# Youth for Change: Scientific Literacy through Bioethics

**Abstract:** Given that we live in a society where science generates knowledge at a constant pace and information reaches us immediately, it is of utmost importance that we achieve a critical understanding of science and make informed decisions about its ethical use. However, most young people today, especially those from vulnerable backgrounds, do not have the opportunity to participate in activities that allow them to develop key skills to question scientific information and make informed decisions about emerging socio-scientific issues. This, in turn, weakens their ability to empower themselves and tackle complex global problems, such as climate change, social inequality, and technological innovation. Our project "Youth for Change: Scientific Literacy through Bioethics" aims to design pedagogical resources that can articulate scientific literacy through a bioethical framework to empower young people. Through activities and educational materials, we inspire critical thinking about socio-scientific issues while integrating ethical reflection and community action. By addressing real-life problems, we seek to make a difference and contribute by equipping young Chileans with the competencies to proactively make decisions on matters that impact their lives and communities. This will not only enhance educational and employment opportunities for youth but also contribute to building a more just and sustainable society where young people have the tools and attitudes to make an active contribution to the development of their community.

**Wilson González:** Bachelor of Education and Professor of Chemistry and Natural Sciences from the Pontifical Catholic University of Valparaíso (PUCV), graduated in 2024. He is currently pursuing a master's degree in "Didactics of Experimental Sciences" and works as a teacher at the Seminario San Rafael school and as an academic collaborator at PUCV. His areas of interest within the didactics of sciences include the development of scientific literacy and the teaching of the Nature of Science (NOS) in curricular documents.

**Camila Ulloa Malfatto:** Bachelor of Education and Professor of Biology and Natural Sciences from the Pontifical Catholic University of Valparaíso, with over 6 years of experience. She holds a diploma in Educational Neurosciences and currently works at the Pan American College in Viña del Mar, leading projects such as "Sustainable Enterprise" and "Garden with a Purpose." Creator of the social network "Ciencias en todo," she is dedicated to scientific dissemination and innovative educational practices. Pursuing a Master's degree in Didactics of Experimental Sciences, her research focuses on educational strategies about breast cancer.

**Martín Núñez Silva:** Bachelor of Philosophy from the University of Chile. He is currently pursuing a Master's degree in Bioethics at the same institution. Since 2023, he has been an academic collaborator for the Master's in Bioethics at the University of Chile and also serves as a professor of Philosophy at the Instituto Premilitar de Chile. His research interests focus on moral philosophy, bioethics, and cognitive sciences.

**Martín Fernández Suárez:** Bachelor of Philosophy from the University of Chile. He is currently pursuing a Master's degree in Contemporary Thought and Political Thought at the Diego Portales University. He participated in three philosophy congresses during 2023 and has also taught philosophy at both Colegio Nidal and Colegio Cristiano Belén. His research focuses on the philosophy of Martin Heidegger, conducting his thesis in collaboration with the Fondecyt Initiation Project led by Professor Rocío Garcés.

**Index**

## 1. Introduction

In our society where technology is advancing rapidly and we have instant access to information, one might think that literacy is an achieved goal and that people have the necessary knowledge to interact with data and their environment, making informed decisions. However, this idealized perception is far from the reality faced by many communities today. According to data from the United Nations (UN, 2023), around 763 million young people and adults (most of them women) lack basic reading, writing, and arithmetic skills. Although schooling has increased exponentially in recent years, in 2023 there are still around 244 million girls, boys, and adolescents out of school. Additionally, the concept of literacy does not only encompass skills such as reading and writing but also involves critically evaluating information, having the ability to discern between sources, and using knowledge ethically and reflectively.

Therefore, literacy lays the foundation for human progress and development in society, enabling the construction of more peaceful, fair, and sustainable societies. Its implementation will lead us as a society to have knowledge that allows and promotes sustainable development, the eradication of poverty, and the protection of the environment considering global change (International Scientific Community, 2010). Given the aforementioned, it seems crucial to advance and consider the importance of scientific literacy for societies. According to experts in the National Science Education Standards, scientific literacy is an urgent requirement and an essential factor in the development of individuals and communities (National Science Education Standards, 1996). Thus, it is necessary to develop, through education, a pathway that provides people with the tools to project a better future. In this sense, providing tools for scientific literacy is in complete alignment with the objectives proposed by the Chilean legislative framework. In particular, Chilean Law 21.430, on Guarantees and Comprehensive Protection of the Rights of Children and Adolescents, has as its central axis the establishment of the progressive autonomy of children and adolescents. That is, recognizing youth not only as objects of protection but also as subjects of rights, capable of reflecting, analyzing, and also self-criticism. Ultimately, morally and civically responsible subjects. In this direction, the law states the following:

> "During their growth process, children and adolescents develop new capacities and deepen others, along with a gradual increase in their capacity for responsibility and decision-making regarding aspects that affect their lives. The development and

> deepening of capacities that favor the autonomy of children and adolescents are affected not only by age but also by cultural aspects and individual and collective experiences that shape their life trajectory." (Law 21.430, ART 11, 2022)

In this way, scientific literacy is a fundamental pillar for youth empowerment. A thorough development of comprehension, analysis, and application of scientific knowledge expands educational and employment opportunities. At the same time, having tools to understand and address scientific and technological challenges allows young people to participate actively and meaningfully in decision-making about their lives and their future. Thus, promoting curiosity, problem-solving, and critical thinking empowers youth and fosters the creation of change agents who can contribute to sustainable development in their communities. In this context, we understand empowerment as a process that drives a person's development towards autonomy, towards self-awareness and awareness of their surroundings. That is, someone capable of reflecting and critically evaluating their reality. However, what tool do we need for this? We assert that to achieve this goal, it is necessary to rethink the way education is understood.

Scientific literacy, with its emphasis on understanding the complex interactions between science and society, provides the necessary foundation to address various ethical and moral dilemmas posed by scientific and technological advances. As proposed by bioethics, the critical understanding of human values and the responsible application of scientific knowledge are essential for rational and cautious participation in the process of biological and cultural evolution. Ultimately, scientific literacy not only empowers individuals to understand the ethical challenges of science but also prepares them to contribute meaningfully to decision-making, thereby promoting a more informed and reflective approach to scientific and technological progress.

Considering the outlined context, our project *Youth for Change: Scientific Literacy through Bioethics* seeks to highlight the relevance of the relationship between scientific literacy and bioethics through the creation of a pedagogical resource that integrates both approaches. Thus, we propose to develop a kit of activities focused on promoting scientific literacy that stimulates youth reflection using bioethical approaches. This resource will provide tools and guidelines for educators, students, and the community in general to facilitate the understanding and application of bioethical principles in the analysis of scientific and social

issues. Additionally, it will explain how this resource can be used effectively to foster critical reflection and promote informed ethical decision-making in various contexts.

## 2. Theoretical Framework

Nowadays, young people face a complex global landscape that demands innovative and ethical solutions. Education is a powerful tool for transforming lives and communities, especially in high-vulnerability contexts. To tackle global challenges such as climate change, social inequalities, and technological innovations, it is crucial to empower young people to become agents of change. For this, not only academic preparation is necessary, but also ethical preparation. In Chile, public schools play a fundamental role in educating millions of students. The New Public Education system, created with the enactment of Law 21.040, aims to restore the social function of education by the State through the National Directorate of Public Education (DEP) and 70 Local Education Services (SLEP) distributed throughout the country (MINEDUC, 2024). This new system seeks to ensure quality, equitable, and accessible education for all students, regardless of their socioeconomic level.

Despite efforts, much work remains to be done to reduce the high level of school vulnerability. School vulnerability in Chile is measured through two main indices: the School Vulnerability Index (IVE-SINAE) and the Multidimensional Vulnerability Index (IVM) (JUNAEB, 2023). These indices are essential for designing, implementing, monitoring, and evaluating programs aimed at children and youth, ensuring that students receive the necessary support to stay in the school system.

