latest survey in February 2015 CAS Master Teacher training (76%) said it was useful or very useful and another 98 saying that parts of it were useful (only 2 out of 429 said it wasn't useful to their professional development).

Impact of Master Teacher training on learners

We have been collecting data on the impact that Master Teacher Training has on different aspects of teaching and learning during the programme by asking teachers to comment on this 10 weeks after a session. Examining this data and comparing responses this academic year 2014-2015 to previous academic year 2013-2014 we can see that although the impact on knowledge and skills is more or less the same in both academic years (see Figure 4), the impact on the learners is much greater (see Figure 5).

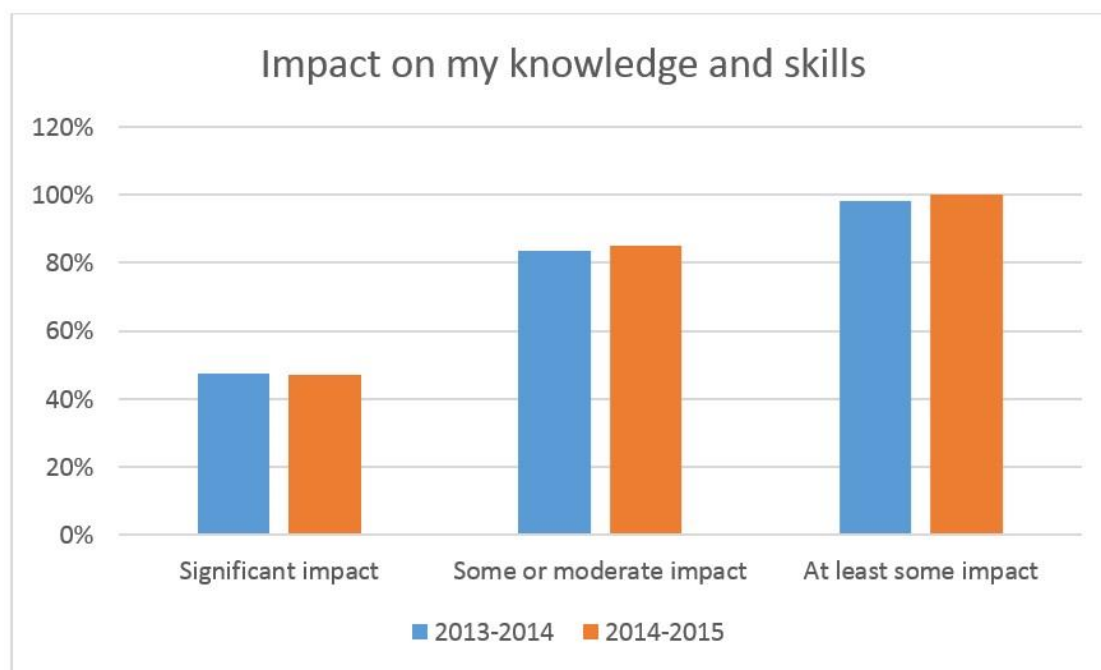


Figure 4: Teachers' reports on impact of MT training on their knowledge and skills

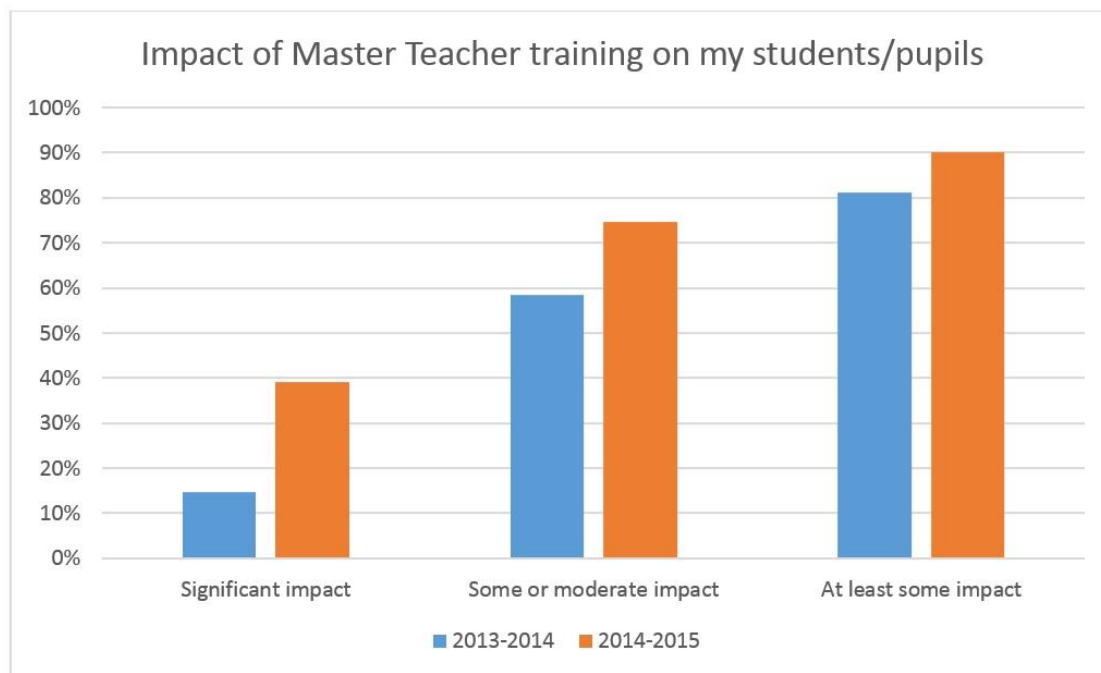


Figure 5: Teachers' reports on the impact of the Master Teacher training on their learners

As the new curriculum has been implemented this gives a direct indication that the teachers feel that the training that they are receiving from Master Teachers is having an impact directly in the classroom. Comments made by teachers support this:

It gave me confidence to know that I am covering the curriculum for my pupils and where I can extend them to if possible. Also networking with others on the course and the course leader gave me new ideas for using other software with the children (Primary teacher, South West region)*

Students accessed a wider range of programmes and I was able to push higher ability children as I knew what steps of progress were expected. (Primary teacher, North West region)

[Students are] More motivated due to increasing the range of practical ideas (Secondary teacher, North East)

Note that these comments are made 10 weeks after the event, and almost half of the teachers completing the survey voluntarily added a comment here.

