*DOI:*
10.1007/978-3-319-25396-1_7

*Document Version*
Peer reviewed version

# Online vs face-to-face engagement of Computing teachers for their professional development needs

Sue Sentance[1] and Simon Humphreys[2]

[1] King's College London, UK
sue.sentance@kcl.ac.uk
[2] Computing At School, UK
simon.humphreys@computingatschool.org.uk

**Abstract.** After a period of intense activity in preparation for the transition, Computing has been implemented in the curriculum in England for all children from ages 5-16. In this paper we investigate the aspects of professional development that Computing teachers are utilising. We conducted a survey of over 900 Computing teachers in England and use the results to reflect on the benefits of face-to-face vs online communities to support teachers. Our results show that teachers find the face-to-face events and training to be useful, and that teachers in our community are participating in many hours of professional development in order to address their needs in content knowledge and pedagogical content knowledge in Computing. Furthermore an online community is valuable in supporting teachers who require resources, access to expertise and guidance on curriculum issues in addition to face-to-face training, networking and support.

**Keywords:** Computer science teacher education, teacher professional development, computing education

## 1 Introduction

Computing has now been implemented in the curriculum in England for all children from ages 5 -16; the rationale and preparation for this was described in [3, 4]. The aims of the new curriculum are that all pupils:

- can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation
- can analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems
- can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems
- are responsible, competent, confident and creative users of information and communication technology [11]

Children at all ages will be learning computational thinking skills, partly through learning computer programming. The curriculum includes the following strands:

- Algorithms and Programming
- Data
- Computers and Social Informatics
- Communication and Networking
- IT and Digital Literacy

The advantage for children of learning computational thinking in school from aged 5 with a gradual introduction to computer programming over the period of their whole schooling means that they will be able to consolidate and extend their understanding of the principles of computing gradually, thus hopefully preventing what Lister describes as "fragile knowledge" [19]. However this gradual introduction to Computing is not possible for teachers, particularly secondary teachers, who have to learn computer programming with some time pressure, at a time when there are already many pressures on teachers in terms of their workload.

This paper describes the results of a survey of over 900 Computing teachers in England which has been compared with a survey of a similar number of Computing teachers last year. The study is primarily focused on the type of professional development (PD) activities teachers find useful and what they value from a professional learning community specifically for Computing in schools. We also reflect on the benefits of face-to-face vs online communities to support the PD of these teachers. The purpose of our research was to identify what PD activities Computing teachers are engaged in and find useful, and whether there is any tendency to prefer online or face-to-face activities in the context of PD.

## 2 Professional development of Computing teachers

The move towards the inclusion of computer science in the school curriculum in many countries has led to concerns about how teachers will manage this change and how sufficient teachers can be found [8, 27, 24, 25]. 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 [27].

Computing is a domain in which teachers may feel isolated [16] and lack confidence [27, 25] or a sense of identity [23]. Professional development (PD) in computer science education for teachers can take a number of forms. Training as the primary or only aspect of PD has been criticised by a number of authors [18, 7, 17], although subject-knowledge workshops for teachers may be one useful form of Computing PD [13]. In New Zealand, preparing teachers for curriculum change has led to the introduction of 2 to 3 day workshops which are followed up with discussion groups with teachers working in clusters [27], exemplifying a type of collaborative PD [7]. Goode describes the provision of

workshops in computer science and pedagogy and notes that these cause teachers to develop their own small networks of support. Morrison et al [22] adopted the originally university-focused Disciplinary Commons approach [14] to be used with school teachers, by providing monthly meetings to discuss issues of teaching and curriculum over a period of a year. One substantial US study into PD across all subjects suggests that key elements are: having ongoing training that is connected to practice; focusing on specific curriculum content; and building of strong relationships between teachers [10], and this is backed up by similar findings in the UK [9]. In addition, the benefits of having frequent contact with a provider was a highlighted by a large-scale synthesis of teachers' professional learning in New Zealand [28]. Work in England which relates to the current study is focusing on a holistic model of CPD [26] including training, mentoring and support with a community of practice, following such recommendations from generic PD research.

