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ORIGINAL

Chile and the neurodiverse rights law: lessons for teacher training in Latin America

Chile y la ley de neuroderechos: aprendizajes para la formación de docentes en América Latina

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ABSTRACT

Introduction: Law 21.383, enacted in Chile in 2021, is a global milestone in recognizing neurorights as a constitutional principle, aimed at protecting mental integrity against the use of neurotechnologies. This legal framework, supported by international initiatives such as the NeuroRights Initiative, poses challenges for higher education, where teacher training must integrate the ethical, cognitive and normative understanding of these technologies in a Latin American context marked by digital divides and scarce neuroethical institutionalization.
Method: a mixed sequential explanatory design was developed with a stratified sample of 126 university professors belonging to five Chilean institutions. A 20-item Likert questionnaire ($\alpha = 0,89$; KMO = 0,81; $p < 0,001$) and 15 semi-structured interviews were conducted, coded by inductive thematic analysis. Quantitative data were analyzed with ANOVA and post hoc tests.
Results: 72 % of teachers are aware of the existence of Law 21,383, but only 28 % have addressed its content in training spaces. Significant inter-university differences were recorded ($p < 0,05$) and a positive correlation between experience and ethical disposition ($r = 0,62$; $p < 0,01$). Qualitatively, demands for institutional guidelines, neuroethical literacy and interdisciplinary integration emerged.
Conclusions: the educational implementation of Law 21.383 requires strengthening teacher neuroethics training, institutionalizing cognitive governance, and articulating regional frameworks that allow the Chilean model to be adapted to other Latin American contexts.

Keywords: Neurorights; teacher training; applied neuroethics; higher education; cognitive governance.

RESUMEN

Introducción: la Ley 21.383, promulgada en Chile en 2021, constituye un hito mundial al reconocer los neuroderechos como principio constitucional, orientados a proteger la integridad mental frente al uso de neurotecnologías. Este marco jurídico, respaldado por iniciativas internacionales como la NeuroRights Initiative, plantea retos para la educación superior, donde la formación docente debe integrar la comprensión ética, cognitiva y normativa de estas tecnologías en un contexto latinoamericano marcado por brechas digitales y escasa institucionalización neuroética.
Método: se desarrolló un diseño mixto secuencial explicativo con una muestra estratificada de 126 docentes universitarios pertenecientes a cinco instituciones chilenas. Se aplicó un cuestionario Likert de

20 ítems (α = 0,89; KMO = 0,81; p < 0,001) y se realizaron 15 entrevistas semiestructuradas, codificadas mediante análisis temático inductivo. Los datos cuantitativos se analizaron con ANOVA y pruebas post hoc.
Resultados: el 72 % de los docentes conoce la existencia de la Ley 21.383, pero solo el 28 % ha abordado su contenido en espacios formativos. Se registraron diferencias interuniversitarias significativas (p < 0,05) y una correlación positiva entre experiencia y disposición ética (r = 0,62; p < 0,01). Cualitativamente surgieron demandas de lineamientos institucionales, alfabetización neuroética e integración interdisciplinaria.
Conclusiones: la implementación educativa de la Ley 21.383 exige fortalecer la formación neuroética docente, institucionalizar la gobernanza cognitiva y articular marcos regionales que permitan adaptar el modelo chileno a otros contextos latinoamericanos.

Palabras clave: Neuroderechos; formación docente; neuroética aplicada; educación superior; gobernanza cognitiva.

INTRODUCTION

In 2021, Chile enacted Law 21.383, a pioneering law recognizing neurorights as a constitutional principle. This regulation protects mental integrity from the use of neurotechnologies and sets a global precedent in ethical and scientific matters.[1] Backed by the *NeuroRights Initiative* led by Rafael Yuste, the law establishes a governance framework for the manipulation and access to neural data, opening new fields of discussion in applied neuroethics.

From an educational perspective, the initiative underscores the need to train teachers capable of understanding the cognitive, social, and moral implications of the use of emerging technologies.[2] In Latin America, where digitization is advancing amid structural inequalities, education faces the challenge of integrating neurotechnological ethics into teacher training programs. This study examines lessons from the Chilean case, identifying its contributions to university education and implications for Latin America.[3]

Figure 1.
Methodological design of the mixed sequential explanatory study

Neuroethics is the branch that addresses the moral, legal, and social implications of neuroscience research and application.[4] According to Ienca et al.[5], the development of neurotechnologies capable of recording, interpreting, or modifying brain activity requires the creation of new human rights,[6] known as neurodights, including: personal identity, free will, mental privacy, equitable access, and protection against algorithmic biases.[7]

Simbaña et al.[8] warn that the governance of artificial intelligence and neurotechnology must include an educational approach that promotes ethical reflection and digital literacy.[9] In this sense, teacher training is a privileged space for strengthening neuroethical awareness,[10] and preparing professionals capable of teaching with cognitive and technological responsibility.[11]

METHOD

The research employed a mixed sequential explanatory design, combining a quantitative diagnostic phase with a qualitative interpretive analysis. The sample consisted of 126 university professors from five Chilean universities: the University of Chile, the Pontifical Catholic University of Valparaíso, the University of Concepción, the University of Santiago, and the University of Valparaíso.

