Underserved Learners' Access to Computer Science Education in Canada

Educator and Community Engagement Report

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Executive Summary

There is no doubt that good quality, accessible Computer Science education is needed in Canada. The COVID-19 pandemic — which required us to live, work, interact, and learn online more than ever before — has highlighted the need for basic digital literacy. It has also demonstrated that most Canadians lack the basic Computer Science skills needed to understand how computers work and how to create with them. The role that digital technologies play in our lives will only continue to grow, and all Canadians need to be equipped with the necessary computer skills and competencies that empower them to not only be the consumers but also the creators of these new tools.

Gaining proficiency in Computer Science skills is particularly important for young Canadians, who will enter a competitive job market: experts estimate that 70 percent of Canada's top jobs of the future will require STEM learning.[1] Furthermore, a working population with strong Computer Science proficiency is needed to help Canada participate fully in what the World Economic Forum has called the Fourth Industrial Revolution.[2]

Canadians are on board — 70% agree that learning Computer Science is relevant for today and for the future.[3] And although the Canadian government devoted up to $50 million in the 2017 federal budget to digital skills development for K-12 students, Canada has not adopted a national strategy for teaching digital skills and Computer Science in schools or on the job, despite repeated recommendations from experts.[4] [5]

"Computer Science is the future."

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[1] "Spotlight on Science Learning: The High Cost of Dropping Science and Math." Let's Talk Science and Amgen Canada Inc., 2013. Available online: https://letstalkscience.ca/sites/default/files/2019-08/2013%20LTS_High%20Cost%20of%20Dropping%20STEM%20EN_0.pdf

[2] Andrew Do and Annalise Huynh. "Hello World! Working in a Digital Era." Brookfield Institute. Available online: https://brookfieldinstitute.ca/hello-world-working-in-a-digital-era/

[3] "Learning for the Digital World: A Pan-Canadian K-12 Computer Science Education Framework." Canada Learning Code. Available online: https://k12csframework.ca/wp-content/uploads/Learning-for-the-Digital-Future_Framework_Final.pdf

[4] Do and Huynh. "Hello World."

[5] Tea Hadziristic. "The State of Digital Literacy in Canada." Brookfield Institute. Available online: https://brookfieldinstitute.ca/wp-content/uploads/BrookfieldInstitute_State-of-Digital-Literacy-in-Canada_Literature_WorkingPaper.pdf

This lack of a national strategy means that implementation of Computer Science education in schools is uneven, with access differing between provinces, territories, schools, and even individual teachers.[6] For some learners, Computer Science learning experiences may be integrated with core curricula, but for the vast majority they are often offered as electives or extracurricular activities. In some cases, there are few or no opportunities for learners to access Computer Science education at all.[7] This dynamic is replicated in adult education, but is even more "fragmented and confusing" as there is a wide variety of programs for adult learners (who have the means to pay for them), with little to no coordination among these programs.[8] This fragmentation means that the best way for children or adults to access quality Computer Science education — and the advantages it provides — is to have the disposable income to pay for it. Given that Computer Science skills are required for many well-paying jobs, it can be assumed that failing to provide accessible and affordable Computer Science education to all will worsen the wealth gap that disproportionately affects Black and Indigenous people as well as racialized immigrants in Canada.

The lack of access to Computer Science education is even more acute for marginalized groups. As noted above, individuals who don't have extra time and money for instruction and resources are disadvantaged in accessing Computer Science learning experiences. Organizations that might provide them with free instruction and communal tools are often under-resourced and therefore lack the funding to do so. In a vicious cycle, lack of access to computers means that many underserved learners have low levels of literacy in basic computer use (such as keyboard use), which places Computer Science learning further out of their reach. Low proficiency in math, science, and language skills is also a barrier. And for some, the most concrete and basic barrier to accessing Computer Science learning remains lack of access to the internet. In rural areas of Canada, only 40 percent of households have internet access with the recommended download speed of 50 Mbps; of those, 31.3 percent are First Nations households. Many learners who are underserved in access to Computer Science learning opportunities in Canada are racialized, and as a result these learners also face complex social and

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[6] Sam Andrey, et al. "Mapping Toronto's Digital Divide." Brookfield Institute, Jan. 2021. Available online: https://brookfieldinstitute.ca/wp-content/uploads/TorontoDigitalDivide_Report_Feb2021.pdf

[7] "Learning for the Digital World."

[8] Annalise Huynh and Nisa Malli. "Levelling up: The Quest for Digital Literacy." Brookfield Institute, June 2018. Available online: https://brookfieldinstitute.ca/wp-content/uploads/Level-Up-report-FINAL-online-1.pdf

psychological barriers such as racism, low expectations of educators, and trauma.

Although studies have been conducted about underserved learners' access to Computer Science education in the United States, much less has been done to analyze the situation in Canada. The project team for this report therefore set out to learn about the needs and barriers experienced by Indigenous people, Black people, and immigrants to Canada through interviews, a questionnaire, and a literature review. Much more research, and more focused study, on underserved learners' access to Computer Science learning experiences in Canada is needed.

It should be noted that there is a huge variation of experiences and circumstances in the broad population groups explored in this report. This report is meant as an overview to allow for further in-depth research centred on the specific cultures — and educational needs and barriers — of these learners.

Brief Summary of Findings: Barriers and Needs

Below is a summary of key findings related to the barriers and needs faced by underserved learners in accessing Computer Science learning experiences in Canada.

Learners Experience Barriers to Educational Success.

> Engagement and research revealed that learners' basic needs — including needs for food, housing, childcare, and more — must be met to enable learners to engage with Computer Science. Learners also need help to achieve proficiency in core curricular subjects and basic computer skills before they can benefit from Computer Science learning experiences. Many underserved learners may also grapple with diverse and complex psychological and social barriers.

Organizations and Learners Need Greater Access to Hardware, Software, and the Internet.

> A common barrier to accessing Computer Science education is the lack of access to hardware, software, and the internet. This scarcity of resources is a barrier both for organizations

providing science and technology learning experiences in communal settings, as well as for learners who might engage with Computer Science learning experiences at home.

Learners need access to Computer Science instructors.

Engagement and research revealed that institutions and organizations do not have enough instructors who are qualified to teach Computer Science. Engagement and research also told us that it is important for learners to have access to Computer Science instructors who belong to the same community as the learners they teach, particularly those who belong to the same racial population group as their learners. Instructors who are neither from the community nor culturally reflective of the community must be culturally sensitive and able to centre their learners' cultures, experiences, and needs to encourage more engagement in Computer Science learning experiences.

Learners need different types of Computer Science learning experiences.

Computer Science learning experiences for underserved learners must be flexible to meet their lifestyles, needs, and aspirations, and should be designed to match learners' proficiency levels in math, science, or language skills. Engagement and research revealed the benefits of Computer Science learning experiences and spaces that are open, unstructured, and judgement free. More structured Computer Science learning experiences should help learners apply Computer Science skills to bring projects to life with imagination and creativity. Computer Science learning experiences should also make real-world connections and leverage learners' ability to support other learners.

Learners need different types of lesson plans.

Engagement yielded some specific ideas for lesson plans. Interviewees who work with immigrant learners with lower English proficiency said that Computer Science learning experiences that incorporate ESL lessons would be valuable. Youth instructors said that their learners would be interested in Computer Science lessons that use exciting methods and tools. Many interviewees recommended creating "MIYO" (Make It Your Own) lesson plans, into which instructors or experts could

insert specific cultural or local connections which they know will resonate with their learners.

Brief Summary of Findings: Recommendations for Action

Below is a summary of key findings related to the actions that Computer Science education organizations can take to help underserved learners access Computer Science learning experiences.

Support culturally reflective organizations that are working with underserved learners.

Interviewees from culturally reflective organizations who are providing educational programming expressed interest in partnering to teach Computer Science. Interviewees also asked that larger organizations use their wider communications platforms and networks of partners to help culturally reflective organizations become better known to gain more funding and support. Finally, interviewees from culturally reflective organizations reported being disadvantaged in competing for funding devoted to Computer Science and asked for help in securing it.

Create and provide “train the trainer” initiatives.

Interviewees frequently recommended that Computer Science education organizations offer “train the trainer” initiatives, which would involve hiring and training community members to provide Computer Science learning experiences to learners in their communities. Many felt that these initiatives would create long-term change in communities and reach more underserved learners.

Make a “community connection” to learn whether direct service provision is needed, wanted, and wise.

While interviewees generally felt that it is preferable for underserved learners to receive instruction from culturally reflective organizations and instructors, they also described how some outside organizations can successfully and

sensitively engage in direct service provision with underserved learners.

Introduction

Who are “underserved learners”?

The purpose of this report was to survey a wide variety of organizations working with different groups of learners to better understand the common barriers to Computer Science education that these groups share and to highlight some key distinctions. More research is needed to better understand the distinct barriers and needs of each community.

This report will repeatedly make use of the term “underserved learners” to describe learners who face barriers in accessing Computer Science learning experiences. There is no clear or established definition for the phrase “underserved learner,” and the term may shift based on the context in which it is being applied, and when.

“Underserved learners” should also be understood to be a complex and intersectional group — many underserved learners might self-identify with more than one of the groups researched in this report.

Individuals who self-identify as belonging to one or more of the groups that this report focuses on — as well as organizations offering educational programming to these groups — were included in our engagement and research on underserved learners for the following reasons:

1. Individuals in these groups are less likely than others to have physical access to the resources needed to engage with Computer Science learning experiences;

2. Individuals in these groups are statistically more likely to live below the poverty line or in under-resourced communities; and/or

3. Individuals in these groups have been historically excluded in Canadian society and continue to be disadvantaged in traditional educational settings and other public spheres.

The project team thus set out to learn whether learners who self-identified with one or more of the following groups could be considered underserved in their access to Computer Science learning experiences, and to better understand the shared and distinct barriers they faced:

- Indigenous people,
- Black people, and
- Immigrants to Canada.

A note about gender: The disadvantages that girls and women experience in STEM fields, including Computer Science, are well documented. Because this inequity is better established in literature, this report focuses instead on the groups identified above. Girls and women in these groups may experience additional barriers to accessing and engaging with Computer Science learning experiences due to their gender.

Access to Computer Science education in Canada

The little research that has been done on Computer Science education in Canada shows that access to it is uneven.[9] But no specific data exists on access to Computer Science education for Indigenous, Black, and immigrant learners. In fact, there is almost no race-based data on Canadian children's relative learning outcomes in school, even on core curricular subjects. The only provincial government that collects race-based data on their students is British Columbia, which identifies and tracks core outcomes of Indigenous students.

