Integrating Cultural Knowledge in Programming Education: An Indigenous Approach

Andrew McConnell
York University, Canada
nish72@yorku.ca

Abstract

The paper critiques the apparent inability of a colonial education system to prepare Indigenous students to take on computer science studies in post-secondary institutions, even in a jurisdiction where most Indigenous students attend government schools for part or all of their education. Given that government accreditation is a prerequisite for post-secondary studies, there is a critical need to examine how computer science is taught in secondary schools, on and off reserve, if Indigenous populations are going to be able to contribute to the development of digital media in the future.

This paper then explores an Indigenous approach to programming education, aiming to integrate programming practices with the reinforcement of cultural knowledge. By encouraging students to observe and explore animal behaviours in their surroundings, this pedagogical process uses these observations as models for code modification, creating a learning experience that parallels traditional Indigenous teaching methods.

Keywords

steering behaviours, programming learning, cultural knowledge, animal behaviours, Indigenous computing, Indigenous perspectives, Digital Divide, Indigenous digital, Indigenous design, Indigenous epistemology, Indigenous sovereignty,

Introduction

Currently Indigenous people are under-represented in computer science and digital media programs. In computer science programs in the United States Indigenous students account for less than 1% of degrees awarded, while in Canada just over 2% of graduate and undergraduate students in all STEM studies were Indigenous in 2021. [1] [2] If we look at the jurisdiction of Ontario in Canada, it is possible to view one contributing factor as the way computer programming is taken up in secondary schools. While the province has recently made changes to computer science (CS) curriculum to prepare more students to work with code, there is no substantial effort in the revamp to include Indigenous epistemologies or build avenues to ensure Indigenous students feel prepared to follow studies in CS and digital media (DM). This is a disappointment when one considers most Indigenous students in the province will attend provincial schools. [3] However, it is possible to still work with the curriculum as is. In Ontario teachers have a wide range of latitude in how they choose to build instructional plans and execute lessons through professional judgment.

By situating programming education within Indigenous contexts and perspectives, this paper aims to provide an example of a more culturally relevant approach to CS education for Indigenous students that can be applied many different cultural paradigms. The pedagogical approach suggests using JavaScript models for coding and scripting, and Reynold's steering behaviours as a framework for exploring and building code that is readily accessible to Indigenous and other students. There have been some strong examples of Indigenous DM and instructional programs built upon Indigenous storywork and game modification in Indigenous communities. Despite this there has been little progress in delivering meaningful Indigenous coding programs in mainstream schools and there is a gap in the research as to how this might be carried out. Additionally, while there is a significant presence of Indigenous knowledge online related to DM, game, and cultural creation, there is a notable lack of representation in academic journals, particularly in the fields of computer programming and Human-Computer Interaction (HCI). This paper aims to address this gap by examining code modification as a method for teaching programming to Indigenous students in secondary school, specifically through the lens of locally positioned Indigenous perspectives. It theorizes a model for Indigenous programming by describing an approach to learning coding in hopes of changing the disturbing trends in CS education where Indigenous students do not study CS or DM in post-secondary programs.

Background

Under-representation

As noted in the introduction there is a very low representation of Indigenous students in North American STEM and CS programs at post-secondary institutions. Megan Bang, Ananda Marin, Lori Faber, and Eli S. Suzukovich suggest there is a need to develop environments and technologies that are routinely based in culture so that students can become more engaged with science and technology use in their lives and find connection to their lived experience while in secondary school. They have found in work with urban Indigenous youth and local Indigenous community members in Chicago that a key aspect to developing interest in science and

technology is exploring the concept of technology in both a traditional historical sense and connecting it with newer technology. They show there is a place for applying Indigenous points of view in designing technical solutions for problems and in grounding the work in traditional and current Indigenous paradigms. Important to the discussion in this paper, Bang et. al. note that urbanization and the current trend of technological development supports globalization and assimilation of Indigenous youth rather than their continuance as Indigenous people. [4]

