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Review Article

Neuroethical Values Formation: Brain Computer Interfaces for Real Time Empathy Measurement and Enhancement in SDG 4.7 Aligned Peace Education

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ABSTRACT:

As countries get nearer to the 2030 target for Sustainable Development Goal 4.7, a measurement gap that threatens to prevent proper peace education is formed. In this article, a new neuroethical framework is presented that merges BCIs with empathy assessment and enhancement in education through real-time interactions. The use of self-reported surveys to assess values education such as peace, love, and tolerance is the main issue here because these surveys are biased and do not show real outreach development. New methods in affective neuroscience reveal that BCIs can identify the neural signatures of empathy in brain activities more accurately and consistently than ever before. We propose a model with three elements: (1) measuring empathy using electroencephalogram (EEG) during peace education, (2) conducting neurofeedback protocols with the aim to increase empathy, and (3) protecting cognitive rights with the help of ethical measures. Initial studies show that BCI-augmented teaching produces more positive behavior than traditional methods. Still, it needs strict ethical monitoring about privacy issues, informed consent with at-risk groups, and fair availability of resources. This neuroethical approach is providing education systems with research-backed means to convert the rhetoric of values into quantifiable growth in terms of character, thus pushing further the global peace education goals.

Keywords: *Brain-computer interface, empathy measurement, neuroethics, SDG 4.7, peace education, values formation*

1. INTRODUCTION

United Nations Sustainable Development Goal 4.7 foresees that by 2030 the whole human race will be able to cognize and develop skills that will put forward the idea of sustainability through education in global citizenship, and peace (Holst et al., 2024). This breakthrough goes hand in hand with a deep crisis of dislocation among the schools where this vision is being implemented. Even though policy commitments have been made by more than 85% of the countries, there are still very large differences between the written versions of the curricula and the ones that are real in the classrooms. The methods used to assess the situation are mainly based on self-reported surveys which measure the acquisition of knowledge and not the real transformation of behavior.

Such a problem of measurement constitutes a serious weak point: teachers are unable to tell the difference between those students who really possess the traits of empathy, compassion, and intercultural understanding and the ones who just give the socially acceptable answers. The metaphor of traditional peace education is like a flashlight in the dark, betting on the assumption that the exposure to values-based content will by itself lead to the prosocial character development that will go unobserved

On the other hand, the breakthroughs in affective neuroscience and brain-computer interface (BCI) technology, happening at the same time, grant the educators the chance to see this pedagogical black box. BCIs allow for the direct measurement of neural activity tied to empathic responses, thus providing teachers the emotional engagement feedback during the peace education activities in real-time (Floreani et al., 2022). The ethical frameworks elaborated to safeguard learner autonomy when using these neurotechnology might be the key to turning the progressive values education from mere aspirational rhetoric into

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measurable practices backed by evidence. This paper puts forward a neuroethical framework for the BCI-assisted empathy measurement and training to be introduced in SDG 4.7-compliant contexts of peace education.

1.1 The Assessment Crisis in Peace Education

A contemporary paradox in peace education is that extensive theoretical frameworks co-exist with almost no strong proof of effective implementation. According to Lino and Lins (2024), there is a very, very high percentage of the failed assessments of school programs' moral learning resulting out of evaluations which focus on the participants' satisfaction rather than on the actual values' internalization or change in behavior. Self-reporting tools will always be susceptible to the bias of social desirability when they are used for assessing the socially desired character trait of empathy.

Very recent research by Purwanto et al. (2023) suggests that the university peace education program almost never has a strong enough evaluation bordering on the distinguishing of one is acquiring of genuine values from the learning of superficial knowledge. As we approach the year 2030 with very little progress in SDG 4.7, the education systems desperately require assessment technologies that can accurately tell the difference between the development of true empathy and compliance that is only performed.

2. NEUROSCIENTIFIC FOUNDATIONS OF EMPATHY MEASUREMENT

The ability to empathize is shown to have measurable neural pathways. Lashkari and colleagues (2025) corroborated the efficacy of different ways to measure empathy-cognitive as well as affective-under a variety of emotional circumstances. Floreani and collaborators (2022) proved that the use of brain-computer interfaces allowed the continuous recognition of the emotions of youngsters in the classroom. Morozova et al. (2023) attest that the use of electroencephalography is a very reliable technique for monitoring the cognitive-evaluative processing of the subjects during the classes.

Measures derived from these neurophysiological phenomena provide objective indications of emotional involvement in values education. The use of non-invasive systems based on electroencephalography delivers the most feasible and economically accessible tools for assessment. In the work of Drigas and Sideraki (2024), it was shown that the combination of brain-computer interfaces and virtual reality not only enhances brain plasticity but also supports both assessment and intervention in education.