What is also interesting is the type of impact the teachers say that the training has had on their learners (see Figure 6). Last year the impact on learners was more likely to be in the form of different classroom activities that they could participate in. This year teachers are increasingly reporting that the training has had an impact on student learning. This is a very encouraging finding.

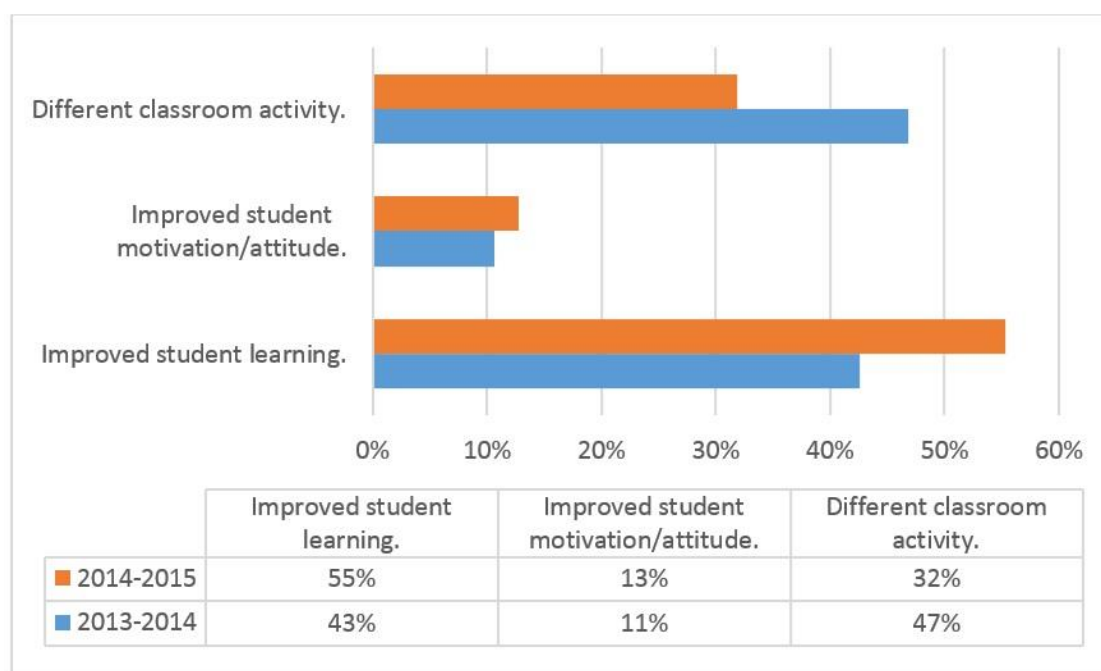


Figure 6: Teachers' reports on the specific impact the training has had on their students' learning (by year)

Teachers confidence

Teachers who complete the CAS survey are increasingly more confident with teaching Computing. This may not reflect the country at large but demonstrates the impact that CAS has on teachers' confidence in this subject area (see Figure 7).

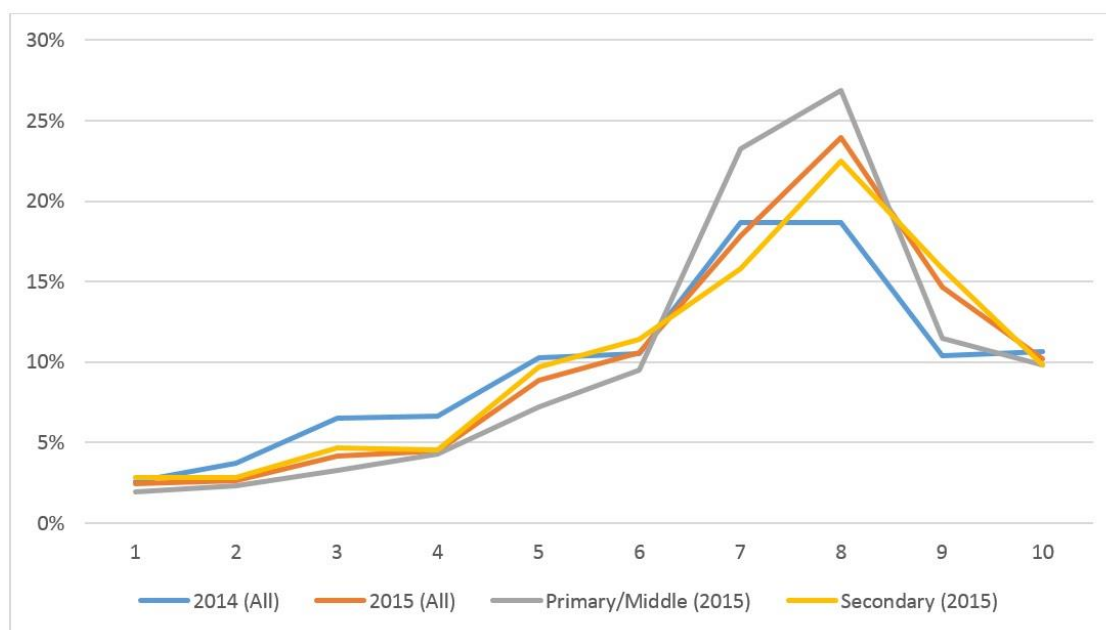


Figure 7: Self-reported confidence in teaching Computing

More information can be found [here](#).

Independent Evaluation

Computing At School (CAS) commissioned Sheffield Hallam University⁷ to undertake an external evaluation of aspects of its provision through the Network of Excellence to:

- understand the impact of CAS Master Teachers on the knowledge and practice of CAS members.
- identify implications of this and of the current programme more generally for future evaluation activity.