The computer science and digital media curriculum in Ontario, Canada, can be criticized along the line that Bang et al. have laid out. The curriculum was recently updated and implemented in 2023 as a response to the provincial government noting that STEM subjects are becoming more important for economic health and development. This response though does not include a need for STEM education that is culturally supportive or acknowledge under-representation of Indigenous people in STEM fields. [5] The stated purpose of the course is to instruct students in programming, so they are "contributing to and leading the global economic, scientific, and societal innovations of tomorrow". It also hopes that they will move from being consumers to creators in the future but it is vague on how to do this for any specific community. [6] The curriculum makes specific mention of Indigenous people in only one place where it looks at contributions to digital media in a general sense. It does not provide examples of what those might be and the extent of explicit inclusion is directing students to look for these contributions as part of one expectation. [7] There is no discussion in the document about including cultural context, connecting to digital media creation through cultural lenses or application of skills relevant to Indigenous community. At the same time, it does not restrict this approach, which makes it possible to cover both the content of the course and build up cultural strength should a teacher be capable and have examples or ways of thinking through this.

Assimilation and Survivance

Crawford-Holland and LeBlanc note that settler media has worked hard to maintain the image of the true Native American as being un-technological and keep them in tokenistic positions building an image and idea of the authentic Indigenous person as dying or already dead. Within these contexts you can tell a real Indigenous person from a false one because they do not understand or use technology and do not live in town. [8] To push back against this racist trope, it can be argued the best way forward both for authentic representation and the building of useful tools for Indigenous people is to develop them inside community. Therefore, it is important that we look for different ways of instructing CS and DM subjects at an age when students are being prepared for post-secondary study and in a way that it can be connected to their actual experience as Indigenous people.

This is complicated though because, as Aikenhead and Elliott point out, for many Indigenous students' entry into school involves crossing a cultural border without instructions or assistance. [9] For that reason, it makes sense that Indigenous students have access to diverse instructional approaches in all subjects. It would also be important for non-Indigenous staff to understand they are teaching culture at the same time they teach curricular content even though they might not see it readily within the content. For culture to be dealt with in a way that it does not stand in the way of Indigenous students engaging with learning, teachers need to be mindful of what they teach, how they teach it and the holistic effect it has on students. Design and creation that is unaware or deliberately ignorant of its effect on Indigenous people does not maintain Indigenous Knowledge and stands as a barrier to survival and well being.

Gerald Vizenor has shown how representation of the Indigenous people widely in media limits their reality and disrupts the continuance of the authentic people. He argues that resistance and survival is more than just reversing roles or "upsetting binaries". [10] There is an active role to play which is rooted in Nativeness, which involves thinking and being that is sourced from the family, community, and relationship to land. He refers to this process of pushing back as survivance which, "is an active sense of presence over historical absence, the dominance of cultural simulations, and manifest manners. Native survivance is a continuance of stories".[11]

Digital Self-determination

Vizenor's idea of survivance is picked up by others to both critique digital media products and to describe various digital media products made by or with Indigenous people. Nijdam argues that Indigenous digital media products like video games stand as a form of survivance "while simultaneously seeking to illuminate the Indigeneity of new media work in terms that move beyond the biography of the producers and the content of the narratives presented, identifying Indigeneity on the level of form as well". [12] She holds that the aim of these types of programs should be to embed Indigenous knowledge systems and methodologies within the design and mechanics of the games and that this could involve coding cultural values and practices into game-play to create experiences that reflect worldviews rather than assimilating Indigenous identity into Western paradigms.

In their exploration of the "digital divide in Canada" Winter and Boudreau examine how Indigenous peoples might assert their right to digital self-determination and innovate with technology as opposed to merely consuming it. They emphasize the importance of Indigenous voices in rethinking narratives around the digital divide and looking at various initiatives in digital storytelling and virtual reality. They advocate for shifting the discourse from a needs-based to a strength-based approach and prioritizing support for community led initiatives. [13] As part of their examination, they look at programs like Dames Making Games and InSTEM to demonstrate the potential for Indigenous youth to engage with technology creatively.

