Teaching Cyber-Education through Simulation and Games

By Timothy King

Teaching cybersecurity in Canada presents an exceptional challenge. Digital media illiteracy has become a persistent social problem that libraries often find themselves on the front lines of as people scramble to cross the digital divide (Mundie, 2022). Few have it (Future Skills Centre, 2025) and the ones that do are off building the digital systems we increasingly live our lives in rather than teaching it. A subject like cybersecurity is especially problematic because its interdisciplinary nature crosses the entire digital spectrum. The anxiety and fear caused by the many hazards associated with cybersecurity also present significant learning challenges.

Fig. 1. Timothy King. Digital technologies begin with electronics with each additional technological domain building on the previous layer in both complexity and abstraction. 2024.

Tackling digital media without understanding the mediums it operates in is a struggle in the same way that teaching someone to read who has no understanding of vocabulary and spelling would be. It is a symptom of our ongoing struggle with digital media literacy (BeckerDigital, 2024) that we continue to ignore the means of transmission that deliver it. Cybersecurity exists throughout the digital spectrum from electronics substrata where digitization begins all the way through to the most abstracted big data layers where you find emerging technologies like artificial intelligence.

A data driven, constructivist approach to crossing our ever-expanding digital divide would be to take a page from established media education and integrate a wholistic understanding of the mediums digital travels on before approaching the media that depends on them. We should be doing this prior to using any digital devices in our classrooms but that ship has long since sailed. In 2024 you will find students from their first moments in school being handed networked digital devices by educators with little understanding of how any of them work. This is usually accompanied by thinly veiled hopes that the myth of the digital native (King, The New Literacy, 2012) will save us. This convenient myth has been disproven by research yet many cling to it as an excuse not to act (Nature, 2017). Most recently everyone is leaping on the artificial intelligence bandwagon with hopes that the machines themselves will teach us the digital skills that we humans have not. In this morass cybersecurity operates from as simple a place as individual online safety awareness through group administration where every educator must operate to protect the minors in their care to technically abstracted, advanced

digital skills which few dare approach. Teaching cyber safety without basic digital literacy in place is an uphill struggle even though it is an issue of safety as well as media literacy.

In 2022 I was seconded from the classroom after over twenty years developing a multi-award winning advanced digital skills program in my rural Ontario high school (CWDHS CompTech, 2022) to work with the Information & Communication Technology Council's Jumpstarting Digital Careers program (ICTC, 2024) . This opportunity allowed me to explore emerging cyber-education tools and, with the help of a few brave partners across Canada, begin building solutions to our multi-generational cyber skills crisis. This cyber fluency not only personally protects staff and students from threats, but also protects school boards who are prime targets for cyberattacks (Snape, 2022). There is also a case to be made for defending Canada's democracy from foreign disinformation campaigns that depend on digital illiteracy to succeed (CSIS, 2021). This paper will reveal two examples of effective, practical cybersecurity education explored in an action research context. It will also suggest next steps for engaging Canadian school libraries as ideal starting points for this essential work.

In 2022 Stanley Singh from a STEM education program in rural Newfoundland (Excitetech, 2024), reached out to see if ICTC would be willing to come to the island and do a two-day workshop with local middle and high school students around cybersecurity education. In spring of 2023 we flew to Newfoundland and drove across the province to Grand Falls-Windsor where we spent two days building cyber-skills from scratch. But how do you engage students with no cyber experience whatsoever in such a short timespan?

CyberTitan (ICTC, 2024) produces a gamified resource that we were only using once in each national final, but could this competitive capture the flag exercise work as an introductory learning tool? CyberTitan happens across Canada each year in schools, community groups, and through Cadets Canada (ICTC, 2021). The competition exposes students to real world cyber-attacks on simulated computers called virtual machines. Student teams work together to analyze and secure these damaged systems in a gamified environment with live scoring. Because these systems are all simulated there is no chance of any damage and this goes a long way towards mitigating the panic and fear that often surrounds the subject (King, De-spookifying Scary with Gameplay, 2024). The competition demands communication, teamwork and organization to explore corrupted networks, itemize damage and then attempt repairs. Without a coordinated effort there is little hope of success (just as in real world cyber defense). This is interactive, team-based cyber skills learning in a gamified environment designed to encourage experimentation and iteration. It's the opposite of the cringeworthy videos and passive media many school boards trot out for cybersecurity awareness month (ECNO, 2024).