A sample of 9 Master Teachers and 15 CAS members were interviewed with participants sampled to reflect the diversity of these groups. The analysis of the interviews provide insight into the experience of rapid change in schools in England as schools meet the demands of the new computing curriculum. CAS is viewed very favourably by teachers with the following features particularly valued:

1. The speed of response to the rapid changes in the curriculum.
2. The approachability and commitment of Master Teachers.

⁷Centre for Education and Inclusion Research [CEIR](#)

3. The quality of professional development courses, particularly those aimed at those who are engaging with computing for the first time.
4. The combination of different types of expertise of Master Teachers.
5. The availability of resources on the website.
6. The flexibility of professional development including on-line training in programming.
7. Face to face meetings to network with other teachers through CAS Hub meetings which at best offer a varied and stimulating professional learning experience.

In addition, although less easy to define or assess, CAS activity appears to have had a significant influence on the development of a Computing Teacher identity, both for CAS members but also Master Teachers.

Case narratives of the nine Master Teachers were developed, which indicate that predominantly teachers' motivations centre on supporting others.

CAS Master Teachers develop their role to fit the needs of their local area. They can be seen as adaptive teacher leaders who enable the professional development of others and catalyse or support curriculum change. The role of the Master Teacher can be considered under the following categories: organiser, networker, broker, curriculum advisor, professional developer and computing champion.

Master Teachers identify a key impact as supporting others' confidence and subject knowledge. The following enablers to impact were identified: CAS organisational support; support from teachers' schools to undertake the Master Teacher role; the mixture of face-to-face and on-line support; the importance of peer relationship and ; the moral purpose and passion of Master Teachers. Barriers to greater impact identified were: the policy and educational context; the limits of what CAS is able to offer; the challenge of marketing CAS; the title of Master Teacher.

CAS members engaged for diverse reasons that can be broadly grouped as: seeking personal and professional development; to support their role in developing others' computing skills and knowledge and developing the curriculum in their own schools; and in some cases to support them to engage in similar system leadership activities as CAS Master Teachers. The effects that CAS members identified of Master Teacher support were: networking and facilitation of peer support and deepening of subject knowledge. Members identified a range of factors that were important to accessing support. Some of these were broadly the same as those identified by Master Teachers. Two particular themes stood out: firstly, the approachability and enthusiasm of individual Master Teachers; secondly, that the various aspects of CAS activity allowed for different ways for teachers to engage at different times and for different purposes. A number of barriers were identified by individuals to accessing support, however no clear pattern emerged in these.

Computing At School has swiftly developed a cadre of Master Teachers to support the development of computing in schools. This study indicates that Master Teachers(and CAS

more generally) are well-regarded by teachers who have engaged with them . CAS is making a significant difference to the implementation of the new computing curriculum.

CAS has previously undertaken extensive evaluation of the April 2013-2015 programme.

This includes data collection from:

- instant feedback from training sessions with Master Teachers
 - online questionnaire (617 responses) and
 - impact 10 weeks on - online questionnaire (50 responses)
- an annual survey about CAS impact of the whole network membership (1417 responses).
- an audit of 199 of 258 CAS Lead Schools in April 2014.

The study of Master Teacher activity and impact supplements the internal evaluation.

Methods

Telephone interviews were conducted with 9 Master Teachers on the impact of their practice and with 15 CAS members who had participated in training events and activities led by Master Teachers. An interview schedule was developed in consultation with CAS and piloted. Ethical approval for the study was obtained through institutional ethics processes and the research was conducted in line with British Educational Research Association guidelines with participants being sent an information sheet (Annexe 2) and consent being obtained verbally. Interviews and consent were digitally recorded.

Members⁸

CAS supplied data on n=151 CAS members who had indicated in a survey they were willing to be interviewed. Of these n=140 were identified as suitable for the study as contact details were available and they had indicated they had engaged with a Master Teacher. A total of 90 teachers were emailed (of whom 25 were sent a reminder email, these were in categories where the population in the sample was relatively low). In order to obtain a representative sample, attention was paid to whether the teacher was based in primary or secondary phases and to their overall view of the usefulness of Master Teacher training from their response to the CAS survey. The table below gives details of the final sample. There is some response bias in that those secondary teachers who found the support only partly useful are somewhat underrepresented in the sample. In addition, as will be seen in **//Section 3.4???? what does this refer to?**, a number of members interviewed had similar characteristics as Master Teachers, for example leading CAS Hubs, or independent activities focused on enhancing computing and teaching of computer science.

⁸For simplicity we use the term 'member' to refer to those study participants who were not Master Teachers. Master Teachers are also CAS members.

View of Master Teacher training

Table 2: Participant sample

	Total	Not useful	Part useful	Useful	Very Useful
Primary population	30	0	4	17	9
Sample	5	0	1	3	1
Secondary population	110	1	25	39	45
Sample	10	0	1	5	4
Population total	140	1	29	56	54
Sample total	16	0	2	8	5

Master Teachers

To obtain the Master Teacher sample, 66 Master Teachers were contacted with attention again paid to whether they were based in the primary or secondary phases. In addition, we considered whether they were funded and Level 2⁹ or Regional Coordinators (Level 3).

CAS supplied a data base of 332 Master Teachers. Additional data was provided separately detailing withdrawn Master Teachers and this was used to confirm the Master Teacher database was up to date. In addition, a further 10 were excluded as there was no data on funding status (of the 10 excluded from sampling due to no data on funding status, 7 were Level 3 teachers). This gave a population of 191 teachers eligible for interviewing.

To identify Master Teachers to invite to participate in interviews, variables considered were level and funding status. For the Level 2 teachers, we also considered if they were Primary or Secondary based.

The number of Master Teachers by level eligible to be invited were:

- Level 2: n=179 (94%)
- Level 3: n=11 (6%)

However, in the event only 1 Level 3 Master Teacher responded to requests for interview. Table 2.3b gives details of Level 2 Master Teachers and the sample. Given the overall number of interviews the sample is broadly proportional of the Master Teacher population as whole, although it is important to note that this does not necessarily mean the views of the interviewees are representative.