It is important for Indigenous people to have control over their online presence to ensure accurate representation and support for their communities. Dyson and Underwood note there is a need for creating more web platforms that are designed and built by Indigenous web designers to ensure these platforms effectively represent the cultural values and needs

of Indigenous communities.[14] For this to happen though, the educational systems that are intended to prepare Indigenous students for working with digital media need to be examined as they are proving to be ineffective in getting students to pursue CS and DM studies.

Different Digital Education

Byrne suggests that video games created by Indigenous people can hold sacred space that is free from physical harm and opens the possibility of using game formats for sharing fundamental cultural knowledge, ones that are protective and respectful of traditions. She applies the ideas of survivance from Vizenor, to argue that video games can be a safe space because they are closed to alteration (being read-only) and can be copied perfectly for complete distribution which maintains their wholeness of culturally connected digital media products. She argues games allow Indigenous creators to express their identity through interactive storytelling, which can lead to healing and self-determination. [15] However, this is only possible if Indigenous people learn to create games, which appears difficult under the current educational process in dominant systems that intend for students to enter a global CS industry [16]. A different approach is then required for teaching coding, one that is both technically and culturally rigorous and connected to community. Dyson and Underwood point out that computing literacy can be improved by teaching students simple coding models and educational games. [17] An example of a culturally relevant method is the Skins game pedagogy developed by Lameman, Lewis and Fragnito.

Skins 1.0 is an Indigenous designed curriculum created for First Nations youth to make video games that reflect their cultural stories and experiences. Researchers Lameman, Lewis and Fragnito have found through various iterations of the program that it is successful in teaching design and programming skills to youth, while encouraging them to be creators on top of being consumers. A key goal in the Skins curriculum is to teach both computational skills and strengthen Indigenous identity. The process of creating a game in this curriculum is facilitated through a game modding format, that allows students to work in a familiar environment, and takes less time to produce a product. The goals of the workshop are multiple, including development of skills, life knowledge and pursuit of higher education. [18] These goals should remain in any Indigenous centered programming instruction.

However, as quick as game modding might be compared to building a complete game environment from scratch, the relative time involved in creating within the complex game environment in the Skins 1.0 project demonstrates that maintaining student engagement can be a challenge. [19] With that noted, Byrne points out that games do not need to be complicated in construction in order to engage with cultural ideas, so if teaching the basics of programming is the goal, it can be argued a simpler and stripped down model could allow students to make quick changes to code and see the immediate effects of their work as well as let a teacher go deeper into programming mechanics and thinking over a longer period of time. This will need more research at the classroom instructional level though to better understand student engagement and if quicker processes are more engaging for all students.

The Framework

With all of this noted, the coding project suggested here would use a small initial JavaScript environment that is readily accessible in areas with both internet and minimal coding tools (Codepen.io for example is an easy access tool with quick response times that can be used to teach code). It is also suggested that the following pedagogical approach would be used within high school CS courses to infuse cultural approaches in a natural way as opposed to a tokenistic approach that is built on settler representations of Indigenous people. Similar to the modding process used by Lameman, Lewis, and Fragnito in their curriculum, students can start with a familiar environment that takes less time to produce a product at a low cost. [20] The ubiquitous nature of JavaScript as an interactive web-based programming tool and the speed of producing a product through modification can support student interest at an early stage of engagement.

In a test of infusing Indigenous knowledge into CS high school instruction however, Davis et. al., have found that a culturally informed process for teaching programming skills in school does not immediately produce desirable results. The study found challenges in maintaining student engagement and integrating cultural aspects into the curriculum and despite positive changes in student confidence and speed of concept attainment, they have found connecting culture with computer science concepts was limited. The course they examined was set up with cultural teaching first and computing second, separated from each other. The results show students developed a negative perception of learning about culture and they felt computer science did not support cultural understanding. Furthermore, students showed only a slight improvement in programming confidence. The authors wonder if the separation of cultural and historical aspects, that were taught at the beginning of the course apart from computer programming skills, played a role. Additionally, they note ”Students were not allowed to set their own goals, overcome their own challenges, or asked to plan out work. Instead, guided instruction, in which students performed tasks with the teacher, was so specific that even minor errors in entered values needed instructor intervention”. [21] This suggests that student agency and a movement away from direct-instruction methods might be needed. While some might argue this study shows that culture and computing should not be mixed in academic locations, neither the authors nor I feel this is the case.