## 3 Communities of practice - online and offline

The community of practice (CoP) has been defined as a group of people who "share a concern or a passion for something they do and learn how to do it better as they interact regularly" [30]. Technology-enabled communities of practice [31] can make effective online learning communities in the domain of education but there is also value in face-to-face interaction [6], not least where people are reticent to join discussions [12] and as such do not fully participate in the online community. Online communities contain an "ecology of resources" [20] and have been shown to have many benefits for teachers' PD [29, 21].

Online learning courses are not the same as online communities, and with purely online training there are reported issues with retention [1, 2]. Although it has been reported that face-to-face interaction for adult learners has no advantage over blended learning [15], that is likely to be because the face-to-face elements of blended learning allow relationships to be established, in comparison to purely online training opportunities, such as MOOCs in computer science. Online learning courses may be better suited to certain domains: the "getting stuck" element of computer programming means that it becomes easy to give up when it becomes difficult [1]. Learning to be a competent computer programmer is a long, slow process that can be difficult to fit in around the daily demands of a busy timetable. Time out at a session locally can be easier to maintain than an online course, and thus an online community that signposts face-to-face PD becomes an option that has many advantages.

## 4 The Computing At School community

Computing At School (CAS) is a grass-roots organisation in the UK which has had a great influence on the emerging changes. CAS exists to provide leadership and strategic guidance to all those involved in Computing education in schools in the UK, with a significant but not exclusive focus on the computer science

theme within the wider Computing curriculum [4]. CAS has a particular focus on supporting teachers to deliver the new curriculum in the classroom, with confidence and enthusiasm, through building local communities of practice.

The CAS community meets many of the criteria for a community of practice in such that there is a clearly identifiable domain, knowledge and practice [30] in common for teachers of Computing in a context of curriculum change. The formation of regional hubs where teachers could meet after school, in local CoPs with their peers, to share resources, receive training, try out lesson ideas and discuss pedagogy with each other has been the centre point of all CAS activity. In addition to face-to-face meetings happening all over the country, CAS has an online community site that enables teachers to communicate with one another and find out about face to face events [5]. This site has four features: news, discussions, resources and event listings and is the primary place where face-to-face events are advertised and promoted to teachers. Despite the fact that the online site is seen as the centrepoint to many who join CAS, CAS is built around the principles of local, face-to-face, support for teachers, as exemplified by its supportive PD training programme, built on the concepts of mentoring, peer-to-peer support, cascade of subject knowledge and accessible role models [26]. The CAS site is growing on a daily basis with 18000 members at the time of writing, as can be seen in Figure 1.

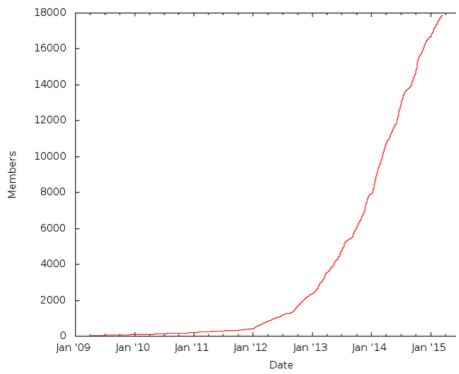


**Fig. 1.** CAS Membership from 2009-2015

In surveying members of CAS, particularly teachers, the questions our study sought to address are:

1. What are Computing teachers doing to address their PD needs in Computing?
2. How many hours are Computing teachers spending on their PD?
3. To what extent are online and face-to-face activities valued by teachers?

## 5 Methodology

For the purposes of this study we surveyed a large group of teachers at the beginning of 2014 and then again in 2015 after the curriculum change had taken place. We also have cross-checked our findings against 764 evaluations from the face-to-face training events run locally by experienced teachers with Computing At School. As part of our continual evaluation we also collect data about events held ten weeks after the event . Other aspects of the evaluation process are reported in [26].