As shown in Figure 1, throughout the regions of Chile, there is a high level of school vulnerability in both primary and secondary education. This scenario presents various challenges at the national level, highlighting the need for effective interventions to improve the educational and social conditions of our young people. The high levels of vulnerability indicate that many students face significant difficulties that can affect their academic and personal development.

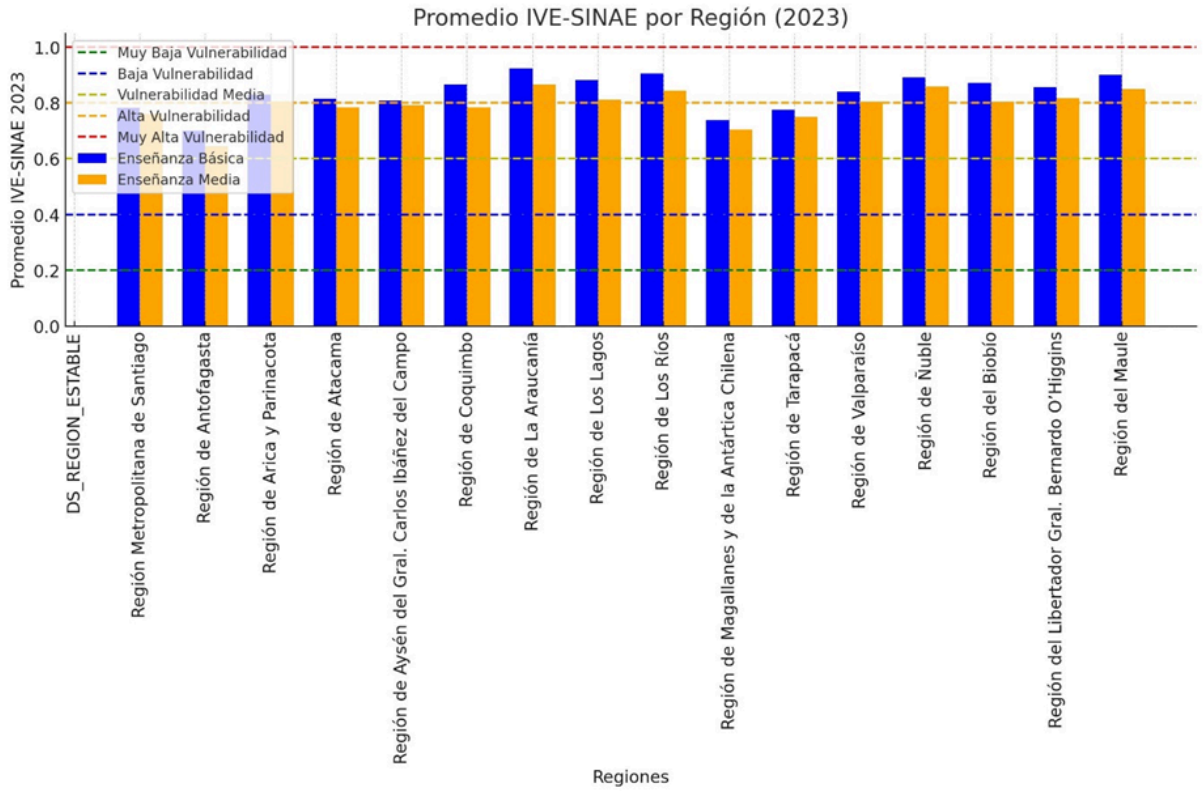


**Figure 1. Average IVE-SINAE by Region. IVE-SINAE:** Calculated annually by JUNAEB through the Vulnerability Survey applied to publicly funded establishments, and includes data from various public institutions, such as the Ministry of Social Development, Fonasa, Mejor Niñez, Sename, the Civil Registry, and Mineduc.

The graph shows the average School Vulnerability Index (IVE-SINAE) by region for primary and secondary education levels in 2023. The blue bars represent primary education, while the orange bars represent secondary education. The reference lines indicate different levels of vulnerability: Very Low Vulnerability (0.0 - 0.2) in green, Low Vulnerability (0.2 - 0.4) in blue, Medium Vulnerability (0.4 - 0.6) in yellow, High Vulnerability (0.6 - 0.8) in orange, and Very High Vulnerability (0.8 - 1.0) in red. This breakdown clearly shows how vulnerability levels vary across different regions of Chile and how they compare between primary and secondary education.

In this context, youth empowerment emerges as a key strategy to address these challenges. Empowerment not only involves providing young people with the tools and resources necessary to overcome their difficulties but also fostering their ability to positively influence their environment. Through empowerment, students can develop critical skills, increase their self-esteem, and actively participate in decision-making that affects their school and community life.

Empowerment develops on two levels: individual and collective. At the individual level, it focuses on the development of self-awareness, confidence, and personal capacity, enabling a critical understanding of the sociopolitical environment and a proactive approach to life. At the collective level, it occurs within families, organizations, and communities, based on cooperation to increase members' competence in political participation and collective action (Rojas et al., 2018). Additionally, empowerment can be determined in two stages: the process of awareness and political action. The awareness process transforms young people into subjects who are aware of themselves and their social environment, raising their confidence, self-esteem, and ability to address community needs and problems through playful-pedagogical workshops that foster reflection and collective knowledge construction. Political action involves youth organization and participation in political, social, and community spheres, promoting their ability to influence public and private processes. Youth participation requires that their opinions be heard and considered in decision-making, fostering cooperation with adults on equal terms (Rojas et al., 2018).

In our proposal *Youth for Change: Scientific Literacy through Bioethics*, we will adopt the critical-pedagogical approach, associated with Paulo Freire's popular education and the feminist movement. This approach seeks to review established structures and promote awareness for social change. With this approach, critical education not only transmits knowledge but also empowers students to question and transform their sociopolitical reality (Novella et al., 2015).

We will implement this approach by creating educational spaces that foster critical reflection and transformative action. The importance of working with this critical-pedagogical approach lies in its ability to empower young people, helping them develop a critical awareness of their environment and promoting their active participation in social transformation. This, along with improving their self-esteem and confidence, also provides them with the necessary tools to question injustices and advocate for change. By involving young people in an active and critical learning process, we contribute to shaping committed citizens who are aware of their power to influence society.

Additionally, by integrating elements of bioethics, we will address issues such as social justice, equity in access to health resources, and the ethical implications of emerging technologies. This will enable students to develop a deeper understanding of the intersections between science, ethics, and society, helping them make informed and ethical decisions in

their personal and community lives. Bioethics, with its focus on moral reflection and responsible action, is essential for addressing current and future global challenges, promoting a culture of responsibility and mutual care. This approach is especially relevant in the present, where global challenges such as the climate crisis, technological development, and sociopolitical conflicts require innovative and collaborative solutions. By empowering young people through critical and participatory education, and by integrating bioethical principles, we prepare them to be leaders of change and advocates for a more just and sustainable future.

### 2.1 Visions of Scientific Literacy for Youth Empowerment

As a global trend, scientific literacy has gained great prominence in various curricular documents worldwide, being considered one of the central objectives of current science education (Abd-El-Khalick & Lederman, 2023). However, changes in contemporary societies, increasing social inequality, the climate crisis, and war conflicts have impacted the purposes of education (Bencze, 2020) and the topics necessary for youth to manage for optimal development in society. According to Salinas et al. (2023), scientific literacy has been conceptualized based on viewpoints that promote individuals having scientific learning experiences. These experiences should provide sufficient tools to address socio-scientific issues in relevant contexts, such as their environment and health.

However, recently a critical perspective has dominated the conceptualization of scientific literacy, where not only is great importance given to scientific knowledge but also to citizens basing their actions on a comprehensive understanding of both the social and humanistic components of science (Hodson, 2010). In general, scientific literacy has been defined by the OECD as:

> *"The capacity of an individual to use scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related topics, understand the specific features of science as a form of knowledge and human inquiry, be aware of how science and technology shape our material, intellectual, and cultural world, and be willing to engage in science-related issues and with scientific ideas, as a reflective citizen" (OECD, 2009, p. 128).*

This definition has led education researchers to reconceptualize scientific literacy in favor of the emerging needs of our time. Roberts (2007) described two visions of scientific literacy. Vision I focuses on theoretical understanding, scientific facts, their internal processes, and methods, where science is primarily promoted for future scientists (Valladares, 2021; Norambuena-Meléndez et al., 2023). Vision II, on the other hand, addresses the interrelationship of science and the way this knowledge relates to everyday situations, aiming for science to be applicable in life and society.