CyberTitan national finals happen on Ottawa based company Field Effect's servers (Field Effect, 2024). Each year since 2018 Field Effect has put together a theme-based challenge (ICTC, 2022) when they aren't providing the cyber range for academia, industry and government (Reevely, 2023) research and training. A favorite was the 2022 Moonbase capture the flag (CTF) where teams restored contact with Canada's first moonbase after a cyber-attack.

Fig. 2. Timothy King. Photograph of students competing in Grand Falls-Windsor, April 26, 2023.

For the Newfoundland experiment we built scaffolded curriculum that helped students get familiar with the cloud based cyber range on day one. Through hands-on practice they became familiar with a variety of operating systems in a web based virtual environment through guided challenges. This kind of information technology and networking learning seldom happens in schools, even though all of them depend on it for their day-to-day operation. On day two we let them loose on the Moonbase CTF to see how they would do.
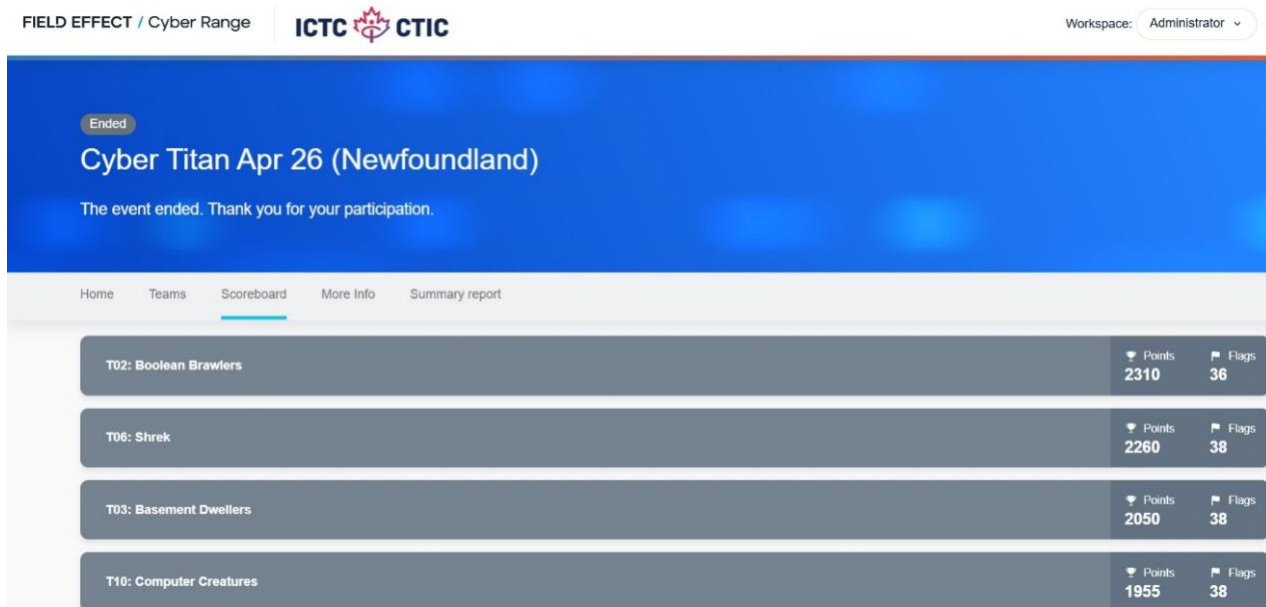
Fig. 3. Timothy King. Top team scores on cyber range CTF from Grand Falls Windsor, April 26, 2023.