Table 3: Characteristics of Level 2 Master teachers

	Frequency	Primary	Secondary

⁹Level 1 teachers were excluded from the evaluation as they were still undergoing subject knowledge training

Funded (population)	120	61	58
Funded Sample	6	4	2
Unfunded	59	18	41
Unfunded sample	2	1	1

Conduct of the interviews

Potential participants were emailed and invited to be interviewed. An information sheet on the project was provided. Consent was obtained at the start of interviews, which were digitally recorded. Case notes were made shortly after the interview.

Master Teacher interviews ranged in length from 32 minutes to 52 minutes with a mean length of 42 minutes.

Member interviews ranged in length from 24 minutes to 41 minutes with a mean of 32 minutes.

Data analysis

Following interviews, a case description was developed based on the interview recording. To analyse the data we considered each interview as a single case, and generated a narrative of engagement for each one. In addition, we undertook thematic analysis across cases related to interview questions. This was informed by previous research on teacher leadership of professional development¹⁰.

Findings

The experience of change in computing in English Schools

Earlier we noted the significant changes in the computing curriculum in English schools with the introduction of a new curriculum in both primary and secondary phases. This has occurred at the same time as reduction in Local Authority support for school improvement as funding has moved to support a school-led system principally through the Teaching School Alliance network. The interviews give insight into how this is being experienced in schools in England.

Change in schools is rapid as teachers respond to the challenge of the new curriculum. In some secondary schools, where computing was already an important part of the old ICT offer, the new curriculum represents an evolution. However, in others teachers report a lack of subject knowledge and confidence. This is an important motivation to engage with Computing At School. In the primary sector the situation appears more uniform, with most,

¹⁰Boylan, M. (2013). [Deepening system leadership: teachers leading from below.](#) Educational Management Administration and Leadership.

if not nearly all, teachers needing to develop their skills and knowledge at a rapid pace and schools adapting their curriculum. Interestingly, one of the interviewees suggested that there are a significant number of primary schools who have not yet engaged with the computing aspect of the new curriculum and so have not yet engaged with CAS.

Given the curriculum changes, it is unsurprising to find that CAS activity including that of Master Teachers is addressing professional development needs. Nevertheless the study does underline that CAS's work is worthwhile and important.

Overall view of the impact of Computing At School

The overall view of interview participants about Computing At School was very positive, as the following quotes illustrate:.

"Hope it continues and develops further. It is a really, really fantastic resource and has been the life blood of computing and long may it continue." (Bill).

"It is very important that funding continues, it would make my job twice as difficult if it was not there." (Julie).

This supports the CAS survey data. Particular aspects that were valued were

1. The speed of response from CAS to the rapid changes in the curriculum

Without CAS I think we would have been really, really struggling. Everything they have done and produced. The resources and community has been absolutely unbelievable because I think for a lot of teachers who have been confident with ICT but not computing at least they've got something to fall back on (Ed).

2. The approachability and commitment of Master Teachers:

She [Master Teacher] is always approachable and willing to talk (Debbie)

I think they're brilliant in that they are giving up their time in what is already a pressurised job. (Lynne).

3. The quality of professional development courses, particularly those aimed at teachers who are engaging with computing for the first time:

They do what they say on the packet. By the end of the first one you will know what an algorithm is and on the next one you will know how to get started with SCRATCH and they did that (Debbie).

4. The combination of different types of expertise that Master Teachers have:

Some Master Teachers are recognised as having a great deal of computing expertise (with one named by people in different parts of the country). Where Master Teachers did not have this, their knowledge of pedagogy and curriculum was recognised:

The MT's are not necessarily that expert. But they are very aware of the context in which they teach and what would be most useful within the primary curriculum ... what needs to be delivered and how (Malik).

5. The availability of resources on the website

I think it's great. They definitely have great resources on it. Yeah I'm a big fan! (Omoye).

6. The flexibility of professional development, including on-line training in programming.

As an example, a number of participants had identified a need or desire to learn the Python programming language. The way these did this varied - one undertook an on-line course, accessed via CAS, another attended a series of 12 twilight sessions led by a local Master Teacher, another attended a two day training course then continued to learn in their own time.

7. Face to face meetings to network with other teachers through CAS Hub meetings which at best offer a varied and stimulating professional learning experience as this description indicates:

I try to get there as often as I can. It's held at the local University. They are very supportive and run programming courses for us as well. There are thirty minutes to chat over tea and coffee at the start. I always think some of the connections you make and all the networking is really good. Then they have an external speaker or someone from the university. Last session there was someone from the robotics department showing us some basic things in robotic and they set up a SCRATCH program that ran a Raspberry Pi that controlled a robot to make a cup of tea. Another time we had a primary teacher showing what they'd been doing with their Y1/2 class. Attendance can vary from 20-40 (Lynne).

In addition, although less easy to define or assess, CAS activity appears to have had a significant influence on the development of a Computing Teacher identity, both for CAS members, but also Master Teachers.

Reasons for becoming a Master Teacher

Considering the above profiles of the Master Teachers and their reasons for becoming a Master Teacher, the interviewees can be grouped into two categories. Claire, Emma and Hugh became Master Teachers as a means of personal professional development and in order to benefit their own school. Alice, Bea, Dan, Frank and Gaynor refer to a desire to support others. However, although the degree of altruism varies, even if the initial starting point is more personal, or centred on their own school, then this appears to change once they become Master Teachers.

Master Teacher activity

Funded Master Teachers are asked to offer a minimum of three training events per year. As well as the formal role, Master Teachers also appear to develop their role to fit the needs of their local area. As such they can be seen as adaptive teacher leaders¹¹ who enable the professional development of others and catalyse or support curriculum change and who broadly fit within the characterisation of teacher system leaders¹².

¹¹Boylan, M. (under review) Enabling adaptive system leadership: Teachers leading professional development. Education Management and Leadership.