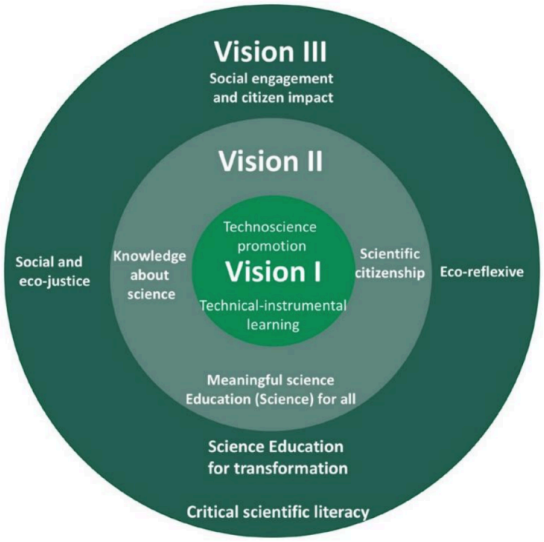


*Fig. 2. Adapted from the 3 Visions of Scientific Literacy (Sjöström & Eilks, 2018)*

Sjöström and Eilks (2018) discussed a third vision of scientific literacy, based on Hodson (2011), where the objective transcends the previous two visions. In this vision, the goal is not only the capacity for understanding and decision-making but also the construction of collective actions that allow solutions to real problems. This interpretation of scientific literacy transforms into a critical practice towards relevant issues by "articulating scientific literacy with socio-political, economic, and environmental dimensions, referencing experiences, reflections, and collective actions that investigate power relations and justify incorporating elements of social reality transformation" (Salinas et al., 2023, p.4). Therefore, this third vision of scientific literacy could be considered collective and be termed critical scientific literacy.

In connection with the objective of this proposal, our interest is to reach young people who are in the school stage, fostering the proper development of their science literacy, as these future citizens must, regardless of the vision of scientific literacy they have been trained with, generate an awareness appropriate to the times in which they live, where science indeed plays a prominent role. It becomes evident that in this proposal, the critical configuration of scientific literacy establishes points of intersection between science education, politics, the economy, the environment, citizenship, and even a moral and ethical dimension (Norambuena-Meléndez et al., 2023).

### 2.2 Bioethics and Youth Empowerment (Ecology and Environment)

Historically, ethics has been concerned with the construction of societies and their interpersonal relationships. From the ancient Greek philosophers, we can see the existence of a robust ontological theorization concerning grand questions such as: What is the good? How do we achieve it? Where does morality come from? In this context, prominent figures like Plato and Aristotle dedicated much of their time to studying such questions. In the Greek context of ethics, there was a focus almost entirely on human relationships, person-to-person interaction. As mentioned earlier, the development was preceded by an ontological development, meaning an explanation of the fundamental status of existence, and from there, deriving the consequences for practical life. Thus, there is a link between ethics and politics, as the concern for how individuals relate to each other can build the foundations for a society. In this way, ethics is presented as a theory of the good life for the individual, and from there, politics as a theory of the good life for society.

Even in our contemporary societies, these types of questions remain relevant. Given this, it seems appropriate to question whether the scope of these questions has not changed along with the nature of the new society that formulates them. A society that, through various technological developments, has faced new dilemmas that no longer solely concern human relationships themselves, but how they impact their environment and thus their future consequences. Due to human development, it becomes inevitable to include the environment in the ethical debate, as our own development has altered the consequences that the natural environment has on our societies.

Despite the broad scope that the concept "bioethics" seems to contain, derived from its Greek roots *bios* and *ethos*, bioethics is essentially a discipline constituted as a response to the significant technological achievements of science. In this sense, the birth of bioethics is entirely driven by the need to reflect on the planetary effects associated with scientific development. In particular, following bioethicist Diego Gracia, it is possible to identify two reasons that gave rise to this new discipline at the end of the 20th century.

First, the advances in the fields of ecology and molecular biology. In this regard, starting in the 1970s, numerous groups expressed their concern about the effects that industrial development was having on nature. Evidence of this includes the publication of the book *The Limits to Growth* by the Club of Rome in 1972 and the report *Our Common Future* by the World Commission on Environment and Development in 1987, which determined that the overexploitation of the environment leads to a deterioration in citizens' quality of life and warned of the potential future dangers associated with this practice.

Second, the transformation in the field of medicine is driven by technology. Devices such as the defibrillator or the new CPR technique moved the boundaries of medical art. With this, new dilemmas associated with the doctor-patient relationship arose; the principle of beneficence no longer structured as the highest good, and what is best or worst for the patient began to become unclear. There emerged an urgent need to establish patients' autonomy over their own bodies in the face of medical authority (2004, Gracia). The Belmont Report, conducted by the United States government, and the book *Principles of Biomedical Ethics* by Beauchamp and Childress attest to this process.

In view of this historical context, it is clear that it is precisely the recognition of a society intertwined with science, and it's driving force, technology, that gives life to the discipline of bioethics. Technology has raised problems of completely new magnitudes and kinds. Therefore, the horizon of ethical concern has had to expand. Moral questioning today is not limited solely to human beings; rather, it extends to nature and the diversity of living beings it encompasses.

Specifically for this project, we understand bioethics from a perspective similar to that proposed by Potter: “[...] to help humanity towards more rational, more cautious participation in the process of biological and cultural evolution” (Potter, V R, 1971, p. 197). In this sense, bioethics stands not only as a discipline but also as a tool to bring scientific advancement into

dialogue with the values of our society. In the same vein, Gracia states that bioethics: "[...] is the attempt to confront the new facts of biomedical sciences with truly human values, with the aim of cross-fertilizing science with the humanities and thus making a global and comprehensive view of the problems possible" [1](Gracia, D, 2004, p. 32). Thus, the concern is about the future of humanity and how we can assess the development of sciences for a promising future. Given this, it is important to situate bioethics in a flexible sense, not only as a method that provides specific guidelines for the evaluation of particular cases but as a tool to encourage critical thinking. Bioethics, from this perspective, is a discipline that uses the means provided by philosophy to understand the various problems and controversies raised by science.

In this sense, the relationship of bioethics with other disciplines is imperative. Reflective practice cultivates critical capacity in any area of life that involves weighing the effects of a decision on practical life. Considering the encompassing nature of the discipline, we propose to place it at the foundation of school education, thereby opening new avenues of questioning and not just as a place where information is delivered as unchangeable axioms or unquestionable facts. That said, placing bioethics at the base of an educational proposal is beneficial as it contributes from a value-based perspective and its impact on the environment, as well as from the development of reflective capacity and, in turn, awareness in those who will be responsible for new scientific and technological developments in the future. All of this is in the same path with the Universal Declaration of Bioethics and Human Rights (UNESCO, 2005), giving this discipline a prominent role in promoting scientific development aligned with human rights.

### 2.3 Scientific Literacy, Bioethics, and Youth Empowerment

According to Guerrero and Torres-Olave (2021), there are certain traditions in science education where researchers have worked on developing and encouraging students' capacity to act and thus empower them, with the aim of analyzing scientific problems in their communities critically or for learning science outside of school. In some analyses of Chilean curricula in terms of scientific literacy, it has been described as primarily referring to the teaching of sciences, such as understanding the natural world, developing scientific skills,

[1]The translation of this quote was made by us.

and fostering curiosity (Salinas et al., 2022). While the aforementioned topics are important, there is also a notion of science that is impermeable to both political and social dimensions, where teaching is limited to maintaining an uncritical relationship with the environment without considering power structures that may hinder (Guerrero and Torres-Olave, 2021). Issues affecting Chile, such as equal access to potable water, the effects of pollution caused by direct emissions from companies on citizens, or the preservation of endangered animals, could not be addressed.

