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Ecological Economics Foundations to Improve Environmental Education Practices: Designing Regenerative Cultures*

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ABSTRACT

The main objective of this article is to explore new paradigms of teacher training in the field of environmental education. That is why this qualitative study explores the literature on ecological economics and degrowth to identify the most important theoretical principles that can be integrated into environmental education practices. From a transdisciplinary approach, the study integrates a philosophical and epistemological dialogue between scientific knowledge and indigenous wisdom of the Ecuadorian peoples. Then, the results of introducing the ecological economics foundations in the Ecuadorian environmental education policies are described with the analysis of the TiNi program. Subsequently, the emergence of the regenerative economics in the literature is discussed. To conclude, the Sustainable Development Goals (SDGs) are questioned for their conventional economic vision, and regenerative cultures are proposed to promote world futures focused in human well-being and environmental justice.

KEYWORDS

Decolonial epistemology; ecological economics; environmental education; philosophy of education; regenerative cultures; transdisciplinary policies

A Decolonial Introduction to the Sustainable Development Goals

In 1972, the scientists and politicians who made up the Club of Rome published the report “*The Limits to Growth*,” which pointed to an

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ecological disaster if long-term global trends in economic and population growth continued. The report revealed that humans have a great impact on the environment, and are causing irreparable and irreversible damage (Meadows et al., 1972). This scientific alarm of ecological degradation is a reality nowadays. That is why the United Nations (2015) seek to achieve 17 Sustainable Development Goals (SDGs) between 2015 and 2030¹. In general, the SDGs have been very well received by governments, international institutions, development cooperation agencies, and the civil society. The academic world was also influenced by this collective euphoria, leading to numerous articles, books, congresses, seminars, courses, and workshops focused on the SDGs (United Nations, 2015).

However, a more critical, serious and in-depth debate is necessary in order to analyze the epistemological pillars on which the SDGs are based. As a product of the United Nations, the SDGs do not question the western, modernist, capitalist, and anthropocentric character of the “development” concept they promote. They neither question the enormous accumulation of capital and resources accumulated only in a few hands, making it impossible to improve the social inequality levels in the world (Dorling, 2015). The SDGs also fail to question the limits of the economy or the political power that transnational companies have to control and monopolize markets. That predatory economy does not consider the irreparable degradation that they exert on the productive factors such as land, work, and capital (Stiglitz et al., 2010).

For this reason, intellectuals, philosophers, and scholars make an urgent call to decolonize the political economy and revalue alternative economic practices, such as regenerative cultures that advocate for the sacredness of life on Earth (Dussel, 2013; Maldonado-Torres, 2008). According to Mignolo (2012) and Quijano (2000), decolonization is defined as the act of getting rid of colonization, or freeing a country from being dependent on another country, especially in political, economic and cultural terms. For this reason, Walsh (2010) argues that decolonial pedagogy is a political, social, epistemic and ethical process whose educational praxis is aimed at individual and collective liberation. Being framed in the international economy, the SDGs represent a planetary challenge of an intercultural and cross-border nature that require new alternatives to think about the complexity of today’s economies (McGregor, 2012). Thereupon, the SDGs must overcome the epistemological fallacies of the concept of “development” on which they are based. This concept is derived from the three areas of sustainability (economic, social, and environmental) that the World Bank reinterpreted from the original notion of “sustainable development,” established by the United Nations (1987). However, this notion is colonial, since it excludes, marginalizes, and

makes invisible all the alternatives that the colonized peoples have historically postulated against the “development” of the west (Shiva, 2005).

As Wallerstein (2004) argues in his World-System analysis, the axis of geopolitical enunciation of knowledge arises in the “central countries,” since they are the most apt to set the guidelines for progress, modernization, development, and growth. In turn, the countries historically colonized by the European powers are situated as “peripheral countries,” whose indigenous and ancestral knowledge is marginalized in the political, academic, and scientific contexts (Tuck et al., 2014). But facing the complex challenges of global change requires a “decolonizing shift” to the geo-knowledge imposed by the hegemonic matrix of political-epistemic power, in order to overcome the monocultural and developmental vision that the SDGs are establishing in the collective imaginary of all countries (Santos, 2014).