¹²Boylan, M. (2013). [Deepening system leadership: teachers leading from below.](#) Educational Management Administration and Leadership.

The role of the Master Teacher can be considered under the following categories.

- Champions - promoting computing and its importance.
- Organiser - organising meetings, events, workshops and hubs.
- Networker- creating and maintaining networks of teachers - this is done principally through hubs but networking is broader than this, and some connect with other networks.
- Broker - supporting colleagues to access support or to connect with networks.
- Curriculum advisor - offering advice on curriculum development.
- Professional developers - leading professional development activities.

The latter two roles of curriculum advisor and professional developer are conducted in two main ways: either in the context of group activities - for example in a training course or workshop - or on a one-to-one basis. The Master Teacher is fulfilling the role of a mentor/coach, when giving curriculum development advice or supporting professional development on a one to one basis. This may occur on a more formal basis - for example, when visiting a school - or on a more informal ad-hoc basis where a teacher may email or phone for advice or a Master Teacher responds to a tweet or posts to a discussion board.

The degree of activity reflects the length of time they are in role and the nature of their role. Unsurprisingly, a CAS Regional Coordinator was the most active Master Teacher interviewed and engaged in work beyond the expected 3 events per year, attending other events to act as a 'a champion for computing'. Although generally those who were new to the role were engaged in less activity, there were examples of new Master Teachers not only hosting training events but also speaking at conferences and engaging in rapidly building or strengthening networks. A number were running CAS Hubs and this was a significant part of their activity. One highlighted their contributions to the website in terms of uploading resources.

Master Teacher views of their impact

The two main areas of impact described by Master Teachers was on teachers' confidence and subject knowledge. As Bea puts it in response to being asked about impact:

I help teachers with subject knowledge and to ensure they understand the concepts prior to teaching them. I give people confidence to go away and actually use the resources. I give them the confidence to give it a go. (Bea)

This was also referred to as 'reassurance':

It was reassuring for them. One of the teachers who came said 'you made me realise I know a lot more than I think I know' (Frank)

Another stated that recipients of support valued the opportunity to develop planning skills and consider a sequence of lessons. Master Teachers acted as a gateway to resources either

through sharing at Hub meetings or advice about the website. Some members sought advice from Master Teachers on specific issues including how to prepare for a lesson observation. A common theme was the importance of creating opportunities for members to network.

Master Teachers found it more difficult to identify specific impacts on members' schools or pupils. This is not surprising given these would be indirect beneficiaries of their activity, although it does highlight the issue of the challenge of identifying this. However, one specifically pointed to training offered and a school beginning an A level computing course.

Enablers to impact

The Master Teacher interviews revealed there to be a number key enablers to eliciting an impact on CAS participants, such enablers are categorised below

CAS organisational support In the main Master Teachers praised the organisational structure of CAS and welcomed the level of support received; this was received in a variety of guises including the training attended, CAS administrative assistance as well as input and encouragement from Regional Co-ordinators, fellow MTs and Hub networks.

Support from their school to undertake the Master Teacher role The majority of respondents noted that their own school played a key role in permitting them to fulfil their Master Teacher role to the extent they did. In most instances school support amounted to little beyond honouring the planning time Master Teachers are entitled to and offering broad encouragement. However, support in other schools extended to hosting CAS events within the school, providing basic catering, sanctioning additional attendance at CAS events (e.g. conferences), and in rarer instances the provision of school administration time for arranging events/training courses run through the school. Greater school support tended to be available when the school was a Teaching School and/or where the school was a designated CAS Lead School. The financial support for funded Master Teachers was important to gaining school support. Although the sample was small it appears that there is a multiplying effect where CAS funding means Master Teachers can access additional support from the schools.

Face to face vs online A number of the Master Teachers sought to endorse the potential contribution an online offer could /does make to CAS members. For example, online delivery could be a pragmatically good alternative if face to face interaction was not feasible; a useful way to sustain/enhance a network initiated through face to face contact and an option to keep costs down.

Nevertheless, all of the Master Teachers indicated that on balance face to face delivery was more favourably received by participants and many outlined a concern as to what would be lost if face to face contact was removed.

No it would just not be the same. Face to face is essential (Bea)

Central to the concerns was that any lack of face to face contact would somehow impede and stifle the relationship between Master Teacher and participant; set amidst a context where many teachers were said to be already feeling alienated might mean participants would feel less comfortable to ask questions and/or seek clarification.

Teachers can feel quite isolated dealing with the new curriculum and online reassurance can feel quite clinical (Claire)

A related apprehension was that the purely online delivery would adversely affect the creation of and future impact of networks between teachers:

I do think it's better face to face. Our hub meetings in particular are quite informal...it's about networking as well (Emma)

One Master Teacher broadly advocated the use of online training/support. However, they stated they had previously tried to run online training in the past but that nobody had engaged. Finally, one Master Teacher even questioned whether they would still want to be involved with CAS should they remove the face to face dimension of the offer.

I don't know how much involvement I would want if it was all online (Bea)

Peer focused Master Teachers as Teacher leaders hold a designation as experts, whilst at the same time they are in similar roles in their own schools to those that they support. Thus they can be considered both as a relative expert and also as a peer. Virtually all of the Master Teachers were at pains to distance themselves from the tag of *Master Teacher*; even though many stated they perceived that many of the participants did view them as being experts, at least initially.

Frank felt that the reason many teachers viewed them as experts were because they were 'desperate for help'. As such MTs appeared to be very sensitive to project themselves as peers as opposed to experts and to do all they could to reduce any power imbalance. Frank for instance typifies a down to earth (often self-deprecating) approach to building a relationship with CAS participants...

I sell myself as somebody who teaches these things in class and these are things that I found out...and I always include at least an anecdote of somewhere it's gone wrong...I don't want to come across as a know it all. I just want to help people. People are more receptive to people who are human (Frank)

A different Master Teacher emphasised the importance of pitching CAS activities in a peer orientated manner that recognises the participants as a capable and professional audience.