One of the main points where the three visions of scientific literacy mentioned in the previous sections converge is in demonstrating how, in this particular case, students relate to and impact the short- and long-term future (Millar & Osborne, 1998). Understanding this is important in the Chilean context where students have proven to be the main actors in recent political changes following the social uprising of 2019 (Rodríguez, 2020). Critical approaches to scientific literacy mean promoting educational processes based on emancipation and transformation that articulate scientific and environmental literacies with social and environmental justice (citation). Thus, moving towards a more critical and transformative direction in scientific literacy addresses new objectives of the sciences, offering the possibility of working with a transdisciplinary approach (de Sousa Santos, 2018). This could allow the exploration of topics such as the history of science or environmental education, breaking conventional boundaries between disciplines (Moura, 2021) to understand social problems where science plays a role, advancing towards a problem-posing education (Freire, 1970) instead of one based on specific content.

Following these guidelines, we consider scientific literacy as a tool for youth empowerment. However, this tool requires certain skills to be applied effectively. Our proposal for this is through bioethics and a philosophical perspective. The relationship between bioethics and school education has been studied, but with few applications in Latin America. Based on the survey work conducted by José Luís Navares et al., in their article *Bioética en educación pública escolar: Una experiencia de resiliencia y voluntad.* (2023), we have an overview of the limited academic work on the relationship we propose. Thus, bioethics is established as a discipline at the foundation of critical development. As shown in Figure 2, this critical intention with a tendency towards reflection from the sciences regarding their environment aligns with the philosophical nature of bioethics. This endeavor does not consist merely of providing a series of guidelines for evaluating a particular case but of generating the right

questions that can drive student reflection. In this sense, the role of bioethics in scientific literacy is not reducible to the execution of protocols. On the contrary, we consider bioethics as a tool that serves progressive autonomy. This idea highlights how a human being, as they grow and develop, must take on more and new responsibilities. In other words, we must consider the developmental stage of the students to demand reflection appropriate to each of their stages. In this line, the task is to provide young people with the tools to manage their will conscientiously, promoting a critical attitude from the concern for their environment and the impact of their decisions on it.

## 3. Pedagogical Proposal

Our proposal for scientific literacy through bioethics is designed to generate a profound and positive impact on youth empowerment. This project and its implementation offer a new perspective on education by integrating scientific knowledge with ethical and critical reflection, empowering young people to become active agents of change in their communities. Students will be able to develop comprehensive skills, including:

Development of Critical and Reflective Skills: Students will participate in activities that promote critical thinking and ethical reflection on contemporary socio-scientific problems, such as climate change, the loss of biodiversity of flora and fauna, gender and identity, STIs and contraceptive methods, euthanasia, clinical trials on humans, eugenics and biotechnology, and applications and consequences in the field of artificial intelligence. This will enable them to develop a deeper understanding of the ethical and social implications of science and technology, equipping them with the necessary skills to make informed and responsible decisions.

Promotion of Self-esteem and Confidence: Through various activities such as debates and research projects, young people will experience an increase in self-esteem and confidence. Our activities are designed to help them recognize their personal value and potential, strengthening their sense of identity and their ability to influence their environment.

Encouragement of Participation and Leadership: The activities and use of tools encourage active participation and youth leadership in decision-making that affects their lives and

communities. By involving students in organizing activities and discussing ethical issues, they are provided with a platform to exercise their voice and leadership effectively.

Development of Critical Awareness and Social Commitment: By integrating elements of bioethics, our project fosters critical awareness of social justice, equity, and the ethical implications of emerging technologies. This not only educates young people on these important topics but also motivates them to actively participate in the pursuit of just and sustainable solutions.

Promotion of a Culture of Responsibility and Care: By emphasizing moral reflection and responsible action, the project promotes a culture of responsibility and mutual care among students. This is crucial for building more cohesive and supportive communities where young people feel responsible for their environment and committed to collective well-being.

Preparation for Global Challenges: In an increasingly challenging and interconnected world, it is important for young people to be prepared to face global problems such as climate change, social inequalities, and technological advances. Our project provides them with the necessary tools to address these challenges with an ethical and collaborative approach.

## 4. Project: Youth for Change: Scientific Literacy through Bioethics

As part of the project "Youth for Change: Scientific Literacy through Bioethics," an educational kit will be developed to explore and analyze various socio-scientific issues. This kit will provide teachers and students with the necessary resources to address these topics from an ethical, social, and scientific perspective.

**Kit Objective:** Develop students' scientific literacy through bioethics, promoting youth empowerment and informed decision-making. Provide teachers and students with the necessary resources to explore and analyze transhumanism and biotechnology, focusing on their ethical, social, and scientific implications. The kit should facilitate interactive teaching and learning, promoting critical thinking and ethical reflection.

### 4.1 Topics to be addressed:

- Climate change
- Loss of biodiversity of flora and fauna
- Gender and identity
- STIs and contraceptive methods
- Euthanasia
- Clinical trials on humans
- Transhumanism and biotechnology
- Applications and consequences in the field of artificial intelligence

### 4.2 For each topic, the Kit will include:

**Activity Guide:**

- Activity Description: Objectives, duration, and detailed steps.
- Teacher Instructions: Tips for directing debates and assessments.
- Schedule: Session plan with suggested times.

**Reading Materials:**

- Scientific Articles: Basic concepts of transhumanism and biotechnology.
- Case Studies: Real examples of biotechnology and transhumanism.
- Additional Resources: List of recommended books, videos, and websites.

**Visual Resources:**

- PowerPoint Presentations: Slides to introduce concepts.
- Infographics: Visualizations of biotechnological processes.
- Posters: Visual material to decorate the classroom.

**Writing and Presentation Materials:**

- Reflection Notebooks: Notebooks for notes and reflections.
- Poster Boards and Markers: Supplies for group presentations.
- Worksheets: Exercises and reflection questions.

**Evaluation Tools:**

- Evaluation Rubrics: Clear criteria for assessment.
- Questionnaires: Questions to assess understanding.
- Feedback Form: Space for comments.

**Access to Digital Resources:**

- Online Platform: Portal with additional resources and a platform to share experiences.
- Educational Videos: Links to explanatory videos.

**Additional Support:**

- Expert Contacts: Contact information for consultations.
- Facilitation Guide: Manual to support teachers

### 4.3 Table 1: Examples of Activities Included in the Kit

| Activity | Objective | Description | Materials | Process | Expected Outcome |
|---|---|---|---|---|---|
| Bioethical Committee on Climate Change | Understand the impact of climate change and develop solutions from a bioethical perspective. | Students will form a bioethical committee to analyze the effects of climate change in their community. They must research scientific data, discuss ethical implications, and propose concrete actions to mitigate the impact. | Scientific articles, climate change data, presentation materials. | Formation of committees of 5-6 students. Research and data collection on climate change. Discussion in the committee about ethical and social implications. Development of an action plan. Presentation of the action plan to the class. | Realistic and ethical action plans addressing climate change from a local perspective. |

| | | | | | |
|---|---|---|---|---|---|
| Bioethical Debate on Euthanasia (Committee) | Evaluate the ethical, social, and scientific aspects of euthanasia. | Students will investigate different perspectives on euthanasia and participate in a structured debate. Each group will represent a different position (pro, con, neutral) and present their arguments. | Scientific articles, case studies, debate guides. | Research on cases and arguments for and against euthanasia. Formation of debate groups. Presentation and discussion of arguments in the debate. Group reflection on the different points of view presented. | Deep understanding of the ethical and scientific aspects of euthanasia and development of critical and debating skills. |
| Research Project on Biodiversity | Investigate and propose solutions for biodiversity conservation. | Students will conduct a research project on local biodiversity, identifying endangered species and proposing conservation actions. | Research tools, local species guides, access to scientific databases. | Selection of a local species or ecosystem. Research on conservation status and threats. Development of a conservation plan. Presentation of the research project. | Detailed and feasible conservation projects demonstrating a clear understanding of biodiversity and its threats. |

| | | | | | |
|---|---|---|---|---|---|
| Transhumanism and Biotechnology | Evaluate the bioethical and social aspects of body modifications or the use and/or study of the human genome. | A series of cases involving body modifications through the addition of non-biological elements and the handling/manipulation of human genetic material will be presented. Students will form debate groups and take a stance (pro, con, neutral). | Descriptive scientific articles for each selected case. Guide questions to encourage taking a stance and developing the debate. | Distribution of selected cases to students for reading. Students organize in groups around a case and take a stance. They contrast their arguments. | Understanding and reflection on the ethical aspects involved in the presented cases, considering both criticisms and benefits of body modifications or the use and/or study of the human genome. |

**4.4 Detailed activities as examples of what our kit will include:**

**A. "The Future of Humanity: Exploring Transhumanism and Biotechnology"**

Objective: Understand the basic concepts of transhumanism and biotechnology, and their implications in society. Foster critical thinking and ethical reflection on the impact of technologies on the future of humanity.