If anything, the study points to a need to better integrate Indigenous ways of thinking throughout instruction rather than a separation of Indigenous content and computing content in the way this course is constructed. For that reason, I am suggesting here that culture and programming skills should be tackled at the same time throughout instruction and that students should have agency in exploring code to see how it works while gradually developing their own versions of a game environment. I also suggest that students be encouraged to use their knowledge of their local community, observation of their immediate environment and thinking through

local stories to both build understanding of computing processes and to reinforce their knowledge of their own culture. There is an opportunity for teaching Indigenous students how to code when we make the workings of the game visible and give them opportunities to solve problems through coding small game designs in ways that can be accessed in high school computer science courses and build confidence in their ability to think through problems.

Method

As Dyson and Underwood note, Indigenous people have less access to the tools of computing and web design. There are also issues of disparity among rural and reserve schools that have less access to technology which, creates divide even between Indigenous students based on their proximity to urban centres and technical resources. [22] Therefore, this method looks at using JavaScript for the purposes of teaching through Indigenous experience and thought. The programming language can be accessed through web resources and code references are readily available, which creates a learning environment for anyone with access to the internet. That said, one must be cognizant of bandwidth and technological requirements for whatever tool is used and it must be tested prior to using for instruction. In situations where the internet is spotty, it is still possible to use JavaScript with modern browsers like Chrome, Firefox, and Safari offline. Students can also develop coding skills through downloadable virtual coding environments.

It is suggested here that programming would start with a model of Reynolds basic behaviours for autonomous agents pre-loaded into the environment. In discussing flocking behaviour, Reynolds notes when combining three simpler behaviours, separation, cohesion, and alignment, one might emulate the behaviour of birds, fish, and herd animals as they move in life situations. In this case programmed behaviour is combined to create a single compound behaviour, one that is recognizable as natural in the world. [23] This opens the possibility for students in a classroom to analyze the behaviour of the animals based on personal experience, videos and through traditional stories to begin to build up a list of potential steering behaviours. This would allow them to both build an understanding of how to emulate behaviour of an animal in an autonomous agent and to build understanding of the beings they live in direct relation to. By applying programming through this lens, it becomes a valuable tool for understanding local Indigenous perspectives, philosophy and encourages observation of the world. It presents as a valuable approach for teaching both programming and Indigenous thinking.

Reynolds points out that developing a realistic performance is best achieved by first normalizing each component of compound behaviour and then fine-tuning the weight of each factor to create believable sum-behaviour. This process of starting with normalized behaviours as created in code offers a natural teaching and learning opportunity for students to observe code using snippets or available libraries to learn the initial process of working with and altering a program. This would be the initial development model for programming that involves starting with a prebuilt JavaScript instance with basic steering behaviours already available that can be turned on and off through comment processes. This would create a natural laboratory setting that would allow students to experiment with working code and make connections to worlds they already know, that is animal behaviours and game environments. Going through a process of gradually mixing and adjusting the code students would learn through an iterative design process to familiarize themselves with the language plus build coding and design habits.

To facilitate this starting from scratch process, the initial code environment would need to be well labeled. Code snippets would need to be initially referred to in connection to the behaviours they emulate or the purpose they serve from a gamer's point of view as well. An initial starting environment could be created in a shared drive on depository which would allow students to access teacher created environments, share work between each other and the instructor, and receive feedback. To support student engagement, the initial framework must be workable as early learning and first encounter scenarios. At the same time, it needs to be completely alterable and allow for connecting with libraries and student tinkering if it is going to support students following their own desires and setting personal goals. This is key to maintaining student interest, which both Lameman et al. and Davis et al. have highlighted.

