Case Study: Computational Thinking and Robotics Professional Development

This case study is a fictional description of a K-12 computer science professional development activity. It is based on an amalgam of observed professional development experiences in mathematics, science, and computer science.

To: yet-another-CS-listserv@computerscienceworld.org
From: abe.straction@college.edu
Re: computer science professional development for teachers

I have developed a unit called Computational Thinking and Robotics (CT&R) for high school computer science that is really exciting. The attached documents describe it in more detail. I feel it should have more impact than it did, so I’m looking for feedback on how this could be improved.

-Abe

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I have developed a unit called Computational Thinking and Robotics (CT&R) for high school computer science that is really exciting. CT&R began as a short 5-week course given in the summer and winter inter-term at my college, geared toward incoming freshmen to introduce them to foundational ideas of computer science and perhaps encourage them to take other CS courses, or even major.

The 5-week long unit had strong results at the college and students reported enjoying the unit. Informal survey data from the course showed that students were more likely to consider enrolling in a computer science course after having taken the unit than before, and enrollments in intro courses at the college did indeed tick up after the course was instituted. Furthermore, students who took CT&R as a group received higher grades in introductory CS courses on average than students who didn’t, indicating that the student learning was effective.

Understanding the need to get more and better computer science into high schools, I thought that CT&R could have a great impact on changing students’ attitudes about CS before going off to college. So, I applied for and received grant money from a local foundation for my team to create a curriculum for CT&R geared toward high school students, and to design some professional development supports in order to train teachers to enact the 5-week unit. My hope was
that if teachers had a tightly packaged curriculum that only took 5 weeks to teach, it might get some traction in high schools looking to improve computer science or technology education.

With the grant money, we created a curriculum binder with daily lesson plans for teachers, as well as activity guides, projects, and assessments for the unit. The content and lessons are all aligned to our state standards in mathematics and technology. (We don’t have computer science standards here to work with.) We made a website to store and share materials, and some of the assessments (like quizzes, tests and web quests) are scored through the website as well. We prepared robotics kits sufficient to support a class of 30 students, and gave this all away to teachers who came to the PD sessions. The website even had a robot simulator for use as part of the curriculum and to use in lieu of an actual robot if necessary.

The PD was advertised as an intensive week-long “summer institute” in which teachers would learn how to introduce their students to the amazing world of computer science through the CT&R curriculum unit. We advertised the summer institute through the local CSTA chapter listserv, a local Mathematics teachers listserv, the AP computer science discussion group, some local robotics clubs, and some other websites that promote PD for teachers. I also reached out through some personal contacts to local schools and school district leaders to promote the curriculum’s effectiveness and potential for schools. A district technology coordinator responded thanking me for providing the opportunity, but the communication unfortunately ended there.

The PD was open to any teacher who might consider using the unit at their school, and was advertised to train teachers to teach this unit regardless of their computer science background. But teachers of computer science, technology, and mathematics especially were encouraged to attend. When teachers applied they were asked about their interest in learning the material and using it in their school, and were asked to pay $50 to attend – we had the funds to put the workshop on for free, but over the years I’ve learned that having participants pay a nominal fee improves the likelihood people will come after registering. I assumed that some schools or school districts would be able to cover some of the costs of their teachers attending.

In the end we managed to get 32 teachers committed to attend. Here is the breakdown:

**Participant Demographics**

32 participants

17 women, 15 men

4 < 30 years old
10 30-40 years
12 40-50
6 50+ years

9 full time CS teachers
12 full time teachers Math/CS
9 business applications/technology teachers
2 part-time/afterschool teachers

6 private schools, all urban
26 public schools
8 suburban
14 urban / 8 select-enrollment / 6 neighborhood schools

**Logistics**
Monday – Friday 9:00 – 3:30

Location: Local University CS dept. facilities.
Most participants traveling <20 miles, a few from ~50 miles away
Funding: Grant paid for some time/staff to develop the curriculum and support the PD as well as to pay for food/parking for participants during PD, as well as limited supplies and robotics kits.
Registration Fee: $50

**Description of PD Activities**

In the PD, we took the teachers through the CT&R curriculum.

The CT&R curriculum is 5 weeks long so they covered roughly one week each day in the PD.

Since each week of CT&R is designed to have 5 class hours, and the PD day was only 6.5 hours (including time for breaks and lunch), some of the curriculum days were omitted from the PD, or left as homework for the teachers in order to allow for adequate time to discuss and debrief some of the lessons.

In the agenda you will see some items say “LEARN it” – this is when we would teach a day from the curriculum and the teachers experienced the unit as students. The agenda items labeled “TEACH it” were an opportunity for teachers to raise issues that came up in the lesson, both in terms of computer science concepts, and to discuss methods for teaching the curriculum with their students. The instructors of the lesson also pointed out the teacher resources provided through the companion web site, and allowed the teachers to explore them.