**Class Structure:**

**I. Introduction and Concept Activity**

- Concept Analysis:
  - Provide students with cards containing words and definitions related to the following concepts:
    - Transhumanism
    - Biotechnology
    - Human enhancement

        - Genetic engineering
        - Advanced prosthetics
        - Nanotechnology
        - Ethics in biotechnology
        - Bioethics
        - Eugenics (negative and positive)
        - Principles of Autonomy, Beneficence, Non-maleficence, and Justice
    - Instruct students to match the words with their definitions and establish relationships between them.
    - Conduct a brief discussion on the established relationships and clarify concepts.

Initial Reflection (10 minutes)

- Reflective Activity:
    - Ask students how they think these concepts might impact their lives and society in general.
    - Have students write a brief reflection in their notebooks about this question.

## II. Development

- Case Analysis and Discussion - "Exploring Biotechnological Dilemmas"
    - Presentation of real biotechnology cases:
        - Henrietta Lacks and HeLa cells: Use of Henrietta Lacks' cells without her consent, which revolutionized medical research.
        - Tuskegee Experiment: Non-consensual study on syphilis in African American men, involving deception and lack of treatment.
        - Neuralink: Brain-machine interface project aimed at enhancing human capabilities and treating neurological diseases.
        - Pet Cloning: Process of cloning pets to genetically reproduce a beloved animal.
- Divide students into small groups.
- Provide a worksheet with guiding questions for case research and analysis:
    - What is the proposed technological advancement?
    - What are the benefits and risks?

- Ethical dilemmas: students analyze these dilemmas and take a stance on them.
- What ethical dilemmas does this case present according to the principles of autonomy, beneficence, non-maleficence, and justice?

## III. Discussion and Position Taking

- Each group analyzes and discusses the ethical dilemmas in their case, considering the following principles:
  - Autonomy: Were the rights and dignity of the individuals involved respected?
  - Beneficence: Was the well-being promoted and maximized for the affected individuals?
  - Non-maleficence: Was harm to individuals avoided?
  - Justice: Were all individuals treated fairly and equitably?
- Students must take a stance on the ethical dilemma and prepare a brief presentation of their arguments.
- Examples of help for taking positions:
- Arguments to help students take a stance on each of the presented bioethical dilemmas can be seen in table below :

| | |
|---|---|
| **A. Henrietta Lacks and HeLa cells**<br><br>**Autonomy**:<br><br>- Could Henrietta make an informed decision about her body?<br>- Did she decide that her cells would be used for scientific purposes?<br><br>**Beneficence**:<br><br>- Did the scientific experiment have effective benefits for both Henrietta and the development of science?<br><br>**Non-maleficence**:<br><br>- Was there any harm to Henrietta caused by this non-consensual procedure? | **B. Tuskegee Experiment**<br><br>**Autonomy**:<br><br>- Did the individuals involved in the study have the option to make an informed decision about the procedure performed on them?<br>- Were the subjects appropriately informed about the risks and benefits of the experiment?<br><br>**Beneficence**:<br><br>- Who benefits from the experiment?<br>- Does it benefit the direct participants or other people? |

| | |
|---|---|
| - Did the research seek not to harm Henrietta?<br><br>**Justice**:<br><br>- Did the research aim to make a significant social contribution?<br>- Is it fair that, even without Henrietta's consent, the procedure was carried out for the benefit of scientific research? | - Under what criteria do we determine who deserves a benefit over the harm of others?<br><br>**Non-maleficence**:<br><br>- Was it ensured that the experimentation did not harm the patients?<br><br>**Justice**:<br><br>- Is it fair to harm a small group for the benefit of a larger one? If so, how do we choose who is part of each group and why?<br>- Why were only African American individuals selected for this study? |
| **C. Neuralink**<br><br>**Autonomy**:<br><br>- How can we ensure a person's autonomy when part of the processes to improve it involve delicate functions of their body?<br><br>**Beneficence**:<br><br>- Has Neuralink demonstrated effective therapeutic benefits?<br><br>**Non-maleficence**:<br><br>- Do the benefits of Neuralink development outweigh the risks associated with its application?<br>- Under what criteria can a patient's health be risked in an experimental | **D. Pet Cloning**<br><br>**Autonomy**:<br><br>- How do we determine if an animal has will? If they did, how could they communicate it?<br>- If not autonomous, under what criteria can their owner make decisions for them?<br><br>**Beneficence**:<br><br>- Does this process have benefits for the animal or only for its owner?<br>- Is it important for these processes to benefit the animals?<br><br>**Non-maleficence**: |

| | |
|---|---|
| process even when informed of these risks?<br><br>**Justice**:<br><br>- Is it fair that only high-income individuals have access to technologies like this?<br>- What measures can be applied to ensure that people who need this treatment but cannot afford it have access to it? | - Does the procedure seek not to harm the animals?<br><br>**Justice**:<br><br>- Is the procedure accessible to the entire society?<br>- Is it fair to subject an animal to unnecessary procedures solely for the owner's personal benefit? What criteria justify this procedure? |

Table 2: Arguments to Help Students Take a Stance on the Presented Bioethical Dilemmas

## IV. Plenary

- General Discussion:
  - Gather all groups for an open discussion.
  - Invite students to share their stances and reflections on the other groups' cases.
  - Foster constructive debate, allowing students to comment on and question each other's positions.
  - Guide the discussion to ensure all ethical principles (autonomy, beneficence, non-maleficence, and justice) are considered.

- Questions for the Plenary:
  - Was there any case that particularly impacted you? Why?
  - What similarities and differences did you find between the different cases?
  - How do you think these dilemmas could influence the future of biotechnology and transhumanism?
  - What solutions or regulations do you think could be implemented to address these ethical dilemmas?

## V. Final Reflection (5 minutes)

- Personal Reflection:

- Ask students to write in their reflection notebooks about what they learned and their final stance on each dilemma.
- Some questions to guide personal reflection might include:
  - ➢ How has your perception of biotechnology and transhumanism changed after this activity?
  - ➢ What ethical principles do you consider most important in decision-making related to biotechnology?
  - ➢ How would you apply what you learned in this activity to future situations?

- Sharing Reflections:
  - Invite some students to share their personal reflections with the class.
  - Conclude with a final reflection from the teacher, highlighting the importance of considering ethical aspects in scientific and technological advancement.