Although there is no comprehensive collection of race-based data on learners in Canada, it is clear from other statistics and research that racialized learners in Canada are disadvantaged in education. K-12 educational attainment continues to be low for racialized groups which

[9] "Learning for the Digital World."

have been historically excluded and systemically disenfranchised in Canada.[10]

Furthermore, although no clear race-based data on access to Computer Science learning experiences in Canada exists, we know that racialized groups are underrepresented in Canada's tech sector. It is also well established that a strong K-12 and post-secondary educational "pipeline" is essential in encouraging students from diverse backgrounds to explore Computer Science careers.[11] It follows, then, that the underrepresentation of certain groups in Canada's tech sector is likely the result of a dearth of Computer Science education experiences in many young people's formative years.

Research from the Brookfield Institute[12] found that:

- In 2016, Indigenous people in Canada participated in tech occupations at a rate of 2.2 percent, compared to the rate of non-Indigenous individuals in Canada at 5.2 percent.
    - Métis people had the highest participation rate of Indigenous people at 2.3 percent — approximately half of all those identifying as Indigenous in tech occupations.
    - Participation rate for First Nations people was at 1.6 percent.
    - Participation rate for the Inuit was at 1.3 percent.
    - Indigenous people participating in tech occupations are paid much less than non-Indigenous workers. In 2016, this gap ranged from $3,400 lower for Métis people to $30,000 lower on average for the Inuit.

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[10] John Richards and Parisa Mahboubi. "Measuring Student Outcomes: The Case for Identifying Indigenous Students in Canada's PISA Sample." C.D. Howe Institute. Available online: https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed/C.D.%20Howe%20E-Brief%20272.pdf

[11] Allison Scott, et al. "The Leaky Tech Pipeline: A Comprehensive Framework for Understanding and Addressing the Lack of Diversity across the Tech Ecosystem." Kapor Centre for Social Impact. Available online: https://mk0kaporcenter5ld71a.kinstacdn.com/wp-content/uploads/2018/02/KC18001_report_v6-1.pdf

[12] Viet Vu, Creig Lamb, and Asher Zafar. "Who Are Canada's Tech Workers?" Brookfield Institute. Available online: https://brookfieldinstitute.ca/wp-content/uploads/FINAL-Tech-Workers-ONLINE.pdf

- In 2016, Black individuals participated in tech at 4.27 percent (the second lowest rate of the groups examined; Filipino individuals participated at a rate of 3.4 percent).
    - Black tech workers are the lowest paid of all visible minority groups working in tech occupations. In 2016, their average salary was $63,000 — over $13,000 less than the average for all other visible minority groups, and more than $16,000 less than the average for non-visible minorities.

- Immigrants, at first glance, appear to do very well in tech and in fact appear to be overrepresented in the field. In 2016, immigrants made up 37.5 percent of tech workers in Canada (they are 21 percent of Canada's total population[13]), with almost 9 percent of immigrants in tech occupations compared to 4 percent of non-immigrants.
    - These high numbers are likely due to economic immigrants who enter Canada to take tech jobs. In 2017, over 1 in 10 immigrants between 25 and 54 years of age worked in professional, scientific, and technical services.[14]
    - Immigrant men received compensation that was nearly equal to non-immigrant men in tech positions.
    - Immigrant women in tech earned less than non-immigrant women in tech.
    - Immigrant women were also three times less likely to participate in tech occupations than immigrant men, with rates of 3.5 and 12.1 percent, respectively. Research shows that immigrant women with STEM training face greater barriers to finding meaningful employment in their fields than immigrant men do, partly due to having more trouble getting their credentials recognized (48

[13] Gilles Pison. "The Number and Proportion of Immigrants in the Population: International Comparisons." *Population & Societies 563.* France: Institut National D'études Démographiques, Feb. 2019.
[14] Statistics Canada. The Canadian Immigrant Labour Market: Recent Trends from 2006 to 2017. Available online: https://drive.google.com/drive/folders/1qOgYAjpIZEsgNdD9MaNSqc7FPQ4EpkWW

percent versus 56 percent for immigrant men).[15]

Canada's Information and Communications Technology industry suffers from talent shortages — and according to some predictions, those shortages may get worse.[16] Multiple studies have identified that supporting women, Indigenous youth, and youth living in poverty to attain STEM education would prevent that shortage.[17]

About the Groups we Describe as Underserved

Indigenous People in Canada

For the purposes of this report, the adjective "Indigenous" will be used to refer to people who self-identify as possessing First Nations, Inuit, or Métis heritage; these are the groups and terms recognized in the Canadian Constitution.

Indigenous people have lived in the geographic area now known as Canada since long before the arrival of European colonizers. Indigenous people are an extraordinarily varied group — according to Statistics Canada, there are more than 630 First Nation communities alone in Canada, representing over 50 nations with rich and diverse cultures, heritages, and histories.[18]

According to the 2016 Canadian Census, there were 1,673,785 Indigenous people in Canada, accounting for 4.9 percent of the total population of Canada. Indigenous people are also the fastest growing population group in Canada — their population grew by 42.5 percent between 2006 and 2016 — and they also constitute the youngest

[15] Saadia Muzaffar, et al. "Workfinding and Immigrant Women's Prosperity in STEM." TechGirls Canada. Available online: https://drive.google.com/file/d/1bW3NhapctYQRD7scdQ0c8eERiHNgBd12/view
[16] Hadziristic. "The State of Digital Literacy."
[17] Ibid.
[18] Statistics Canada. Aboriginal peoples in Canada: Key results from the 2016 Census. Available online: https://www150.statcan.gc.ca/n1/daily-quotidien/171025/dq171025a-eng.htm?indid=14430-1&indgeo=0

population in Canada; about 44 percent were under the age of 25 in 2016.[19]

At the time of the 2016 Census, just over half (51.8 percent) of Indigenous people in Canada lived in a metropolitan area of at least 30,000 people. Of Indigenous people aged 18 and older living in urban areas, 38 percent lived in a food insecure household.[20]

First Nations people

The term "First Nations" is used by the Canadian government to refer to people "who are members of a First Nation/Indian Band and those who are not, as well as those with and without registered or treaty Indian status under the Indian Act."[21]

In 2016, First Nations people accounted for 2.8 percent of the total population of Canada. This group included 744,855 First Nations people with registered or treaty Indian status and 232,375 people who did not have registered or treaty Indian status, as defined by the Indian Act.[22]

The Indian Act created reserves, areas of land "set apart for the use and benefit" of First Nations bands.[23] In 2011, there were 3,100 reserves in Canada.[24] 44.2 percent of First Nations people with registered or treaty Indian status lived on reserve and 55.8 percent did not live on reserve. Almost all the people who did not have registered or treaty Indian status did not live on reserve.[25]

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[19] Government of Canada. Indigenous peoples and communities. Available online: https://www.rcaanc-cirnac.gc.ca/eng/1100100013785/1529102490303
[20] Statistics Canada. Indigenous people in urban areas: Vulnerabilities to the socioeconomic impacts of COVID-19. Available online: https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00023-eng.htm
[21] Statistics Canada. Aboriginal peoples in Canada.
[22] Ibid.
[23] *Indian Act.* R.S.C., 1985, c. I-5. Available online: https://laws-lois.justice.gc.ca/eng/acts/I-5/page-1.html
[24] Statistics Canada. Aboriginal peoples in Canada.
[25] Statistics Canada. The housing conditions of Aboriginal people in Canada. Available online: https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016021/98-200-x2016021-eng.cfm

In 2016, the First Nations population was concentrated in western provinces, with over half of First Nations people living in British Columbia, Alberta, Manitoba, and Saskatchewan. Just over 24 percent of the First Nations of Canada population lived in Ontario, 9.5 percent in Quebec, 7.5 percent in the Atlantic provinces, and 2.1 percent in the territories.[26]

Inuit

"Inuit" refers to the Indigenous people of the Arctic. The word Inuit means "the people" in the Inuit language of Inuktitut. The singular of Inuit is Inuk.

64,325 individuals identified as Inuit in the 2016 Census — 4 percent of the total Indigenous population of Canada and 0.2 percent of the Canadian population overall.[27]

Of these 64,325 individuals, 73 percent lived in Inuit Nunangat, which comprises 51 communities across four regions:

- Inuvialuit Settlement Region (Northwest Territories and Yukon), with over 6.57 percent of the Inuit population;
- Nunavut, with over 63.66 percent;
- Nunavik (northern Quebec), with 24.93 percent; and
- Nunatsiavut (Labrador), with 4.84 percent.[28]

Métis people

The word "Métis" has been used to describe a group of individuals with mixed Indigenous and European (usually French) ancestry. In Canada, the Métis people are recognized as a distinct culture as well as one of three Indigenous groups acknowledged in the Constitution.

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[26] Statistics Canada. Aboriginal peoples in Canada.
[27] Government of Canada. Annual Report to Parliament 2020. Available online: https://www.sac-isc.gc.ca/eng/1602010609492/1602010631711
[28] Statistics Canada. Aboriginal Population Profile, 2016 Census. Available online: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/abpopprof/details/page.cfm?Lang=E&Geo1=AB&Code1=2016C1005086&Data=Count&SearchText=Inuvialuit%20region&SearchType=Begins&B1=All&GeoLevel=PR&GeoCode=2016C1005086&SEX_ID=1&AGE_ID=1&RESGEO_ID=1

587,545 people identified as Métis in the 2016 Census, representing about 32 percent of the total Indigenous population and 1.7 percent of the total Canadian population.[29]

In 2016, over 80 percent of Métis people lived in the western provinces and in Ontario, and over 60 percent lived in a metropolitan area of at least 30,000 people. Just over a third of Métis people lived in eight cities: Winnipeg, Edmonton, Vancouver, Calgary, Ottawa–Gatineau, Montréal, Toronto, and Saskatoon.[30]

Indigenous People, Education, and Income in Canada

For the purposes of this report, the phrase "the education system" will be used to refer to institutional systems of Eurocentric education.

In Canada, many Indigenous children attend provincial or territorial schools with non-Indigenous children. The education provided to students in a school falls under the jurisdiction of the provincial or territorial government in which the school is located.

