

Impacts of Brain computer interface (BCIs) within the Canadian Educational Context

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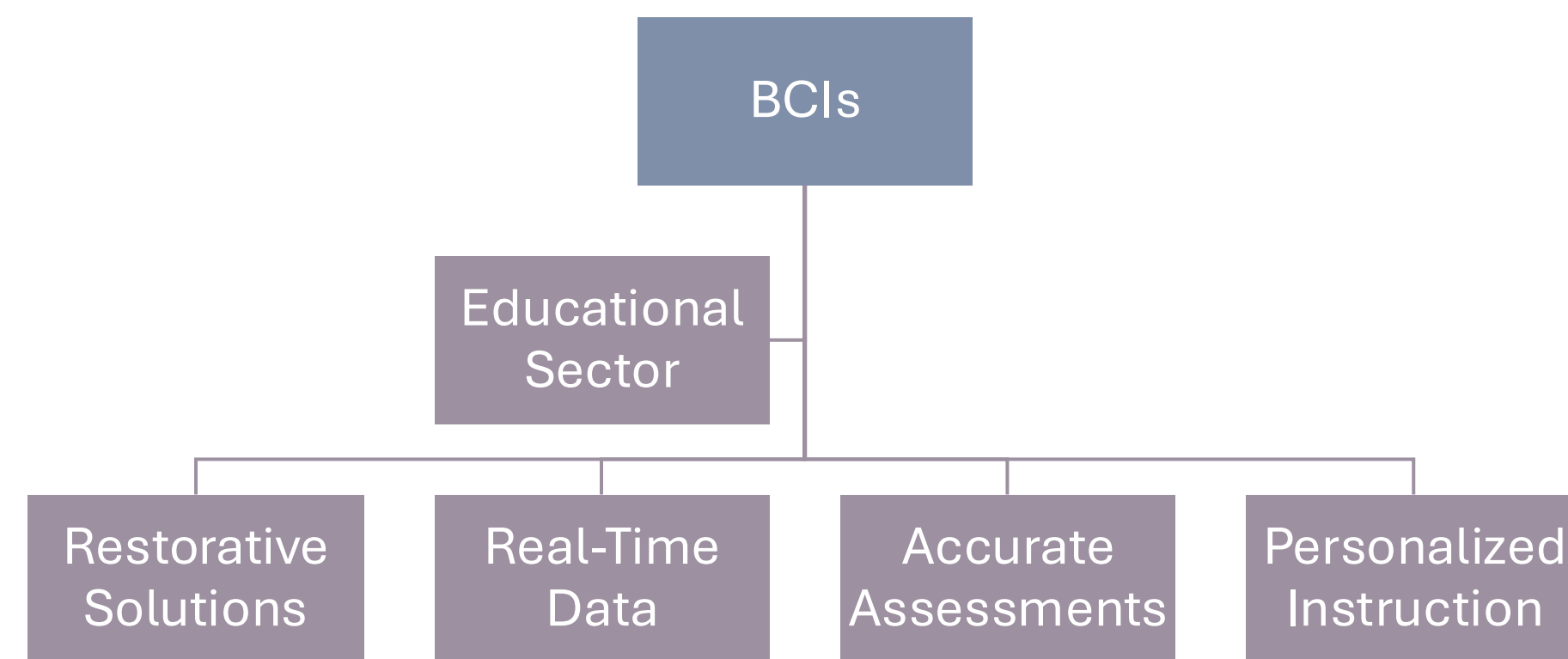
Abstract

Recent advancements in the field of Brain-Computer Interface (BCI) technology have emerged in the academic context. This technology offers groundbreaking capabilities for neurorehabilitation. BCIs also hold potential to improve learning, enhance concentration and memorization, provide real-time data monitoring, and support personalized learning strategies.

The purpose of this review was to synthesize current studies, combining findings to better understand the educational benefits of integrating the technology within the current academic framework, as well as the potential societal impact it may pose.

Key findings have demonstrated a positive correlation between BCI integration in the medical field; however, there is limited understanding of its integration in the educational context, and its impact remains unclear.

Keywords:



Literature Review

The research has revealed the fundamentals of how BCIs have the potential to enhance the current pedagogic framework by offering restorative measures for students with physical disabilities, enhancing communication capabilities, providing personalized learning strategies with the guidance of real-time neurofeedback, transforming the symbiotic relationship between educational technology and social norms, and ultimately redefining the Canadian educational system.

Symbiotic Relationship with BCI

BCIs have demonstrated the potential to foster a collaborative relationship between technology and learning, creating a new paradigm that cannot be achieved independently. BCIs possess neuro-engineering capabilities that enable communication between brain signals and external devices (Abdulmawjood & Oyibo, 2025; Beauchemin et al., 2024; Zhang et al., 2024).

Communication Accessibility

The use of BCIs for students with speech impairments provides valuable neurofeedback data. This information can be analyzed through a series of essential steps that acquire, process, and translate the data into output commands. As a result, students can communicate more easily and independently, thereby increasing autonomy and reducing existing barriers (Peksa & Mamchur, 2023; Kawala-Sterniuk et al., 2021).

