Adoption of new Computer Science high school standards by New Zealand teachers

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ABSTRACT

Computer science was progressively introduced as a subject in New Zealand high schools between 2011 and 2013, and teachers have played a key role in the success of the introduction of the new curriculum. This paper looks at how the process has worked from their point of view, primarily by comparing teacher responses to two surveys, one early in the process and one after all three years of material had been introduced. We look at the support teachers have had to prepare to teach the new topics, and we identify the aspects of the transition that worked well and the aspects have been problematic. The two surveys reveal an increase in teacher confidence after they had professional development and gained experience teaching the new standards.

Categories and Subject Descriptors

K.3.2 [**Computer and Information Science Education**]: Computer Science education

Keywords

Computer Science education, teachers, assessment

1. INTRODUCTION

Teachers play a pivotal role in the adoption of a new computer science curriculum, and therefore it is important to understand teachers' needs and attitudes to new material [12]. In recent years several countries have had major curriculum changes advocated (for example, the UK [9], Denmark [8], Germany [7], and the US [1]), and these changes require rapid upskilling of the teacher workforce. In New Zealand, computer science became available as a nationally assessed topic in 2011, being phased in to the third-to-last year of high school (Year 11) in that year, and progressively introduced to the last two years of high school (Years 12 and 13) in 2012 and 2013 respectively [2, 3]. This has provided an opportunity to run a case study of the process of the rapid introduction of a new curriculum.

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An earlier survey (made in 2012) of NZ teachers one year after the new computer science curriculum was introduced provided insight into the kind of support that teachers valued during the change [13]. This short paper repeats the survey a year later, looking at how the situation has changed.

At the time of the first survey only the year 11 material had been taught; the survey reported here was run after Year 12 had been running for a year, and teachers had started to teach the Year 13 material i.e. they were now familiar with the full range of topics that had been introduced.

The changes were in the form of new programming and computer science "Achievement Standards", which are national standards for evaluating students, and count towards the main school leaving qualification. The programming standards increase in difficulty over the three years, with the Year 11 standard being possible to complete in a "drag and drop" language like Scratch, and the Year 13 standard requiring some OO and GUI programming. The computer science component of the standards introduces students to topics such as algorithms, HCI, compression, encryption, data representation, formal languages, AI, and so on. (For more details of the standards, see [2, 3].)

The new standards are not compulsory, and whether or not they are introduced depends a lot on whether a teacher chooses to include them in a computing course. This in turn can depend on how confident the teacher is with the topic (both content knowledge and pedagogical knowledge), as well as them seeing a benefit to introducing the new topic. The nature of computer science as a subject is generally not understood well by students, career counsellors, or school management, and so the confidence and enthusiasm of teachers is a key driver to making this work in the classroom, and to influence these other groups to see the value of teaching and learning computer science [10].

From the previous survey it is also clear that many computing teachers have come from a background that doesn't involve computer science, with many being from "ICT", which focuses more on being users of computing technology rather than developers. Many of these teachers have embraced the new standards as an opportunity to add depth to their teaching and to enhance their role, but getting up to speed on the new material can be a challenge, and the survey reported here gives an idea of how this process has worked. The rapid introduction of the new standards has meant that the upskilling has had to be done by teachers "on the job", as

	Feb 2012	May 2013
Respondents	89	109
Size of mailing list	404	216
Response rate	22.0%	50.5%
Number of different schools	69	87
Male/Female	48.9%/51.1%	50.5%/49.5%
50+ years old	60.4%	56.0%

Table 1: Demographics for the two surveys

there has been no time or opportunity for formal teacher training, even though that would have been ideal [11].

The 2012 survey of teachers found that computing teachers most often had low confidence in their ability to teach the new subjects, and also reflected a weak maths background, which would affect the teaching of some topics (such as computer graphics or algorithm analysis) [13]. It also found that most computing teachers were over 50 years old; although this might raise concerns about their attitude to computer science, it has the advantage that they have generally had considerable classroom experience.

In this paper we compare a new survey (2013) with the previous 2012 survey. Section 2 gives some of the main demographics around adoption of the new standards from the 2013 survey, and then in Section 3 we look in some detail at how teacher confidence has changed a year later after adoption. Section 4 looks at the kinds of training that teachers have found valuable, and the resources that have helped to deliver the new standards.

2. DEMOGRAPHICS

The new survey reported here ran for 19 days during May 2013. The New Zealand school year runs from late January to December, so this survey is part-way through the third year that the new programming and computer science standards had been offered in NZ schools. The survey that it is being compared with was run for 15 days during Jan/Feb 2012, which was after the first year of the standards being offered, but before any significant teaching had begun on the second year of standards. Both surveys were left open until there were no new responses for two days.