I think it's important when you are training adults that you treat them as peers because they are and their ability to learn is very different to that of a student (Alice).

Moral purpose/Passion However, arguably the greatest enabler to participant impact was the dedication/enthusiasm of the MTs themselves. There was talk of a 'can do attitude' and in a most instances a genuine willingness to do whatever they could to assist CAS participants.

As a Master Teacher if someone asks you to do it you do it (Claire).

Anything I can do, I do (Emma).

Although the financial contribution was useful, the majority of Master Teachers appeared to spend considerably greater amounts of time beyond the official allotted time they received - as discussed above, this was driven by an altruistic desire to help fellow colleagues.

I have always had to find time to train staff at school and done a lot of CPD in school anyway. Thought it would be something I'd be able to help with as have lots of experience (Bea).

I've always enjoyed doing staff CPD...The dovetailing of doing CPD with computing...really appealed (Frank).

Personally, it's a commitment after school and 'you can't do everything; particularly when you have a family. My family are supportive but there's a lot of time spent at home working on your laptop. (Gaynor).

Barriers to greater impact

The interviews with MTs drew out a number of barriers to maximising the impact that MTs could have on CAS participants directly and/or for CAS participants to further disseminate learning within their own schools. These are categorised into the following three broad categories, discussed in this section.

Policy and educational context It was clear from the Master Teacher responses that the financial landscape across schools was one often characterised by very limited budgets (if any) earmarked for training generally, but particularly in relation to subjects like computing. This is combined by, what Master Teachers reported as, a lack of status of computing in comparison to core subjects such as English, Mathematics and Science. The focus of accountability measures such as performance tables meant that computing was often seen as a relatively low priority area. This is particularly the case within primary schools.

As such this meant it was almost inevitable that most CAS courses were run after school. This was seen to be difficult for many teachers and as such acted as a key barrier to maximising attendance.

There just seems to be an expectation from the government in the way they want teachers to learn about computing, you can do it in your own time. They won't give you curriculum time to do it because it's not a core subject. It's not that important...There is an expectation with the way CAS is doing things that you have to do it in your own time (Dan).

Within this context of competing priorities and stretched time, teachers (again particularly at primary) were often said to have a tendency to 'bury their head in the sand' when it comes to computing and it remained something to 'face next year' (Frank).

The limitation of what CAS is able to offer When asked about other sources of CPD teachers or Master Teachers were accessing, it was clear that CAS were the most important source; as such it is perhaps not that surprising that meeting the needs of all members was challenging.

It is very difficult to cater for every single need of every school. I mean with the training sometimes I don't even know what they need training on (Emma).

As outlined earlier, the extent of the 'offer' provided by each Master Teacher varied considerably with the focus varying on the basis of need in each locality but also to some extent the expertise of each Master Teacher and their familiarity with particular school phases.

For example, one Master Teacher stated that they took the decision to focus on building up a computing community by running sessions through a newly formed CAS hub and deliberately decided to not run formal training sessions because they felt without 'a critical mass of people' this was not warranted.

In addition, there was a sense from one Primary Master Teacher that CAS did not fully appreciate the level that the typical primary school could engage with computing content.

I don't think CAS knows where primary schools are...they have an over-inflated view of where primary schools are. For example when we give out the progression pathways which are supposed to help primary school teachers to assess it means nothing to them...For many you really need to go back to square one and just build it up from nothing. I've never been in a situation where I've been doing training and thought I'd pitched that too low (Frank).

In a separate example, a Master Teacher from the independent sector revealed they nearly stopped becoming a Master Teacher because they were being forced to charge for courses despite previously having secured sponsorship from a private company to subsidise the costs for each delegate.

The comprehensiveness of the CAS offer was often dependent upon the goodwill, available additional time and willingness to go above and beyond the core requirements of being a Master Teacher and/or Hub Leader.

You run your own ship really. You are your biggest barrier (Dan).

Marketing CAS

It appears that Master Teachers particularly struggled with the marketing aspect of their role. Administration and marketing was said to take a disproportionate amount of the Master Teachers' time and therefore was a barrier to supporting teachers.

Better marketing and awareness among schools would free us up to focus on our role to make more of an impact (Frank).

In a number of instances Master Teachers articulated how they would like CAS to provide more clarity/help on who to invite to meetings and to provide greater assistance with compiling lists of contacts or mailing list to improve communication externally.

Found it difficult marketing myself to schools (Frank).

Am I a marketing manager? Probably not. There needs to be a better way to get the message out (Alice).

Sadly I don't think CAS have been very good in promoting things (Dan)

According to at least one Master Teacher some of the marketing issues stemmed from the lack of national awareness of what the Master Teacher role entailed.

I don't think it's very clear at all what Master Teachers are for outside of the organisation (Dan).

The title of Master Teacher

Above we discussed issues of the peer/expert boundary that Master Teachers straddle. For some Master Teachers the title of 'Master' teacher was said to be itself problematic and unnecessarily muddled what the remit of the Master Teacher was. On a number of occasions Master Teachers reported dedicating time when introducing themselves to CAS members in order to distance themselves from such a title and clarifying what they themselves took their role to be. This issue appears to be of greater concern for primary Master Teachers.

I laugh at that all the time (Alice)

I think by your title they feel a bit intimidated (Claire)

The role involves sharing ideas - giving people information to share with each other. But we are not the masters of everything (Gaynor)

CAS Members

Networking and peer support

The most frequently mentioned and valued impact of engaging with CAS support was the opportunities afforded for networking with other teachers.

The community thing really drives it for me (Gayle)

Even though most CAS Hub meetings happened after school, participants were grateful to have some dedicated space/time to engage with 'like-minded' teachers to exchange ideas.

Allowing time for people to talk to others, that is what is rated most highly (Amanda).

