BIRS report

Geri Lorway, Tim Bell, Sean Graves

January 2015

1 Introduction

The goal of this project was to bring together educators and researchers from the fields of computer science, applied mathematics and Education K to 12 as well as University and College levels, to consider questions, concerns and issues that surround the international attention being paid to developing a computer science curriculum for the elementary grades. There are several current frameworks for thinking, learning and teaching that might make the integration of topics and skills from computer science more manageable in terms of classroom teachers and their planning for including computer science and computational thinking in their teaching and in their assessment of student learning.

The Computer Science Unplugged materials, co-authored by Tim Bell, Mike Fellows and Ian Witten, offer a starting point for teachers who wish to investigate ideas around computer science and the trending themes of “computational thinking” and “coding”. Jeanette Wing’s challenge to include computational thinking as the fourth R when considering curriculum in the 21st Century offers another possible starting point. (See article in appendix)

Teaching for Thinking, Critical Thinking, Design Thinking, STEM Sciences are all terms that teachers are hearing, reading about and trying to make sense of as they respond to the constantly evolving dialogue around what constitutes the skills, attitudes and knowledge base we need our students to develop. The goal of this weekend was to consider ways to begin to connect these “terms” and “trends” into a connected whole. Finding Common Ground across the Disciplines might be one way to describe it. The questions that emerge for teachers: Where will we? How do we? Why should we? position Computational Thinking and Computer Science within our evolving conceptions of curriculum and competencies for 21st Century Learners?

2 Themes

2.1 Computational thinking

It is a difficult term to define but we all have a better idea of what it is about after the weekend.
Do we need to define it?
A starting point for the discussion of computational thinking is offered by Woollard and Selby as follows:

“As supported by the preceding arguments, computational thinking is an activity, often product oriented, associated with, but not limited to, problem solving. It is a cognitive or thought process that reflects

- the ability to think in abstractions,
- the ability to think in terms of decomposition,
- the ability to think algorithmically,
- the ability to think in terms of evaluations, and
- the ability to think in generalizations.

This proposed definition attempts to incorporate only those terms for which there is a consensus in the literature or those terms that are well defined across disciplines. The intent is to focus on the thinking aspect of the original phrase. In other words, computational thinking is a focused approach to problem solving, incorporating thought processes that utilize abstraction, decomposition, algorithmic design, evaluation, generalizations.”

Selby, C., Woollard, J., *Computational Thinking: The Developing Definition*, SIGCSE 2014, 5-8 March, Atlanta GA

### 2.2 Computer science isn’t about computers

One of the themes of the workshop was that computer science is mainly about people, not about computers. This comes up in several ways: first, that computer software is developed essentially to make the world a better place for people; second, that there are exciting jobs available for graduates, yet many don’t get a taste for what is involved and therefore don’t find their calling; and third, that all interfaces need to take account of the human using them, such as keeping response times under 0.1 seconds to appear instant. A related topic that came up was sustainability; wasting time on computation creates more power usage and requires more cooling, which has a direct impact on the environment. Also, good algorithms for planning can reduce the distance travelled by vehicles, and again reduce the impact on the environment, improve the safety for the people involved, and reduce the amount of human time required for a delivery. These connections seemed to resonate with the educators at the workshop, and made them realize both the importance of the subject, and also the value of having a more diverse range of students access ideas from computer science through school curriculum.

A growing theme among those who study thinking: What do we mean by Community Thinking and how does it relate here? Community thinking, Sustainability,
2.3 Design Thinking
How and where does design thinking fit? How does computational thinking support, link to, develop from, merge with design thinking and the current move to Maker/Thinker Explorations in the classroom? Susan Crichton offered some potential sources of insight:

- http://blogs.ubc.ca/centre/2013/11/18/maker-day-tool-kit/
- http://theelearningcoach.com/elearning_design/design-thinking-for-instructional-desig/

2.4 Visual Spatial Reasoning
Nora Newcombe’s articles offer an interesting and engaging entry point for teachers to consider the role that visual spatial reasoning plays in the learning of science, math, social studies. The design of the Computer Science Unplugged materials definitely meshes with many of the key aspects of learning in math and science that Newcombe outlines.

The group was challenged to consider how the “packaging” of knowledge and content might help keep the focus on process not product when we are designing and delivering curriculum.

**Picture This:** Available at www.aft.org/periodical/american-educator/summer-2010/picture

**Seeing Relationships:** Available for download at http://www.aft.org/sites/default/files/periodicals/Newcombe0.pdf

2.5 STEM vs STEAM
What about the link to the ARTS and the role of the arts in conceptions of the STEM disciplines...

2.6 Connecting to 21st Century Competencies
Currently many education systems are re-aligning curriculums to better reflect a need to focus on process, not product. In Alberta, the Ministerial Order for Student Learning, May, 2013 identifies the competencies that Alberta teachers need to expect their students to develop. Teachers who participated in the weekend indicated that building a framework, with specific examples linked to actual curriculums currently in use is a project they would like to pursue and plans are underway to re-connect this group in the near future to continue that work.
3 Feedback

- I want to thank you again for making arrangements for me to attend the Computational Thinking workshop this weekend. I found it truly inspiring, not the least of which was watching all the light bulbs go off for this dedicated group of elementary teachers from across the province. Thank you for your dedication to mathematics education and for gathering us all together for this important and timely event.

- You were definitely right when you said we would barely have time to scratch the surface on this topic! I took away a great deal of information, and I’m excited to share with my group tomorrow the perspectives and insight I received.

- I just wanted to say thanks again for including me in the weekend. I really appreciated the opportunity to learn with Tim and the other participants to get a better understanding of computational thinking. The resources are terrific and I introduced binary numbers to my class yesterday. It was pretty exciting to have one of my grade one students recognize the pattern and be able to tell what the next number in the pattern was. You could really see the brains working as we worked out how to show numbers from 1-25 with the cards! I can see so many possible extensions with these ideas.

- Thank you very much for inviting me. I loved having the opportunity to talk to primary teachers.

- I have already been contacted by a (non-participant) teacher who heard that the weekend was extremely successful and is asking about when the next one will be!

- I have been sharing the materials, the topics and the insights from the weekend with colleagues and they are anxious to know when there will be a follow-up as they would like to attend.

4 Bibliography


- Bell, T., Newton, H., Duncan, C. and Jarman, S. 2014. Adoption of Computer Science in NZ Schools. ITX 2014, incorporating the 5th annual conference of Computing and Information Technology Research and Education New Zealand (CITRENZ2014) and the 27th Annual Conference of the National Advisory Committee on Computing Qualifications and CSANZ2014. 8-10 October, Auckland, New Zealand.
• Selby, C.C. and Woollard, J. 2010. Computational Thinking: The Developing Definition. Submitted: SIGCSE 2014. 5-8 March, Atlanta, Georgia, USA.

• Thompson, D., Bell, T., Andreae, P. and Robins, A. 2013. The Role of Teachers in Implementing Curriculum Changes. SIGCSE 2013. 6-9 March, Denver, Colorado, USA.

• Tomohiro, N., Kanemune, S., Idosaka, Y., Namiki, M., Bell, T. and Kuno, Y. 2009. A CS Unplugged Design Pattern. SIGCSE 2009. 3-7 March, Chattanooga, Tennessee, USA.