Many other Indigenous children attend on-reserve schools. On-reserve schools are managed by First Nations and organizations designated by First Nations to deliver culturally appropriate education. However, there is no comprehensive system of education on reserves.[31] Legally, under the 1985 Indian Act, on-reserve schools technically fall under the jurisdiction of the federal government. First Nations schools are chronically underfunded; it has been asserted that First Nations children in on-reserve schools receive about 30 percent less funding for their education than children in provincial systems.[32] [33]

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[29] Statistics Canada. First Nations People, Métis and Inuit in Canada: Diverse and Growing Populations. Available online: https://www150.statcan.gc.ca/n1/pub/89-659-x/89-659-x2018001-eng.htm
[30] Statistics Canada. Aboriginal peoples in Canada.
[31] Richards and Mahboubi. "Measuring Student Outcomes."
[32] Chiefs Assembly on Education. "Federal Funding for First Nations Schools." Available online: https://www.afn.ca/uploads/files/events/fact_sheet-ccoe-8.pdf
[33] Jody Porter. "First Nations students get 30 per cent less funding than other children, economist says." CBC News, March 14, 2016. Available online:

2011 estimates indicated that of 120,000 eligible on-reserve First Nation students, 60% attended school on reserve, 40% attended provincial schools (usually at the secondary level), and less than 2% attended one of seven schools operated by the federal government.[34] One researcher noted that many children "pass back and forth between schools in different systems [which is] hardly conducive to educational success."[35]

Gaps in equity for Indigenous learners are clear in their rates of educational attainment. While 90 percent of young adults aged 20-24 in Canada have high-school certification, this figure is only 48 percent for First Nations people of the same ages who live on reserve. Among the Inuit, just over 49 percent of this cohort have completed high school. Among Métis people the figure is 84 percent; this high number may be attributed to the fact that most Métis people live in cities, where they do not attend on-reserve schools.

Similarly, fewer than 1 in 10 Indigenous people in Canada have a bachelor's degree.[36] Studies show that Indigenous youth between 15 and 24 years of age are significantly underrepresented in scientific fields of study, including mathematics, Computer Science, physical science, engineering science, and applied science.[37]

These gaps in graduation rates are one likely cause of the significant wage gap between Indigenous and non-Indigenous people in Canada.[38] In 2015, the median income of non-Indigenous people aged 25 to 64 in Canada was nearly $43,000. Métis people of this age group were paid $40,814; Non-Status Indians $34,458; the Inuit, $33,135;

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https://www.cbc.ca/news/canada/thunder-bay/first-nations-education-funding-gap-1.3487822

[34] Canada Parliament Senate. Report of the Standing Senate Committee on Aboriginal Peoples. *Reforming First Nations Education: From Crisis to Hope*. 1st Session, 41th Parliament, June 16, 2011. Available online: https://sencanada.ca/content/sen/Committee/411/appa/rep/rep03dec11-e.pdf

[35] Richards and Mahboubi. "Measuring Student Outcomes"

[36] Editorial Board. "More Indigenous people in Canada are graduating from high school than ever. It's still not nearly enough." *The Globe and Mail,* June 4, 2020. Available online: https://www.theglobeandmail.com/opinion/editorials/article-more-indigenous-canadians-than-ever-are-graduating-from-high-school/

[37] "Spotlight on Science"

[38] Government of Canada. Annual Report.

Registered Indians off reserve, $32,553; and Registered Indians on reserve, $20,357.[39]

Finally, no conversation about Indigenous people and the education system in Canada would be complete without acknowledging the trauma of the residential school system. This network of mandatory institutions in which "seven generations of Aboriginal children were denied their identity through a systematic and concerted effort to extinguish their culture, language, and spirit"[40] operated for over 160 years in Canada.

The residential school system was just one of many inhumane and disenfranchising policies that contributed to the wide disparities between Indigenous people and non-Indigenous people in Canada, and this history strongly affects the relationship between Indigenous people and the education system in ways that are far too complex to be encapsulated here.

The ongoing impacts and trauma of this system cannot be overstated.

Black People in Canada

In this paper, the adjective "Black" will be used to refer to the varied group of 1.2 million people who self-identified as Black in the 2016 Canadian Census.

Black people in Canada, who make up 3.5 percent of the country's total population, have diverse backgrounds and experiences.[41]

Many Black Canadians have deep roots in Canada, with families who have been here for many generations and whose ancestors may have arrived in Canada under many different circumstances.

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[39] Ibid.
[40] Truth and Reconciliation Commission of Canada. 2015. Canada's residential schools. The final report of the Truth and Reconciliation Commission of Canada. Volume 1.
[41] Statistics Canada. Diversity of the Black population in Canada: An overview. Available online: https://www150.statcan.gc.ca/n1/pub/89-657-x/89-657-x2019002-eng.htm

Conversely, approximately half of individuals who identify as Black are landed immigrants or permanent residents.[42] Most Black immigrants who came to Canada before 1981 arrived from the Caribbean, while many more recent Black immigrants arrived from Africa.[43]

Today, a huge majority of Black people in Canada live in metropolitan areas: over 94 percent, in contrast to 71.2 percent of the country's total population. Toronto has the largest Black population in the country, with 442,015 or 36.9 percent of Canada's Black population. As of 2016, Montréal, Ottawa–Gatineau, Edmonton, and Calgary were each home to at least 50,000 Black people.

Black People, Education, and Income in Canada

As explained earlier, Canadian provinces do not collect race-based data related to student outcomes. However, a very small number of school boards in Canada do collect some race-based data — and the Toronto District School Board (TDSB) is one of them. The TDSB student census is voluntary but popular: 220,000 of 254,000 students completed it in 2017.[44] [45] Among other findings, this data showed that Black students were more likely to be streamed into applied programs, which include fewer prerequisite courses that prepare students for university admission, than their non-Black counterparts. Approximately 40 percent of Black TDSB students were enrolled in applied programs, compared with 18 percent of other racialized groups, and 16 percent of white students.

Similarly, the TDSB's data highlighted that 40 percent of Black students had been suspended at least once by the time they finished high school, and although Black students make up 12 percent of the TDSB high school population, nearly half the students who had been

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[42] Ibid.
[43] Ibid.
[44] Veronica Appia and Dominik Kurek. "Closing the Gap: Why are Black Students in Toronto Less Likely to Thrive?" Toronto.com, June 17, 2019. Available online: https://www.toronto.com/news-story/9405747-closing-the-gap-why-are-black-students-in-toronto-less-likely-to-thrive-/
[45] Carl James, et al. "Towards Race Equity in Education: The Schooling of Black Students in the Greater Toronto Area." York University, April 2017. Available online: https://edu.yorku.ca/files/2017/04/Towards-Race-Equity-in-Education-April-2017.pdf

expelled were Black. Moreover, Black students were twice as likely to drop out of school compared to other racialized and white students, and less likely to apply to post-secondary education than their non-Black counterparts.

It is likely these trends are not specific to Toronto. A CBC news analysis, for example, found that Black students from five of eight school boards in Nova Scotia were suspended at a rate of up to three times higher than the overall representation of Black students in the student population.[46]

Attainment gaps persist past high school for many Black Canadians. For instance, 51 percent of Black males and 69 percent of Black females receive a postsecondary certificate, diploma, or degree compared to 62 percent and 75 percent of males and females in other groups. Integrated 2006 and 2016 census data showed that young Black males were half as likely as males of other groups to be involved in employment, education, or training. Over twice as many Black Canadians as non-Black Canadians reported experiencing discrimination at work or during a hiring process.[47] 2015 data showed that the median wage of Black men aged 25 to 59 was $41,000, while the median wage of other men of other races was $56,000.[48]

Immigrants to Canada

The Canadian government defines an immigrant as "a person who has been granted the right to live in Canada permanently by immigration authorities." Canadian law distinguishes four categories of immigrants: family, who are related to residents of Canada; economic, who are skilled workers; protected people or refugees, who are escaping persecution or unrest; and humanitarian, who

[46] Richard Woodbury. "African-Nova Scotian students being suspended at disproportionately higher rates." CBC News, December 12, 2016. Available online: https://www.cbc.ca/news/canada/nova-scotia/african-nova-scotian-students-suspension-numbers-1.3885721

[47] Statistics Canada. Results from the 2016 Census: Education and labour market integration of Black youth in Canada. Available online: https://www150.statcan.gc.ca/n1/pub/75-006-x/2020001/article/00002-eng.htm

[48] Statistics Canada. Black History Month… by the numbers. Available online: https://www.statcan.gc.ca/eng/dai/smr08/2020/smr08_248

are people accepted as immigrants for humanitarian reasons.[49]

Over 21 percent of Canada's population was born in another country and immigrated to Canada — one of the highest ratios for industrialized Western countries.[50] Of immigrants to Canada in 2019, 58 percent were economic immigrants, 27 percent were family class, and 15 percent were either refugees or people admitted for humanitarian reasons.[51]

In 2019, over 57 percent of the 341,180 immigrants arriving in Canada came from ten countries, with the highest percentage by far — over 25 percent — coming from India. 8.9 percent and 8.2 percent arrived from China and the Philippines, respectively. The fourth and fifth highest percentage of immigrants came from Nigeria (3.7 percent) and the United States (3.2 percent).[52]

Immigrants to Canada make up 27 percent of the urban population and 6 percent of the rural population.[53] According to the 2016 Census, 29.4 percent of immigrants who entered the country between 2011 and 2016 settled in Toronto, 14.8 percent in Montréal, and 11.8 percent in Vancouver.

