Formal Report into the State of Coding Education in BC's Elementary and Secondary Public Curriculum

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1 Introduction

1.1 Background of Problem

Programming skills are slowly becoming recognized as a necessary part of early education by

educators around the world. Often, students are not properly introduced to programming unless

they actively make a choice to pursue it. This is in contrast to nearly every other academic study,

which people generally hold some rudimentary knowledge about before entering the field

academically. Considering that computer science, information science, and computer engineering, are ranked as the 3rd,4th, and 5th most employable degrees (Strauss 2016), there should be a greater emphasis on promotion of tech-related education. Approximately 100,000 people work in the technology sector in BC and their pay averages 75% above the BC average (BC Government 2017). Many economists forecast that the technology sector in BC to grow dramatically in the next 10 years. In order to create a more diverse and successful younger generation, more resources should be going into the teaching and promotion of computer science in BC's public education system.

1.2 Purpose of Report

This report is intended to showcase the current state of programming education in BC's public

education system. This report should create a relatively well-rounded view of the current situation from the perspective of the teachers and the students. The goal of this report is to identify obstacles that educators and students face when it comes to learning about computer science and provide reasonable solutions.

1.3 Intended Audience

This report is meant to be viewed by educators. To a lesser extent however, it would be useful for the general population of BC. The report discusses obstacles that prevent and deter students from learning more about computer science. It also provides some solutions on how the situation can be improved. Unfortunately, one of the major obstacles is funding, which is something that teachers are already very familiar with. Even so, there are so smaller scale changes that could be carried out by teacher to help increase student interest in computer science.

1.4 Scope of Inquiry

The following questions will be pursued:

1. What is the current state of computer science education in BC’s public educations system?
2. How familiar are K-12 students with programming? How interested are they in programming?

3. What are the main difficulties faced by educators in the teaching and promotion of computer science?

4. How can more students be encouraged to learn introductory programming in the hopes

that some will eventually pursue it as a career path?

1.5 Methods of Inquiry

This report employs 3 type of inquiry. First, online research on the current and planned state of

computer science in the public school curriculum is used to introduce the topic. Second,

interviews with teachers are discussed in order to see their outlook on how computer science is

perceived by students and educators. Finally, a survey of high school students helps shows how

much students know about programming and the extent of their interest in the field.

1.6 Limitations of Inquiry

One of the main limitations of this reports inquiry is a non-diverse sample of survey subjects and

interviewees. Many of the interviewees are teachers from Elgin Park Secondary, which is a

public school in a relatively wealthy part of Surrey. All of the students surveyed were 12th grade

students from Elgin Park Secondary. Future investigations into this subject should contain a

more diverse sample of students from all around BC, particularly rural and low-income

areas.

Another limitation of this report is a lack of easily implementable solutions. Many of the solutions come down to investing more money into public education. There are some solutions that do not specifically involve increased funding. In this report, an effort will be made to discuss other solutions as well.

1.7 Conclusion

It is clear that technology will be an important sector of the BC's economy in the future. For this reason, it is important that we encourage as much talent to enter the sector as we can. In order to do this, it is crucial students get exposure to technology early in their academic careers. With more exposure, more people will unexpectedly discover their passion for technology and the number of talented workers in the field will increase.

2 Collected Data

2.1 Research

Starting in 2015, BC schools began a 3 year long transition to a new curriculum for grades K to 12. During the transition process, schools will be able to incorporate both old and new parts of

the curriculum into their school's courses (Ministry of Education 2017).

In the current curriculum, computer programming has been incorporated as an elective that is

available for grade 11 and 12. Although Christy Clark has announced that eventually,

programming will become mandatory even in earlier grades (Silcoff, 2016).