**VI. Activity Evaluation:** Rubric

| **Criterion** | **Excellent (4)** | **Good (3)** | **Satisfactory (2)** | **Insufficient (1)** |
|---|---|---|---|---|
| **Understanding of Principles** | Demonstrates a deep and precise understanding of the bioethical principles of autonomy, beneficence, non-maleficence, and justice. | Demonstrates a good understanding of the bioethical principles, with some minor gaps. | Demonstrates a basic understanding of the bioethical principles, but with several important gaps | Demonstrates a poor or incorrect understanding of the bioethical principles |
| **Case Analysis** | Thorough and well-argued analysis of each case, appropriately applying the | Adequate case analysis, with good application of the bioethical principles, but | Basic case analysis, with superficial or incomplete application of the bioethical principles | Poor or nonexistent case analysis, with little or no application of the bioethical principles. |

| | | | | |
|---|---|---|---|---|
| | bioethical principles. | with some shortcomings | | |
| **Ethical Justification** | Solid and well-founded ethical justification for each decision made in the cases. | Adequate ethical justification, but with some areas that could be more detailed or better argued. | Basic ethical justification, with poorly developed or unconvincing arguments. | Weak or absent ethical justification, with poorly founded or irrelevant arguments. |
| **Clarity and Coherence** | Clear, logical, and coherent argumentation throughout the analysis. | Mostly clear and coherent argumentation, with some minor inconsistencies. | Limited clarity and coherence in argumentation, with several inconsistencies. | Confusing, illogical, and incoherent argumentation. |
| **Use of Sources and References** | Excellent use of relevant and updated sources and references, correctly cited. | Adequate use of sources and references, with some minor incorrect or irrelevant citations. | Limited use of sources and references, with several incorrect or irrelevant citations. | Poor or nonexistent use of sources and references, with incorrect citations or lack of citations. |
| **Presentation and Format** | Impeccable presentation, well-structured and properly formatted. | Clear and structured presentation, with mostly proper formatting. | Basic presentation, with acceptable structure and format, but with several areas needing improvement. | Disorganized presentation, with improper format and lack of structure. |

| | | | | |
|---|---|---|---|---|
| **Originality and Innovation** | Highly original and innovative proposal, with well-developed new ideas. | Original and innovative proposal, but with some less developed ideas. | Proposal with some original ideas, but mostly traditional or unoriginal. | Unoriginal proposal, lacking innovation, with poorly developed ideas. |

**Materials Needed**

- For the Class:
  - Projector and screen to show the video and presentations.
  - Concept and definition cards.
  - Worksheets for case analysis.
  - Reflection notebooks for students.
  - Poster boards and markers for group presentations.
  - Feedback forms.
  - Evaluation questionnaires.
- Visual Resources:
  - Introductory educational video.
  - PowerPoint presentation with basic concepts and case studies.
  - Infographics and posters on biotechnology and transhumanism (optional).
- Reading Resources: Brief scientific article on transhumanism, case studies, and a teacher's guide to support reflection and activities

**B. Making changes: bioethics committee**

**I. Division into Groups and Formation of the Bioethics Committee**

- Divide the class into two large groups, each responsible for one of the topics. Within each large group, form smaller subgroups that will act as "bioethics committees".

**II. Case Analysis**

- Each bioethics committee uses a worksheet with the following guiding questions:

- What is the ethical dilemma presented in this case?
- What are the possible benefits and risks of the proposed interventions or decisions?
- Which ethical principles (autonomy, beneficence, non-maleficence, justice) are affected?
- What are the possible positions and arguments of the different stakeholders (patients, families, doctors, society)?

**III. Preparation of the Presentation**

- Each bioethics committee prepares a brief presentation of their analysis, including:
  - Description of the case and the ethical dilemma.
  - Arguments for and against the possible interventions or decisions.
  - Final stance of the committee, with justification based on ethical principles.

**IV. Presentation of the Bioethics Committees**

- Each group presents their arguments and stance on the ethical dilemma of their case in 5 minutes to "experts" (other students or the teacher acting as a panel of experts).

**V. Plenary and General Discussion**

- General Discussion:
  - Gather all groups for an open discussion.
  - Invite students to share their stances and reflections on the other groups' cases.
  - Foster a constructive debate, allowing students to comment on and question each other's positions.
  - Guide the discussion to ensure all ethical principles (autonomy, beneficence, non-maleficence, and justice) are considered.
- Questions for the Plenary:
  - Was there any case that particularly impacted you? Why?
  - What similarities and differences did you find between the different cases?
  - How do you think these dilemmas could influence the future of gender and identity policies?
  - What solutions or regulations do you think could be implemented to address these ethical dilemmas?

**VI. Final Reflection and Linking Cases**

- **Personal Reflection:**
  - Ask students to write in their reflection notebooks about what they learned and their final stance on each dilemma. Some questions to guide personal reflection might include:
    - ➢ How has your perception of ethical dilemmas related to gender and identity changed after this activity?
    - ➢ What ethical principles do you consider most important in decision-making?
    - ➢ How would you apply what you learned in this activity to future situations?

**VII. Sharing Reflections**:

- Invite some students to share their personal reflections with the class. Conclude with a final reflection from the teacher, highlighting the importance of considering ethical aspects in decisions related to gender and identity and how ethical principles can be applied similarly in different contexts.

**How to Form a Bioethics Committee**

**I. Define Roles within the Committee:**

- Committee Chair: Leads the discussion and ensures all members participate.
- Recorder: Takes notes during the discussion and prepares the final report.
- Members: Actively participate in the discussion and analysis.

**II. Discussion Process in the Committee:**

- Introduction to the Case: Brief presentation of the case by the chair.
- Identification of Ethical Dilemmas: Committee members identify the ethical dilemmas present in the case.
- Analysis of Ethical Principles: Discussion on how the principles of autonomy, beneficence, non-maleficence, and justice apply to the case.
- Development of Arguments: Each member presents their arguments for and against the possible interventions or decisions.
- Taking a Stance: The committee reaches a final stance based on the discussion and ethical principles.

**III. Preparation of the Presentation:**

- **Case Summary:** Clear and concise description of the case and the ethical dilemma.
- **Analysis of Ethical Principles:** Explanation of how the ethical principles apply to the case.
- **Final Stance:** Presentation of the committee's final stance with ethical justification.

**IV. Activity Evaluation: Rubric**

| Criterion | Excellent (4) | Good (3) | Satisfactory (2) | Insufficient (1) |
|---|---|---|---|---|
| **Research** | Thorough and well-documented research on bioethics and committee functions. | Adequate research with some areas that could be improved or lack detail. | Basic research covering main concepts, but with several gaps. | Minimal or inadequate research, lacking understanding of basic concepts. |
| **Committee Structure** | Clear and well-defined structure with detailed roles and responsibilities. | Defined structure with clear roles and responsibilities, but missing some details. | Basic structure with poorly detailed or clear roles and responsibilities. | Unclear structure with poorly defined or absent roles and responsibilities. |
| **Action Plan** | Detailed and realistic action plan with clear goals and | Adequate action plan with some areas that could be more | Basic action plan with general and poorly detailed | Vague or unrealistic action plan with unclear or |

| | | | | |
|---|---|---|---|---|
| | well-developed strategies. | detailed and realistic. | goals and strategies. | absent goals and strategies. |
| **Oral Presentation** | Clear, well-organized presentation with excellent use of time and visual resources. | Clear and organized presentation with limited use of visual resources or time. | Adequate presentation but disorganized or poor use of time and visual resources. | Disorganized, unclear presentation with no use of visual resources. |
| **Teamwork** | Excellent collaboration and task distribution, with effective and respectful communication | Good collaboration and task distribution, with mostly effective and respectful communicatio n. | Adequate collaboration with problems in task distribution or communication. | Poor collaboration with lack of communication and problems in task distribution |
| **Understanding of Bioethics** | Demonstrates a deep and nuanced understanding of bioethical principles and dilemmas. | Demonstrates a good understanding of bioethical principles and dilemmas, but with some gaps. | Demonstrates a basic understanding but lacks depth in bioethical dilemmas. | Demonstrates a poor or incorrect understanding of bioethical principles and dilemmas. |
| **Creativity and Innovation** | Highly creative and innovative proposal with original and well-founded ideas. | Creative and innovative proposal with some less developed ideas. | Proposal with some creative ideas, but mostly traditional or unoriginal. | Proposal lacking creativity, with no innovation or poorly founded and unoriginal ideas. |

**V. Materials Needed:**

- Projector and screen to show the video and presentations.
- Worksheets for case analysis.
- Reflection notebooks for students.
- Poster boards and markers for group presentations.
- Feedback forms.
- Evaluation questionnaires.