The survey was advertised and promoted through the CAS organisation. The vast majority of the 1949 respondents (92%) were members of CAS. For this purpose we have extracted only the responses from teachers in England,which is 981 from the 2015 survey (with 864 from the previous year's survey for comparison). The data were collected using an online tool then extracted into statistical software for further analysis. Teachers gave consent for the data from the surveys they complete to be used to find out more about the community and their engagement with it. Teachers were also asked if they wish to take part in follow-up interviews for more in-depth analysis.

## 6 Findings

In this section we report on the findings of our survey, contrasted where relevant with the previous year's survey.

### 6.1 Teacher profile

In 2015, 65% of the teachers responding teach in secondary education (75% in the 2014 survey), with 31% teaching in a primary (ages 4-11) or middle (ages 7-13) school (21% in the 2014 survey). 4% teach in institutions that only have students aged 16 and over. For the rest of this paper we will ignore this latter group to focus on teachers that teach children affected by the new Computing curriculum. The teachers responding teach different amounts of Computing during an average week (see Figure 2). Since 2014 the number of hours teaching Computing has increased; there is an increase of 7% in the number teaching more than 15 hours of Computing each week and 5% at 10-14 hours per week. This is due to the introduction of the curriculum which was optional up to September 2014. Primary teachers who are mostly generic teachers teach mostly 1-4 hours per week (70%) whereas secondary teachers are more likely to be specialist teachers with 53% at least 10 hours of Computing a week. However there is a small but increasing number of primary and middle teachers who are becoming specialist Computing teachers in their schools.

Teachers were asked how confident they were in their delivery of the Computing curriculum. The mean confidence of a primary teacher (of those answering the survey) was 7.1 and the mean confidence of a secondary teacher answering the survey was 6.8. Figure 3 shows the increase in confidence from 2014 to 2015

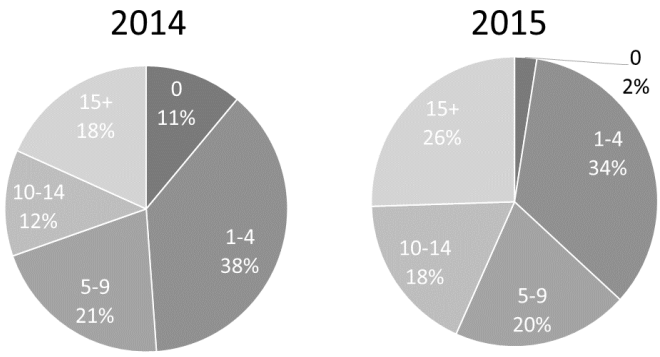


**Fig. 2.** Hours a week teaching Computing

with 48% of both secondary and primary/middle teachers reporting confidence of 8 or more.

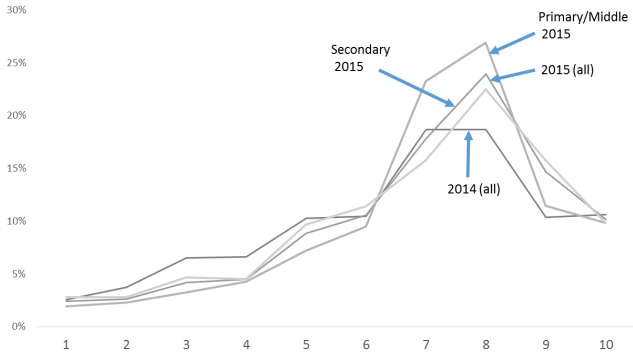


**Fig. 3.** How confident are you in your ability to teach Computing (1-10)?

The next section describes teachers' perception of their PD in Computing.

