

Fostering Ethical Neurotechnology Leadership: Preparing BCI Innovators Through Education

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Abstract— As neurotechnology reshapes healthcare, industry and human-computer interaction, we have a rare opportunity to steer its burgeoning development with ethical leadership. Just as ethical principles guide engineering and medicine—ensuring public safety, trust, and accountability—they are equally important in neurotechnology. Programs that offer specialized education related to brain-computer interfaces (BCIs) must prepare future neurotech leaders to navigate complex ethical challenges associated with connecting minds with machines. Therefore, it is crucial that educational programs in this area not only develop technical expertise but also instil a sense of responsibility in advancing innovative technologies to enhance lives and benefit society.

The Neurotechnology Microcredential program (NTMC) at Queen's University offers foundational courses including The Neuroscience and Neurotech Primer, Neuro-electronic Recording and Processing, Neuroimaging, as well as a hands-on Capstone Project course. NTMC implements ethical practice as a core competency of neurotechnology training. Ethical considerations are integrated throughout each course via presentation of case studies covering topics including data privacy breaches and device abandonment.

As of Jan 2025, we have had 114 enrolments across courses. Demographics indicate that half were University students (mostly upper year undergrads and graduate students), with many mature learners (28% over 35) and gender parity (44% female). Only 52% were Canadian (22%US, 13% Europe, 9% Australia) despite being a Canadian programme. This composition reflects the growing interest in neurotechnology education worldwide. With a cohort reaching over 70 credentials issued from these the courses, the program is being expanded to offer Neuro-Entrepreneurship, Brain-Computer Interfaces, Neuromodulation, Behavioural Measurement and a focused course on Ethical Considerations in Neurotechnology.



Figure 1: The first Cohort of students in the intensive NTMC Capstone Project Course pictured sitting with Program directors Dr. Boehnke and Dr. McIntosh

A cornerstone of the curriculum is engagement with diverse, real-world challenges and perspectives. The program guides graduates to independently identify ethical challenges, practice humility, and engage in thoughtful, reflective discussions when co-creating solutions with the communities they serve. Reflections from executives of world-leading medical device companies, BCI startups and neuro-related corporations are integrated within the courses, providing practical context and insights for learning. Facilitators, with lived-experience, support students in grappling with challenges such as: access to therapies, risk of exploitation and regulatory challenges.

Conclusion— By emphasizing ethical leadership as a skill developed through the NTMC program, students think critically about the impact of their choices and about their approach to problem solving with BCIs. By equipping students with mentorship and practical strategies to navigate complex issues, the NTMC program lays a foundation for neurotech innovators to steer the field responsibly.

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