**Visual Resources:**

- Introductory educational video.
- PowerPoint presentation with basic concepts and case study.
- Infographics and posters on gender and identity (optional).

**Reading Resources:**

- Brief scientific article on the cases presented above, teacher's guide.

### 5. Contest: "Agents of Change: Youth for Bioethics"

**Description:** The contest "Agents of Change: Youth for Bioethics" is an initiative aimed at encouraging students to apply the knowledge acquired in scientific literacy and bioethics activities to develop innovative and ethical projects. Students who complete the activities can upload and present their work online for the contest, highlighting their proposals and solutions to socio-scientific problems. This contest not only promotes applied learning but also fosters critical thinking and the ability of students to positively influence their environment.

**Prize:** The 10 best projects will be selected to be published in the first student bioethics journal for change. This journal will serve as a platform for students to share their research and proposals with a wider audience, contributing to the dissemination of innovative ideas and the promotion of youth empowerment. Additionally, having their work published in the journal will provide recognition and validation of their efforts and achievements.

**Event:** Students participating in the contest will be invited to the Student Bioethics Day, an event designed to generate working groups and interconnect ideas among participants. During this day, students will have the opportunity to present their projects, receive feedback from experts in the field of bioethics and science education, and collaborate with other young people interested in social change and justice. This event will serve as a space for the exchange of knowledge and the development of support networks between students and professionals.

## 6. Implementation and Evaluation

**Training:** To ensure the success of the project, a training program for teachers and facilitators will be conducted. This training will include workshops and educational resources that will enable them to effectively implement the activities in their classrooms. Teachers and facilitators will learn how to guide students through the process of research, discussion, and presentation of their projects, as well as how to use bioethical tools to enhance learning and youth empowerment.

**Local Partners:** Identifying local organizations and experts is crucial to the project's success. Partnerships will be established with universities, NGOs, research centers, and professionals in the field of bioethics and science education. These partners will provide technical support, educational resources, and collaboration opportunities that will enrich the activities and the contest. Additionally, they can participate as judges in the contest and offer workshops and lectures during the Student Bioethics Day.

**Evaluation:** Monitoring and evaluating the activities are essential to measure their impact on youth empowerment. Various evaluation tools, such as surveys, interviews, and analysis of the projects presented, will be used to collect data on students' learning and skill development. This data will allow for adjustments and improvements to the activities and the contest, ensuring that the objectives of empowerment and scientific literacy are met. Additionally, periodic reports will be prepared to document the project's progress and results, facilitating accountability and communication of achievements to all stakeholders.

**Implementation:** The implementation of the project will begin with the development and training in the use of the kit. This process will include:

**Creation of the Kit:** The kit will be developed in collaboration with experts in bioethics, science education, and experienced teachers. This collaboration will ensure that the kit's contents and activities are rigorous, relevant, and adapted to effective learning methodologies.

**Development of the Kit:** The kit will include essential resources such as activity guides, reading materials, and evaluation tools, designed to address key topics such as climate change, biodiversity loss, gender and identity, STIs and contraceptive methods, euthanasia, clinical trials on humans, eugenics and biotechnology, and applications of artificial intelligence.

**Teacher Training:** Initial training through interactive workshops, presenting the kit's content, recommended pedagogical techniques, and best practices for implementation. The training will include:

- **Initial Workshops:** Interactive sessions that will present the kit's content, recommended pedagogical techniques, and best practices for implementation.
- **Continuous Training:** Ongoing support and follow-up through online platforms, where teachers can access additional resources, share experiences, and resolve doubts.
- **Practical Training:** Hands-on activities where teachers can directly experience the kit's materials and receive feedback.
- **Ongoing Support:** Continuous support for science teachers to ensure they can effectively incorporate the kit into their classes, resolving doubts and adapting activities to their specific contexts.

**The team responsible for the training and implementation of the project will consist of**:

- **Trainers and Facilitators:** A team of experts in education, bioethics, and sciences who will conduct the workshops and provide ongoing support. This team will include two students who will be remunerated for their work.
- **Bioethics Experts:** Professionals with deep knowledge in bioethics who will provide the context and ethical importance of the proposed activities.
- **Experienced Educators:** Professionals with experience in participatory and critical methodologies who will guide teachers in adopting these techniques in their classrooms.

**Participant Selection:** Focus on public schools with high vulnerability rates in the Valparaíso region of Chile. Local partners will help identify these schools and facilitate the project's logistics.

**Launch:** The kit's launch will take place at an event that will bring together teachers, students, local partners, and the media. During this event, several key activities will be carried out to ensure the proper introduction and adoption of the kit in schools. Initial presentations will include speeches on the project's importance, highlighting its objectives and expected impact on the educational community. The first training workshops for teachers and facilitators will be held, presenting the kit's content and recommended methodologies. Finally, the kits will be distributed to the participating schools, along with user guides and additional resources to support teachers in the effective implementation of the project.

Additionally, the kit will also be launched in allied institutions, such as universities and research centers, to expand the project's reach and impact. These allied institutions will help promote the project, offer technical support and additional resources, and facilitate collaboration among different educational and community actors.

## 7. Evaluation and Scale:

### 7.1 Budget

| **Component** | **Detail** | **Quantity** | **Unit Cost (USD)** | **Total Cost (USD)** |
|---|---|---|---|---|
| Didactic Materials and Educational Resources | Production of Kits (50 kits at $50 each) | 50 kits | $50 | $2,500 |
| Fees for Trainers and Facilitators | 2 trainers/facilitators for 50 sessions ($18 per session each) | 100 sessions | $18 | $1,800 |
| Logistics and Event Organization | Venue Rental | 1 event | $100 | $100 |

| | | | | |
|---|---|---|---|---|
| | Equipment and Materials for Events | 1 event | $50 | $50 |
| | Catering | 1 event | $50 | $50 |
| | Transportation and Accommodation for Participants | 1 event | $100 | $100 |
| Teacher Training | Training Materials (digital) | - | - | $100 |
| Project Evaluation | Development of Evaluation Tools | - | - | $50 |
| | Data Analysis and Reporting | - | - | $50 |
| Contingencies and Other Expenses | Contingency Fund | - | - | $200 |
| **Total Budget** | | | | **$5,000** |

### 7.2 Pilot and Scalability

We will conduct a pilot in a select group of schools to evaluate the effectiveness of the project and adjust the model as necessary. The results of the pilot will inform the expansion of the project to more schools and regions. The pilot will include:

- **Implementation Monitoring:** Conducting periodic visits to pilot schools to observe and document the project's implementation.
- **Data Collection:** Gathering information on student participation, the effectiveness of activities, and the impact on learning and youth empowerment.
- **Activity Modification:** Adjusting the kit's activities and materials based on the collected data and feedback received during the pilot.
- **Additional Teacher Training:** Providing additional training to teachers to ensure the full and effective use of the kit, addressing any challenges identified during the pilot.

## 8. Contribution to the SDGs

Our project on scientific literacy through bioethics contributes to several Sustainable Development Goals (SDGs), promoting quality education, gender equality, climate action, and strengthening strong and just institutions.

**SDG 4: Quality Education**

- **Enhancing Scientific and Ethical Education:** The project provides resources and activities that improve students' scientific understanding and ethical reflection. Through critical and participatory education, inclusive and equitable learning is ensured.
- **Teacher Training:** Continuous training and support for teachers ensure they can implement effective pedagogical methodologies, raising educational standards in participating schools.

**SDG 5: Gender Equality**

- **Addressing Gender and Identity Issues:** Our activities and resources address gender and identity, promoting equality and inclusion in the educational environment. Students learn to recognize and respect diversity, fostering a more inclusive and equitable environment.

**SDG 13: Climate Action**

- **Climate Change Education:** Through activities focused on climate change and biodiversity loss, students develop a deep understanding of environmental issues and their impact, motivating them to take action and participate in sustainable solutions.
- **Promoting Sustainability:** The themes and activities foster awareness and action around environmental sustainability, preparing young people to face and mitigate climate challenges.