Roughly 7 in 10 immigrants born outside of Canada are identified by Statistics Canada as visible minorities, meaning that they are not white and not Indigenous.[54]

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[49] Statistics Canada. Dictionary, Census of Population, 2016: Immigrant status. Available online: https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/pop148-eng.cfm
[50] Pison. "The number and proportion."
[51] Government of Canada. Permanent Residents – Monthly IRCC Updates. Available online: https://open.canada.ca/data/en/dataset/f7e5498e-0ad8-4417-85c9-9b8aff9b9eda
[52] Government of Canada: 2020 Annual Report to Parliament on Immigration. Available online: https://www.canada.ca/en/immigration-refugees-citizenship/corporate/publications-manuals/annual-report-parliament-immigration-2020.html#tbl2_5
[53] Statistics Canada. Rural and Small Town Canada Analysis Bulletin. Available online: https://www150.statcan.gc.ca/n1/pub/21-006-x/21-006-x2002002-eng.pdf
[54] Statistics Canada. Immigration and ethnocultural diversity: Key results from the 2016 Census. Available online: https://www150.statcan.gc.ca/n1/daily-quotidien/171025/dq171025b-eng.htm

In general, adult immigrants to Canada arrive with, or attain, a high level of education. In 2017, almost half of immigrants aged 25 to 54 held a university degree compared to just above 30 percent of Canadian-born individuals of the same age group.[55]

The proportion of immigrants arriving with knowledge of French or English is over 93 percent[56] — likely because knowledge of one of the two official languages is among the selection criteria for economic immigrants. That said, a 2018 study found that in Toronto 1 in 20 residents cannot speak either English or French, with seniors and women overrepresented in that group. Over 36 percent of these Torontonians lived below the poverty line compared to 20 percent of residents overall.[57]

The National Settlement program offers Language Instruction for Newcomers (LINC), a free language training program for eligible adult learners. A 2009 evaluation of this program showed that there were nearly 2,000 LINC classes running across Canada in mid-spring. Of 2,008 LINC learners, 37 percent possessed a secondary school diploma or less, 24.5 percent possessed a non-university certificate, and 38.5 percent had a university degree.[58]

Although many immigrants are skilled workers, most newcomers to Canada earn a lower wage than the average Canadian. In 2018, the median entry wage for immigrants to Canada was $30,100, in contrast to the Canadian median

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[55] Statistics Canada. The Canadian Immigrant Labour Market: Recent trends from 2006 to 2017. Available online: https://www150.statcan.gc.ca/n1/pub/71-606-x/71-606-x2018001-eng.htm

[56] Statistics Canada. Linguistic integration of immigrants and official language populations in Canada. Available online: https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016017/98-200-x2016017-eng.cfm

[57] Beth Wilson, Laura Buccioni, and Richard Lau. "Talking Access and Equity: A Profile of City of Toronto Residents Who Speak Neither Official Language." Social Planning Toronto, July 2018. Available online: https://d3n8a8pro7vhmx.cloudfront.net/socialplanningtoronto/pages/2015/attachments/original/1531846236/Language_Report_J5-v5-web.pdf?1531846236

[58] Government of Canada. Evaluation of the Language Instruction for Newcomers to Canada (LINC) Program. Accessible online: https://www.canada.ca/en/immigration-refugees-citizenship/corporate/reports-statistics/evaluations/language-instruction-newcomers-canada-2010/appendixa.html

wage of $37,400. This wage gap widens, however, for visible minority immigrants. Racialized immigrant men earned 71 cents for every dollar earned by non-racialized immigrant men, while racialized immigrant women earned 79 cents for every dollar earned by non-racialized immigrant women.[59]

Interestingly, while over a third of young adults in Canada have parents who are both from another country, children of immigrants seem to perform as well scholastically as non-immigrant children. According to student assessments conducted by the Organisation for Economic Co-operation and Development, within three years of arriving, children of new immigrants score as high on a standardized test as the rest of their classmates.[60]

Our Engagement Process

For the purposes of this report, "educator" will be used to refer to teachers and others who provide any type of learning experience, while "instructor" will be used to refer to those who specifically provide Computer Science learning experiences.

Between April 15 and June 24, 2021, the project team for this report identified, and invited for an interview, 144 experts and educators who work with underserved learners across Canada. 34 individuals working with underserved learners from diverse backgrounds in all regions of the country graciously agreed to participate.

Interviewees joined via phone or video call to discuss their experiences teaching underserved learners, their knowledge of these learners' needs and barriers in accessing Computer Science learning experiences, and the supports that would be useful to them and their learners. We used a semi-structured interview guide to conduct the conversation, with interviews lasting between 30 and 90 minutes. (For a sample of the interview guide, please see page 57.)

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[59] Statistics Canada. Income and mobility of immigrants, 2018. Available online: https://www150.statcan.gc.ca/n1/daily-quotidien/210201/dq210201a-eng.htm

[60] Sean Coughlan. "How Canada became an education superpower." BBC News, August 2, 2017. Available online: https://www.bbc.com/news/business-40708421

Unfortunately, no Francophone organizations responded to our invitations. Francophone learners may face unique challenges in accessing Computer Science learning experiences — more research will be needed to explore this.

The project team also created a questionnaire as another form of engagement. This questionnaire was sent in each of the 204 emailed invitations and was also distributed through SurveyMonkey to educators. 110 respondents took the questionnaire, 43 of whom self-identified as working with underserved learners. In citing the questionnaire in this report, we focused largely on their responses.

It should be noted that this engagement process was carried out during the COVID-19 pandemic, which may have affected response rates.

The project team also conducted a literature review of articles, journals, and sources to seek out scholarship and statistics on underserved learners' access to Computer Science learning experiences in Canada. Each expert who was interviewed was also asked whether they knew of resources relevant to this subject, and many kindly sent articles which were included in research.

All quotes in the margins of this report are unattributed but were provided by interviewees. To see a list of organizations whose representatives joined us for an interview, please see the appendix on page 55.

Summary of Findings

This section summarizes the needs and barriers experienced by underserved learners which were most frequently described in interviews and noted on our questionnaire.

Please note that interviewees frequently and emphatically asserted that every community and learner is different. To be most effective, supportive programs should assess the needs and barriers that learners experience — which interviewees said could be "hidden" or "surprising" — on an individual, case-by-case basis. Similarly, supportive programs should be responsive to the articulated needs of individual communities and should centre each community's unique culture in shaping curricula, practices, and spaces.

Barriers to Educational Success

Learners' basic needs must be met to benefit from Computer Science learning experiences.

When describing the needs and barriers experienced by their underserved learners, almost all interviewees began with descriptions of basic needs, and said that these needs must be met to enable learners to successfully engage with Computer Science learning experiences.

"Meet these basic needs and many learners blossom."

The inability to meet these needs — which can result in food insecurity, housing insecurity, lack of childcare, and lack of financial resources to pay for extracurricular classes and other resources — stems from poverty or unstable household financial conditions. Many interviewees who run successful programs said that a key reason for their programs' success was that they learned about and met these needs first, so that learners could focus on their learning experiences.

Even seemingly small efforts, such as providing a meal or a snack, can go a long way in helping learners to participate in Computer Science learning experiences. For instance, a Brookfield study focusing on after-school programs that provide digital skills

education to underserved youth noted that many successful programs provided meals.

Brookfield's study also highlighted that program affordability was key to providing support to underserved youth who might lack the financial resources needed to participate in extracurricular programming.[61] This theme was echoed by the Conference Board of Canada, which noted that as Indigenous people earn median incomes 35.5 percent below non-Indigenous people, there is not much money left over to invest in education.[62] Making programs free is therefore key to ensuring more equitable access to Computer Science education.

Another barrier mentioned by interviewees working with learners who live in more rural areas was the distances their learners need to travel to access learning experiences. Interviewees spoke of lost time, tiring travel, hazardous travel conditions and routes, and the cost of transportation. These interviewees urged that organizations who wish to reach these learners either pay for travel, or better yet, remove the need by bringing learning experiences into remote communities.

Significantly, of questionnaire respondents, educators who taught underserved learners noted 50 percent more barriers than those who didn't teach underserved learners.

Learners need help to achieve proficiency in core curricular subjects and basic computer skills before they can benefit from Computer Science learning experiences.

Interviewees working with underserved learners reported that many of these learners lack proficiency in core curricular subjects such as math, science, and literacy skills. Interviewees said that

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[61] Annalise Huynh and Nisa Malli. "Plugging In: Empowering Communities to Ensure Digital Literacy Access for Youth." Brookfield Institute, Sept 2020. Available online: https://brookfieldinstitute.ca/wp-content/uploads/Plugging-In-Report-2.pdf

[62] The Conference Board of Canada. "Incorporating Indigenous Cultures and Realities in STEM." June 2020. Available online: https://fsc-ccf.ca/wp-content/uploads/2020/07/24559_10697_incorporating-indigenous-culture-and-realities_primer.pdf

gaining these skills is a more pressing issue for these learners than learning Computer Science subjects like coding. Moreover, questionnaire respondents identified both language barriers and learning disabilities as two of the top three barriers that limit their learners' ability to succeed academically.

Barrier	Number of Respondents
Learning Disability	19
Low or no access to technological resources	18
Language barrier	17
Distance to educational institutions	13
Teachers who lack training or skills	12
Low graduation rate	10
Poverty	9
Low Grades	9

Table 1: Questionnaire responses to "Which of the following difficulties, challenges, and barriers do your learners face in accessing and fully benefiting from education and training in general?"

Some interviewees particularly emphasized low math literacy — and even a fear of or aversion to math — as a likely barrier to engaging with Computer Science, a trend that has been observed elsewhere. For example, a Maryland study found that adolescents who at a young age considered themselves good at math, who took Information Technology (IT) courses, and who were encouraged by role models to enter IT, had the highest aspirations for IT careers.[63]

[63] Nicole R. Zarrett and Oksana Malanchuk. "Who's Computing? Gender and Race Differences in Young Adults' Decisions to Pursue an Information Technology Career." New Directions for Child and Adolescent Development 2005, no. 110 (2005): 65–84. https://doi.org/10.1002/cd.150.

Interviewees from organizations that work with immigrant learners mentioned that their learners' low language proficiency would impede their ability to access Computer Science learning experiences, as most are offered in English and coding relies on knowledge of the English language. Similar language barriers also exist for Indigenous elders who speak Indigenous languages.

Interviewees also said that many learners need to gain more basic computer skills before progressing to Computer Science, a trend that has been observed more generally. For example, a Brookfield paper on digital literacy reported that even instructors leading intermediate or advanced digital training programs felt that their learners didn't come to them with sufficiently strong basic digital skills.[64]

Interviewees noted that different groups of learners would need different types of basic digital literacy:

- Interviewees who work with older learners spoke about a gap in general computer literacy, likely stemming from their learners having studied and worked before digital technologies became ubiquitous.

- Conversely, educators who work with younger learners in more rural areas mentioned a lack of keyboard and hardware skills, as these learners are often accessing the internet from a smartphone rather than a desktop or laptop computer.

Access to basic digital literacy training, however, appears to be more common in urban and suburban areas. Questionnaire respondents — the vast majority of whom were from urban and suburban areas — noted that digital literacy is the element of Computer Science that is most taught to their learners, and indicated that more advanced subjects, such as programming, computing, data, design, and technology and society, would benefit their learners more. These findings suggest that digital literacy, once achieved, can serve as a jumping board for learners to tackle more complex Computer Science subjects.

[64] Andrey, et al. "Mapping Toronto's Digital Divide."

	Currently Learning	Would Benefit from Learning
Basic Skills: Typing, Computer Parts, Creating, saving, downloading, moving files	24	9
Programming: Coding, Algorithms, Modelling	17	14
Computing: Hardware and software, Digital connectivity, cybersecurity	16	17
Data: Storing, collecting, Organizing, and Visualizing Data	14	20
Technology and Society: Digital citizenship, Social impacts, the Law and Ethics	15	17
Design: Program design, Visual design, User design, accessibility	14	16

Table 2: Questionnaire responses to "Which of the following Computer Science subjects are your learners currently learning, and which would they benefit from learning?"