From this critical and decolonial stance, it should be emphasized that the SDGs also ignore the alternative forms of social and solidarity economy that ensures energy and food sovereignty. The SDGs do not recognize the economy as a subsystem of the Earth System, where it draws the natural resources to produce raw materials for the industry (Mayumi & Giampietro, 2004). By not questioning the current model of modern development, the SDGs cannot recognize the limits of growth and degrowth is reduced to the need of safeguarding the health of the planet (Daly 2014; Georgescu-Roegen, 2011; Kallis, 2011). With this underlying epistemic problem, some critical voices believe that the SDGs are a neo-colonial way of imposing Western cultural values, political ideologies, economic indicators, philosophical worldviews, and educational practices (Datta, 2018; Hidalgo et al. 2019). For this reason, we conclude that the SDGs must be opened epistemologically to include worldviews, episteme, and ancestral knowledge, which are nourished by decolonial, postmodern, intercultural, post-capitalist, and biocentric principles.

In this line of critical and decolonial thinking, this article adopts the transdisciplinary approach of Collado et al. (2019), which philosophical horizons combines and unifies scientific knowledge with the indigenous wisdom of the Ecuadorian peoples. From this approach to the philosophy of education, it is devoted to exploring and analyzing the importance of integrating the theoretical foundations of ecological economics with the pedagogical practices of environmental education. Evidence data from Europe and developing countries show how education increase pro-environmental behavior and citizenship emancipation (Findlow, 2019; Meyer, 2015). By highlighting the strong link, implication, and scope that exists between the economy and the philosophy of education, the article seeks to explore new paradigms of teacher training in the field of environmental education. This also aims to overcome the cognitive fallacy of unlimited economic growth that is still present.

Methodology

No transdisciplinary studies have been found that relate the theoretical principles of ecological economics with the pedagogical practices of environmental education to improve them. Thus, this explorative review constitutes a tool that offers a critical evaluation of the published work, and allows drawing important conclusions based on the scientific evidence presented. This qualitative study allows to examine, select, and determine the optimal literature from ecological economics and degrowth to answer our research question: what are the theoretical principles and epistemological foundations of ecological economics that should be learned for environmental educators? To answer the question, a transdisciplinary philosophical approach is carried out to examine the integration of economic theory with educational practice, with the purpose of developing the professional profile of educators in environmental education field.

Therefore, our contribution to the literature consists of collecting and evaluating the most comprehensive evidence of ecological economics theoretical frameworks, and bringing them into educational practice. The critical review of this research uses a qualitative selection criterion of the existing scientific literature. This qualitative criterion focuses on the main ideas that comprise the economy as a subsystem of the Earth System, subject to the biophysical and thermodynamic laws of nature (Hanaček et al. 2020). That is why we included some books that are considered classics and pioneers in the literature, despite they are not peer-reviewed, because we have used these concepts as keywords in our qualitative review. The search strategy also explores specialized databases such as Greenleaf Online Collection, Google Scholar, Journal Citation Reports (JCR), ScienceDirect, Scopus, and Web of Science for the period of 1950–2020.

As a result, fifty-one original studies have been analyzed, examined, and synthesized, to increase the validity of scientific information that show the ecological impact that we leave in nature by following the idea of unlimited economic growth (see the [Appendix A](#)). This article has a rigorous qualitative review methodology using the Mendeley and EndNote software tools. The VOSviewer and Microsoft Excel software tools were also used in the following techniques: citation analysis and co-occurrence of terms/words. In addition, the main topics discussed about ecological economics, degrowth, and regenerative cultures were identified in the literature.

Our contribution then shifts from the theoretical to the applied realm by describing the implementation of the identified principles of ecological economics and degrowth into environmental education policies. For this purpose, we present the experience of the Ministry of Education in

Ecuador, which, based on these principles, introduced environmental education as a transversal axis of the curriculum throughout the Ecuadorian educational system (Ministerio de Educación del Ecuador (MinEduc), 2018a, 2018b). As a result, this article offers an innovative perspective on how to include the theoretical foundations of ecological economics and degrowth into the environmental practices of primary and secondary schools. This theoretical-practical combination is promising for sowing a citizen conscience rooted in regenerative cultures, which integrates the philosophy of nature with the philosophy of education.