A validation phase was incorporated based on expert judgment, consisting of five academics specializing in neuroscience and bioethics from the University of Chile and the University of Concepción.[12] This process allowed the wording of the items to be adjusted, ensuring relevance and conceptual clarity.[13]

During the quantitative analysis, normality tests were applied to confirm the data distribution, followed by ANOVA and Tukey's post hoc tests to compare inter-university differences.[14] In the qualitative component, the interviews were transcribed and coded using the inductive thematic analysis method proposed by Braun et al.[15], which enabled us to construct a conceptual map of relationships among emerging categories and subcategories related to ethical thinking and pedagogical practice.[16]

Population and sample

The total population was estimated at 420 teachers; the sample (n = 126) was obtained through stratified random sampling. Fifty-four percent of the participants were women, 46 % were men; 62 % had more than 10 years of professional experience, and 73 % had a master's or doctoral degree.[17]

Table 1.
Sociodemographic characteristics of the sample

Variable	Category	%
Gender	Male	46
	Female	54
Age	25-35	22
	36-50	47
	51+	31
Teaching experience	< 5 years	18
	5-10 years	20
	>10 years	62

Instruments

A 20-item Likert-type questionnaire (1 = strongly disagree; 5 = strongly agree) was designed, divided into three dimensions:

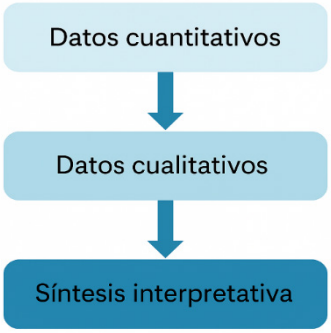
- Normative knowledge about neuro-rights
- Pedagogical application
- Ethical perception

A Cronbach's alpha of 0,89 was calculated, indicating high reliability. An exploratory factor analysis (KMO = 0,81; $p < 0,001$) was also performed, confirming construct validity. Semi-structured interviews (n = 15) explored perceptions of ethics and cognitive technology in greater depth. Participants approved the academic use of their responses. A university ethics committee validated the project.
In addition to the instruments applied, a validation phase was incorporated based on expert judgment, consisting of five academics specializing in neuroscience and bioethics from the University of Chile and the University of Concepción. This process allowed adjustments to the wording of the items, ensuring relevance and conceptual clarity.[18]

Data analysis

The data were processed using SPSS v.28 (descriptive analysis, ANOVA, linear regression) and ATLAS.ti v.9 for qualitative coding. Methodological triangulation was applied to correlate quantitative findings with teacher narratives.[19]

Figure 2.
Analysis and methodological triangulation scheme



During the quantitative analysis, normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) were used to assess data distribution, followed by ANOVA and Tukey's post hoc tests to compare inter-university differences.[20]

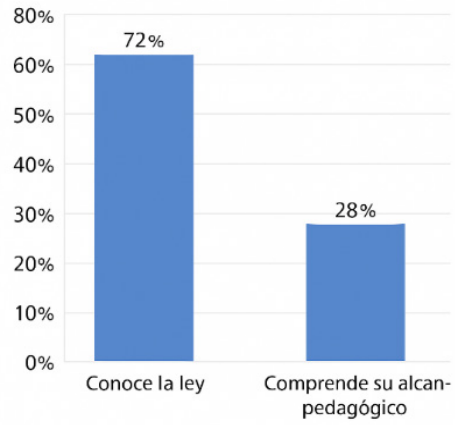
In the qualitative component, the interviews were transcribed and coded using the inductive thematic analysis method proposed by Braun et al.[15], which allowed us to construct a conceptual map of relationships between emerging categories and subcategories linked to ethical thinking and pedagogical practice.[21]

RESULTS

Level of knowledge

The findings reveal a significant asymmetry between legal knowledge and its pedagogical application. While 72 % of teachers acknowledged the existence of Law 21.383, only 28 % reported having discussed its content in formal academic settings. This gap suggests the need to institutionalize neuroethics within university education.

Figure 3.
Percentage distribution of teacher knowledge about Law 21.383



Inter-university differences

The ANOVA analysis showed significant differences ($p < 0,05$) between institutions: the University of Chile and the University of Concepción had higher average ethical knowledge scores ($M = 4,2$; $SD = 0,51$).
Simple linear regression indicated that prior ethics training explains 42 % of the variance in training disposition.