Each day ended with a “teachers roundtable” which had two main goals: 1) to have a structured discussion/activity to help teachers better understand the computing concepts learned in the weeks-worth of curriculum covered that day, 2) for teachers to discus and share ideas for teaching strategies for the lessons. Many teachers had great ideas for how to introduce concepts in different ways than those laid out in the curriculum book, and they were encouraged to share them. The teacher’s roundtable also served as way to build some sense of community amongst the participants.

**Immediate Feedback**

Feedback from the participants was overall very positive. Participants reported that they felt like they learned a lot from the PD and were more or less confident about their ability to teach it. Confidence tended to correlate with the amount of CS background a teacher had, but it was not a strong correlation.

Teachers particularly noted the “roundtable” at the end of each day as a great way to collaborate with colleagues and share ideas. Teachers seemed to really like spending time going over the concepts covered each day. In the survey they cited this as a major contributing factor to their confidence with the material.
One area of critique from the teachers was that the “TEACH it” portions could have been longer. Many teachers reported that the 30-45 minutes for those sessions was frequently not enough especially when the task was to explore the online resources, and they felt discussions were often cut short.

Teachers rated the online and course materials highly, and said they planned to use the online forum to share ideas and ask questions. Of the 32 teachers attending the PD, 27 said they planned to use “all” or “most” of the CT&R curriculum in the upcoming school year.

**Results & Outcomes**

During the school year the Q&A section of the CT&R companion site was lightly used and I am getting worried.

In a follow-up survey and phone calls to the teachers in the spring, I was disappointed to learn that of the 32 teachers in the PD only two used the full 5-week curriculum. Twelve teachers said that they started the curriculum and had planned to use it, but had to stop after only a week or two for a variety of reasons. Most of those who started but stopped cited a lack of time and need to move on in their own curriculum. Others said that it wasn’t connecting with the kids and they couldn’t make it work as well for their kids as it did for them in the PD; teachers said they were nervous about doing justice to the CT&R curriculum—they didn’t want it to fail. The teachers who did not use the curriculum at all despite saying they would in the PD, said that once the school year got started they didn’t feel adequately prepared to teach it, and weren’t sure how they were going to fit it in.
MONDAY:

9:00 – 9:30:
Welcome – distribution of materials – goals, setup, logistics for the week.

9:30 – 10:30    LEARN IT – Day 1

Break

10: 45 – 11:45 LEARN IT – Day 2

11:45 – 12:15 – TEACH IT – Days 1&2

LUNCH

1:15 – 2:15 – LEARN IT – Day 3

Break

2:30 – 3:30 – Teaching Round table

Understanding the important computer science concepts in the first week of the curriculum and discussion of strategies for teaching it.

HOMEWORK: Look at Days 4 and 5 of the curriculum, do the activities if desired, be prepared to learn Day 6 tomorrow.

TUESDAY

8:30 – 9:00 - Breakfast

9:00 – 10:00    LEARN IT – Day 6

Break

10:15 – 11:15 LEARN IT – Days 7,8

11:15 – 12:00 – TEACH IT – Days 6-8

LUNCH

1:00 – 2:30 – LEARN IT – Days 9,10,11

Break

2:45 – 3:30 – Teaching Round table

Understanding the important computer science concepts in the first week of the curriculum and discussion of strategies for teaching it.

HOMEWORK: Catch up on lessons missed

WEDNESDAY
8:30 – 9:00 - Breakfast
9:00 – 10:00   LEARN IT – Day 12
Break
10:15 – 11:15 LEARN IT – Day 13
11:15 – 12:00 – TEACH IT – Days 12,13
LUNCH
1:00 – 2:30 – LEARN IT – Days 14,15
Break
2:45 – 3:30 – Teaching Round table
HOMEWORK: Reading on artificial intelligence

THURSDAY

8:30 – 9:00 - Breakfast
9:00 – 10:00   LEARN IT – Day 16
Break
10:15 – 11:15 LEARN IT – Day 17
11:15 – 12:00 – TEACH IT – Days 16,17
LUNCH
1:00 – 2:30 – LEARN IT – Days 18,19,20
Break
2:45 – 3:30 – Teaching Round table
HOMEWORK: Reading on artificial intelligence

FRIDAY

8:30 – 9:00 - Breakfast
9:00 – 10:00   LEARN IT – Days 21,22
Break
10:15 – 11:15 LEARN IT – Day 23
11:15 – 12:00 – TEACH IT – Days 21,22,23
LUNCH

1:00 – 2:00 – LEARN IT – Days 24,25

2:00 – 2:30 – Teachers roundtable (last one!)

break

2:45 – 3:30 – What it all means! How to get kids interested in CS and why it’s important. Recruiting and retaining underrepresented groups.