Learners experience complex psychological and social barriers.

Many underserved learners may grapple with diverse and complex psychological and social barriers. Learners who live or have lived in poverty, for example, can experience shame and stigma which can lead to social exclusion.[65] [66] Living in poverty has been tied to a negative sense of self.[67] Interviewees noted that it's important that these learners do not feel stereotyped or judged.

[65] Robert Walker and Grace Bantebya-Kyomuhendo. *The Shame of Poverty*. Oxford: Oxford University Press, 2014.
[66] A.M.W. Simons, et al. "The silent burden of stigmatisation: A qualitative study among Dutch people with a low socioeconomic position." BMC Public Health 18, 443 (2018). Available online: https://doi.org/10.1186/s12889-018-5210-6
[67] Brett Milano. "Taking the Stigma out of Poverty." Harvard Gazette. November 17, 2016. Available online:

More commonly mentioned by interviewees — many of whom work with Black, Indigenous, and other visible minority learners — were the many barriers that learners experience due to racism and discrimination.

Like poverty, racism and discrimination is well documented to have negative impacts on mental health.[68] Some researchers use the term "racial trauma" to describe psychiatric and emotional conditions resulting from experiencing racism; these conditions resemble posttraumatic stress disorder.[69] The varying experiences of racism and discrimination that Black, Indigenous, and visible minority learners are subjected to in Canada impact their experiences of all systems in society — education included. As previously mentioned, Indigenous learners may carry even more trauma related to education due to the history of residential schools in Canada.

Many interviewees spoke of the low scholastic expectations the education system seems to have for underserved learners, recounting anecdotes in which educators told young learners that certain academic subjects were too difficult for them. Interviewees said that their learners internalized these low expectations and became discouraged about their educational prospects from a young age. Multiple studies show that the stereotypes of, and corresponding low expectations for, girls and racialized students in math and computing are echoed by teachers, which results in lower aspirations in computing.[70]

"The school system has not targeted Black youths to excel in STEM"

Other interviewees spoke about school systems making subjective and faulty choices when placing their learners in classes, or when

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https://news.harvard.edu/gazette/story/2016/11/taking-the-stigma-out-of-poverty/

[68] Ontario Human Rights Commission. Racial discrimination and mental health in racialized and Aboriginal communities. Available online: http://www.ohrc.on.ca/en/race-policy-dialogue-papers/racial-discrimination-and-mental-health-racialized-and-aboriginal-communities

[69] Robert T. Carter and Jessica M. Forsyth. "A Guide to the Forensic Assessment of Race-Based Traumatic Stress Reactions." *Journal of the American Academy of Psychiatry and the Law*. Online March 2009, 37 (1) 28-40. Available online: http://jaapl.org/content/37/1/28

[70] Microsoft Philanthropies. "Guide to inclusive computer science education: How educators can encourage and engage all students in computer science." Available online: https://csteachers.org/documents/en-us/2730df36-1cb1-422b-ba2f-afe033750b2e/1/

directing them towards higher education or certain fields of study. As previously mentioned, race-based data on learning outcomes in Canada is thin, but interviewees from the Greater Toronto Area often spoke of the practice of "streaming" Black students into lower-level courses which disadvantage them in applying to university. A TDSB study has confirmed that this is occurring.[71] One interviewee noted that when educational authorities suggest lower-level classes for immigrant learners, the guardians of these learners may not push back or question the choice due to deference or a lack of awareness of other options. This same interviewee said they had witnessed immigrant students with accents being placed in English as a Second Language (ESL) classes regardless of their English proficiency — some had immigrated from countries like India and the Philippines, where English is an official language.

Many interviewees also spoke of social barriers created by the Eurocentricity of the curricula, teaching styles and practices, and physical spaces of Canadian educational institutions. Several interviewees spoke of inflexible "one size fits all" teaching methods that do not take varying cultural practices into account. Interviewees also discussed how their learners do not see themselves or their cultures represented in textbooks, portraits of historical figures, and in many cases their educators (much more on this later).

These difficulties were mentioned by interviewees working with young underserved learners of many backgrounds, but particularly emphasized by those working with Indigenous learners. Most provincial curricula include Indigenous themes and content wedged into lessons,[72] but Indigenizing curricula requires a fundamental shift in the methods and thinking with which education is delivered.[73]

For many Indigenous learners, these Eurocentric institutions may feel connected with — or even like a continuation of — residential

[71] James, et al. "Towards Race Equity."
[72] Adam Gaudry and Danielle Lorenz. 2018. "Indigenization as Inclusion, Reconciliation, and Decolonization: Navigating the Different Visions for Indigenizing the Canadian Academy." *AlterNative: An International Journal of Indigenous Peoples* 14 (3): 218–27. Available online: https://doi.org/10.1177/1177180118785382.
[73] Ibid.

schools and violent colonialism. Interviewees working with Indigenous learners spoke of the need to Indigenize education to create safe cultural spaces and communities for Indigenous learners attending non-Indigenous institutions. One interviewee noted that this would also enrich and benefit non-Indigenous learners.

Organizations and Learners Need Greater Access to Hardware, Software, and the Internet.

One of the most common and concrete barriers underserved learners face in accessing Computer Science education is lack of access to hardware, software, and the internet. This scarcity of resources exists both for organizations providing science and technology learning experiences in communal settings, and for learners at home.

Organizations need key resources in communal settings.

Interviewees working in schools and community organizations often mentioned the shortage of communal hardware for learner use. Interviewees described the computers and hardware they do possess as outdated or in pieces (many organizations receive donated computers and computer parts). Interviewees said that their schools or organizations do not have the resources to purchase more or newer computers. They also said that hardware is a difficult thing to secure funding for — they sense that many funders think of computers as “an extra” (as opposed to, say, ESL classes or life skills training).

Many interviewees also said that their schools and organizations cannot afford to purchase software. And while some software programs have both paid and free versions, some educators noted that the free versions mine data from users, and therefore cannot be used due to privacy policies.

Learners need access to key resources at home.

Most interviewees mentioned that many of their learners cannot afford to buy home computers, and that many learners who do have home computers are using outdated devices. When this aging hardware breaks or fails, learners may not be able to pay for repair (if repair is even accessible — as one interviewee noted, computer repair shops are few and far between in rural and remote areas). Moreover, many learners who have home computers share them with others in their household, resulting in restricted access. Interviewees also said affordability is a barrier when it comes to purchasing software, and some noted that many current software programs cannot run on outdated hardware.

One study suggests that having consistent access to a computer from a young age is one way to bolster interest in technology and cultivate a sense of proficiency with computer tasks.[74] Several others corroborate that informal, self-directed learning at home can increase computer skills, and may be just as important as formal digital skills training.[75] Another study found that young people who do not have digital access at home are less likely to self-learn through experimenting with communal technology in public spaces.[76]

A large number of interviewees also said that their learners do not have adequate home internet access. Many said that their learners simply cannot afford internet access, while others blamed the inadequate internet infrastructure in Canada. Many educators said that outside of metropolitan areas — in some cases, not far outside — internet connectivity is so poor and speeds so low that its use is severely limited.

According to the CRTC, almost 86 percent of households in the country have the recommended broadband download speed of 50 Mbps, but in rural areas, only 40 percent do — and not only is the connection slower, but it's usually more expensive as well.[77] This

[74] Zarrett and Malanchuk. "Who's Computing?"
[75] Uwe Matzat and Bert Sadowski. 2012. "Does the 'Do-It-Yourself Approach' Reduce Digital Inequality? Evidence of Self-Learning of Digital Skills." *The Information Society* 28 (1): 1–12. Available online: https://doi.org/10.1080/01972243.2011.629023.
[76] Hadziristic. "The State of Digital Literacy."
[77] Briar Stewart. "How COVID-19 Worsens Canada's Digital Divide." *CBC News,* September 23, 2020. Available online:

inequity is not only playing out with an urban/rural split, however; a recent report found that over half of Toronto's low-income households report download speeds below the national target.[78]

Learners need access to Computer Science instructors.

Many interviewees mentioned that their institutions or organizations do not have enough instructors who are qualified to teach Computer Science. Similarly, questionnaire respondents whose underserved learners have no access to Computer Science education indicated that lack of instructors, lack of funding, and insufficient time to pursue training are the greatest barriers to bringing Computer Science education to their learners.

Barrier	Number of Respondents
Lack of financial resources to pay for more instructors	5
Lack of time given to teachers to pursue training	5
Lack of staff with computer science training, or lack of financial resources to pay for training	4
Lack of financial resources to pay for computers	4
Lack of space in required curricula	3
Limits to maintaining and repairing technological equipment	2

Table 3: Questionnaire responses to "Which of the following describe barriers that prevent you or your workplace from providing Computer Science instruction?"

https://www.cbc.ca/news/canada/british-columbia/covid-19-highlights-urban-rural-digital-divide-1.5734167.

[78] Andrey, et al. "Mapping Toronto's Digital Divide"

Although there is limited data on the availability of Computer Science training in Canadian schools, an American study found that 60 percent of polled public schools did not have a Computer Science class available; the most frequently cited reason for this was the dearth of qualified teachers.[79] Canadian teachers agree that this is a significant reason for the lack of Computer Science classes offered in Canadian schools as well, especially before high school. In 2015, only about a third of Ontario high schools offered any Computer Science learning experiences — and these were generally offered to older students as electives.[80]

Interviewees said that there is a huge need for instructors to be given the requisite time and resources for professional development, which would enable them to provide Computer Science learning experiences. While discussing this need, many interviewees mentioned that instructors experience a steep learning curve and would need ongoing support to become and remain comfortable with the subject matter. Where there are qualified instructors, interviewees said that they — or school administrators — are still uncomfortable with teaching Computer Science.

"When it comes to training the trainers there's a steep learning curve, especially when you're asking for more than a standalone or one-off lesson"

Compounding the issue of the lack of qualified Computer Science instructors is the lack of educators in general. Some interviewees who have particular experience with rural, remote, northern, or on-reserve schools said that they sometimes don't have enough educators to teach core curricular subjects like math, much less a more specialized subject like Computer Science.

This trend is corroborated by multiple studies showing that students who attend school in under-resourced areas are less likely to be taught by fully qualified educators.[81] One analysis showed that only 30 percent of math teachers in California's high-poverty schools possess credentials to teach mathematics.[82]

[79] Hadziristic. "The State of Digital Literacy."
[80] Ibid.
[81] Scott, et al. "The Leaky Tech Pipeline."
[82] Ibid.