The lack of a coherent plan has been noticed by the media. On January 19, 2016, the Vancouver

Sun posted an article entitled, 'Coding to be added to the BC school curriculum, sort of'(Shaw, 2016). The article goes on to say:

> *Premier Christy Clark announced that computer coding will become part of BC's school's curriculum, starting this September. However, the news didn't come attached with a budget or detailed plans of how that would work. For those who imagine a coding camp in every classroom, that's not going to happen.*

Some have mocked some of the haphazard plans put forward by the Ministry of Education. They

have stated that only in grade 9 will students start learning actual programming languages like

Java, HTML, and C++. Before then, students will engage in 'exploratory and purposeful play'

intended to teach algorithms, robotics, binary number systems, and other tech-related topics.

Many feel as though the government is simply throwing buzzwords out to the media without

putting genuine focus into the details of how they will implement the change.

Some educators, including Alexandra Greenhill feel that coding should be taught at a far younger

age. “My argument was you needed to start earlier than that if you are really going to make them

literate in that language, not as a second language but fluent,” said Greenhill. UBC’s Marina

Milner-Bolotin has commented that the addition of coding into the curriculum is long overdue

considering decades of research showing it benefits such as improved problem solving skills,

critical thinking, and information processing (Shaw 2016).

As is often the case, funding for this new addition is considered to be a core issue. Plenty of

money will be needed in order for schools to have adequate computer hardware and software. In

addition to this, and perhaps more importantly, the training of teachers in these topics will be

necessary as well (Shaw 2016).

2.2 Teacher Interviews

2.2.1 Interview Responses

Interview questions were sent to 3 teachers, 2 from Elgin Park Secondary in South Surrey, and 1

substitute teacher. All of the teacher interviewed were high school teachers. Funding issues were

expected to come up as an obstacle to implementing coding into high school classroom. For this

reason, mentions of money or funding were omitted from the questions to avoid leading the interviewees.

The teachers often provided insightful and helpful responses. Some of the same talking points

came up repeatedly: underfunded schools, and lack of proper training. These are issues that

affect many aspects of the education system, not just computer science.

It became clear that lack of funding plays a central role in the lagging computer science

education in public schools. When asked 'do you think that students are adequately exposed to

computer science?' one teacher was particularly straightforward, saying "Students are not

exposed to computer science mostly because of the vast underfunding and overcrowding in

schools." Another teacher said, "Probably not. Most students rely on self-motivation to achieve

skills in computer science, unless they attend a well-funded school."

Similar responses were made with respect to training of teachers. One older teacher said "...

[technology] is still under-utilized as the teachers of my era and before don't really know how to

use it.” Another teacher responded “do [the students] have a teacher who is capable of executing

this program?”

The teachers also provided advice on how to increase interest in computer science in schools. “A

lot of student need to be told exactly why it is beneficial for them to take a subject,” said one

teacher. Another said “I think in order for computer science to appeal to most people it has to be

integrated into other classes...this will take resources and training (Therefore, unlikely to happen

in my life as an educator).” Some teachers thought of ways to get students, and specifically girls

more interested in computer science. “Developing educational games that appeal not only the

boys, but girls as well, will help. There are stereotypes at play as well I think. Girls don't go into

the trades either because they are scared off by traditional beliefs. I have many students that

watch other people playing games on YouTube. This tends to mostly be boys because of the

nature of the games. More female interest could come as games are developed for them.”

2.2.2 Discussion of Interview Responses

It is clear from the interviews that, ultimately, there is one major obstacle to the implementation

and promotion of computer science programs in public schools: Funding. Improving training to

teachers would require additionally funding as well. Even thinking of better apps for education

would require more funding.

BC has been lagging behind other provinces in terms of funding. Education has fallen from 3.3%

of GDP to 2.5% between 2001 and 2016. While this sounds like a dramatic decrease, UBC's

Craig Riddell has stated that this might not be the best metric for discussing the education

budget. "Because the age structure of the population is changing — fewer school-aged children,

more adults, especially older adults— we would expect a shift in expenditure even if priorities

haven't changed," Riddell explained (McElroy 2016).

Riddell explains that a better metric is funding per student. In 2011, BC was ranked the second

lowest in Canada with $11,832 per student (figure 1). Underfunding to schools in BC has been

widely reported for years now, and stories of cutting programs or even entire schools are

common. Riddell argues that these problems are not necessary. "In B.C., the numbers show we

can afford to invest strongly and stably in education. Underfunding is a political choice" (McElroy 2016).