**SDG 16: Peace, Justice, and Strong Institutions**

- **Promoting Youth Participation:** The project encourages youth participation in decision-making and community action, strengthening their role as committed and responsible citizens.

- **Social Justice and Ethical Reflection:** Through the integration of bioethics, students learn about social justice, equity in access to health resources, and the ethical implications of emerging technologies, fostering a culture of responsibility and mutual care.

**9. <u>SWOT Analysis</u>**

| Strengths | Opportunities |
|---|---|
| - Integration of Bioethics and Science: The innovative approach that combines bioethics and science provides a comprehensive and holistic education, preparing students to face complex challenges. | - National and International Expansion: The project has the potential to be replicated and adapted in different educational contexts, expanding its impact nationally and internationally. |
| - Participatory and Critical Approach: Participatory and critical methodologies empower young people, fostering critical thinking skills, ethical reflection, and community action. | - Collaboration Networks: Strengthening connections between educational institutions, NGOs, universities, and research centers, creating a support and collaboration network. |
| - Interdisciplinarity: Collaboration between experts in bioethics, science education, and experienced educators enriches the content and ensures the kit's relevance. | - Increased Social and Environmental Engagement: Education on topics such as climate change, biodiversity, and social justice increases youth engagement in social and environmental action. |
| - Teacher Strengthening: Continuous training and support for teachers improve their pedagogical skills and their ability to implement new methodologies. | - Creation of Networks among Youth and Visibility of their Ideas and Work: The project provides a platform for young people to share their ideas and work, increasing their visibility and recognition. |
| - Institutional Support: Collaboration with universities, NGOs, and research centers provides additional resources and technical support. | - Participation Space for Youth Empowerment: Fosters active youth participation in decision-making and community action, strengthening their role as committed and responsible citizens. |

| | |
|---|---|
| - Youth Empowerment: The project promotes active participation of young people, developing their capacity to positively influence their environment. | |
| - Alignment with International Standards: The project aligns with global agendas, contributing to several Sustainable Development Goals (SDGs) and attracting potential funding and collaborations. | |

| **Weaknesses** | **Threats** |
|---|---|
| - Need for Continuous Resources: The implementation and expansion of the project depend on the continuous availability of funds and resources, which can be challenging. | - Budget Limitations: Financial constraints can affect kit production, teacher training, and project expansion. |
| - Resistance to Change: Some teachers and schools may be reluctant to adopt new methodologies and content, which can slow down implementation. | - Teacher Engagement: Active participation and effective use of the kit depend on teachers' commitment and willingness. |
| - Varied Teacher Capabilities: Teachers' levels of experience and pedagogical skills may vary, affecting the uniformity and effectiveness of the kit's implementation. | - Value Conflicts with Institutions: Sensitive topics such as euthanasia may generate ethical differences and value conflicts with the policies and values of some educational institutions. |
| - Difficulty in Accessing Schools due to Geography and Territory: Geographical characteristics can hinder kit delivery and training in some areas. | |
| - Lack of Experience with the Topics by Teachers: Some teachers may not have prior | |

| | |
|---|---|
| experience with the kit's topics, requiring more intensive training. | |

## 10. Conclusions

The "Youth for Change: Scientific Literacy through Bioethics" project has the potential to make a significant impact on education and youth empowerment. By integrating bioethics with science education, the project fosters a holistic understanding of scientific and ethical issues, preparing students to become responsible and engaged citizens. With the right support, resources, and collaborations, the project can be successfully implemented and expanded, contributing to the development of a more just, sustainable, and informed society.

The implementation of our kit empowers youth, promoting their ability to evaluate, analyze, and act on socio-scientific issues. Involving students in these discussions and proposing solutions to ethical dilemmas fosters their sense of responsibility and commitment to society. This aligns with the OECD objectives and aims to be a real contribution to the challenges we face now and in the future.

Furthermore, our project collaborates with teachers, educational institutions, social organizations, and community members. Together, they will develop a network of support and learning that will strengthen a dynamic and comprehensive educational environment. Besides the outcomes for the students and the education system, this program will train teachers, including payment, to address the concerns of students who are already worried about these issues. In this way, the entire educational environment benefits from this program. Moreover, we will track the results of the kit’s application, gathering statistics that will be helpful for continuously improving this significant task. In this way, the project is committed to the various layers of the social fabric, enriching education from a perspective that considers social inclusion as a priority value.

## 11. References


1. Abd-El-Khalick, F., & Lederman, N. G. (2023). Research on Teaching, Learning, and Assessment of Nature of Science. En Routledge eBooks (pp. 850-898). https://doi.org/10.4324/9780367855758-32
2. Bencze, J. L. (2020). Stepwise Progress Towards More Widespread Altruistic Uses of Science and Technology. JASTE, 11(1), VI-VIII. https://doi.org/10.33137/jaste.v11i1.34246
3. Beauchamp TL, Childress JF (2009). *Principles of Biomedical Ethics*. 6th Edition. New York: Oxford University Press.
4. Bybee, R. (2015). Scientific Literacy. In R. Gunstone (Ed.), Encyclopedia of Science Education (pp. 944–947). Springer.
5. Gracia, D. (2004). Fundamentación y enseñanza de la bioética. Editorial El Búho.
6. Hodson, D. (2010). Science Education as a Call to Action. Canadian Journal of Science, Mathematics and Technology Education, 10, 197–206.
7. JUNAEB. (2023). Medición de la Vulnerabilidad Multidimensional del Estudiante. Junaeb. Retrieved June 23, 2024, from https://www.junaeb.cl/medicion-la-vulnerabilidad-ivm/
8. Ley 21.430 Sobre garantías y protección integral de los derechos de la niñez y adolescencia. (2022). https://bcn.cl/2yies
9. MINEDUC. (2024). ¿Qué es la nueva educación pública? Ayuda Mineduc. Retrieved June 23, 2024, from https://www.ayudamineduc.cl/ficha/que-es-la-nueva-educacion-publica
10. Navares, J. Gómez, E., Cogollo, Z. (2023). Bioética en educación pública escolar: Una experiencia de resiliencia y voluntad. Revista latinoamericana de bioética. Vol. 23 (2).
11. Norambuena-Meléndez, M., Guerrero, G. R., & González-Weil, C. (2023). What is meant by scientific literacy in the curriculum? A comparative analysis between Bolivia and Chile. Cultural Studies Of Science Education, 18(3), 937-958. https://doi.org/10.1007/s11422-023-10190-3
12. Novella, A., Soler, P., & Úcar, X. (2015). Investigando el empoderamiento juvenil desde y con los jóvenes. La planificación de un proceso de evaluación participativa. Pedagogía Social. Acción social y desarrollo, 744-759. https://dugi-doc.udg.edu/bitstream/handle/10256/16261/InvestigandoEmpoderamientoJuvenil.pdf?sequence=1&isAllowed=y
13. Potter, V. R. (1971). Bioethics: bridge to the future. Prentice-Hall.
14. Roberts, D. (2007). Scientific literacy/science literacy. In N. G. Lederman & S. K. Abell (Eds.), Handbook of Research on Science Education (pp. 729–780). Lawrence Erlbaum Associates.
15. Rojas, S. B., Scarpeta, D. F., & Algarra, D. M. (2018, June). Youth empowerment: some reflections towards the participatory formulation of youth public policies. Desbordes - Revista de Investigaciones de la Escuela de Ciencias Sociales, Artes y Humanidades - UNAD, 9(1).

16. Salinas, I., Guerrero, G., Satlov, M., & Hidalgo, P. (2022). Climate Change in Chile's School Science Curriculum. Sustainability, 14(22), 15212. https://doi.org/10.3390/su142215212
17. UNESCO. (2005). Universal Declaration of Bioethics and Human Rights.
18. World Commission on Environment and Development. (1987). Our common future. Oxford University Press.
19. National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). The Belmont report: Ethical principles and guidelines for the protection of human subjects of research. U.S. Department of Health and Human Services .https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html.