Learners need access to culturally reflective instructors.

Interviewees stressed that it is important to have Computer Science instructors who belong to the same community as the learners they teach. Instructors from the community are more likely to have first-hand "insider knowledge" of the community's culture. With this knowledge, they can shape or alter their curricula, teaching style, and physical spaces to reflect the culture of the community. Instructors from the community are also more likely to have first-hand experience of their learners' situations and are therefore more likely to understand their unique needs and skills.

Instructors from the community are also more likely to belong to the same racial population group as their learners — and the value of students learning from educators of the same race has been repeatedly demonstrated in research.

One large study focusing on over 100,000 Black students in South Carolina found that having just one Black teacher in Grade three, four, or five reduced low-income Black boys' probability of dropping out of school by 39 percent. By high school, the same students had higher expectations of going to college.[83] Closer to home, the parents of Black TDSB students whose child had a Black teacher stated that their kids were more excited for school. These parents also expressed the belief that Black teachers' higher expectations would result in greater support and better academic performance.[84]

"These paths are not common in their cultures, and they haven't seen it in their families, they haven't been exposed to the opportunities – so these paths feel out of their reach"

Although we could not locate demographic data about the racial and ethnic backgrounds of Computer Science teachers in Canada, a study conducted in the United States points to some trends that were also described by our interviewees. According to a 2020 survey by the Kapor Centre, the majority of Computer Science teachers were white (75 percent) and women (64 percent), and they predominantly taught in high income, urban, and less racially diverse schools.[85] A

[83] Seth Gershenson. 2017. "The Long-Run Impacts of Same-Race Teachers." Institute of Labor Economics, IZA DP No. 1063. Available online: http://ftp.iza.org/dp10630.pdf
[84] James, et al. "Towards Race Equity."
[85] Sonia Koshy, et al. "The Computer Science Teacher Landscape: Results of a Nationwide Teacher Survey." Kapor Center, May 2021. Available online: https://csteachers.org/documents/en-us/e1d6ac1e-3ae1-4ac1-983d-aaffdacd03c1/1/

2009 study showed that just 18.6 percent of all teachers in Toronto were racialized; at the time, the population of Toronto was 42.4 percent non-white.[86]

Interviewees suggested that if an instructor cannot be found or trained in community, hiring an instructor who reflects the ethnic or racial backgrounds of their learners is the next best option. Interviewees were clear and emphatic on this point: the value of Black, Indigenous, and visible minority learners seeing themselves in their instructors is invaluable in changing learners' perceptions of what is possible for their own futures. One interviewee even suggested that creating short videos with a person who is visibly Indigenous demonstrating Computer Science concepts could inspire Indigenous youth — so rarely do Indigenous learners see an Indigenous person working with computers and tech.

Another interviewee pointed out that seeing instructors and role models who are Black, Indigenous, or a visible minority could change the pre- and mis-conceptions of learners of other backgrounds as well. For example, a Black learner with a visible minority instructor might not see themselves directly in this instructor, but being exposed to them might expand the learner's understanding of who can succeed in Computer Science.

Instructors who are neither from the community nor culturally reflective must be culturally sensitive and centre their learners' cultures, experiences, and needs.

If instructors cannot be found or trained in community, and outside instructors are not reflective of the community, outside instructors must be diligent and careful in the way they approach their work with underserved learners. Microsoft has noted that issues of power and privilege, particularly in the Computer Science realm, have a history of marginalizing groups of people through innovations and normative professional practices.[87] Many interviewees we spoke with, especially those working with Indigenous learners, highlighted the importance of being aware of these dynamics to avoid replicating

[86] Morgan Sharp. "Breaking the Cycle of Racism in Ontario's Schools." *Canada's National Observer,* June 18, 2020. Available online: https://www.nationalobserver.com/2020/06/18/analysis/breaking-cycle-racism-ontarios-schools

[87] Microsoft Philanthropies. "Guide to inclusive computer science"

them. Interviewees also noted that to further build trust between outside instructors and learners, instructors should not be "a flash in the pan" — they should be embedded in the community for as long as possible.

Interviewees said that outside instructors engaging with underserved learners should have trauma-informed training, so that they are compassionate and understanding, flexible, and responsive to learners' unique situations. For example, an interviewee who works with refugees noted that his learners — many of whom are separated from their families who remain in unstable regions — experience unique stress. Educators and community partners of the Academy of Indigenous Studies recommend that instructors "recognize that students are bringing issues to school that educators need to be able to identify, understand, and address."[88]

Interviewees also strongly asserted that outside instructors must centre and privilege the community's culture and needs in Computer Science learning experiences. Interviewees urged that instructors position themselves as students in the community to gain thorough knowledge of the community's needs and culture. As an Okanagan elder and educator explained: "[We] have the answers for [ourselves], we are not asking others to figure that out for us, we already have that knowledge. What we do need is a partnership to work with people who have other training to help us implement our vision. Not create the vision for us."

Leroy Little Bear, a leader and advocate of First Nations education, wrote, "Because of the fact that Aboriginal people understand the world in terms of relationships, the inclusion of community in the learning process of Aboriginal people is fundamental."[89] Interviewees echoed this in asserting that outside instructors should ask members of the community for help in shaping curricula, teaching practices, and physical spaces to be culturally relevant to, and safe for, learners. Instructors should also ask members of the community to be present when learning experiences are being delivered. Several interviewees working with Indigenous learners suggested that outside instructors

[88] EdCan Network. "Reconciling Broken Promises," YouTube video, 6:45, May 28, 2018, https://www.youtube.com/watch?v=Tn2gB30kqhA
[89] Leroy Little Bear. "Naturalizing Indigenous Knowledge." University of Saskatchewan, July 2009. Available online: https://www.afn.ca/uploads/files/education/21._2009_july_ccl-alkc_leroy_littlebear_naturalizing_indigenous_knowledge-report.pdf

ask community elders to Indigenize spaces and provide traditional medicine during instruction.

It is thought that when educators provide educational experiences that combine Indigenous knowledge and traditions with Western science, Indigenous learners take more interest and perform better. Mi'kmaw Elder Albert Marshall introduced the term "Two-Eyed Seeing" to describe how learners might see "from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways of knowing."[90]

It should be specified that non-Indigenous instructors working with Indigenous learners must be particularly sensitive and devoted to asking for help from experts in the Indigenous community to help shape curricula, practices, and spaces.

Even well-meaning non-Indigenous instructors can inadvertently re-enact the dynamics of colonialism and residential schools. Indigenous instructors who were interviewed for this report were, in fact, divided on whether non-Indigenous instructors should be working with Indigenous learners at all.

Interviewees also said that instructors who are not culturally reflective of their learners should invite guests who are, so learners are exposed to role models who look like them. Interviewees said that bringing in culturally reflective speakers who demonstrate that success in Computer Science is attainable will help underserved learners see that they can attain success as well. Interviewees also mentioned that learners are not aware of the many types of jobs — and the day-to-day specifics of those jobs — that require some level of Computer Science knowledge. Bringing in guest speakers from the tech industry would showcase the many, and sometimes unexpected, careers that Computer Science education makes available. These recommendations are echoed in the advice of experts, who suggested that educators invite a wide range of diverse role models in Computer Science into the classroom, and encourage them to talk about not only the work that they do but also their personal backgrounds.[91]

"We need to interrupt the idea that if you aren't a white male, you can't be a leader."

[90] The Conference Board of Canada. "Incorporating Indigenous Cultures"
[91] Microsoft Philanthropies. "Guide to inclusive computer science"

Learners need different types of Computer Science learning experiences.

Interviewees described the characteristics of Computer Science learning experiences that would be most supportive and beneficial to their learners.

Learners need access to more flexible Computer Science learning experiences.

Interviewees stressed that Computer Science learning experiences for underserved learners must be flexible to meet their lifestyles, needs, and aspirations. Many studies have also shown that meeting learners where they're at will allow more learners to engage in Computer Science learning.[92] [93] [94]

Many underserved learners and potential learners are attending school, working one or more jobs, caring for children or elders, serving as translators for family members, or hunting for game when the season is right — they have many pressing demands on their time. Interviewees therefore stressed that learning experiences should be offered at many different times of the day and during the week. They also felt that learners (and adult learners in particular) should be able to choose the pacing with which they engage with these learning experiences. While some learners may choose a regular schedule, others may prefer to access resources and check in with instructors on their own timeline.

Interviewees also said that learning experiences must be accessible both online and offline. One interviewee proposed putting a step-by-step program on a thumbdrive, so that learners could work independently offline and go online once a week to check their work with an instructor.

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[92] Ibid.
[93] Scott, et al. "The Leaky Tech Pipeline."
[94] Huynh and Malli. "Plugging In."

Interviewees also felt that learners should have more control to choose their Computer Science learning goals and identify pathways to achieve them — although interviewees talked about this in different ways.

- Those who work with adult learners described the success of programs that, by design, do not have strictly set curricula; instead, they ask what learners want to know, then provide the information.

- Interviewees who work with young learners talked about offering learning experiences in which learners can make choices. Giving learners the power to make decisions, they felt, creates a sense of ownership as well as higher levels of motivation. This was echoed by experts who advised that Computer Science learning experiences be focused on problem solving activities that have more than one possible solution.[95]

Computer Science learning experiences should meet learners where they're at.

Computer Science learning experiences should be carefully designed to meet learners where they're at — not only their level of proficiency with Computer Science subjects, but also their proficiency with math, science, or language skills. A Computer Science learning experience that depends on immigrant learners being fluent in English, for example, may cause learners to feel excluded and demoralized when they cannot engage with the material.

"Introduce kids to materials in a non-threatening, open situation. No obligation, no failure. Just showcase it."

Conversely, instructors should show learners that they already possess digital skills, and encourage learners to build on those skills. One interviewee, for example, mentioned that her learners already have many of the skills needed to be social media managers or content creators, but are unaware that these skills are highly marketable.