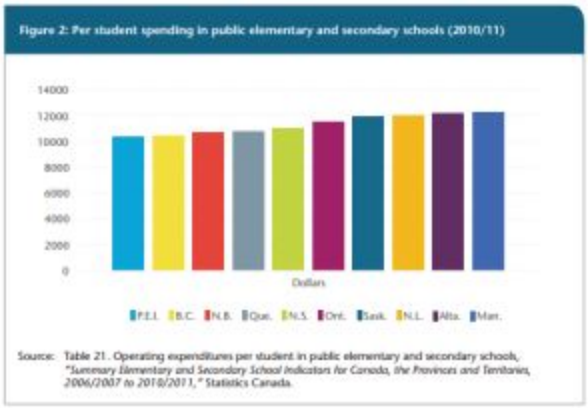

Figure 1: Per student funding for each province (McElroy 2016)

There are ways that computer science can be promoted in school that likely would not require

additional funding. For example, all public schools usually host a large number of clubs

dedicated to various activities like sports, woodwork, humanitarianism etc. It would be unusual

and frowned upon if a school did not host various sports teams. Perhaps if more schools hosted

extra-curricular coding clubs, together with advertisement, more student would pick up coding as

a hobby.

It also is important that teachers understand that having expensive equipment is not always needed in order to run a computer science classes. At UBC, there are many upper level computer science classes where no actual programming or use of a computer is needed for the course, only pen, paper, and textbooks. Topics like sequential execution, unit testing, and propositional logic can easily be taught with pen and paper. While additional funding will be needed, teachers should understand that there are ways to teach students about coding without huge costs.

2 Student Surveys

2.3.1 Survey responses

Surveys were sent to a group of 17 and 18 year olds at Elgin Park Secondary. A total of 10
students were interview, 6 were girls and 4 were boys. Questions pertained to their use of
technology, and their knowledge and interest in programming.

When asked "How often do you use a computer (or iPad, iPhone etc.)?" and "How often do you
use apps?" nearly all responded with "several times a day." When asked "Are you interested in
creating your own apps" the responses showed that a moderate interest overall with boys

showing slightly more interest on average. Asked the question "*How much do you know about*

programming" and "have you ever done any programming," most replied with "very little" and

"no", respectively. When asked "Are you interested in learning how to program", the results

were varied with boys showing more interest on average (figure 2). When asked "*Do you like puzzles*" the responses varied from "moderate" to "a lot" (figure 3).

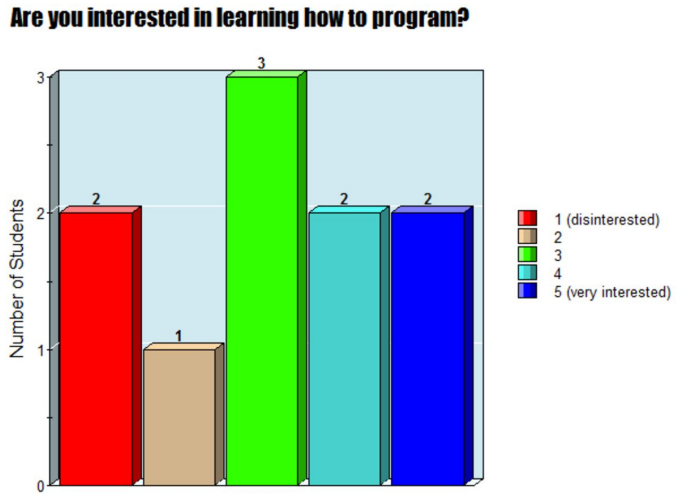

Figure 2: There is moderate interest in learning how to program among 16-17 year olds.

