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Indigenizing the Artificial Intelligence (AI) Programmed Engineering Education Curriculum, Challenges and Future Potentials

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Abstract – In this Work-In-Progress (WIP) paper, the integration of Indigenous ways of knowing is explored with a focus on pedagogy that is technologically enhanced with artificial intelligence (AI). An overview of AI programs, providing their key methods of decision making is presented. The technological, educational/philosophical challenges of integrating Indigenous ways of knowing considering AI programs are then discussed from the perspective of a non-Indigenous researcher. The contribution of this work is in recognizing the larger issue of not knowing what Scientific vs. Non-scientific is in the engineering education curriculum and where Indigenous ways of knowing fall into the spectrum. Subsequently, AI programs used in the engineering education curriculum may be challenged to characterize and account for Indigenous ways of knowing through an equitable, diverse, and inclusive lens.

Keywords – Indigenous ways, Engineering Education, Education Technology, Equity Diversity Inclusion EDI, Artificial Intelligence AI

Introduction

This Work-In-Progress WIP paper shares challenges and future potentials for Indigenous integrations in the Artificial Intelligence (AI) Programmed engineering education curriculum where AI is employed to facilitate teaching and learning. The Truth and Reconciliation Commission (TRC) of Canada is calling on individuals, groups, and organizations to acknowledge the hardships and challenges of Indigenous populations on this land in the past and present [1]. As a way of making amends, two streams of work have been done. First, attempts have been made to acknowledge both the gloomy, that is the discrimination and hardships the Indigenous people experience(d), as well as the rich history of Indigenous persons in the curriculum. Second, there are conversations and efforts to integrate Indigenous ways of knowing and practices into the curriculum, which has coined the term “Indigenizing the Curriculum”. The purpose of this paper is to take a closer look at the second stream since it is clear that the place of true reconciliation in the curriculum is necessary.

Positionality Statement

A positionality statement is shared to lay the research goals and directions of the author. The author self-identifies as a female non-Indigenous minority in the STEM fields. She relocated and resided as an uninvited settler on the lands of Indigenous people in Canada and was saddened to learn about the past of Indigenous populations. As a researcher and educator, she aims to practice non-biased ways of research execution and synthesis and pay attention to under-represented minority groups in research. She believes that technology, such as AI can bring good to all if used through a universally equitable, diverse, and inclusive lens (e.g., including a complete and nonamplified picture of the world’s populations). She has also embarked on a journey and

explored how potential Indigenous integrations can be made in the curriculum. Over a month, she reviewed the literature surrounding programs and initiatives from around the world on "Indigenizing the curriculum". She explored survey questions for obtaining experiences and metrics from the literature. The arguments she makes in this paper were born out of this reflection.

Literature review

The "Indigenization of the curriculum" has been explored through various positionalities in the literature [2], [3], [12], [13], [4]–[11]. Both Indigenous and non-Indigenous scholars have examined the requirements and initiatives to achieve equity, diversity, inclusion, and decolonization in the curriculum [2], [3]. In Canadian engineering education, Aikenhead et al. have explored the pragmatic implications of onboarding Indigenous topics through their concept of "cross-cultural crossing" [4]. They argue that students' life-world subcultures are multidimensional and may be different from the subculture of science, and so the curriculum design needs to account for such differences and crossings students need to make while learning. The work by Seniuk Cicek et al. has critically considered the role of Indigenizing the curriculum in the context of engineering education. Through a balanced "two-eyed seeing" approach, the authors make the case for including and reflecting on both Indigenous and non-Indigenous perspectives [5]. Friesen et al. have examined the outcomes of increasing concepts of Indigenous concerns and knowledge in several design, capstone, and theoretical courses [7]. Work has also been done to inspect the integrations of learning modules and technical courses that are woven with Indigenous topics [8], [9]. In the United States and the American Society of Engineering Education (ASEE), discussions have been done to compare engineering and Native American philosophies of learning [10], increase recruitment of underrepresented and minority groups [11], explore how to engage with Native American communities and culture [12], and conduct participatory research with the communities [13].

Efforts have been made on equity, diversity, and inclusion (EDI) when integrating Indigenous ways of knowing in the curriculum [14]–[18]. One area explored is the data points and indicators developed for equity, diversity, and inclusion on Indigenous topics [14], [15]. Another area has focused on questions targeted to the Indigenous community and educators (e.g., students, and faculty) to identify their challenges and ways that are specifically Indigenous [16]. Personal factors that may come to influence the individual's likelihood to be successful in Scientific and engineering fields have also been studied [17]. Further, the experiences and process strategies that institutions can adopt to maintain EDI, particularly for First Peoples in Canada have been examined [18].