Key Features of Ecological Economics and Degrowth Literature

This section pursues to identify the ecological principles of the economy, in order to enrich the epistemological and philosophical foundations of the professional profile of environmental educators. The historical root of ecological economic thought already appears in the seventeenth and eighteenth centuries, with John Evelyn, Carl von Varlowitz, Adam Smith, and David Ricardo, who addressed the consequences of over-exploiting nature to make it an industrial raw material. In 1798, Thomas Malthus published his book “*An Essay on the Principle of Population*,” where he stated that the rate of population growth follows a geometric progression, while the increase in natural resources for its survival does so arithmetically. In this demographic, economic, and sociopolitical theory postulated during the Industrial Revolution, Malthus (1989) envisioned that population growth would bring catastrophic consequences.

In 1873, the philosopher and political economist John Stuart Mill (Mill, 2012) published “*Principles of Political Economy*,” where he argued the need to safeguard the nature of industrial growth, since it constitutes the most important element to achieve our human well-being. However, it was not until the middle of the 20th century that those epistemological foundations were established in academic and scientific discourse.

In 1944, the economic anthropologist and social philosopher Karl Polanyi published “*The Great Transformation*,” a pioneering work in proposing a global economic transition. In essence, his works reflect on the stability and unity of the economy through three integration patterns: reciprocity, redistribution, and exchange through the market. According to Polanyi (2001), the commercial logic of “laissez faire” started when the Industrial Revolution brought about “the great transformation.” Then, big markets and financial speculation replaced these historical economic patterns. Polanyi’s futuristic vision perceived the possibility that the market economy originated a market society, where nature and the human being would be subjugated to the logic of free trade capitalism.

In 1949, ecologist Aldo Leopold published “*A Sand County Almanac*,” a pioneering book in the development of environmental ethics and wilderness conservation. For Leopold (1989, XXVI) there is a golden rule in ecology: “a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.” In this way, Leopold synthesized an ethical perspective on nature that has been used by environmental educators to raise awareness and sensitize about human actions in the biotic community. In sum, he proposed an economic ethics that would stop considering rich biodiversity as a simple commodity subject to exchange. Environmental educators have to raise awareness that natural resources are a common good and cannot be privatized or exploited.

The evolutionary economist Karl Kapp, in his work “*The Social Costs of Private Enterprise*,” published in 1950, also defended this ethical trend. Kapp’s thinking is impregnated with an ethical and political sense that advocates social development through a genuine theoretical and conceptual reformulation of classical economics. According to Kapp (1975), the so-called neoclassical or conventional economy is limited by its analytical and reductionist methods, which dissect reality by separating the social and ecological reality by its closed and one-dimensional reasoning. These philosophical ideas allow environmental educators to understand that reality is interdependent and requires a holistic, systemic, and multidimensional approach that integrates the economy in its physical, ecological, and socio-cultural context.

In relation to this interdependence, the work “*Resource Conservation: Economics and Policies*,” published in 1952 by Ciriacy-Wantrup, brought an interdisciplinary approach between the field of agricultural economy and the conservation of natural resources. From a notorious concern about the “inter-temporal distribution” of resources, Ciriacy-Wantrup (1952) argued that conservation is not a problem that can be solved through technological innovation. It rather requires a broad international consensus with an intergenerational vision to change socio-economic relationships that prevent people from making better use of natural resources.

A decade later, “*Silent Spring*,” written in 1962 by marine biologist and conservationist Rachel Carson (Carson, 2002), was also a landmark in environmental sciences. Carson denounced that many of the synthetic pesticides manufactured by the chemical industry caused highly harmful effects in nature. Her work is very important in the development of the professional profile of environmental teachers, because it focuses on the relationship between economic growth and the enormous environmental degradation that it generated.

From an evolutionary economics perspective, the essay “*The Economics of the Coming Spaceship Earth*,” written by the economist philosopher Kenneth Boulding (1966), identified that the economic system

had to adjust to the limited resources of the ecological system. In 1967, Ezra Mishan published "*The Costs of Economic Growth*," warning developing nations that industrialization leads to waste lands. The key principle of his book is that expanding population, technology, and affluence have unintended effects and social costs. He questions whether progress should be decoupled from technological advance, advocated an extension of human rights to include quiet, air, and water, and suggests "reserves," areas of land where certain consumer choices would not be permitted.