These capture the flag simulations are designed for the most cyber-literate students in Canada who have spent a formidable year earning their finalist spots in increasingly challenging rounds of the U.S. based CyberPatriot (CyberPatriot, 2024) competition that CyberTitan is the Canadian center of excellence in. CyberTitan national finalists are dropped into the CTF without the scaffolded supports that the GFW students were provided with, but even with that material we didn't expect any of the teams to get over a thousand points due to the complexity of the challenge. Over the day the GFW students adapted quickly and surprised us by digging deep into the hacks. The top teams in the GFW event would have finished mid-pack in the CyberTitan nationals that used the same CTF which is astounding considering that these students had never touched this technology before let alone performed complex digital forensic work on it.

The Grand Falls-Windsor experiment highlighted several key points. Firstly, you can quickly develop cybersecurity context and skills with inexperienced students that lets them see success in this prickly discipline. Secondly, by emphasizing the virtual nature of the event fear, a major blocker for anyone first engaging with cyber skills, is set aside. Finally, the team-based nature of the competition meant students with many diverse skillsets could contribute.

Contrary to popular belief, people working in cybersecurity aren't all hoodied, loner hackers. Skills like organization, documentation and applying engineering process in the testing of solutions as well as soft skills like communication and teamwork are all highly valued. CyberTitan's team based, simulated approach to cyber skills development relaxes anxiety in both teachers and students about doing something potentially damaging to digital technology that they struggle to understand. It also encourages teams with diverse skillsets to contribute in a variety of ways – much as a cybersecurity team would in real life (Bykowski, 2023). Perhaps the greatest indicator of success is that GFW has run multiple CyberTitan teams in every season since. Demystifying cyber-skills is essential if we're to help Canada fill its ongoing shortage of talent in this discipline (ICTC, 2022) and even a two-day event can spark regular involvement.

Following our time in Grand Falls-Windsor we drove back across the island to meet with Leigh Borden, an award-winning teacher librarian (CSL, 2022) working with elementary students in Torbay near St. John's. Leigh set up her school library for a morning of cybersafety education with her grade fours, but like the CyberTitan CTF

experiment, this was not going to be a passive cyber-awareness experience but another gamified hands-on learning opportunity.

ICTC partners Cyber Legends (Cyber Legends, 2024) have built a unique web-based game that drops students onto an alien planet cyber-attacked by the evil Lord Hacker. Through game play students perform functions like restarting compromised technology and securing it with passwords and updates to prevent further cyber-attacks. Cyber Legends leverages state of the art video game design through a browser-based interface that allowed us to make use of the school's Chromebooks to explore the prickly subject of online safety and essential cyber skills with nine-year-olds.
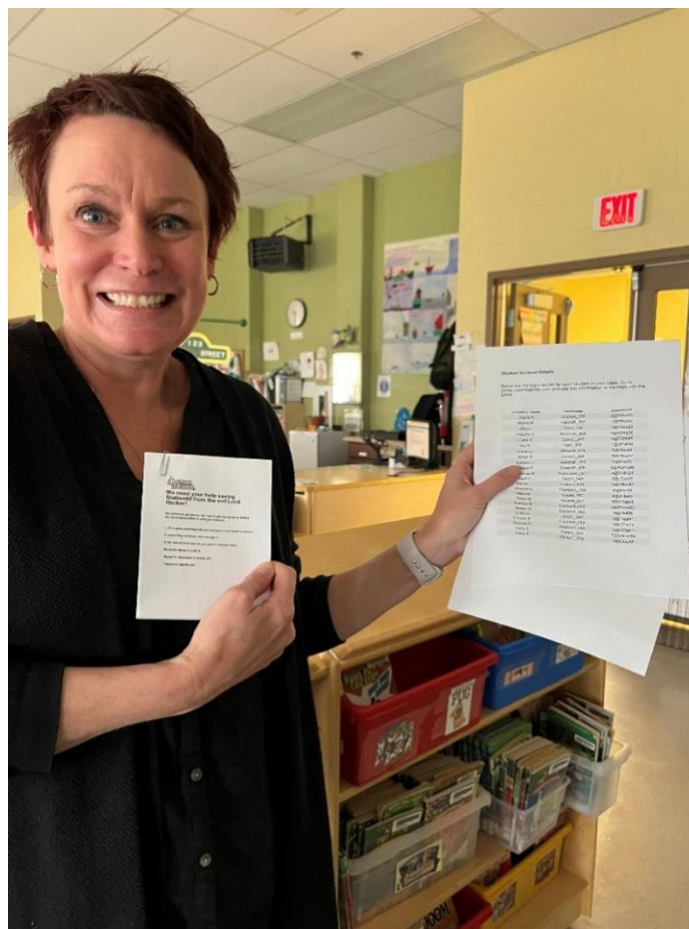