After students have become familiar with how to alter code and access JavaScript libraries for support, they would then have the basic skills required to represent stories and environments tied to their culture. As Nijdam notes, Indigenous storytelling traditions are pedagogical tools that foster critical thinking and community engagement. [24] Lameman et al. make extensive use of traditional stories as well in their curriculum and find that students were able to engage with them as frameworks for programming their games. [25] Therefore, this approach of working with and through stories can support game design when they are integrated into the core game-play mechanics, which supports players learning and applying story lessons through their interaction with the game. [26]

An example code and example course of study are provided for the following discussion. The JavaScript file demonstrates an initial starting file that functions immediately with extensive notation for students. The included course shows where this file might be used over an 18 week course and how it would connect to the Ontario curriculum for the grade 11 Introduction to Computer Science. The files can be accessed and downloaded from GitHub here.

Discussion

Reynolds notes that gradually more complex and life like behaviours can be developed by creating different responses for characters based on situations and environments. Characters might switch between behaviours based on changes in environments the actions of other autonomous characters or player actions. By gradual modification of code settings and the environment of the initial game through changing and adding snippets of code students would develop understanding about the modularity aspects of programming. It would also allow for students to switch back and forth between the

virtual world they are creating and discussions about how animals behave in the real world giving them moments to apply decomposition skills. This can move to discussion about traditional stories which presents students a moment to reinforce their cultural knowledge and again apply computational thinking to better understand how one might encode a story into a game. As suggested in the work of Nijdam and Lameman et al, the introduction of stories would come through work with community elders and knowledge keepers. [27] [28]

The behaviours that Reynolds describes are considered basic and have been in use for over 20 years. They are fundamental, one might argue traditional, when it comes to learning programming for autonomous agents. What is proposed in this paper is a way of approaching the learning of these fundamental programming skills through a fundamental and traditional Indigenous cultural practice of observing the world and connecting with stories. The process, which can be generalizable across many cultures and locations, calls on students to model their game on the familiar world around them and initially model animals they know.

The building up of a game environment from a very initial programming state would support a more authentic approach to an Indigenous created game. It would be working with the observable world and traditional stories in community and be free from the tokenistic representations of Indigenous people that Vizenor criticizes. It would allow Indigenous learners to apply their lived knowledge of the world to both reconstruct reality and the stories their community hold as important and allow them to explore the world through their own agency by selecting what animals to represent and how to interpret their behaviours.

Reynolds notes it is possible to plug in different locomotion methods independent of the steering behaviour which would allow for a continued process of creating a more natural representation over time to the game environment and another layer of computer design for students to explore. [29] The overall layering process of learning programming coupled with an initially working program would be engaging for students at the outset and if carried on over time, a teacher can teach students to build new environments and processes using initial code snippets from the first program.

The process stated here would support the learning of computer programming concepts as there are clear moments for computational thinking development without sacrificing Indigenous thinking in the process. In fact, one would hope the process would build relations between game elements and the simulation with Indigenous concepts of relationality.

The end goals of the process here, and noted in the sample course, are to build interest in programming, teach coding skills, teach how coding libraries work, develop cultural knowledge and understanding, connect digital technology to Indigenous communities, and move Indigenous students from consumer to creator. Approaching computer learning this way is important as there is a need for Indigenous people to create solutions for themselves, and be creators of code rather than another market for consumers of colonial programming operations. [30] [31]

Conclusion

The Skins 1.0 curriculum developed by Lameman et. al. shows it is possible to work respectfully with traditional stories and be creative in their application in a game environment when working with students who are learning coding. This demonstrates there are possibilities for students to work with Indigenous knowledge in digital creation projects that are more hands on and less didactic. The method described in this paper would similarly accomplish this through playing with code and support Indigenous students to understand how digital media creation works at the programming level. At the same time, it would not ask them to abandon their cultural ways of thinking which is important. Though not all Indigenous students need to become coders they all need to remain Indigenous for their societies to survive.