Similarly, Georgescu-Roegen postulated that the bioeconomy is a subsystem that is within the Earth System. His work "*The Entropy Law and the Economic Process*" from 1971, developed a co-evolutionary perspective of the economy based on thermodynamics. He stated that the evolution of the economic system is a subsystem of the biological coevolution of the human being in the Earth System. By combining the law of entropy with economics, Georgescu-Roegen (2011) demonstrated the serious consequences of the economy in nature. This thought implied a categorical break with classical economic thought, which considers the environment as one more variable. This epistemological foundation establishes limits to the production and consumption processes to preserve the limits of biophysical regeneration of the Earth System. This is a landmark to build the professional profile of environmental educators.

In 1972, the Club of Rome published "*The Limits to Growth*," where researchers made a significant study to model the consequences of economic growth in the health of our planet. In this decade of 1970s, the term of "economic degrowth" emerged notably in the literature. The oil crisis of 1973 caused a tremendous shock in the world economy. Arab countries with oil reserves refused to export to the United States and its allies from Western Europe, since they had supported Israel in the Yom Kippur war. This situation led to a large number of intellectuals questioning the economic model based on fossil fuels. This context of war and deterioration in the health of our planet is another important epistemological foundation to take into account in the development of the professional profile of environmental educators.

In this line of thought, the work "*Small Is Beautiful: A Study of Economics as If People Mattered*," published in 1973 by EF Schumacher (Schumacher, 1973), questions the Gross Domestic Product (GDP) as an indicator to assess human well-being. Under what Schumacher refers to as Buddhist economics, he defends that the main purpose of the economy should be to obtain the maximum possible well-being with the minimum possible consumption, for which it is necessary to degrow, consume locally, have a simple life, adequate technology, and a fair social distribution of resources. From this economic philosophy, Schumacher postulated that degrowth and environmental justice require the regulation of

globalizing markets and the promotion of the ecological economics that ends the over-stimulation of consumption that ends life in nature. This notion of degrowth has been widely used in publications by environmental educators in recent decades (Novo, 2009).

In that same year, Herman Daly (1973) creates the theoretical foundation for a steady-state economy. He noted that classical economics has created a theoretical model of “weak sustainability” where natural capital and human capital are complementary and can be reciprocally substituted if that need arises. In practice, this model is not feasible, since it does not matter how much innovation can be achieved in human formation if there is no natural capital that can be used: “the complementary nature of natural and human-made capital is made obvious by asking: what good is a sawmill without a forest? A refinery without petroleum deposits? A fishing boat without populations of fish?” (Daly, 1992: 25). The latter makes clear the argument that any progress on human training or technological innovation can become useless if there are no natural resources.

The limiting production input will always be the volume of natural capital that can be regenerated. This fundamental principle is very important for environmental educators to build regenerative cultures, as explained later. That is why we must promote public policies that regenerate the flows of natural capital, which is complementary but not interchangeable or substitutable to capital of human training and technological innovation.

Delving deeper into economic degrowth, the environmental philosopher Arne Naess (1973) theoretically and conceptually developed the terms of ecosophy and deep ecology. For Naess, ecosophy is a philosophical worldview inspired by the environments that life develops in the ecosphere. Its understanding derives in a deep ecology, where it is glimpsed that all life forms have intrinsic value that cannot be quantified in economic terms.

Similarly, the work “*L'Économique et le vivant*,” published in 1979 by the economist René Passet, was a pioneer at using the Systems Theory and concluding that human activities alter the planetary ecosystem. His work introduced the transdisciplinary approach to economics, which allows environmental educators to understand the impact of human activities in our planet. This approach urges economic organizations to respect laws and regulatory mechanisms, especially the rates of reconstitution of renewable resources to promote regenerative practices (Passet, 1996).

Enhancing the Professional Profile of Environmental Educators with Epistemological Foundations of Ecological Economics

As noted in [Appendix A](#), exploring the literature on ecological economics and degrowth allows us to identify epistemological foundations.

That is why the qualitative review is also extended in this section, with the aim of reflecting philosophically on the professional profile of environmental educators. In the last decades, multiple studies have showed more scientific evidence on the limits of growth (Stokey, 1998; Turner, 2008). In this sense, Hickel (2019) claims it is possible to achieve a good life for all within the planetary boundaries if we understand the meaning of degrowth.