### 6.2 Professional development (PD) in Computing

Teachers were asked which ONE aspect of PD in Computing is most valuable to them. Figure 4 shows that the three most valuable aspects of PD for Computing teachers across our whole sample are:

- Sharing of good practice (26%)
- Attending training events (22% )

– Trying out new ideas in the classroom (20%)

This was then analysed in relation to how confident teachers had previously rated themselves. Teachers rating themselves at least 8 out of 10 are "confident" with teachers rating themselves 7 or less are "less confident". We found that for the less confident teachers more of them identified attending training events (27.5%), followed by sharing of good practice (24.5%) and then being supported by a colleague or Master Teacher (MT) (18%). Both groups of teachers also valued the networking aspect of professional development activities (17.9% for confident teachers and 12.5% less confident teachers saying it was the most valuable aspect for them). A CAS Master Teacher is a teacher who is trained and released from school to support other teachers [26].

| No. hours on PD | CAS MT training | University PD | MOOC | Self-Study | CAS Hub |
|---|---|---|---|---|---|
| 2014 | | | | | |
| At least 1 hour | 34.2 | 38.6 | 35.4 | 95.4 | 55.6 |
| More than 6 hours | 14.1 | 20.2 | 18.7 | 78.6 | 13.6 |
| More then16 hours | 5.5 | 11.8 | 9.3 | 59.1 | 2.4 |
| 2015 | | | | | |
| At least 1 hour | 54.2 | 47.1 | 39.8 | 96.3 | 63.1 |
| More than 6 hours | 20.7 | 28.1 | 25.7 | 86.1 | 17.8 |
| More than16 hours | 5.2 | 17.1 | 11.6 | 67.2 | 3.2 |

**Table 1.** Teachers/hours on professional development

Teachers were asked how many hours they had spent on PD in Computing. Table 6.2 shows the increase from the 2014 to the 2015 survey. Obviously teachers will on average have spent more time since the previous year's survey but the greatest increase is for the number of teachers who have attended at least one Master Teacher's session (face-to-face); this shows an increase of 20%. There are a number of MOOCs now available for teachers learning computer science subject knowledge - some of these are specifically for teachers. Some teachers are utilising the MOOCs, and we were interesteed to find out whether they had found them useful.

What the survey results show is that 78% of primary/middle teachers and 74% of secondary teachers said that they had found the CAS Master Teacher training useful compared to 52% and 61% of those who attended MOOCs which was a larger difference than in the previous year's survey (see Figure 5). Overall 329 teachers out of 429 attending CAS Master Teacher training (76%) said it was useful or very useful and another 98 saying that parts of it were useful.

Other types of face-to-face PD was also seen as useful with 70% saying that university-provided PD was useful, 70% other CAS events, 68% other non-CAS events and 70% the CAS Conference. Overall 60% teachers said that MOOCs were useful or very useful PD, which was the lowest percentage of all the other types of PD (which were all face-to-face).

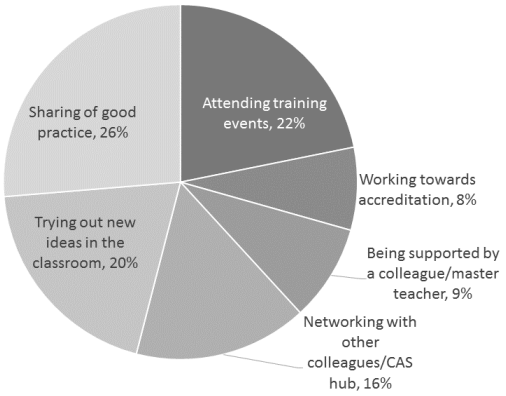


**Fig. 4.** What type of professional development is most valuable to you?

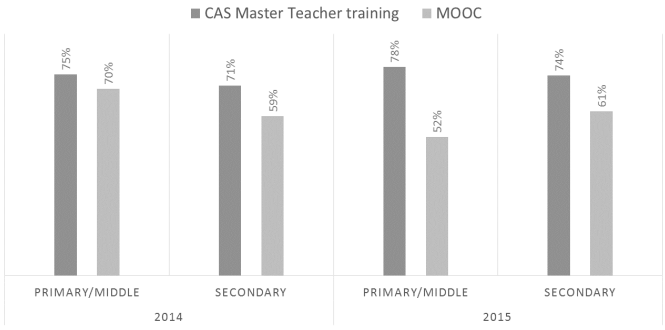


**Fig. 5.** Type of PD is useful/very useful by year/teacher type (% responses)

### 6.3 The CAS community

Teachers were asked which ONE thing was most useful about CAS. The results are shown in Table 2.