Many interviewees also described the need for Computer Science learning experiences and spaces that are open, unstructured, and judgement free. Learners should be given opportunities to try

[95] Microsoft Philanthropies. "Guide to inclusive computer science"

things, build things, and break things, with no set goal to complete and no assessment or evaluation. In these spaces, failure does not exist: participation and creation is success. The descriptions of these spaces seem to have a lot of overlap with a description of Two-Eyed Seeing as "not a linear beginning-to-end process, as is the Western paradigm of assessment, with targeted outcomes. Rather, it is process-oriented, much like the continual cyclical philosophy and teachings embedded in the Aboriginal medicine wheel."[96]

When describing more structured Computer Science learning experiences, interviewees asked for content that would help learners apply Computer Science skills to bring projects to life with imagination and creativity. Interviewees used terms like "creative," "hands-on," "interactive," and "practice-based" in describing learning experiences that would pique learners' interests and encourage them to invest their own creative passions in Computer Science projects. These experiences would also likely result in tangible creations. One interviewee's suggestion of a "virtual art gallery" jives with expert advice suggesting that instructors make their learners' creative work visible, both to build learners' self-esteem and to show others that Computer Science is a creative field.[97]

"Lessons should hinge on one word: "if".

Learners need access to Computer Science learning experiences that connect to real life.

Many interviewees encouraged the creation of Computer Science learning experiences that have real-world applications and relevance — this was described differently depending on the ages of the learners.

Interviewees who work with young learners spoke about making material more accessible and fun by contextualizing it in learners' experiences and interests, so "it speaks to them." One interviewee said that Computer Science skills should be related to real-world situations, but stipulated that this will only be effective if instructors get to know their learners in order to make those

[96] Michelle Hogue and Cheryl Bartlett. "Two-Eyed Seeing." Education Canada, June 2014. Available online: http://www.neatoeco.com/iwise3/wp-content/uploads/2015/08/Two-Eyed_Seeing.pdf

[97] Microsoft Philanthropies. "Guide to inclusive computer science"

connections. Similarly, experts interested in ensuring more equitable access to Computer Science education recommend that educators ground Computer Science concepts in the real world and allow learners to identify opportunities to connect learning to their personal experiences.[98]

Interviewees who work with adult learners felt they would prefer to learn tools and methods that focus on practical, everyday skills. Because "real-world applications" differ depending on whose "real world" one is in, suggestions for adult offerings ranged from content for immigrant adults focusing on how hardware operates, to content for Indigenous adults focusing on geographic information systems.

"Educational reform is needed in STEM. It's very cold — no humanity, no values, it is tedious and prescriptive."

Learners can teach other learners.

Interviewees spoke about the positive potential of leveraging learners' ability to support other learners, and were interested in content that encourages and enables learners to teach each other.

Some interviewees described this overtly while talking about programs that they run or aspire to create. One interviewee described a program that trains and supports university students to teach underserved learners in traditional classroom settings or at events or camps. Another interviewee hopes to launch a program bringing Indigenous high schoolers to on-reserve schools to teach younger learners. Both of these interviewees mentioned that these programs help meet the need for culturally reflective role models, as older learners show younger learners that they too can attain higher-level STEM competencies.

Many other interviewees also recommended that Computer Science learning experiences include group work. Some noted that working in groups helps encourage collaboration and camaraderie. Others noted that learners with stronger skills will be able to assist those who are still progressing or who are shyer. The benefits to having learners work in groups are well documented. Researchers have found that learning from peers promotes deep understanding of, and positive attitudes towards, the subject

[98] Ibid.

matter.[99] Furthermore, researchers have tested and verified the old adage "teach once, learn twice" and found that learners who explain information to peers gain new understanding in the process.[100] In a report on British Columbia's Computer Science education program, the authors noted that pedagogical research shows that Indigenous learners in particular prefer learning in teams rather than individual, competitive learning.[101]

"I like to have my students work in teams. The high achievers help the others."

Learners need different types of lesson plans.

When asked about the needs and barriers facing underserved learners, most interviewees gravitated towards describing the systemic issues, needs, and suggestions above. They did, however, provide their ideas for subjects that would most interest their learners.

Interviewees who work with learners who are learning to speak English want Computer Science lessons that connect with ESL.

Interviewees who work with immigrant learners with lower English proficiency said that Computer Science learning experiences that incorporate ESL lessons would be valuable. One interviewee suggested that a Computer Science curriculum that aligns with the LINC curriculum, teaching both Computer Science and Canadian Language Benchmarks, would be a useful tool.

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[99] Peter A. Cohen, James A. Kulik, and Chen-Lin C. Kulik. "Educational Outcomes of Tutoring: A Meta-Analysis of Findings." American Educational Research Journal 19 (2): 237–48, 1982. Available online: https://doi.org/10.3102/00028312019002237.
[100] Jonathan G. Tullis and Robert L. Goldstone. "Why Does Peer Instruction Benefit Student Learning?" Cognitive Research: Principles and Implications 5 (1), 2020. Available online: https://doi.org/10.1186/s41235-020-00218-5.
[101] Brian Fowler, Yuri Nesen, and Emiliana Vegas. "How British Columbia implemented its computer science education program." Centre for Universal Education at Brookings. April 2021. Available online: https://www.brookings.edu/wp-content/uploads/2021/04/British-Columbia-CS-education-program-FINAL-042321.pdf

Youth instructors want Computer Science lessons that use exciting methods and tools.

Interviewees who work with K-12 and university learners most often mentioned the following tools and subjects as some that would excite their learners:

- Game development
- Augmented and virtual reality
- Smartphone app development
- Computer art and design
- Digital storytelling
- User design
- Robotics

"I would love to do some app development...the phone is a powerhouse. There's great potential there."

Many interviewees requested "MIYO" (Make It Your Own) Computer Science lesson plans.

Many interviewees felt that their learners are more interested and invested in Computer Science learning experiences which have real-world applications and relevance. One way to create real-world relevance is to connect lessons to cultural stories and traditions. Many educators, however — particularly those who are Indigenous or work with Indigenous learners — cautioned against non-Indigenous organizations attempting to create lessons that incorporate Indigenous cultural teachings or language.

Indigenous cultures are richly varied. A lesson that uses the stories and traditions of the Kwakwaka'wakw will not be relevant to a Mi'kmaq learner — worse, it might be considered erasure of the diversity of Indigenous cultures. An Indigenous interviewee who works with on-reserve youth shared an anecdote about working with a national education organization which presented her with a lesson plan built on Indigenous stories. Unfortunately, the stories were from a First Nations community in a different province. She altered the material.

It's true that some commonalities between Indigenous teachings may exist; one Indigenous interviewee noted respect for the earth as a common value. Creating lesson plans centred on common teachings, however, is likely to miss the mark. If the intention is to create a sense of real-world cultural relevance for learners, the content should connect specifically to their culture. This passage

from the First Nations Ethics Guide on Research also indicates that there are greater missteps possible here: “researchers who are unfamiliar with Aboriginal Knowledge may not follow proper protocols or traditional laws in accessing, using, or interpreting the knowledge. Most First Nations consider improper access, collection, use, or interpretation of Aboriginal Knowledge an act of theft.”[102]

Interviewees therefore often requested MIYO, or Make It Your Own, lesson plans. MIYO lesson plans would supply Computer Science content with open space in the lesson where instructors or experts could insert the specific cultural or local connection which they know will resonate with their learners. Some educators particularly suggested creating Computer Science lessons built on storytelling, or land-based projects or references, which could be tailored to the community’s culture and location.

[102] First Nations Ethics Guide on Research and Aboriginal Traditional Knowledge. Assembly of First Nations. Available online: https://www.afn.ca/uploads/files/fn_ethics_guide_on_research_and_atk.pdf

Recommendations for Action

Interviewees recommended that Computer Science education organizations take the following actions to help underserved learners access Computer Science learning experiences.

Support culturally reflective organizations that are working with underserved learners.

Interviewees advised that Computer Science education organizations provide support to culturally reflective organizations that are working with underserved learners. Interviewees requested the support of Computer Science education organizations in the following ways.

Partner with and supply resources to culturally reflective organizations that want to start providing Computer Science learning experiences.

Many culturally reflective organizations are already embedded in communities of underserved learners and are providing educational programming that focuses on subjects other than Computer Science. Interviewees working for these organizations expressed interest in partnering with Computer Science education organizations to add Computer Science learning experiences to the programming they already provide (assuming their learners are interested in learning Computer Science).

This partnership could be beneficial to both organizations.

- The Computer Science education organization would provide resources and tools that culturally reflective organizations with knowledge of the community and its learners would select from, adapt, and deploy to the greatest effect.

- The culturally reflective organization could help the Computer Science education organization learn about the community, and could advise on how to design new tools, resources, and lessons that would fit the needs, culture, and interests of their learners.

- If desired, the Computer Science education organization might also train instructors from the culturally reflective organization to help them deliver Computer Science learning experiences (see the “train the trainer” initiatives recommendation below).

Interviewees strongly stipulated that for these partnerships to be successful, Computer Science education organizations must take a supporting — and if needed, invisible — role when partnering with culturally reflective organizations.

Some interviewees from culturally reflective Computer Science education organizations said that they would consider using content created by non-culturally reflective Computer Science education organizations.

Some interviewees, while they work for education organizations that are not culturally reflective, have worked or currently work closely with communities of underserved learners. These organizations have built relationships, trust, knowledge, and experience with those communities. Interviewees from these organizations also said they would be willing to partner with a Computer Science education organization to add Computer Science learning experiences to the programming they already provide.

Amplify the work of culturally reflective organizations.

Interviewees mentioned that it would be helpful if larger Computer Science education organizations would amplify the

work already being done by culturally reflective organizations providing Computer Science education to underserved learners.

Larger organizations could use their wider communications platforms and networks of partners to help culturally reflective organizations become better known. Interviewees noted that this could help culturally reflective organizations gain more funding and support.

Help Culturally Reflective Organizations Secure Funding.

There are a number of culturally reflective organizations working hard to provide underserved learners in Canada with access to Computer Science learning experiences. However, interviewees from these organizations reported that they are disadvantaged in competing for funding devoted to Computer Science learning for the following reasons:

"It takes money out of the community when non-Indigenous organizations receive funding [to serve Indigenous learners]."

- Larger organizations often have staff devoted solely to fundraising, while smaller culturally reflective organizations' staff may be stretched thin with providing programming.
- Larger organizations are more likely to have name recognition with funders.
- Several interviewees reported feeling that their organizations are disadvantaged due to discrimination.

Interviewees therefore said that the best way for larger organizations to assist underserved learners was to help culturally reflective organizations secure more funding.

Interviewees recommended this be done in the following ways:

- Fund culturally reflective organizations directly, if within the Computer Science education organization's mandate; or

- Assist culturally reflective organizations in securing funding (by partnering on grants, for example).

Create and provide "train the trainer" initiatives

Interviewees frequently recommended that Computer Science education organizations offer "train the trainer" initiatives, which involve hiring and training community members to provide Computer Science learning experiences to learners in their communities. Many interviewees felt that "train the trainer" initiatives would create long-term change in communities and reach more underserved learners.