However, after so many years denouncing and warning that the economy is a subsystem of the planet, the SDGs still continue to exclude the epistemological principles and foundations of the ecological economics and degrowth (Kallis et al., 2012). For this reason, some intellectuals and activists such as Noam Chomsky, Yanis Varoufakis, and Naomi Klein (2019), claim for a “Green New Deal” (GND) to face the current ecological, economic, and civilizing crisis with degrowth, decarbonization, less use of energy and materials, efficient use, and regeneration of forests and watersheds. Other good example is the “European Green Deal,” lead by the European Union, that striving to be the first climate-neutral continent in 2050.

All of those environmental and philosophical horizons go beyond epistemological reductionism of the SGDs, and they cause a space for philosophical discussion for environmental educators. Undoubtedly, facing the socio-environmental problems of the 21st century entails rethinking the whole role of education –at all its educational levels–, but also the processes of teacher training, because they will act as actors of social transformation. But, what are the theoretical principles and foundations of ecological economics to be learned for environmental educators?

As show in the [Figure 1](#), Collado and Pasquier (2022) argue that trans-disciplinary philosophical approach allows us to understand the different levels of ontological and epistemological reality that co-exist at the same time in nature and the cosmos. On the left side, the different levels of organization of living and non-living matter that have been established by scientific consensus are observed (Capra & Luisi, 2014). In each of these ontological levels, there are biophysical laws with operational principles different from the others. For example, quantum physics operates at sub-atomic levels, characterized by wave-particle duality, the uncertainty principle, non-linear causality, entanglement and superposition, among many others (Bohm & Hiley, 2009).

On the right side of [Figure 1](#), the humans are represented with the Vitruvian Man designed by Leonardo da Vinci. The subjects observe around us and create artistic, spiritual, religious, scientific and technological languages to better understand the social, natural and cosmic phenomena that surround us. By unifying all levels of ontological reality, Capra and Luisi (2014) argue that natural and cosmic operational

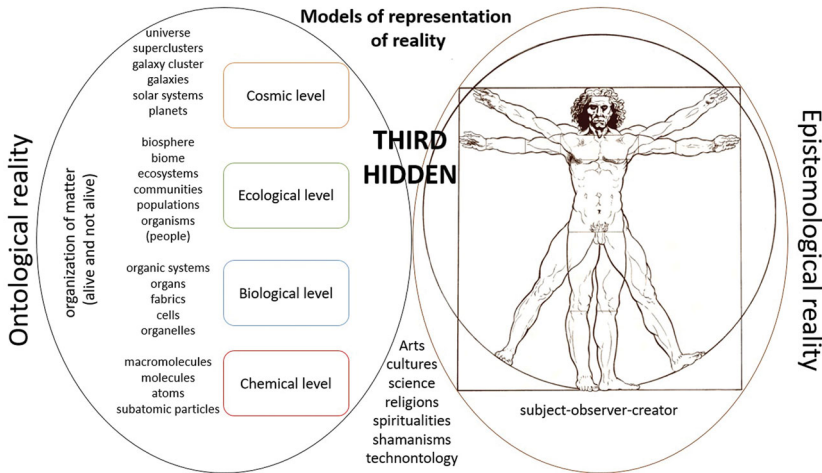


Figure 1. Models of representation of ontological and epistemological reality. *Source:* Collado and Pasquier (2022).

principles are characterized by their co-evolutionary interdependence. Then, it is clear that our economies must be understood as a subsystem of the Earth System, and it cannot be dissociated from the physical laws of thermodynamics. Degrowth, defended by ecological economists is a clear epistemological principle to be learned by environmental educators.

Therefore, measuring the progress of a country by GDP is a cognitive fallacy with dire consequences for the health of living beings that co-inhabit the Earth. In recent months, many countries have discussed including the GDP in their recovery program from COVID-19, because climate change increases the risk of such epidemics (Tarsney, 2017; World Health Organization (WHO), 2020). The current situation requires transforming the social habits of capital accumulation and environmental exploitation, especially in the so-called countries of the “Global North.” The multidimensional crisis brought by the COVID-19 in 2020, has shaken the epistemological assumptions of a growth-based economy (Akbulut & Adaman, 2020). That is why, the current context is a historical opportunity to discuss philosophically about the role of environmental educators.

From a historical analysis, Escobar (2015) and Martínez-Alier (2002) argue that the western socio-economic model cannot be universalized to the countries of the “Global South” because it is an unjust and unsustainable model. But it is also not fair that 80% of the world citizenship is excluded from the great advances and privileges of social welfare achieved by countries that have been “overdeveloped” at the expense of the natural resources of other countries (PNUD, 2015). Riechmann (2014) called this situation of socio-environmental injustice as a “planetary apartheid.”