| Single most important benefit of CAS (2015) | Primary/Middle | Secondary |
|---|---|---|
| Guidance on teaching the Computing curriculum | 35% | 25% |
| Access to others' resources | 26% | 35% |
| Subject knowledge training | 16% | 14% |
| Access to others' experiences | 9% | 14% |
| Meeting other supportive colleagues | 5% | 8% |
| Other | 9% | 3% |

**Table 2.** Benefits to teachers of Computing At School

Overall the most popular aspect of the CAS community is the sharing of teachers' resources. Teachers voluntarily upload resources that they have developed for their classes for other teachers to share. However, the results differed for different groups of teachers. Primary teachers most valued the guidance on teaching the Computing curriculum (35%), whereas the secondary teachers most valued the access to other teachers' resources (35%). Certainly, overall, the most popular aspect of CAS is the access to resources from those given (33%) . Some teachers gave other valuable aspects:

"Through CAS I have made contacts with other organisations that are helping me improve my ability to teach the computing curriculum"

"Finding out how other people are addressing delivery and assessment of the new computing curriculum"

We compared the confidence of teachers against what they most appreciated about CAS. Less confident teachers were more likely than confident teachers to indicate that the subject knowledge training was most valuable to them (24% compared to 11%).

Teachers were also asked to rank the aspects of Computing At School that they valued. Figure 6 shows again that access to other resources are useful, alongside discussions about approaches to teaching, particularly for secondary teachers.

Teachers reported on how often they accessed aspects of the online community. 46% of members viewed the discussion sections of the community site at least weekly (56% in 2014), 26% the events section at least weekly (33% in 2014), and 58% looked at the resources at least weekly (63% in 2014). This indicates that regular accessing of the site has gone down in the previous year (although the number of members has more than doubled).

## 7 Discussion

The CAS model of PD is built on the belief that face-to-face interaction is the preferred vehicle for supporting subject knowledge development [26]. This

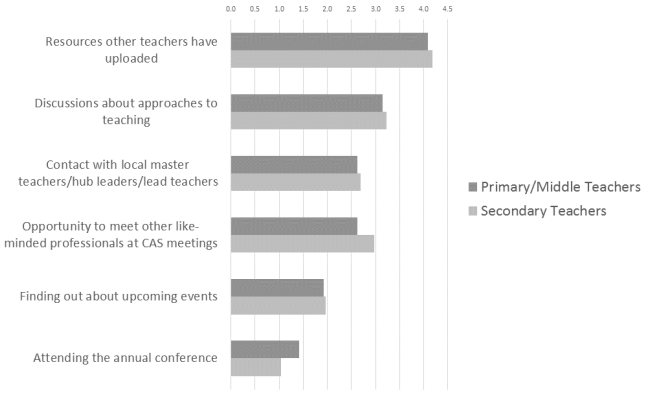


**Fig. 6.** Features of CAS ranked in order of value

is because teachers work in a face-to-face environment by the nature of their role so are comfortable with this type of interaction, and because the potential challenges of learning the subject mean that the confidence building elements of face-to-face training are needed.

The results of this survey has highlighted the following:

- In the year between the two surveys, there has been an increased attendance at face-to-face training.
- Teachers report face-to-face training to be more useful than MOOCs.
- Less confident Computing teachers report that the most valuable aspect of PD is attending training events.
- Confident teachers most value the sharing of good practice and trying out new ideas in the classroom as PD.

This implies that face-to-face learning is important to Computing teachers, although the online community is also important. When taking feedback from events (analysis of 764 forms), 99% of these teachers stated that face-to-face interaction was an important or very important consideration when choosing PD, with 95% also valuing local delivery of training. Darling-Hammond [10] emphasise the importance of strong working relationships between teachers for effective PD and this can be achieved by the kind of face-to-face interactions that are facilitated through CAS.

The support amongst teachers for "trying out ideas in the classroom" also encourages us with our current accreditation programme for teachers that is focused partly around classroom investigations into pedagogical approaches appropriate for teaching Computing [3]. This also relates to research that indicates the importance of relating to practice [10, 9].