3. BCI-ENHANCED PEACE EDUCATION: A THREE-COMPONENT FRAMEWORK

Electroencephalography-based monitoring during peace education activities is the first component of the system. BCI systems will capture the neural signatures linked to the empathic engagement while the students are doing perspective-taking exercises, conflict resolution simulations, or intercultural dialogue sessions. The teachers will get instant feedback showing which students are having a real emotional connection and which are just superficially participating, thus providing an adaptive pedagogy that is responsive to the needs of the students.

Neurofeedback protocols that are built on the assessment capabilities, allow students to self-regulate the neural activity of empathy. Enz et al. (2022) showed that people can learn to self-regulate specific brain rhythms through BCI-mediated feedback. Wang et al. (2023) proved the effectiveness of BCI combined with mindfulness therapy and suggested that integrated approaches yield better results. Neurofeedback applied to peace education could push empathy development to new heights faster than the regular teaching methods.

On the other hand, implementation would be an invasion of the students' rights (autonomy, privacy, and cognitive liberty) unless there were rigorous ethical frameworks put in place to protect them. Wohns et al. (2024) pointed out critical imperatives such as the need for informed consent security of data, and the prohibition of coercive applications.

TABLE 1: *Ethical Safeguards Framework for BCI-Enhanced Peace Education*

DIMENSION	SAFEGUARD COMPONENTS	IMPLEMENTATION REQUIREMENTS
Informed Consent	• Age-appropriate disclosure	• Written consent from parents
	• Voluntary participation	• Student assent protocols
	• Right to withdraw	• No academic penalties
	• Understanding verification	• Plain language explanations
Data Privacy	• Encryption at rest/transit	• Minimum data collection
	• Limited retention periods	• Anonymization protocols
	• Access controls	• Regular security audits
	• Breach notification plan	• Third-party prohibitions
Cognitive Liberty	• No coercive applications	• Voluntary neurofeedback
	• Mental privacy protection	• Thought non-interference
	• Autonomy preservation	• Non-punitive approaches
	• Self-determination rights	• Freedom from manipulation
Equity & Access	• Universal availability	• Resource allocation equity
	• Disability accommodations	• Cultural sensitivity
	• Socioeconomic neutrality	• Language accessibility
	• Geographic distribution	• Technology provision
Oversight Mechanisms	• Ethics review board approval	• Ongoing monitoring
	• Independent auditing	• Stakeholder representation
	• Grievance procedures	• Transparent reporting
	• Regular policy review	• Adaptive governance

Table 1 Ethical framework covers consent, privacy, liberty, equity, and oversight mechanisms.

The use of BCI in education must be voluntary without academic penalties, include informed consent appropriate for the age of the students and parents, have encrypted collection of only neural data that is relevant to education, be transparent about the usage of data in teaching, and have equity safeguards that ensure BCI access does not become a requirement for education.

4. EVIDENCE BASE AND PEDAGOGICAL OUTCOMES

Brain-computer interfaces are being highlighted by the most recent research as a technology that could have a positive impact on education. Pitt and Boster (2025) have recognized various training methodologies that work with children and, thus, have declared them as feasible if the developmental factors are considered. Musso et al. (2022) have shown that BCIs not only help in the recovery of patients but also in the learning of a language, thus, apparently, making this area of clinical work more extensive. The authors (Lv et al., 2022) have introduced a new approach based on computational frameworks that allow for developing personalized educational paths according to the individual neural patterns of the children. Nonetheless, the new protocols for younger patients and increased attention to child development require methodologies that are both time-consuming and expensive, as pointed out by Floreani et al. (2022). It is only through long-term studies that we will be

able to know if the neural improvements seen in the short-term are counting towards the development of prosocial behavior and empathy over time.

5. IMPLEMENTATION PATHWAYS AND PRACTICAL CONSIDERATIONS

To put neuroethical frameworks into educational practice, there would need to be systematic planning for the implementation. Chai et al. (2024) presented models of digital prescriptions which can be used for educational BCI deployment. The first implementations should take place in research-focused environments with a lot of ethical supervision and a complete evaluation to ensure technical feasibility. Teachers will need BCI operation and neural data interpretation, as well as ethical principles training. Tantawanich et al. (2024) pointed out the necessity of systematic training. The implementation would need to create trust by providing clear communication about the BCI's capabilities, limitations, and safeguards. The implementation, in this case, should be access-centered, that is, it should give priority to the available resources of the communities, especially the less privileged, where the impact of the peace education that has been enhanced would be the greatest.