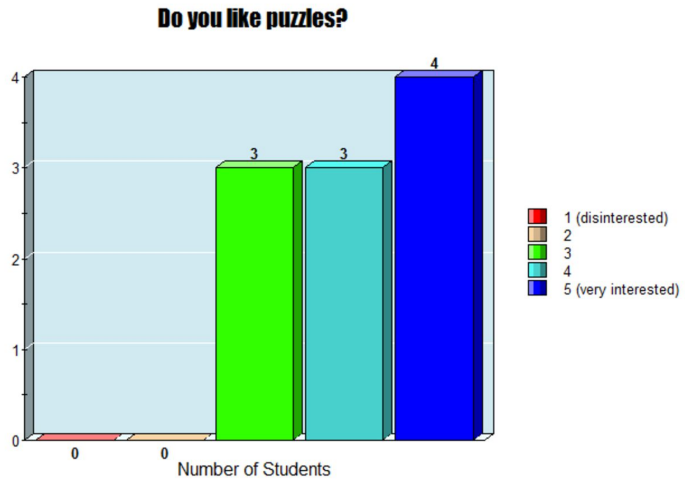

Figure 3: Most 16-17s year olds tend to like puzzles.

2.3.2 Discussion of Survey Responses

The results of this survey have made it clear that, while students use computers heavily, they do

not understand how software works. However, there is moderate interest in creating apps, as well

as generally liking puzzles.

Creating an app is not a simple process, and is far from anything that you will learn in an

introductory programming course. However, the question was an example of how presenting

something in an interesting way can make it more desirable. The respondents tended to show

more interest in app creation than they did in learning how to program. The students also tended

to have favourable views towards puzzles. This is interesting because many problems

in

computer science are presented as puzzles.

A UW study has shown that many girls do not find stereotypically ‘geeky’ environments to be

inviting. In the study, 270 students aged 14 to 18 were shown pictures of 2 different computer

science classrooms. One was a stereotypical computer science room filled with computers parts

and ‘Star Trek’ posters, and the other was non-stereotypical with art and picture of nature. Girls

(68%) were more likely than boys (48%) to prefer the non-stereotypical classroom. The study

suggests that the stereotypes attached to computer science are unattractive to girls,

while boys are ambivalent (McElroy 2015).

3 Conclusion

3.1 Overall Discussion of Findings

This proposal touches on many issues all pertaining to the state of computer science in BC’s

public education system. The BC government appears to be inauthentic in its commitment to

adding coding to the mandatory curriculum. While the BC Liberals claim they want to add

coding to the mandatory curriculum, statements like “School districts can choose to upgrade computers or buy new gear within their existing budgets” from Education Minister Mike Bernier, appear to contradict their supposed intentions. This lack of funding was made clear by most teachers that were interviewed.

The survey revealed that very few high school students have any knowledge of computer science. Many people, and especially girls, might be finding stereotypes associated with computer science to be unattractive. This leads to significantly fewer girls going into computer science. The survey also showed that students had more interest in puzzles and creating apps than they did in learning how to program. This indicates that presenting programming in a different way might lead to increased interest.

3.2 Proposed Solutions

In order to create more funding for BC schools, there are 2 potential solutions. In both cases, spreading awareness towards the school funding situation is very important. First, petitioning the BC Liberals to allocate more money towards education is potential course of action. However,

considering the large amount of criticism they have received from the media over the issue, this appears unlikely to cause any change. An alternative course of action is to promote the NDP party for the next BC election (May 9, 2017). The NDP has been fiercely critical of the BC Liberals education stance for a long time. In general, the NDP support high taxes for the wealthy which goes towards social services like education. Again, spreading awareness about the funding issue is the first place to start. As discussed throughout this report, if schools were adequately funded, they would be able to implement computer science programs for all students.

There are some ways that computer science can be taught in classrooms without incurring high costs. The use of puzzles and logic to introduce computer science topics is common and does not require expensive equipment. While the use of computers is ultimately necessary to teach the practical application of programming, many of the initial ideas can be taught without them.