Correlational analysis

Positive correlations were detected between teaching experience and willingness to undergo training ($r = 0,62$; $p < 0,01$), and between normative knowledge and ethical perception ($r = 0,47$; $p < 0,05$).

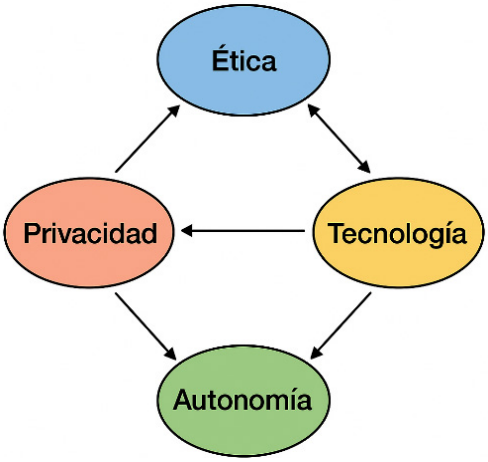
Table 2.
Significant correlations between main variables

Variables	r	P
Experience – Ethical willingness	0,62	< 0,01
Knowledge – Ethical relevance	0,47	< 0,05
Experience – Knowledge	0,39	< 0,05

Qualitative results

The analysis of the interviews conducted with teachers revealed three main categories that reflect the current state of neuroethics integration in Chilean education. First, an emerging awareness of neuroethics in the classroom was identified, evidenced by its recognition as important for the development of responsible teaching practices in relation to new technologies. Second, institutional uncertainty was observed regarding the use of educational artificial intelligence, due to the lack of clear guidelines for its ethical application. Finally, a demand for interdisciplinary training emerged, with participants calling for programs that integrate education, neuroscience, and ethics as pillars of contemporary teacher training.

Figure 4.
Map of qualitative categories (ATLAS.ti)



DISCUSSION

The results suggest that the effective implementation of Law 21.383 requires synergy between legislation, university policies, and teacher training. The legal framework alone does not guarantee structural changes; an educational strategy is needed that promotes a comprehensive understanding of neurorights from a pedagogical perspective.

Internationally, countries such as Spain[22] and Mexico[23] have launched pilot projects on ethics in educational AI is working on cognitive governance policies. However, Chile remains the only country with constitutional recognition of mental integrity, positioning it as a global benchmark for ethical innovation.[24,25]

Teacher training should be oriented toward applied neuroethics, focused on protecting cognitive autonomy and mental privacy, but also on promoting digital empathy and emotional understanding in AI-mediated environments. This approach can strengthen professional skills to address the growing automation of learning and the use of neurocognitive data in academic performance assessment.

CONCLUSIONS

- Chile is consolidating its position as an international benchmark in the creation of an ethical-cognitive paradigm that transcends the legal sphere and extends to higher education. Law 21.383 sets a historic precedent by protecting mental integrity and cognitive autonomy, paving the way for a profound reflection on the role of neuroscience and ethics in teaching.
- Neurodigital literacy is emerging as a priority in teacher training, requiring educators to acquire skills in neuroethics, mental privacy, and the ethical management of neural data. These skills will enable them to respond judiciously to the challenges posed by artificial intelligence and neurotechnologies in the classroom.
- Curriculum updates are essential. Training programs must include modules on applied neuroscience, technological ethics, and critical thinking, promoting interdisciplinary and innovative teaching.
- Ethical institutionalization in universities, through observatories and committees on neuro-rights, would ensure the responsible application of cognitive technologies, balancing innovation and human values.
- The Chilean model offers a roadmap for Latin America, provided it is adapted to each country's sociocultural and regulatory contexts. It is recommended to promote comparative and longitudinal research that measures the impact of neuroethical training on teaching practice and its contribution to the development of a more ethical and conscious education.

REFERENCES

1. Silva PL, Ramírez RM. Sobre la conveniencia de incluir los neuroderechos en la Constitución o en la ley. Rev Chil Derecho Tecnol. 2021;10(1):53-76.

2. Proenza JG. Neuroderechos y derechos humanos en la era de la neurotecnología: ¿Regulación necesaria o inevitable? Iuris Dictio. 2025;(36):17-17. https://doi.org/10.18272/iu.i36.3532

3. Plaza IC. La legislación chilena sobre neuroderechos y su relevancia para la salud mental: Críticas y perspectivas. Salud Ment. 2023;46(5):269-73.