According to OXFAM (2016, 1–2) “the richest 1% now have more wealth than the rest of the world combined (...). In 2015, just 62 individuals had the same wealth as 3.6 billion people - the bottom half of humanity.” Undoubtedly, doing social and environmental justice requires new socio-economic models and policies that respect the limits of economic growth (Chomsky, 1999). Here, the role of environmental educators is essential to promote a change in biocultural citizen awareness.

Rethinking the professional teaching profile involves reflecting philosophically on socio-economic injustice. Here the economist philosopher Latouche (2003) proposes that countries of the global North degrowth quantitatively and develop qualitatively, to allow the countries of the global South to grow and develop. The work of the ecological economist Jackson (2016) points to a prosperous future without economic growth by managing sustainable production and consumption models. For Costanza et al. (1997), it is urgent to create co-development strategies and equitable redistribution policies for natural resources, focused on life models that are less damaging to the environment. Max-Neef (1991) seeks dignified human development for all humanity. Naredo (2000) warns that transforming the north-south gap requires overcoming the cognitive fallacy of human progress based on unlimited economic growth. According to Ramos-Martín (2003), economies are open complex systems that are far from thermodynamic equilibrium, which is why neo-classical and traditional economic visions fail.

In this set of epistemological foundations for the development of the teaching professional profile, Ayres (1998) challenges the economic theory of growth by applying the physical and thermodynamic principles in the economy. His works in industrial ecology and industrial metabolism analyze the long-standing flows of natural materials and energies, and advocate for “points of no ecosystem return.” In other words, it demonstrated that the environmental degradation that our human activities exert can cause an irreparable collapse of ecosystems, with chain biochemical reactions of devastating effects on life on Earth.

Faced with these civilizing challenges, the Nobel Prize in Economics Tirole (2016) proposes to create an economy for the common good that regulates the markets and reorganizes the oligopolistic competition of the industrial powers. This is another important epistemological foundation for environmental educators: social justice is directly linked to environmental justice. If there is no equitable distribution of the natural resources necessary for development, there can never be social equity. However, current market forces are not interested in conserving or protecting the natural environment from overexploitation. Their only interest is to increase productivity in human training and technological innovation (Daly, 1992). According to the critical philosopher and economist

Castoriadis (1987, 157) “the domination of the imaginary is just as clear as regards the place of individuals at all the levels of the productive and economic structure.”

For this reason, Mayor-Zaragoza (2012) argues that the economic privileges that the plutocratic groups maintain must be ended and that the United Nations should be re-founded. This means that in order to fulfill the SDGs in 2030, it is essential to recognize the limits of biophysical regeneration of our biosphere, carry out an equitable social redistribution, and value great cultural diversity (Müller, 2020; Wahl, 2016). In other words, the collective imaginary, which sits on the epistemic pillars of economic growth and unlimited consumption, must be transformed using the epistemological foundations we have identified to explore new paradigms to improve environmental education.

In this sense, Falconí (2017) defends a philosophical vision of joint public policies that integrate environmental education and degrowth. This integrating view is in harmony with the “Earth Charter” that UNESCO published in 2003 (UNESCO, 2003), which promotes the preservation of a healthy biosphere and environmental conservation (Tisdell, 2005). Its biocentric, intercultural, and transdisciplinary approach understands the planet as a sacred being, and this implies developing a deep spiritual connection based on respect for natural phenomena (Laszlo & Laszlo, 2021). For Orr (2004) and Kumar (2011), environmental education and ecological economics study human cultural processes within the processes of ecosystem coevolution. According to Mondéjar and Vargas (2018), these complement each other because they study the interactions between the socio-economic sphere and the biophysical sphere.

That is why philosopher of education Illich (2000) claims for deschooling society and argues that promoting environmental awareness is a process that lasts a lifetime and should not be limited only to academic curriculums. With other scope, environmental educator Novo (2009) argues that environmental awareness should be also extended to all areas of society, including non-formal and informal education. For Kerschner (2010) and Spash (2020), linking environmental practices to student communities implies a deep knowledge of biophysical laws that must be respected. Herein lies the importance of training environmental educators with the fundamental principles, concepts, and foundations identified in this qualitative review focused on ecological economics and degrowth.