Table 1 shows the main demographic statistics for the 2012 and 2013 surveys. Responses were solicited by mailing to the NZACDITT (NZ Association of Computing Digital and Information Technology Teachers) mailing list. This is the national teachers' association formed in March 2009 when the changes in standards were being developed, to "strengthen, encourage and improve the teaching of a broad range of Computing, Digital and Information Technologies in NZ secondary schools". At the end of March 2013 the mailing list was restricted to only paid members, which reduced the number of subscribers from 404 to 216. This likely reflects the number of teachers actively involved in delivering the new standards. The number of respondents has increased despite the membership of the list decreasing, which would indicate a higher level of interest in the new standards from those who are involved.

The number of schools represented in the surveys has increased from 69 to 87, with a total of 116 schools being represented in one survey or the other (29 from the first survey didn't respond to the second, but there were 47 new schools represented in the second survey). While this represents only about 20% of the number of educational organisations teaching at the level of the new achievement standards, many of the schools not represented are small organisations or rural schools with limited offerings, and several of the larger schools in New Zealand have been early adopters of the new standards, since they have more staff and flexibility with classes. The schools that responded to at least one survey cover 36.2% of the Year 11 students in New Zealand, which indicates that at least a third of NZ students are in a school where the new standards are likely to be available.

Geographic location of teachers can have an influence of adoption because of access to communities of practice for peer support. In particular, the 2012 survey had relatively few responses from the Auckland region. Over a third of the national population of NZ is in the Auckland region, yet in the first survey only 19% of the responses were from Auckland. This increased to 34% in the second survey, reflecting informal observations that teachers in the region engaged with the new standards later than others.

The gender balance of digital technology teachers remains very close to an even split. The respondents are still dominated by teachers who are 50 years and older, although this time there were 5 respondents under 30 years old, whereas in 2012 there were none. The advantage of having older teachers involved is that they bring a wealth of teaching experience, although it is good to see some engagement from younger teachers so that succession is possible.

3. TEACHER CONFIDENCE

A significant issue highlighted in the 2012 survey is that most teachers lacked confidence for teaching and assessing the new standards, which isn't surprising since the topics hadn't been taught before, relatively little professional development had been available to develop subject knowledge or pedagogical knowledge, and the new standards were introduced very quickly.

In this section we compare views relating to confidence between the two surveys. The responses reported below have been restricted to the 40 schools that are represented in both surveys, so that although the responses may not necessarily be from the same teachers (this couldn't be matched because surveys were anonymous), comparisons are at least like-for-like from the point of view of students in the schools.

The new standards contain five main strands [2], most of which had been taught previously to some extent before the changes. However, the programming and computer science strand contained a lot of topics that hadn't been taught previously, which was reflected in slower adoption. Table 2 shows the change in adoption of the five main strands between the two surveys, indicating that the extra year of professional development, peer support, experience and new resources has increased adoption more than the other strands.

Between the two surveys, responses to the question "What is your level of programming experience?" changed noticeably, particularly for the two extremes; the number who gave the most positive response ("I am fairly confident") increased by 14.8%, and least positive ("I have rudimentary programming skills") *decreased* by 14.0%.

In both surveys teachers were asked about their own knowledge of topics through the question "How well did you think you were able to teach the topics in following standards". Table 3 shows the change in confidence on a 4-point scale, from 1 ("Quite unconfident") to 4 ("Quite confident"). The

	Feb 2012	May 2013	change
Digital information	84.3%	84.8%	+0.5%
Digital infrastructure	41.2%	32.6%	-8.6%
Digital media	90.2%	93.5%	+3.3%
Electronics	9.8%	15.2%	+5.4%
Programming and computer science	62.7%	82.6%	+19.9%

Table 2: Number of schools adopting standards from each of the five strands

Survey:	2012	2013	change
1.44 Computer science	2.47	2.89	+0.42
1.45 Program planning	2.64	2.85	+0.21
1.46 Program implementation	2.92	3.10	+0.18

Table 3: Change in confidence for teaching topics on a scale of 1 to 4 for three level 1 standards

table shows results for the three level 1 (Year 11) standards, which had been available since 2011 [2]. In each case the level of confidence has increased, and particularly for computer science, which was the topic that would have been newest to the teachers.

One important aspect of teacher confidence is the ability to predict how well students will do in external assessment, as the teacher needs to guide students to perform well, and if they don't understand how the grading works then the result will appear unpredictable. In response to the question: "How confident do you feel about assessing your students' work in the new standards?", 19.7% of the teachers moved from the negative side of the response to the positive, increasing the mean on a scale of 1 to 4 from 2.43 to 2.80.

When asked "If you have seen the results from your students for the ... standards, would you agree that the grading seemed fair?", the mean response on the scale from 1 (disagree) to 4 (agree) moved up slightly from 2.75 to 2.86, and moving from 5% strongly disagreeing that it was fair, to none strongly disagreeing. In the free-form comments, a large number of comments were around difficulty predicting external grading, especially for the first time the standards were offered, when there was no experience to draw on.

Previous work reporting on an analysis of student work found that the student results were heavily influenced by instructions given by teachers [4], and as teachers become more confident and experienced, students will do better and their results will be more in line with what the teacher was expecting. The results show that there is still concern over the fairness of grading, although more professional development for teachers may make a difference here.