Potential Barriers/Limitations

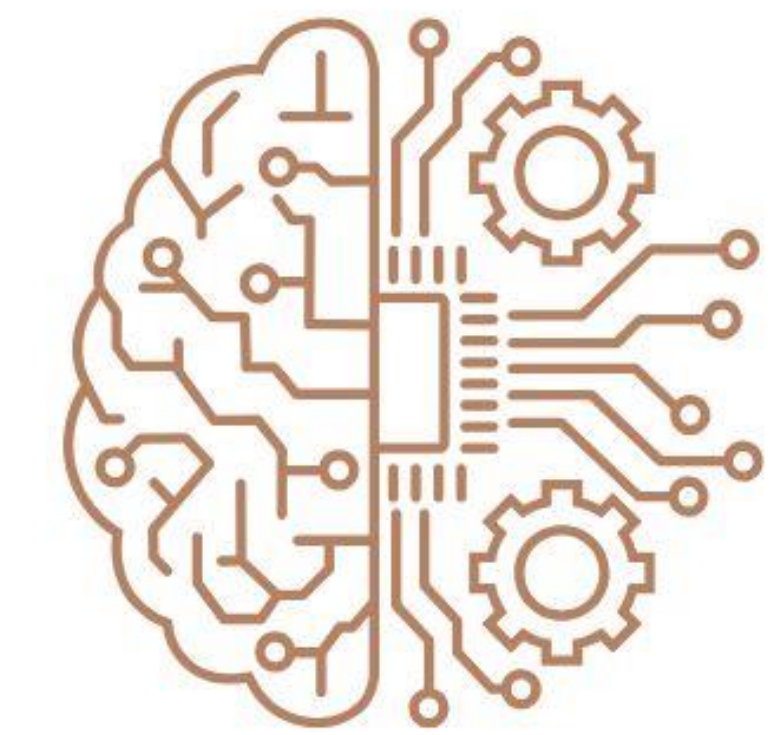
The analysis revealed promising outcomes attributed to BCI integration within the educational paradigm; however, barriers and feasibility challenges remain. Technology-based learning has demonstrated incredible promise for the future of education by facilitating diverse learning needs, flexibility, and accessibility; however, it raises the need to address the complexities of intersectional inequalities, especially in marginalized communities (Judijanto et al., 2025). The evidence suggests that BCIs integration must consider a more diverse group of participants to better understand the complexity of overlapping educational disadvantages within these group as current research limitations exist within underrepresented communities (Abdulmawjood & Oyibo, 2025).

Furthermore, evidence indicates that BCIs can exacerbate existing systemic disparities, particularly impacting underrepresented communities that may already face obstacles with technological resources. As educational technologies continue to evolve, it is imperative to consider Indigenous literacy and traditional practices to honour Indigenous knowledge and customs, grounded in their worldview (Li et al., 2021; Bujold et al., 2021).

Conclusion

In conclusion, Brain-Computer Interface technology shows promise for enhancing the current pedagogical approaches. It creates a collaboration between neurotechnology and human capabilities, reshaping present-day education. Evidence demonstrates that BCIs offer significant opportunities for personalized learning strategies, enhancing cognitive abilities, and fostering a more inclusive and equitable learning environment for students. The revolutionary technology marks an important shift in the Canadian educational framework, redefining how knowledge is acquired, and information is retained through direct interactions between the brain and technology. As a result, students' cognitive capacity is likely to see an exponential increase in communication capabilities and knowledge bandwidth, ultimately redefining how students learn

Emergence of BCI technology



Introduction

Brain-Computer Interfaces (BCIs) enable users to control external devices using neural communication (Zhang et al., 2024). This innovative technology is being integrated into the Canadian education system as a systematic approach to enhance and adapt the learning experience for students of all ages. Furthermore, BCIs provide alternative communication pathways for students with physical and communication disabilities, helping to remove barriers and create a more inclusive educational environment.

Thesis Statement

(BCI) enhances the current pedagogical framework by offering restorative measures for students with physical disabilities, improving communication capabilities, providing personalized learning strategies guided by real-time neurofeedback, transforming the symbiotic relationship between educational technology and social norms, and ultimately redefining the Canadian educational framework. Central concepts shaping the educational landscape involving BCI need further exploration, including the symbiotic relationship with BCI, communication accessibility, learning enhancement, inclusivity, ethical considerations, and academic innovation.

Recommendations

Pilot Project

To complement existing research, a pilot project should be integrated in smaller-scale classrooms in conjunction with larger-scale, correlational, mixed-method, and experimental studies involving students of all ages, with more scrutiny towards the demographics of high-risk groups, such as young children, to better understand the potential impacts on brain development (Gordon & Seth, 2024).

Accessibility Consideration

Expanding access to BCIs' in rural areas is crucial, as many isolated communities have limited access to advanced technology. Significant attention is required to assess these unique challenges, including accessibility, community partnerships, ongoing support and sustainability. Successful BCIs integration will require particular attention to technological implementation, availability, connectivity and practicality of professional development for educators to equip them with the necessary skills to navigate these new technologies.

Ethical Considerations

Uncertainties surrounding neuroethics include an overall lack of stringency with the rapid emergence of BCIs. Some concerns have been consistently mentioned throughout the literature, primarily due to "the rapidity of technological changes involving BCIs. Ethical considerations and guidelines are imperative to ensure their successful advancement (Eaton, 2025).

References

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Land Acknowledgement

This literary review and research have been conducted with respect and gratitude on the traditional territory of Treaty 8, located on Turtle Island. This land is the ancestral home of the Beaver, Cree, Dene, Métis, and other Indigenous and Inuit Nations, who have been the original caretakers of these lands.