There were various benefits of networking. For example, one participant met a teacher at the assessment session who had created a scheme of work and sent them an electronic copy. They further developed it together and they are now both using the same materials for Year Seven students. Many participants voiced how reassuring it was to realise that there were other teachers in a similar position, given the context of rapid and wholesale changes to the curriculum:

With me having such limited knowledge at the start it was very helpful to sit down and realise there was a lot of people in very similar positions to me (Henry)

Deepening of subject knowledge

Specific training courses afforded participants opportunities to deepen their knowledge around particular areas/technology such as Python, Java and Scratch

I think everyone felt their understanding of computing had moved on from attending (Debbie)

Heightened confidence and subject knowledge had additional benefits in that individual teachers felt more able to pass this on to their fellow teachers back at their own schools.

I feel I have become more proficient in Computing particularly in regards to the new curriculum and also passing on that to my fellow teachers has been a really good thing (Omoye)

Some had benefits in terms of career development of taking on leadership responsibility. Carol stated that without initial CAS training she would not have been able to have taken on her current role teaching computing across the school.

It's given me the confidence to start thinking for my myself about how I deliver things in the classroom (Carol)

Participants, in the main, referred to benefits in term of their own and others' professional development. Others, such as Bill, made clear that through CAS involvement, pupils had a richer computing experience with more programming languages available to them.

Factors that enable accessing support

Members identified a range of factors that were important to accessing support. Some of these were broadly the same as those identified by Master Teachers. Two particular themes stood out. Firstly, the approachability and enthusiasm of Master Teachers. Secondly, that the various aspects of CAS activity allowed for different ways for teachers to engage at different times and for different purposes.

Barriers to accessing or making use of CAS Master teacher support

Teachers identified a number of ways that the CAS offer could be improved. What is notable is that there was no clear pattern between them. It should also be noted that 5 of the interviewees did not offer any suggestions, presumably this means they were satisfied with the current offer.

The remaining 10 suggested or commented t:

- the discussion boards were cumbersome and not easy to participate in - they preferred to use Twitter
- there was a lack of CPD in their area on underlying ideas about computational thinking
- to access some training they needed to travel a relatively long way as it was not available in their area
- they would like sessions on assessment
- a training on Python focused on assessment for a particular exam board
- the lack of time to get involved
- they needed advice on equipment purchases

- Master Teachers having more capacity
- sessions on coursework
- sessions to support teachers not interested in computing.

It appears from this list that the diversity of what is offered in particular localities may not meet the needs of all teachers in the area.

Although not a main focus of the study, teachers also identified barriers to developing computing in their school, which in turn impacted on engagement in CAS. The most common barrier teachers identified was time both to engage with CAS including on line materials and, for those who were computing school leaders, lack of time to work with colleagues. The issue of time was also raised in relation to computing in curriculum, particularly in primary schools with the focus on English and Mathematics.

Others reported issues with equipment include school networks and incompatibility of equipment with new software such as Python. With regard to equipment, decisions were made to purchase tablet computers in order to allow use of educational applications but the need of computing was not necessarily understood or considered by senior leaders. The issue of lack of understanding of school leaders was also raised in relation to the challenge being faced with the new curriculum. One teacher had a head of department who they said was an ICT teacher and was 'out of their depth' and 'putting on a brave face'.

Others identified colleague' lack of knowledge and confidence:

The other teachers are not willing to take that leap of faith. They need to get beyond making mistakes that's the whole fun of it, telling the children that you are learning with them. You will make mistakes with them but that it doesn't matter. The children get that very easily but the staff don't. Staff are used to doing the digital literacy dimension i.e. typing and PowerPoint but it is the computer science that they struggle with (Debbie).

Discussion and implications

Resourcing Master Teachers and Hubs

Computing At School has rapidly developed a network of Master Teachers, Hubs and Lead Schools. It has been able to do this by drawing on the enthusiasm of members in a context of relatively low levels of resource. It has provided enabling leadership¹³ that has supported both teachers who already had expertise and increasingly new experts to support colleagues to meet the challenge of the new curriculum. For CAS to have greater impact a key issue is securing more resource to enable its network to grow and for activity to increase. Clearly, CAS will already be aware of this need. Earlier in the reportspecific

¹³Boylan, M. (under review) Enabling adaptive system leadership: Teachers leading professional development. Education Management and Leadership.

issues were mentioned, such as marketing and administrative support that Master Teachers identify as needed to enhance their work.

The Master Teacher designation

The interviewees have somewhat conflicting messages about the Master Teachers. Some of the CAS Master Teachers are seen as experts. However, other Master Teachers, particularly those less experienced in teaching computing, are uncomfortable with the title. For some of the Master Teachers the first motivation to become a Master Teacher was to access the professional development it offered for them personally. The rapid growth of the Master Teacher network helps to increase overall activity and impact, but it can also mean that some Master Teachers may lack depth of computing expertise.

One of the member interviewees, Malik, who has a profile of expertise similar or indeed beyond that of some of the Master Teacher interviewees has an interesting perspective. He contends that many Master Teachers are not necessarily experts in computing. He states that more needs to be done to ensure Master Teachers are put into contact with subject experts.

From what I have seen they[CAS] have taken on some people who don't have the subject knowledge of Computing Science...what I think is still essential is for the Master Teachers to be put in contact with the subject experts...so what needs to be delivered and the knowledge of the subject is combined together (Malik)

In some areas at least, this appears to be already happening e.g. where Hubs that meet at local universities and have sessions that are regularly led by University computing experts.

It is notable that although Master Teachers' primary contractual role with CAS is to provide training, they described their role in broader terms. The balance between being a peer and being an expert is clearly a complex one. It may be that this should be directly addressed in Master Teacher training, if it is not already considered.

More tentatively, it may be that the designation of Master Teacher may be a barrier to some of those we have identified as school computer leaders to undertake training with CAS.