Yet, the findings from most studies remain at a high level (e.g., collaborating with Indigenous peoples across postsecondary institutions, and Indigenous Elders and Knowledge Keepers) and do not specify implementational considerations. More significantly, there is still a lack of conversation around how Indigenous integrations can be specified considering advancements in educational technology such as artificially intelligent tools and tutors in higher education [19]. This gap motivates exploring potential challenges and potentials of integrating Indigenous ways of knowing in engineering education, particularly when AI programs are used to facilitate the design and delivery of the curriculum.

Technological Challenges

From a technological perspective, AI programs used in pedagogy need to strive for accuracy (i.e., the desired process/outcome) and transparency (i.e., making the inner workings of the AI's algorithm apparent). Achieving both accuracy and transparency, however, may be challenging. In a simplistic view, AI-generated programs that tend to answer questions (e.g., chatbots) may lie on a spectrum with two ends being either unsophisticated or sophisticated [20], [21].

At the unsophisticated end, AI programs find responses that best match a question based on a set of basic rules and data stored in a repository that humans may have made available to the AI program. Unsophisticated AI programs are dependent on the quality of the basic rules set and the data repository. This may make the unsophisticated AI program's transparency high but accuracy low. At the sophisticated end, AI programs imitate and build from human forms of decision-making but also harness advanced computational and mathematical means to offer more rigorous and accurate responses. Sophisticated AI programs are dependent on little continuous support and understanding of humans. This may make the sophisticated AI program's transparency low but accuracy high. In the context of Indigenous integrations, an unsophisticated AI program can respond to a question like "Give me background information on Inuit and Metis nations" or "Give me differences in backgrounds of Metis and Inuit nations". A sophisticated AI program on the other hand may respond to a more open-ended and situational question like "Tell me which of Inuit and Metis nations would more likely accept the use of solar panels in their environment".

Whether sophisticated or not, if the AI program's algorithm and associated data structures are defined or understood poorly, responses can quickly become inaccurate (unsatisfactory, biased, or stereotypical for communities) or follow a chain of reasoning hidden from humans. Adding to this issue is that different communities have different interpretations of what is and is not appropriate when meeting Indigenous needs in the curriculum. Therefore, AI programs used in pedagogy need to be accurate, and transparent, and target the needs of different communities appropriately.

Educational Challenges

From an educational and more broadly philosophical perspective, AI programs used in pedagogy need to strive for equity and inclusion. It is suggested that the world can be viewed through the Scientific and Non-scientific spectrum with the Indigenous ways of knowing being near the Nonscientific end. Often the Scientific view is considered as the Western way of scientific reasoning and Non-scientific to be anything apart from Western science [22]. Here lies an assumption that creates a paradox, and that is whether we should consider all that is Indigenous to be Non-scientific and Scientific to be Scientific [23]. Engineering as a program and profession, for example, is largely biased towards Western science and may be resistant to equity and accepting different views. Such culture may as a result implicitly push researchers and educational practitioners to reformulate and package non-scientific ideas in a scientific and positivist way to be able to achieve their goals (e.g., research funding, new course design). To prevent such efforts and gain a better picture of different world views, we may utilize AI programs as artificial assessors, reviewing proposals and plans primarily through textual and natural language processing methods. However, we again need to set rule-based conditions and

exceptions for AI programs on what to consider Scientific and Non-scientific and where Indigenous ways of knowing fall into that spectrum. So for either AI or human decision-makers, choices need to be made on the chain of logic and reasoning employed to appropriately locate research and teaching on the Nonscientific-Scientific spectrum.