I have suggested that students can build characters based on actual animal behaviour as a teaching tool for both learning programming and learning about how the animals behave. This method can create an environment where students can program through a process of critical computational thinking about the world they live in and begin to reflect it in a game they design.

This paper has described a possible pedagogical process for doing this through gradually emulating creature behaviour on screen by:

- Using Reynolds steering behaviours to emulate realistic animal behaviours
- Applying knowledge of animal behaviour to evaluate code results
- Building representations of traditional story through coded environments

Indigenous peoples are sovereign people, separate from the settler governments who occupy their lands, as such they need to vision diverse futures built from their methods. They have always been makers, thinkers, builders, and engineers. They can continue to be engineers using their own core ways of thinking while selectively choosing from the engineering traditions of others to create solutions to meet their needs. However, this will only be possible if they are able to learn from different ways of thinking while maintaining and building upon their own knowledge systems.

References

[1] F. McAlear *et al.*, "State of Diversity: The Native Tech Ecosystem," Oct. 2023. [Online]. Available: https://www.kaporcenter.org/wp-content/uploads/2023/10/NativeTechEcosystem_v5a.pdf, 6.

[2] Statistics Canada, "New entrants to postsecondary education by Indigenous identity, educational qualification, field of study (STEM and BHASE (non-STEM) groupings), gender and age." Government of Canada, 2024. doi: 10.25318/3710026401-ENG.

[3] K. Gallagher-Mackay, M. Yau, C. Corso, N. Debassige, and N. Snow, "Chiefs of Ontario Systemic Gaps in Education Project Report #1: Student Outcomes in Provincially Funded Schools.," Chiefs of Ontario, Nov. 2023, 6.

[4] M. Bang, A. Marin, L. Faber, and E. S. Suzukovich, "Repatriating Indigenous Technologies in an Urban Indian Community," *Urban Educ.*, vol. 48, no. 5, pp. 705–733, Sep. 2013, doi: 10.1177/0042085913490555, 725.

[5] Ministry of Education, "Ontario Modernizing Computer Studies and Tech-Ed Curriculum to Ensure Students Are Prepared for the Jobs of the Future," news.ontario.ca. Accessed: Oct. 19, 2024. [Online]. Available: https://news.ontario.ca/en/release/1002583/ontario-modernizing-computer-studies-and-tech-ed-curriculum-to-ensure-students-are-prepared-for-the-jobs-of-the-future

[6] Ministry of Education, Ontario, "Digital Technology and Innovations in the Changing World." Accessed: Oct. 19, 2024. [Online]. Available: https://www.dcp.edu.gov.on.ca/en/curriculum/computer-studies/courses/icd2o/home, 5.

[7] Ministry of Education, Ontario, "Digital Technology and Innovations in the Changing World.", Sec. A2.3.

[8] S. Crawford-Holland and L. LeBlanc, "'Making Things Our [Digital] Own': Lessons on Time and Sovereignty from Indigenous Computational Art," in *Indigenous Media Arts in Canada*, D. Claxton and E. Winton, Eds., Wilfrid Laurier Press, 2023, pp. 324–349. doi: 10.51644/9781771125437-018, 324–325.

[9] G. S. Aikenhead and D. Elliott, "An Emerging Decolonizing Science Education in Canada," *Can. J. Sci. Math. Technol. Educ.*, vol. 10, no. 4, pp. 321–338, Nov. 2010, doi: 10.1080/14926156.2010.524967, 325.

[10] G. R. Vizenor, *Native liberty: natural reason and cultural survivance*. Lincoln: University of Nebraska Press, 2009, 18.

[11] G. R. Vizenor, *Native liberty: natural reason and cultural survivance*, 1.

[12] E. "Biz" Nijdam, "Sami-digital storytelling: Survivance and revitalization in Indigenous digital games," *New Media Soc.*, vol. 25, no. 11, pp. 3093–3116, Nov. 2023, doi: 10.1177/14614448211038902, 3097.