Another solution involves the active advertisement of computer science in public schools. Again, this begins with spreading awareness of the issue to teachers. Telling teachers the benefits that coding and computer science in general can have on students could motivate them to

advertise it

better. There are many benefits to learning to code: more job prospects, higher average income,

and greater critical thinking skills to name a few. With all of these facts at their disposal, it seems

as though teacher should be able to motivate more students to give programming a try.

Finally, work needs to be done in order to make computer science more enticing for students.

This would require more research into this topic to find what type of environments would attract

a large and diverse portion of the population. During the training of teachers, it should

be emphasized that the environment of their computer science classrooms can play an

important role in attracting women to computer science.

It should be noted that these proposed solutions would not “solve” the problem. But they would

improve the current situation. The most impactful solution, and the most difficult to achieve, is to

increase funding to schools. But even small changes such as increasing teacher’s knowledge of

the benefits of programming, and more effort into creating a more inclusive environment would

surely help to motivate students to learn more about programming.

4 Appendix

4.1 Interview Questions

1) Do you think that computer science skills are important to learn for elementary and high

school aged students?

2) Do you think that students are adequately exposed to computer science?

3) Do you think students are interested in computer science?

4) Do you think that it should be mandatory for students to learn introductory level programming

skills? What are some pros and cons of making programming mandatory?

5) Do you think that computer science should be part of a science class, or its own independent

course?

6) How do you think awareness and interest in programming could be increased among students?

7) More specifically, how do you think awareness and Interest in programming could be

increased among girls?

8) Do you have any final thoughts on this subject?

4.2 Survey Questions

Gender: man woman other

Age:

1) How often do you use a computer (or iPad, iPhone etc.)?

Rarely a few times a week every day several times a day

2) How often do you use apps?

Rarely a few times a week every day several times a day

3) Are you interested in creating your own apps? [1 = disinterested, 5 = very interested]

1 2 3 4 5

4) How much do you know about computer programming [1 = very little, 5 = a lot]

1 2 3 4 5

5) Have you ever done any computer programming?

Yes No Unsure

6) Are you interested in learning how to program? [1 = disinterested, 5 = very interested]

1 2 3 4 5

7) Do you like puzzles? [1 = disinterested, 5 = very interested]

1 2 3 4 5

Citations

BC Government. "B.C. tech sector now employing more than 100,000 people." *B.C. tech sector now employing more than 100,000 people*. N.p., 18 Jan. 2017. Web. 10 Apr. 2017.

McElroy, Molly. “To get girls more interested in computer science, make classrooms less ‘geeky’.” *UW Today*, 24 Aug. 2015, www.washington.edu/news/2015/08/24/to-get-girls-more-interested-in-computer-science-make-classrooms-less-geeky/. Accessed 8 Apr. 2017.

Ministry of Education. “B.C.'s New Curriculum.” *Province of British Columbia*, Province of British Columbia, 15 Mar. 2017, www2.gov.bc.ca/gov/content/education-training/k-12/teach/curriculum. Accessed 8 Apr. 2017.

McElroy, Justin. “Student funding in B.C. second worst in Canada, argues new report.” *CBCnews*, CBC/Radio Canada, 25 Aug. 2016, www.cbc.ca/news/canada/british-columbia/education-funding-british-columbia-ccpa-2016-1.3735255. Accessed 8 Apr. 2017.

Shaw, Gillian ShawMore from Gillian. “Coding to be added to BC school curriculum, sort of.” *Vancouver Sun*, 19 Jan. 2016, vancouversun.com/news/staff-blogs/coding-to-be-added-to-bc-school-curriculum-sort-of. Accessed 8 Apr. 2017.

Silcoff, Sean. “B.C. to add computer coding to school curriculum.” *The Globe and Mail*, VANCOUVER — The Globe and Mail, 18 Jan. 2016, www.theglobeandmail.com/technology/bc-government-adds-computer-coding-to-school-curricul

um/article28234097/. Accessed 8 Apr. 2017.

Strauss, Karsten. "Top Degrees For Getting Hired In 2017." *Forbes*. Forbes Magazine, 23 Nov. 2016. Web. 10 Apr. 2017.