Results: Integrating Ecological Economics Foundations into Environmental Education Practices

In order to test the theoretical principles of ecological economics and degrowth in real educational contexts, it was proposed to follow up the

environmental education program implemented in Ecuador. In September 2017, the Ministry of Education crossed the primary and secondary curriculum with the Environmental Education Program “*Tierra de todos*” (Land of all)². This program was based on TiNi’s methodology and was implemented in all Ecuadorian educational system, with more than 15,000 schools³. TiNi methodology has been recognized by UNESCO for its good environmental practices in more than 12 countries worldwide. These countries include Peru, Ecuador, Colombia, Chile, El Salvador, Canada, Japan and India (ANIA, 2021). As argued by Leguía and Paredes (2016), the TiNi methodology consists of creating a natural space in schools, both rural and urban. Thus, Falconí et al (2019) argue that TiNi’s methodology allows students to learn the rhythms of nature through environmental dialogues that integrate theories and practices. It is worth noting that Ecuador is a megadiverse country for hosting some 4,800 species of animals, plants, insects and fungi (Ministerio de Ambiente del Ecuador (MAE), 2015). Regarding cultural diversity, the inhabitants of Ecuador self-identify according to the customs and traditions of 45 ethnic groups (indigenous, afro-Ecuadorian, mestizos, and white) distributed in four regions: Coast, Highlands, Amazon, and Galápagos Islands (INEC, 2010). This cultural diversity is grouped into 14 nationalities and 20 peoples, who speak 14 languages throughout the territory. In this complex socio-ecological context, the integration of ecological economics foundations with the artistic, cultural, philosophical, and spiritual manifestations of these indigenous, mestizo and Afro communities was a challenge. Although the environmental education program is no longer available in Ecuador, the transdisciplinary philosophical approach enriched pedagogical practices with biocentric and intercultural vision for approximately two years (Falconí et al. 2019).

As shown in Figure 2, the epistemological foundations of ecological economics allowed TiNi program to develop environmental practices in schools directed toward regenerative cultures. Ecuadorian schools underwent a significant transformation by engaging in transdisciplinary dialogues with their communities. Here we must emphasize that Amerindian’s ancestral worldviews conceive the whole universe and nature as sacred entities (Twance, 2019). Many indigenous cultures consider plants to be spirits that can guide us in our daily decisions, so they have a greater respect for the natural environment (Metzner, 1998). In fact, the indigenous people achieved a historic milestone when the Ecuadorian constitution of 2008 recognized their wisdom and worldviews with the creation of the Rights of Nature. That is why the multi-ethnic, plurinational, and intercultural Ecuadorian peoples have strong spiritual links with all natural phenomena, which materialize in offerings, rites, cultural practices, philosophical worldviews, and artistic manifestations (Walsh, 2010).

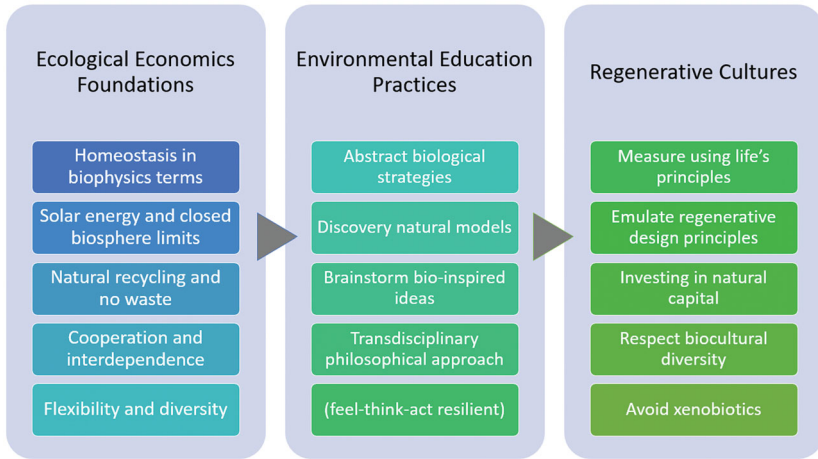


Figure 2. Integrating ecological economics foundations into environmental education practices. *Source:* Own elaboration.