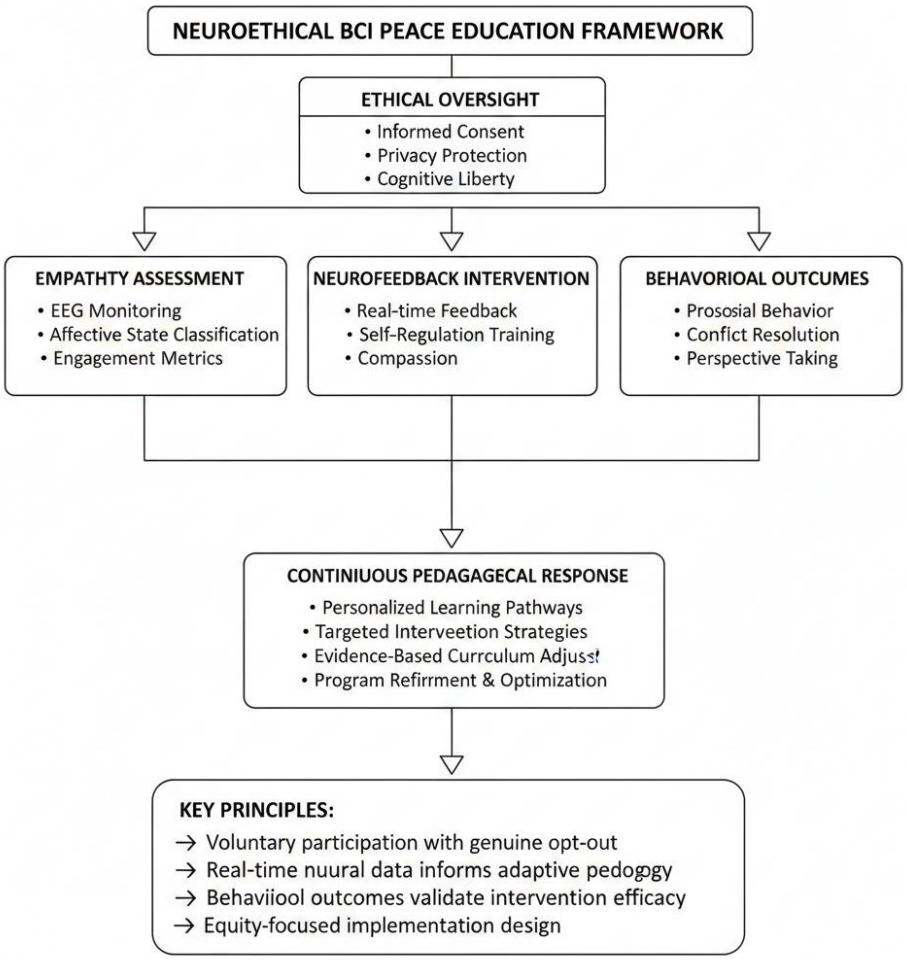

Figure 1: *Integrated Neuroethical BCI Implementation Model for Peace Education*
Source: Authors Creation

Figure 1 The model illustrates continuous cycling between empathy assessment, neurofeedback intervention, behavioral measurement, and ethical oversight throughout BCI-enhanced peace education.

6. CHALLENGES, LIMITATIONS, AND FUTURE DIRECTIONS

Although the optimistic potential is there, BCI-enhanced peace education faces significant challenges on almost all fronts. Another batch of challenges arises from the imperfections of the technology such as connected issues of ambient noise in naturalistic classroom settings, individual differences of learners in the brain activity leading to difficulties in understanding and interpretation across, the necessity of age-specific protocols due to the developmental changes in children's brains, and possible exaggeration of differences in neural interpretation bias due to cultural factors in emotional expression.

Ethical issues are not limited to the question of privacy, and reliability of the monitoring method also comes into question; neuromonitoring Tactics may impede educational freedom and diminutive character traits that are not measurable may be dismissed through the measurable outcomes. De Souza and de Castro (2025) cautioned that BCI approaches could oversimplify values formation, thereby narrowing educational vision. Future research must include long-term empathy-tracking, cross-cultural validation, and confirmation that measured neural changes produce sustained prosocial behavior beyond the classrooms.

7. CONCLUSION

The overlapping areas of affective neuroscience, brain-computer interface (BCI) technology, and educational reforms are providing the world with the best possible means to further the SDG 4.7 peace education goal. BCI-embedded teaching methods could bring about a shift in the teaching of values from being a mere aspirational slogan to being an empirical practice through objective empathy measurement and neurofeedback-assisted development, the outcomes being even measurable.

Nevertheless, the capability of technology does not guarantee the wisdom of education. The execution of this task requires the strongest possible dedication to the ethical principles that protect the students' autonomy, privacy, and liberty of thought. The proposed framework consisting of real-time empathy evaluation, neurofeedback enhancement, and strong ethical protection offers the education systems a way to develop the real values formation while respecting the most basic human rights.

With the 2030 SDG deadline approaching, education systems are faced with significant alternatives regarding the adoption of innovations. BCI-enhanced peace education is a very promising, very risky innovation that requires careful and gradual implementation, very stringent evaluation, and constant moral oversight. The determining factor for success is not the level of sophistication of the technology but rather the educational communities' ability to use their wisdom in finding the right balance between innovation and the protection of the learners' dignity, autonomy, and flourishing, while at the same time equipping them for peaceful, sustainable, and just futures.

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