The relationship between being a Master Teacher, Hub leadership and delivery of training

From both Master Teacher interviews and member interviews, it appears that the most important and valued activity by both groups were the CAS Hubs. Many of the Master Teachers were also Hub Leaders. It appears that leading a Hub is more time consuming than the organisation of training. At present Hub Leaders can claim expenses for Hub sessions, for refreshments and travel expenses for speakers. There is no funding for the actual organisation of the Hub itself. An issue to consider is whether the time for running a Hub should be resourced in some way. In any case it appears that the relationship between Master Teachers and Hubs needs clarifying.

Above we identified six aspects of the current Master Teacher roles. In practice not all Master Teachers fulfil all of these roles. One approach would be to more clearly identify a designation of 'computing champion' or 'CAS lead who would undertake the following roles: organiser, networker, broker and champion'. Such CAS leads might also offer curriculum advice or support the professional development of others, but this would be clearly on the basis of being more experienced peers. CAS training for such leads would focus on undertaking these roles.

It appears that there is still a role for expert curriculum advisors and professional development leaders or trainers, particularly at a regional and national level. One way to address this might be to consider a similar approach to the NCETM CPD standard. Under this scheme, those delivering mathematics CPD can accredit the quality of their work with the NCETM.

Face to face or on-line support

Both groups of interviewees valued face-to-face contact. However, it is important to note that in responding to this question, participants were not necessarily only considering Master Teacher training. As stated above for many members the Master Teacher represented the Hub as much as any specific training event. Given the nature of the Hub networking meetings it is unsurprising that physical meetings were valued. Participants were more positive about on-line training that focused on specific skills and in particular on learning programming languages.

Relationship of CAS to other networks

A number of interviewees referred to other networks that related to computing and to the relationship of Master Teacher to other experts. These issues point to the question of the relationship between CAS and the wider infrastructure of the school led system and in particular specialist leaders in education with a computing expertise as well as the Teaching School Alliance network.

One particular issue raised by Master Teachers was that of marketing. Further, considering the way in which members first become engaged indicates the importance of the promotion of CAS through networks and other organisations, such as exam boards. The developing network of Teaching Schools appears an important route for CAS to increase knowledge of its offer both through national communication and also by reviewing advice documents to Hub Leaders, Master Teachers and Lead Schools on the importance of using Teaching Schools as a route to advertise and promote activity.

Promoting a space for computing in the primary curriculum

The inclusion of Computer Science as a subject that contributes to the EBacc measure means that it potentially has a relatively high status within secondary schools. In primary schools the situation is different where considerable focus is put on mathematics and English/literacy. A number of interviewees discussed how they addressed this through

developing both specialist computing teaching/lessons and through cross curricular work. This appears to be an area for development for CAS.

Exploring the links with the new primary mathematics curriculum may be a useful given connections between the development of conceptual understanding of some mathematical concepts and the development of computational thinking. There is a potentially rich tradition to draw on here, Given the close links between mathematics education and computing during the first phase of development of computer science in education in the 1980's and early 1990s.

A diverse offering

CAS originated as a grassroots membership organisation. Its development of a Network of Excellence is based on teachers initiating activity and teacher leadership. One positive feature of this is the development of a cadre of computing enthusiasts. Intrinsic to a network approach and teacher leadership is that there is diversity. The advantage of this is that adapts to meet local needs. However, the disadvantage is that the CAS offer is heterogeneous, varying in different locations. In addition this variation is amplified because Master Teachers often go beyond what is expected of them. Although not a specific focus of this study, this also appears true of Hubs - both those led by Master Teachers and others. To address this, CAS might consider identifying a core offer of training and workshops hosted by local and regional networks. This might lead to the most judicious use of the most expert of CAS Master Teachers as well as other experts.

There is a risk that moving to a less diverse offer may undermine local autonomy and the energy that comes with a do-it-yourself, bottom up approach to professional development. However, the nature of the Hub networks themselves suggest that this will continue to be a feature of CAS activity.

Taking stock

Interview participants identified varying levels of engagement. At some point CAS may wish to take stock of the current level of reach and identify the extent to which schools have become part of the CAS network, patterns of engagement and identify - 'cold spots' where there is little CAS activity. Further study may be worthwhile to understand barriers to engagement by those who have not yet engaged.

Issues to consider

Given the scope of the study we report on here we do not consider it appropriate to make firm recommendations. Rather we propose in this section we summarise a number of issues for CAS to consider.

CAS organisation

1. Resourcing of Master Teachers and Hubs. The study indicates that CAS support for Master Teachers and Hubs leads to considerable 'added value' in terms of CPD. Further, support is needed for administration and marketing tasks to enable Master Teachers to focus on leadership activities.
2. The term "Master Teacher" and other designations. As discussed above, for the next phase of development of CAS the appropriateness of 'Master Teacher' as a designation should be considered.
3. More generally, CAS should consider the nature of the relationship between Master Teacher and Hub Leader activity as well as other aspects of the Network of Excellence. The need here may be for further clarification or changes to meet the next phase of CAS growth
4. Marketing. CAS should seek additional resource/funding to promote its activity and develop greater recognition of what it does.

The CAS offer

5. The study indicates the value of face to face support. Further on-line support is indicated for specific training such as in programming languages. CAS should consider the extent to which the offer made locally should vary from place to place.
6. There is potential to support computing in primary schools through making clearer links to other subjects and particularly mathematics. CAS should consider whether this should be a priority and if so how this should be undertaken.

CAS as part of a self-improving system

7. CAS should consider how to strengthen its network with the Teaching School Alliance network both to promote its work but also because Teaching Schools are effective Lead Schools or hosts for Hubs.
8. CAS should consider mapping patterns of engagement and identify 'cold spots' to target areas for development.

Future evaluation

9. Regardless of whether for future independent evaluation or otherwise, CAS should consider identifying the intended impacts on teachers, teacher networks, schools, and pupils of activity. This would involve both in general and potentially specific impacts for particular aspects of the CAS programme.
10. In planning future evaluation, CAS should consider lessons to be learnt from evaluation of comparator organisations and potentially seek advice directly from them and/or DfE representatives who work with these organisations.

10. In seeking further funding, CAS should consider the extent to which independent evaluation is a priority and seek funding for this as appropriate.