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Enhancing Accessibility in Education Through Brain-Computer Interfaces: A Scoping Review on Inclusive Learning Approaches

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ADMINISTRATIVE INFORMATION

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INTRODUCTION

Review question / Objective This scoping review aims to identify and synthesize existing research on the application of Brain-Computer Interfaces (BCIs) to enhance accessibility in educational contexts. The review explores key themes, technologies, benefits, and challenges associated with using BCIs to support inclusive learning for students with physical and communication disabilities.

Rationale Ensuring accessibility in education is crucial for equal learning opportunities. While traditional assistive technologies provide some support, they often require manual input. BCIs offer the potential for direct brain-to-computer communication, enabling hands-free control and interaction. This review consolidates current evidence to highlight advancements, identify gaps, and guide future research on integrating BCIs into inclusive educational environments.

Condition being studied Accessibility challenges in education for students with physical, motor, or communication disabilities.

METHODS

Search strategy We conducted a comprehensive search in ACM Digital Library, Scopus, and IEEE Xplore. Search terms included combinations of "accessibilit*" OR "disabilit*", "Brain-Computer Interface" OR "bci" OR "Brain Machine Interface" OR "bmi", and "education" OR "learning". Boolean operators and truncations ensured broad capture. The search included peer-reviewed journal and conference papers without date restrictions and limited to English-language publications. Snowballing of references from included studies was also performed.

Participant or population Students and adult learners with physical, motor, or communication disabilities who may benefit from BCI-enabled educational tools and platforms.

Intervention Use of Brain-Computer Interfaces (BCIs) to facilitate educational accessibility and inclusive learning.

Comparator Not applicable (scoping review, no comparative intervention).

Study designs to be included Empirical studies including qualitative, quantitative, and mixed-method designs that investigate BCI applications in educational settings.

Eligibility criteria Inclusion criteria: The article must be a journal or conference paper, and must be written in English. Studies must focus on Brain-Computer Interface (BCI) applications aimed at improving educational accessibility and learning outcomes for individuals with disabilities.

Exclusion criteria: Articles that are not peer-reviewed, studies focusing solely on clinical, entertainment, or non-educational applications, and articles in languages other than English.

Information sources ACM Digital Library, Scopus, IEEE Xplore, and reference lists of included studies (snowball method).

Main outcome(s) Identification of key themes, benefits, challenges, and technological advancements in BCI applications to improve accessibility and engagement in education.

Data management Records were managed using reference management software for deduplication and screening. Data extraction used standardized forms; synthesis was thematic.

Quality assessment / Risk of bias analysis The Mixed Methods Appraisal Tool (MMAT) was used to evaluate methodological quality across different study designs.

Strategy of data synthesis Thematic synthesis was conducted to consolidate findings across studies. Key outcomes were categorized by application type, technological approach, and identified challenges.

Subgroup analysis Not applicable.

Sensitivity analysis Not applicable.

Language restriction English only.

Country(ies) involved Canada.

Keywords Brain-Computer Interface, BCI; accessibility, inclusive education; assistive technology, EEG, neurotechnology.

Contributions of each author

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