Accepting and having discussions on Scientific and Non-scientific views may be one step towards equitable education, yet there are still challenges lying ahead. Often, the Scientific and Non-scientific ways of knowledge production have clashing or non-comparable methods of inquiry. Non-scientific methods seem to be local and holistic, whereas Scientific methods strive for controlled, reproducible, and methodical approaches. And so how smoothly and effectively can learners or AI programs "cross the borders" as Aikenhead denotes [4] and utilize differing knowledge systems under different contexts is still largely unknown. Further, we still know little about what specifications (e.g., variables, metrics, units, thresholds) should be used to conceptualize Scientific, Non-scientific, and Indigenization ways of knowing and how the AI programs should decode and synthesize the specifications. It is unclear how inclusion should be implemented. A question for debate, for example, is whether Indigenous topics/ways of knowing should be defined in more universal (Indigenous ritual agnostic) or local (specific Indigenous community) terms. A local outlook may result in more specified interpretations of communities but may be highly dependent on the storytellers and those who claim such histories and cultures, should they be today's elders or youngsters or unfavorably those who were not part of each community for a long time. Therefore, AI programs used in pedagogy need to be equitable and inclusive of alternative views that are often dynamic and change from one group or another and over time.

Discussion

This WIP shared factors that may impact the quality of Indigenous integrations in the engineering education curriculum equipped with AI programs like chatbots, namely:

- Technological: the tradeoff between transparency and accuracy.
    - Whether to set logic in a specific way using unsophisticated AI programs or allow sophisticated AI programs to generate logic and solutions of their own.
    - How and when to involve communities and stakeholders. The different interpretations of what is and is not appropriate when meeting Indigenous needs in the curriculum.
- Educational: the challenges of characterizing equity and inclusion.
    - Mystery of what constitutes Scientific and Nonscientific and its specifications for AI programs; the paradox of Indigenous ways being both Scientific and Nonscientific under different lights.
    - Uncertainty of how Indigenous or any other important social topic is detailed for AI programs; Aftermath of a holistic (community agnostic) vs. granular (community-centered) specification.

The advancements in educational technology and the ways courses can be designed, developed, and delivered may suggest that curriculum modifications and including new concepts are easily within reach [20], [21]. The use of artificially intelligent agents may serve different purposes in integrating Indigenous topics into the curriculum. Intelligent virtual chatbots, for example, can collect and summarize the experiences of Indigenous and non-Indigenous members in the

curriculum. Intelligent virtual tutors, on the other hand, can teach and instill a sense of equity, diversity, and inclusion in students' thought processes. Artificial intelligence may be further used to present different types of curricula based on the demographic needs and interests of participating user groups. However, integrating Indigenous ways of knowing may still suffer from an underdeveloped technological and pedagogical/philosophical framework. As a result, AI programs used in engineering education may become susceptible to bias. And so important discussions and decisions need to be made both within communities and outside of communities and with society as a whole on how to conceptualize societal integrations in the engineering education curriculum. Challenges may include the tradeoff between transparency and accuracy in the decision-making for different demographic groups and deciding on what voices are more equitable and inclusive.

With that being said, we should neither over-trust nor completely dismiss the benefits of AI programs in education. AI programs have the power to synthesize large volumes of data, and if used in a universally non-biased way can serve as an agent to achieve the needs of underrepresented minority groups (e.g., Indigenous) and maintain EDI more generally. Initiatives can be done, for example, to close the educational gap by considering the perspectives of all members of the educational community as the feedback loop. Diversity may be understood through sharing the world views of individuals, how they interpret, and where they see themselves on a spectrum with Scientific on one end and Nonscientific on the other end. The inclusion of diverse interpretations of both Scientific and Non-scientific views may close the gap in the uncertainties we have regarding the act of science-based teaching, learning, and research. Yet what is important about "Indigenizing the Curriculum" is not to just combine a set of Indigenous experiences or perspectives with Scientific ones and expect more conclusive or humane problem-solving. Rather, AI programs, learners, educators, and researchers alike need to be transparent and attempt to be equitable and inclusive with their understanding, motives, and methods of utilizing Indigenous ways of knowing. Concepts similar to "Cross-cultural learning and border crossings" [4], [24]–[27] may need to be defined for AI programs to understand how individuals truly work around Scientific and Non-scientific views; create an amalgam, keep them separate, or situate one in the other.

Conclusion

"Indigenizing the Curriculum" necessitates acknowledging the hardships and history of Indigenous communities and can proceed with integrating or respecting "Indigenous ways of knowing" when addressing societal conflicts in the curriculum. There is a paradox of knowing what exactly wholly "Scientific" and "Non-Scientific" is and where everyone's teaching, learning, and research practices lie on this spectrum. Deciding on important technological and pedagogical/philosophical underpinnings for "Indigenizing the curriculum" may help situate the role of AI more transparently and equitably. Using AI programs to thematize the perspectives and experiences of individuals, groups, and organizations, and using them as a starting point to address Indigenous-related concerns in the curriculum may also be useful.

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