4. Figueroa G. Neuroética: Comienza el reinado de las neurociencias en la fundamentación de la ética. Acta Bioeth. 2022;28(2):183-95. https://doi.org/10.4067/S1726-569X2022000200183

5. Ienca M, Andorno R. Towards new human rights in the age of neuroscience and neurotechnology. Life Sci Soc Policy. 2017;13(1):1-27. https://doi.org/10.1186/s40504-017-0050-1

6. Borbón D, Borbón L. A Critical Perspective on NeuroRights: Comments Regarding Ethics and Law. Front Hum Neurosci. 2021;15:703121. https://doi.org/10.3389/fnhum.2021.703121

7. Zuñiga A, Villavicencio L, Zaror D, Salas R. Neurorights in Chile: Between neuroscience and legal science. En: Developments in Neuroethics and Bioethics. Vol 4. Academic Press; 2021:165-179. https://doi.org/10.1016/bs.dnb.2021.06.001

8. Simbaña MYP, Abad DJ, Lanchimba VFQ, Canacuan MPM, Coelho C, Ortiz SMC. La ética en el uso de la inteligencia artificial en los procesos educativos. Retos Cienc. 2024;1(4):145-58.

9. Cornejo-Plaza, I. Chilean neurorights legislation and its relevance for mental health: Criticisms and outlook. Salud Mental, 46(5), 269-273. https://doi.org/10.17711/sm.0185-3325.2023.034

10. Ruiz S, Valera L, Ramos P, Sitaram R. Neurorights in the Constitution: From neurotechnology to ethics and politics. Philos Trans R Soc Lond B Biol Sci. https://doi.org/10.1098/rstb.2023.0098

11. Banerjee N, Stearns E, Moller S, Mickelson RA. Teacher Job Satisfaction and Student Achievement: The Roles of Teacher Professional Community and Teacher Collaboration in Schools. Am J Educ. 2017;123(2):203-41. https://doi.org/10.1086/689932

12. Parga RP. Derecho del trabajo: Neuroderechos a partir de la reforma de la Ley 21.383 y su proyección. Rev Chil Derecho Tecnol. 2024;(13):1-24. https://doi.org/10.5354/0719-2584.2024.68771

13. Leal LEV. Neuroderechos, Constitución y neuroética: Aportes de la neuroética al proceso de constitucionalización de los neuroderechos en Chile. Anu Derechos Human. 2022;18(1):121-36. https://doi.org/10.5354/0718-2279.2022.63604

14. Guerrero F. Neurorights: A New Legal and Ethical Frontier. Multidiscipl Health Educ J. 2024;6(1):979-91.

15. Braun V, Clarke V. Reflecting on reflexive thematic analysis. Qual Res Sport Exerc Health. https://www.tandfonline.com/doi/abs/10.1080/2159676X.2019.1628806

16. Argueta De Sáenz MI, Brennan E, De Salles Andrade JB, Jácome Guerrero JL, Mazzone GL, Mar Monti MD, et al. Challenges and potential of science diplomacy in Latin America: A focus on neurosciences. Neuroscience. 2025;572:248-53. https://doi.org/10.1016/j.neuroscience.2025.02.014

17. Borbón D, Ramírez-Gómez JA. Between politics and scholarship: The (un)settled debate over neurorights. Front Polit Sci. 2024;6:1335561. https://doi.org/10.3389/fpos.2024.1335561

18. Granado De la Cruz E, Gago-Valiente FJ, Gavín-Chocano Ó, Pérez-Navío E. Education, Neuroscience, and Technology: A Review of Applied Models. Information. 2025;16(8):664. https://doi.org/10.3390/info16080664

19. Castillo P. Los límites éticos de la neuroeducación. Teoría Educ Rev Interuniv. 2023;35(2):191-208. https://doi.org/10.14201/teri.28580

20. Peregrina Nievas P, Gallardo-Montes C del P. The Neuroeducation Training of Students in the Degrees of Early Childhood and Primary Education: A Content Analysis of Public Universities in Andalusia. Educ Sci. 2023;13(10):1006. https://doi.org/10.3390/educsci13101006

21. Parra-Díaz J, Vera-Bachmann D, Vanzella-Castellar SM. Neuroeducación: ¿real aporte al aprendizaje o mito? Salud Publica Mex. 2019;61(1):3-4. https://doi.org/10.21149/9277

22. Peñalvo FJG, Guerrero MJC, Forment MA, Varela JAP. La ética de la inteligencia artificial generativa

en educación a debate. Perspectiva desde el desarrollo de un caso de estudio teórico-práctico. Rev Esp Pedagog. 2025;83(291):281-93. https://doi.org/10.22550/2174-0909.4577

23. Torres CI. Conectivismo y neuroeducación: Transdisciplinas para la formación en la era digital. Cienc ergo sum. 2021;28(1):12.

24. Salzer JL. Control of Channel Clustering by Cleavage. Neuron. 2020;106(5):707-9. https://doi.org/10.1016/j.neuron.2020.05.017

25. S A-G, J VH, Vf I. Neuromyths about neurodevelopmental disorders in Chilean teachers. Trends Neurosci Educ. 2023;33:100218. https://doi.org/10.1016/j.tine.2023.100218

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CONFLICT OF INTEREST

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