As previously mentioned in the Summary of Findings section, underserved learners need access to qualified and culturally reflective Computer Science instructors who can be role models. Training members of the community would kill these two birds with one stone.

"Hire local trainers."

Furthermore, interviewees noted that training community members to become Computer Science instructors is a model of providing Computer Science experiences that scales up better than one-off coding workshops. An instructor working in a community of underserved learners can provide more and better learning experiences to more learners over a longer period of time. Studies have shown that teacher education is one of the most effective ways to alter attitudes.[103] The Martin Family Initiative Model School Literacy Project is one example of the success of this approach. By providing targeted teacher training at two First Nations schools, the percentage of grade three children who met or exceeded the Ontario reading standard jumped from 15 percent to 81 percent in just five years.[104]

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[103] Laura Sokal and Jennifer Katz. "Oh, Canada: Bridges and Barriers to Inclusion in Canadian Schools." Support for Learning 30 (1): 42–54, 2015. Available online: https://doi.org/10.1111/1467-9604.12078.
[104] Julia O'Sullivan. "Wiiji Kakendaasodaa: Let's All Learn." The Model School Project, March 2016. Available online: https://themfi.ca/wp-content/uploads/2021/04/FinalReport_WIIJI_KAKENDAASODAA_LetsAllLearnTogether_Mar2016-1.pdf

Interviewees who made this recommendation urged organizations that choose to engage in “train the trainer” initiatives to do the following to ensure success:

- In looking for potential instructors from the community, look for those who are passionate about community improvement.

- Do not require that instructors have or attain a formal degree. One interviewee said that a community member shouldn't need a degree to become an instructor, and likened “train the trainer” initiatives to micro-credential programs. A culturally reflective, community-based instructor with knowledge of just a few Computer Science concepts can still have a huge impact on learners.

- Be flexible. The person being trained as an instructor may need flexibility when it comes to timelines and their ability to consistently commit to training. Keep in mind that if they are members of an underserved community, they may deal with some of the same needs and barriers that their learners do.

- Offer varied levels of support after the person is trained. Some instructors may appreciate consistent and frequent check-ins, while others may prefer a lighter touch and more independence.

- Instructors and communities should define what success is for their programs and learners, and should not be required to report on benchmarks or measurements for success that are created outside the community.

In describing the role of instructors-in-training, interviewees recommended the following:

- Instructors-in-training should be empowered to alter all content to better fit the culture and interests of their learners.

- Instructors-in-training should be allowed to decide what Computer Science subjects they want to learn and engage

with. Instructors who are genuinely enthusiastic about, and confident with, the material they teach are more likely to inspire curiosity in their learners.

- Instructors-in-training should be encouraged to infuse their Computer Science instruction with their own passions — for example, a musician might incorporate music into their lessons. This helps instructors feel ownership over the work they're doing, and may help with instructor retention. (One interviewee pointed out that when people in a community gain greater qualifications, they often find jobs outside the community.)

- Instructors-in-training should be paid, both during their period of training and when they are working as instructors.

Some interviewees also mentioned that they would value a network of Computer Science instructors where they could share resources, tools, and learnings. This was mentioned both in the context of "train the trainer" initiatives, and by instructors and educators who are already trained and teaching.

Make a "community connection" to learn whether direct service provision is needed, wanted, and wise.

Several interviewees strongly asserted that only culturally reflective organizations should directly engage with underserved learners.

"We've developed a relationship of trust with our Nunavut partners. We co-create, co-design, and invent programs together. It takes time to build trust and do the work."

Other interviewees, however, acknowledged that while it is preferable for underserved learners to receive instruction from culturally reflective organizations and instructors, there are some outside organizations that do successfully and sensitively engage in direct service provision with underserved learners. Interviewees who have worked with these organizations described how they approach direct service provision, and how a Computer Science

education organization might do the same to provide Computer Science learning experiences.

1. The Computer Science education organization should make a “community connection” by making contact with a person, organization, or school working in the community, and building a relationship with them.

2. The Computer Science education organization should learn about the needs and culture of the community through this relationship, and ask the community and others whether Computer Science learning experiences are needed and wanted in the community before proposing direct service provision.

3. If the community is interested in Computer Science learning experiences, the Computer Science education organization should ask a member of the community to provide an introduction to key individuals and organizations.

4. When providing Computer Science learning experiences, the Computer Science education organization must ensure that learners' basic needs are met and that instructors, curricula, practices, and spaces meet the needs of learners as described in the Summary of Findings. The community should be deeply involved in, if not leading, this process.

5. The Computer Science education organization should embed staff in the community, part-time or full-time, if possible. If not, the Computer Science education organization should find other ways to be a consistent and trusted presence in the community.

6. The Computer Science education organization should continually adapt their role and programming to the needs and preferences of the community, which will change over time as the community changes and the relationship between the community and the Computer Science education organization evolves.

“Listen, listen, listen. And then in a good way — which is not yours to define — start down the road.”

In talking about this process, interviewees warned that this method requires long-term commitment and cannot be rushed. Above all, it requires that the Computer Science education organization establish trust with the community and centre the community's needs and culture.

Appendix

Participating Organizations:

In some cases, multiple individuals from the same organization were interviewed.

Advancing New Canadian Women in Technology

African Canadian Christian Network (ACCN)

Black Youth in Technology, Engineering and Science (BYTES) Network

Centre for Newcomers

Challenger Consulting & Associates Inc.

Computers for Schools Newfoundland

Digital Literacy Exchange program, Peel Multicultural Council

Eagles of Tomorrow

EDGE Skills Centre

Engineering Access Program, University of Manitoba

First Nations Technology Council

Frontier College

Indigenous Student Achievement Pathways, University of Saskatchewan

IndigiSTEAM

Iniskim Centre, Mount Royal University

Joint Economic Development Initiative

Jumpstart Refugee Talent

Let's Talk Science

Martin Family Initiative

Pathways to Education

Pinnguaq Association

Rainy River District School Board

Realize Your Potential Youth Program

Six Nations Polytechnic STEAM Academy

Society for Canadian Women in Science and Technology

The Tree of Peace Friendship Centre

Thompson Rivers University

Unama'ki College, Cape Breton University

Yukon Learn Society

Sample from the Interview Guide

- What is the mission or mandate of your organization?
- Where does your organization work, geographically?
- Can you tell me about the community of learners you work with?
- What barriers or challenges exist for your learners in accessing educational resources?
- What barriers or challenges exist for your learners in accessing Computer Science educational resources?
- Does your organization offer programming that teaches computer use, Computer Science, technology, or STEM?
- If YES: Is there anything you would like to change about the programming?
- If NO:
    - Do you feel that the learners in your community would benefit from CS programming?
    - Does your organization want to provide this kind of programming? Why/why not?
    - What are the barriers that prevent your organization from providing this programming?
- What types of tools or supports would be most helpful for educators working with the learners in your community?
- Is there anyone who you think we should make sure to talk to as part of this engagement project?

Sample of Questionnaire

Which of the following duties do you perform on a weekly basis? (Select all that apply.)

- Teaching classes of learners
- Tutoring learners in small groups or one-on-one
- Providing counselling or social services to people
- Assisting multiple other educators
- Curriculum creation and development
- Other (please specify)

Which of the following best describes the subject(s) that you teach? (Select all that apply)

- Math
- Science
- English/ Language Arts/ Literacy
- History
- Second Language
- English as a Second Language
- Physical Education
- Computers/ Technology
- Health
- Job skills training
- Other (please specify)

Which of the following difficulties, challenges, and barriers do your learners face in accessing and fully benefiting from education and training in general? Please rank them in order of how large a barrier they are, from large to small.

- Low or no access to technological resources such as computers or adequate internet connectivity
- Learning disabilities
- Language barriers
- Distance to educational institutions
- Teachers who lack training or skills
- Low graduation rates
- Low grades
- Poverty
- Other

To what extent do you agree with the following statement: "the Computer Science education that is available to my learners is sufficient to their needs and aspirations"?

- Strongly agree
- Somewhat agree
- Somewhat disagree
- Strongly disagree
- Not sure

Which of the following Computer Science subjects are your learners currently learning, and which would they benefit from learning?

- Basic Skills: Typing, Computer Parts, Creating, saving, downloading, moving files
- Programming: Coding, Algorithms, Modelling
- Computing: Hardware and software, Digital connectivity, cybersecurity
- Data: Storing, collecting, Organizing, and Visualizing Data
- Technology and Society: Digital citizenship, Social impacts, the Law and Ethics
- Design: Program design, Visual design, User design, accessibility

Which of the following describe barriers that prevent you or your workplace from providing Computer Science instruction? (Select all that apply).

- Lack of financial resources to pay for more instructors
- Lack of financial resources to pay for computers
- Lack of time given to teachers to pursue training
- Lack of staff with Computer Science training, or lack of financial resources to pay for training
- Lack of space in required curricula
- Limits to maintaining and repairing technological equipment
- None of the above
- Other (please specify)

Questionnaire Respondents

What is your age?

Age	Percentage of Respondents	Number of Respondents
Under 25	34.88%	15
25 to 45	58.13%	25
46 to 65	6.97%	3
Over 65	0	0
	100%	43

What is your gender?

Gender	Percentage of Respondents	Number of Respondents
Beyond Binary	0	0
Man	27.90%	12
Two-spirit	0	0
Woman	72.09%	31

Which of the following best describes your job or job title?

Job Title	Percentage of Respondents	Number of Respondents
Teacher	27.90%	12
Assistant Teacher	11.63%	5
College Instructor	6.97%	3
University professor	6.97%	3
School Administrato	11.63%	5
Not-for-profit organization worke	4.65%	2
Other	23.25%	10

Which of the following best describes your workplace?

Workplace	Percentage of Respondents	Number of Respondents

A public K-12 school	32.55%	14
A private K-12 school	0%	0
An after school or extracurricular education program	13.95%	6
An educational not-for-profit organizatio	6.97%	3
An adult education centre or program	18.60%	8
A college	13.95%	6
A university	20.93%	9

Where is your workplace?

Province/ Territory	**Percentage of Respondents**	**Number of Respondents**
Alberta	13.95%	6
British Columbia	9.30%	4
Manitoba	4.65%	2
New Brunswick	2.32%	1
Newfoundland	4.65%	2

Northwest Territories	0%	0
Nova Scotia	2.32%	1
Nunavut	0%	0
Ontario	48.83%	21
Prince Edward Island	0%	0
Quebec	13.95%	6
Saskatchewan	0%	0
Yukon	0%	0