The fact that teachers are accessing some of the features of the online community less often may be due to the fact that there is, even in one year, more

[3] http:\\computingatschool.org.uk\certificate

social media available for teachers and an increasing number of websites and organisations supporting Computing. The CAS membership has almost doubled in 12 months, with an ever increasing number of teachers grateful for the resources that teachers freely share amongst themselves. The plethora of online resources mean that it can be time consuming to even locate the appropriate help. Benda et al give examples of students looking for resources posted by others rather than contributing to discussions themselves [1]. Resources on CAS have a higher viewing than discussion items; this seems feasible in a time when teachers are increasingly busy and under pressure in all areas.

As Benda et al aptly describe, programming is hard and finding time to do this online is very difficult [1]. Teachers who need subject knowledge development in addition to the resource-sharing benefits of such a vibrant community need to be able to set aside clear blocks of time to do this and this can be more easily achieved with a commitment to a local course. We suggest that the CAS Master Teacher training and support offered within the CAS community provides both the focus on curriculum content recommended by [10] and the close relationship with a provider that is recommended in [28].

## 8 Conclusion

In this paper we have sought to describe how teachers are accessing and utilising PD in Computing. Our results show that teachers find the face-to-face and locally delivered opportunities very useful, and that teachers in the community are participating in many hours of PD in order to address their needs in content knowledge and pedagogical content knowledge in Computing. Furthermore an online community is valuable in supporting teachers who require resources, access to expertise and guidance on curriculum issues in addition to face-to-face training, networking and support.

## References


1. Benda, K., Bruckman, A., Guzdial, M.: When life and learning do not fit: Challenges of workload and communication in introductory computer science online. Trans. Comput. Educ. 12(4), 15:1–15:38 (Nov 2012)
2. Boston, W., Diaz, S.R., Gibson, A.M., Ice, P., Richardson, J., Swan, K.: An exploration of the relationship between indicators of the community of inquiry framework and retention in online programs. Journal of Asynchronous Learning Networks 13(3), 67–83 (2009)
3. Brown, N.C.C., Kolling, M., Crick, T., Peyton-Jones, S., Humphreys, S., Sentance, S.: Bringing Computer Science back into Schools: Lessons from the UK. In: Proceedings of the 44th ACM Technical Symposium on Computer science education. SIGCSE '13, ACM (2013)
4. Brown, N.C.C., Sentance, S., Crick, T., Humphreys, S.: Restart: The Resurgence of Computer Science in UK Schools. ACM Transactions of Computing Education 14(2) (Jun 2014)