[13] J. Winter and J. Boudreau, "Supporting Self-Determined Indigenous Innovations: Rethinking the Digital Divide in Canada," *Technol. Innov. Manag. Rev.*, vol. 8, no. 2, pp. 38–48, Feb. 2018, doi: 10.22215/timreview/1138, 38-40.

[14] L. Dyson and J. Underwood, "Indigenous People on the Web," *J. Theor. Appl. Electron. Commer. Res.*, vol. 1, no. 1, pp. 65–76, Apr. 2006, doi: 10.3390/jtaer1010007.

[15] M. I. Byrne, "Read-Only Sacred Spaces: Indigenous Video Games as Space Safe from Vandalism and Theft," Medium. Accessed: Oct. 10, 2024. [Online]. Available: https://meagan-i-byrne.medium.com/read-only-sacred-spaces-indigenous-video-games-as-space-safe-from-vandalism-and-theft-55a0e3e30550

[16] Ministry of Education, Ontario, "Digital Technology and Innovations in the Changing World." , Sec. Introduction

[17] L. Dyson and J. Underwood, "Indigenous People on the Web," 3.

[18] B. A. Lameman, J. E. Lewis, and S. Fragnito, "Skins 1.0: a curriculum for designing games with first nations youth," in *Proceedings of the International Academic Conference on the Future of Game Design and Technology*, Vancouver British Columbia Canada: ACM, May 2010, pp. 105–112. doi: 10.1145/1920778.1920793, 107.

[19] Ibid., 110.

[20] Ibid., 106.

[21] J. Davis, M. Lachney, Z. Zatz, W. Babbitt, and R. Eglash, "A Cultural Computing Curriculum," in *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, Minneapolis MN USA: ACM, Feb. 2019, pp. 1171–1175. doi: 10.1145/3287324.3287439, 173-175.

[22] L. Dyson and J. Underwood, "Indigenous People on the Web," *J. Theor. Appl. Electron. Commer. Res.*, 3.

[23] C. Reynolds, "Steering Behaviors For Autonomous Characters." Accessed: Oct. 20, 2024. [Online]. Available: https://www.red3d.com/cwr/steer/gdc99/

[24] E. "Biz" Nijdam, "Sami-digital storytelling: Survivance and revitalization in Indigenous digital games," *New Media Soc.*, 3095.

[25] B. A. Lameman, J. E. Lewis, and S. Fragnito, "Skins 1.0: a curriculum for designing games with first nations youth," in *Proceedings of the International Academic Conference on the Future of Game Design and Technology*, 111.

[26] E. "Biz" Nijdam, "Sami-digital storytelling: Survivance and revitalization in Indigenous digital games," *New Media Soc.*, 3097.

[27] Ibid., 3095.

[28] B. A. Lameman, J. E. Lewis, and S. Fragnito, "Skins 1.0: a curriculum for designing games with first nations youth," in *Proceedings of the International Academic Conference on the Future of Game Design and Technology*, 107.

[29] C. Reynolds, "Steering Behaviors For Autonomous Characters."

[30] M. I. Byrne, "Read-Only Sacred Spaces: Indigenous Video Games as Space Safe from Vandalism and Theft," Medium,

[31] B. A. Lameman, J. E. Lewis, and S. Fragnito, "Skins 1.0: a curriculum for designing games with first nations youth," in *Proceedings of the International Academic Conference on the Future of Game Design and Technology*,

Author Biography

Andrew McConnell, a member of Nipissing First Nation, is both a PhD student at Lassonde School of Engineering in Digital Media and a course director for the Faculty of Education at York University. He was the coordinator for Indigenous education and consultant at the YRDSB from 2016 to 2023 and a technology teacher at the board for almost 20 years, including being the head of Technological Education at Thornlea Secondary School. Before teaching, he worked in the media, spending time at Aboriginal Voices, a Native arts magazine, and CTV News, a private broadcaster in Canada, where he worked in production for 7 years.