Fig. 4. Timothy King. It takes a skilled and experienced librarian to take on the challenges of digital literacy. Leigh had printouts of everyone's (anonymous) logins and passwords ready. April 27, 2023.

Leigh had her Chromebooks set up with some cunning school-librarian digital tricks including sticker enhanced keyboards to teach typing, paper copies of logins, and a box of ewasted mice to make gameplay more comfortable. Students couldn't get into the game quickly enough and once there we had trouble getting them out again.

Fig. 5. Timothy King. Photograph of students deeply immersed in Cyber Legends. April 27, 2023.

If you work in education, you know that teaching with educational technology is by no means an easy feat. In addition to her many digital learning enhancements, Leigh also had the schoolboard's IT person available to help with network challenges. Even with two CSL award winning librarians and the only cybersecurity qualified K12 teacher in Canada on hand, we still experienced difficulties. The network freaked out with all the logins, and some took a frustrating amount of time to sort out. One particular generation of Chromebook (Leigh was working with four different models, some of them almost as old as the students), simply wouldn't play the game, but she had alternates available

and we were always able to move everyone forward. Without a digitally fluent librarian on hand, this experiment simply wouldn't have worked.

　　Having worked in I.T. for decades and being aware of the many layers of technology needed for this to come together, I came up with an idea to help frame our morning that would minimize frustration. When introducing the activity, I explained that this was a beta test of a new game, and we needed students to help us play test it. This got students excited as well as less anxious about things not working – if you're experimenting with new technology this framing turns problems into opportunities. I wish we framed digital exploration in learning this way more often as it would result in more effective use of technology in schools.

Fig. 6. Timothy King. Photograph of student finding a way to keep playing Cyber Legends, from Torbay Cyber Legends Day. April 27, 2023.

Even with the technical challenges students persisted and everyone got into the game and began learning cyber-safety skills through play. Follow up engagement was strong. Multiple classes stayed in touch with the Cyber Legends development team and helped them with feedback and suggestions for months after our visit. Perhaps the highlight was the conversations all of the grade 4 teachers had with students around online safety that wouldn't have happened otherwise.

The lessons learned from our morning with Leigh's grade fours were many. Students enjoy exploring new technology and if you frame it as exploration the inevitable technical difficulties become an opportunity to teach the engineering design process (Teach Engineering, 2024). In my travels I've seen teachers struggling with technology across the country as they attempt to offer students cyber-education opportunities. Having a digitally fluent librarian like Leigh on hand makes these opportunities more successful and accessible to all.