5. Brown, N.C.C., Kölling, M.: A tale of three sites: Resource and knowledge sharing amongst computer science educators. In: Proceedings of the Ninth Annual International ACM Conference on International Computing Education Research. pp. 27–34. ICER '13, ACM, New York, NY, USA (2013)
6. Cooper, S., Grover, S., Simon, B.: Building a Virtual Community of Practice for K-12 CS Teachers. Communications of the ACM 57(5), 39–41 (May 2014)
7. Cordingley, P.: The Impact of Collaborative CPD on Classroom Teaching and Learning: Review: What Do Teacher Impact Data Tell Us about Collaborative CPD? EPPI-Centre, Social Science Research Unit, Institute of Education, University of London (2005)
8. CSTA: Running on Empty. Tech. rep. (2010), http://runningonempty.acm.org/
9. CUREE: Understanding what enables high-quality professional learning. Tech. rep., Pearson (2013)
10. Darling-Hammond, L., Wei, R.C., Andree, A., Richardson, N., Orphanos, S.: Professional learning in the learning profession. Washington, DC: National Staff Development Council (2009)
11. Department for Education: National Curriculum for England: Computing programme of study. Tech. rep., Department for Education (2013), https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study/national-curriculum-in-england-computing-programmes-of-study
12. Dron, J., Seidel, C., Litten, G.: Transactional distance in a blended learning environment. Research in Learning Technology 12(2) (2004)
13. Ericson, B., Guzdial, M., Biggers, M.: A Model for Improving Secondary CS Education. SIGCSE Bull. 37(1), 332–336 (Feb 2005)
14. Fincher, S., Tenenberg, J.: Warren's question. In: Proceedings of the Third International Workshop on Computing Education Research. pp. 51–60. ICER '07, ACM, New York, NY, USA (2007)
15. Fishman, B., Konstantopoulos, S., Kubitskey, B.W., Vath, R., Park, G., Johnson, H., Edelson, D.C.: Comparing the impact of online and face-to-face professional development in the context of curriculum implementation. Journal of Teacher Education 64(5), 426–438 (2013)
16. Goode, J.: If you build teachers, will students come? the role of teachers in broadening computer science learning for urban youth. Journal of Educational Computing Research 36(1), 65–88 (2007)
17. Guskey, T.R., Yoon, K.S.: What works in Professional Development? The Leading Edge (2009)
18. Kennedy, A.: Models of continuing professional development: a framework for analysis. Journal of In-Service Education 31(2), 235–250 (2005), http://www.tandfonline.com/doi/abs/10.1080/13674580500200277
19. Lister, R., Adams, E.S., Fitzgerald, S., Fone, W., Hamer, J., Lindholm, M., McCartney, R., Moström, J.E., Sanders, K., Seppälä, O., Simon, B., Thomas, L.: A multi-national study of reading and tracing skills in novice programmers. In: Working Group Reports from ITiCSE on Innovation and Technology in Computer Science Education. pp. 119–150. ITiCSE-WGR '04, ACM, New York, NY, USA (2004)
20. Luckin, R., Weatherby, K.: Online learning communities in context. International Journal of Web Based Communities 8(4), 440–454 (2012)
21. Matzat, U.: Do blended virtual learning communities enhance teachers' professional development more than purely virtual ones? a large scale empirical comparison. Computers & Education 60(1), 40–51 (2013)

22. Morrison, B.B., Ni, L., Guzdial, M.: Adapting the disciplinary commons model for high school teachers: Improving recruitment, creating community. In: Proceedings of the Ninth Annual International Conference on International Computing Education Research. pp. 47–54. ICER '12, ACM, New York, NY, USA (2012)
23. Ni, L., Guzdial, M.: Who Am I?: Understanding High School Computer Science teachers' professional identity. In: Proceedings of the 43rd ACM technical symposium on Computer Science Education. pp. 499–504. SIGCSE '12, ACM, New York, NY, USA (2012)
24. Schulte, C., Hornung, M., Sentance, S., Dagiene, V., Jevsikova, T., Thota, N., Eckerdal, A., Peters, A.K.: Computer science at school/cs teacher education: Koli working-group report on cs at school. In: Proceedings of the 12th Koli Calling International Conference on Computing Education Research. pp. 29–38. Koli Calling '12, ACM, New York, NY, USA (2012)
25. Sentance, S., Dorling, M., McNicol, A.: Computer science in secondary schools in the uk: Ways to empower teachers. In: Informatics in Schools. Sustainable Informatics Education for Pupils of all Ages, pp. 15–30. Springer (2013)
26. Sentance, S., Humphreys, S., Dorling, M.: The Network of Teaching Excellence in Computer Science and Master Teachers. In: WIPSCE '14 (Workshop in Primary and Secondary Computing Education). ACM (2014)
27. Thompson, D., Bell, T.: Adoption of new Computer Science High School Standards by New Zealand teachers. In: Proceedings of the 44th SIGCSE technical symposium on Computer science education. SIGCSE '13, ACM (2013)
28. Timperley, H.S., Parr, J.M., Bertanees, C.: Promoting professional inquiry for improved outcomes for students in New Zealand. Professional Development in Education 35(2), 227–245 (2009)
29. Tseng, F.C., Kuo, F.Y.: A study of social participation and knowledge sharing in the teachers' online professional community of practice. Computers & Education 72(0), 37–47 (3 2014)
30. Wenger, E.: Communities of practice: A brief introduction. National Science Foundation (US) (2011)
31. Wenger, E., White, N., Smith, J.D.: Digital habitats: Stewarding technology for communities. CPsquare (2009)