In terms of student gender balance, between 21% and 30% of students enrolled in Level 1 standards are female. While low, it is still above the 10–20% female enrolment rate for CS courses in NZ universities. Achievement levels between genders is slightly better for females, with a mean achievement level[1] of 2.23 for females versus 2.06 for males.

4. PROFESSIONAL DEVELOPMENT NEEDS

The previous survey revealed that very few current digital technology teachers had significant formal training in computing, with only 56% having any computing qualification at all, and only 11% having a computer science degree [13].

[1]The categories of Not Achieved, Achieved, Merit and Excellence, converted to a 4–point scale.

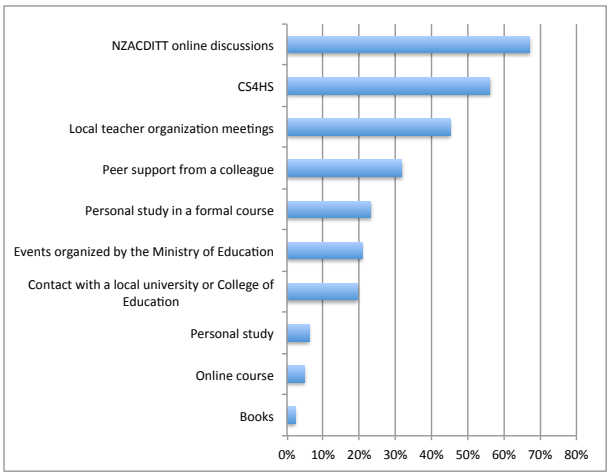

Figure 1: Sources of professional development for teachers

There are a number of ways that teachers can upskill, including courses, communities of practice, and "master teachers" who develop the skills and share them with their colleagues (Sentance covers a number of models [12]). Figure 1 shows the sources of PD that teachers in NZ reported in the second survey. The most popular sources were the online discussions in the teachers' association newsgroup, where specific questions could be asked and detailed information is shared. The CS4HS events are annual two- and three-day workshops sponsored by Google Inc., held at a university and run by university staff and experienced teachers. These have been run internationally to engage teachers in computer science and computational thinking in general [5, 6], but the NZ events were very specifically focused on the new standards. Teachers also formed local "clusters", and some of these meet monthly to share best practices. Individual peer support also features as an important source of PD.

Of those responders who had received PD through local teaching organisations or formal study, 60% did not use the 1.44 standard in 2013. For those with peer support, university contact and CS4HS workshop attendees, only 30% did not use the 1.44 standard.

Resourcing for PD remains an issue; when asked about financial support to participate in professional development, 42% reported receiving "good" financial support to undertake PD, while 50% reported receiving "partial" support, and 7% were expected to fund their own PD. In the free-form comments, one of the most often mentioned issues was a lack of time or opportunities for professional development, with some teachers feeling overwhelmed or exhausted by the changes. Others have reported enjoying the new opportunities and stimulation of more interesting topics to teach. The comments indicated a high value was placed on ready-to-use content. Although many disparate resources have been identified, teachers benefit greatly from material designed specifically for the local standards. Some local resources for this were mentioned favourably, including the CodeAvengers online programming lessons[2], Python and Java workbooks

[2]http://www.codeavengers.com/

written specifically for the new standards[3], and an online "Computer science field guide"[4].

In the free-form comments, eight of the comments noted that the transitional period was difficult ("Hopefully, the work load will ease as courses settle in"), but showed hope for the long term ("I am now into my third year with the [Year 11] students and feel really confident delivering the standards"). Two respondents mentioned that management and colleagues don't understand the new courses ("Educating other staff (still) that this is not a typing class").

Eleven teachers commented that the amount of work that students need to do for the new standards seems significantly higher than that required for other subjects. To some extent this could be ameliorated by teaching some of the material (e.g. introductory programming) prior to the last three years when it is being assessed. This would be the norm for other subjects; for example, if the first time a student encountered maths was in Year 11, and it was being formally assessed, it would be a steep learning curve. One teacher reported teaching material prior to Year 11, and found that Year 9 students could do equally well, which would take considerable pressure off those students once they reach Year 11.

The most mentioned topic in the comments was around the quality of students attracted (16 comments). Of these, 5 were positive ("For the first time in many years have a Year 13 programming class with very able students"), but another 6 had attracted students who expected the older style of course about using computers ("not what the students expected, they are still thinking the old ... courses that their brothers took"). The remainder had mixed experiences, and/or had to deal with classes that had a wide range of abilities.

5. CONCLUSIONS

Teachers are showing an increase in confidence in just over a year of experience, as well as an increase in participation in the new standards. However, a lack of time and resources to prepare to teach the unfamiliar topics is an issue, and therefore resources specifically designed for the standards are highly valued. Informing management and students so that the right students take the class can be a problem, but as courses develop a reputation they attract good students, which is in turn more rewarding for teachers. Overall, the transitional period is clearly demanding for teachers, but many are already seeing the benefits.

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