Since our first experiment in Grand Falls-Windsor we have run regional CyberTitan CTFs across Canada. This usually happens remotely but, in the spring of 2024, it involved a ten-day road trip across Nova Scotia, New Brunswick and Prince Edward Island. Most of our drop-in events involved working with the school librarian to make space (both digitally and physically) to offer these gamified cybersecurity learning opportunities. Hundreds of students have benefitted from the experience but the work we've done in cyber education remains the tip of a much bigger digital skills iceberg when it comes to media literacy in Canada.
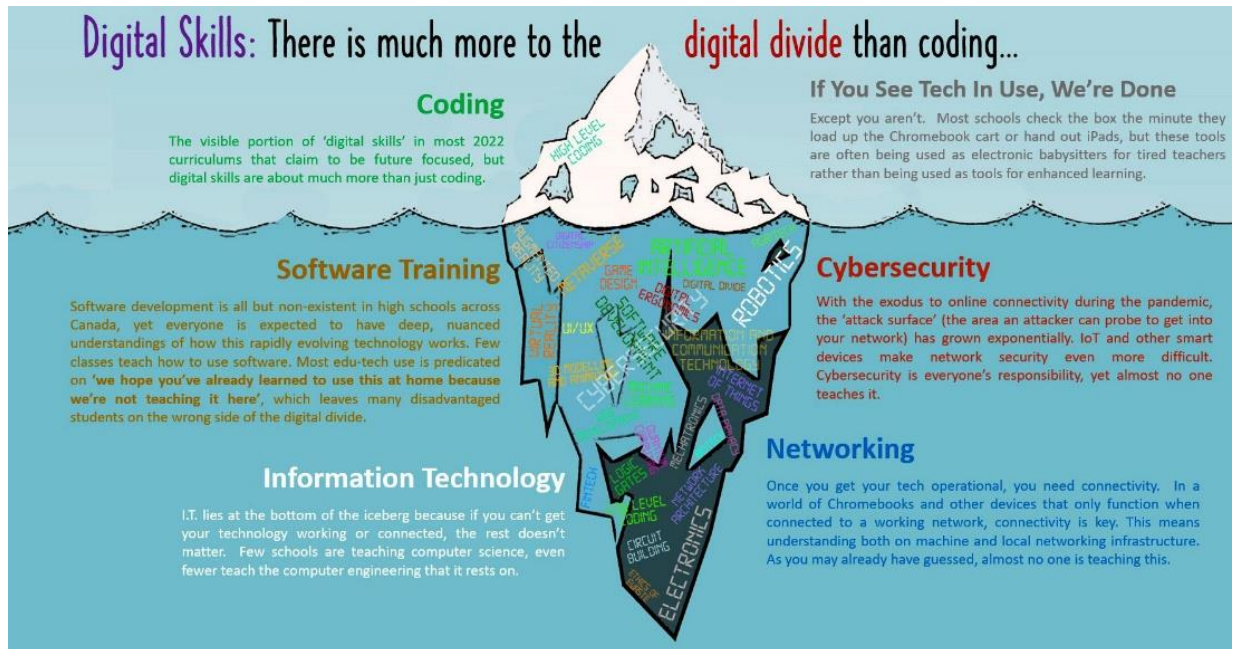
Fig. 7. Timothy King. Digital skills iceberg. There is much more to digital media literacy than just coding.

In 1981 I started middle school, and our school library had a brand-new Commodore PET computer - it was the first time I touched a computer and from that initial contact I developed a fascination that became a hobby, then an educational pathway and finally a career. Having worked with both school learning commons and public libraries on cyber education, I am now more than ever convinced that librarians serve an essential role in introducing students to new media literacies. Complex interdisciplinary digital skills like cybersecurity are simply not optional these days and we can't climb the technology fluency pyramid to them without digitally skilled librarians like Leigh Borden and Alanna King who are willing to provide the learning framework and digital tools necessary to help us cross a persistent digital divide.

In 2025 ICTC has partnered with the federal Canadian Centre for Cybersecurity (cyber.gc.ca, 2024), the Knowledgeflow Cybersafety Foundation (Knowledgeflow, 2024) and Cyber Legends to present at the Ontario Library Association Super Conference

(OLA, 2024) on the many cyber-education opportunities on offer from Canadian cybersecurity centers of expertise. Library learning commons are the perfect platform to offer both first contact with emerging technologies as well as teaching the essential media literacies that will allow us to leverage digital technology safely and effectively.

Fig. 8. OLA Super Conference Schedule, 2025.

ICTC's CyberTitan CTF won the gold medal for top international K12 educational simulation at the Serious Games Conference last summer (Serious Play Conference, 2024), demonstrating that when we work together using industry expertise and cutting edge technology to support digitally empowered educators, we can produce world-class learning opportunities in this very challenging subject. Without school librarians able to provide both physical and digital spaces to help us cross the digital divide in schools, we will be unable to bring these advanced cyber-education tools to staff and students and reverse a skills gap that is costing us billions of dollars in damage (WEF, 2024) while also putting ourselves and our country at risk (Canadian Centre for Cyber Security, 2024).

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