Surprisingly, these ancient philosophical principles of respect and veneration for nature are in concordance with the limits of growth posed by the theoretical foundations of ecological economics. That is why the results of integrating the theoretical arguments of ecological economics and degrowth into the public policies of environmental education in Ecuador were remarkable. According to environmental leaders, the practical experimentation of the theoretical principles of ecological economics and degrowth already bring multiple benefits in educational practices (Müller, 2020; Wahl, 2016). As shown in Figure 2, the most visible benefit was the resilient attitude of regenerating ecosystems. This represented a qualitative leap with respect to the notion of education for sustainable development. Collado et al. (2020) define regenerative cultures as the transdisciplinary dialogue of scientific knowledge and ancestral practices of Ecuadorian communities. In short, this philosophy of education revalues indigenous worldviews that perceive nature as a sacred entity.

From a qualitative point of view, educational environmental practices have integrated ecological economics foundations to enhance knowledge, abilities, behavior, and skills (Ministerio de Educación del Ecuador (MinEduc), 2018a). These educational practices embraced that, just as an animal or plant cannot grow to infinity, in an unlimited way, the economy is a subsystem of the Earth System that also has its limits to growth. Direct contact with nature has also led to greater interaction between teachers, students, family members, and community actors, who have worked collectively toward regenerative cultural practices. Ecuadorian students understood that nature and society are interrelated in a co-evolutionary process, both embedded in an overall dynamic biophysical environment (Ministerio de

Educación del Ecuador (MinEduc), 2018b). This learning conforms to the scientific definition of coevolution explained by Gual and Norgaard (2010), which states that sociocultural evolution is linked to natural evolution.

From a quantitative point of view, the Ministry of Education (Ministerio de Educación del Ecuador (MinEduc), 2018b) estimates that more than 2.6 million students and 161,500 teachers have benefited from this program, which included an area of over 1,000,000 m² for environmental protection, restoration, and regeneration. In the short term from September 2017 to June 2018, the 65% of the country's educational institutions had created their own TiNi spaces. The participation into TiNi program was at the discretion of each school, as it was not mandatory by the government. This demonstrates the ease of planting fruit and vegetables, both in urban and rural schools. It can be concluded that environmental educators have the fundamental role of promoting a regenerative culture focused on a more hopeful economic paradigm (Viteri et al., 2013). Could we speak, then, of the emergence of a regenerative cultures?

Discussion: From Ecological Economics to Regenerative Cultures?

To some extent, rethinking the professional profile of environmental educators means rethinking philosophically the fundamentals of our economy. Currently, the SDGs, the Green New Deal (GND) and the European Green Deal are action frameworks that involve cooperation between governments, international institutions, the private sector, and the civil society. The United Nations General Assembly also declared 2021–2030 the “*UN Decade on Ecosystem Restoration*” to fight the global change crisis. Ecosystem restoration refers to the process of reversing the degradation of ecosystems and allowing them to have a natural regeneration. So, what really means “regenerative cultures?”

The origins of “regeneration” goes back to 1942, when J. I. Rodale used the term to create organic agriculture that rebuilds, naturally, the soil damaged by conventional agriculture. In the 1980s, his son Robert Rodale coined the term “regenerative agriculture” to refer continuing organic renewal of the complex living system. While the term “restoration” means to get ecosystems back to the original state, the term “regeneration” tries to re-align human activity with the co-evolutionary and dynamic processes of ecosystems. According to catalyst Wahl (2016, 264): “The creation of regenerative cultures is also rooted in a shift from seeing ourselves only as separate individuals, communities, nations, and species to understanding our deep interbeing as fundamentally interconnected expressions of life itself.” Then, sustainable cultures are not enough, and humanity need regenerative cultures as a new

way of looking forward. That is why environmental educators must combine sustainability with regeneration.

This conceptual term emerges as a prosperous approach in the specialized literature, where also appears “regenerative economics.” While the ecological economics term is based on the principles of thermodynamics to set limits on economic growth, the novelty is that regenerative economics is based on the principles and strategies that life develops in nature (Müller, 2020). By mimicking the eco-efficient logic of nature, responsible businesses can be created while ecosystems are regenerated (Pauli, 2010). This economic outlook could meet the GND and SDGs in a more resilient way because is focused on not producing waste.

However, what does it mean to go from an ecological economics to a regenerative cultures? In this philosophical discussion, economist John Fullerton (2015) questions the long-term viability of the dominant capitalist system, and proposes a regenerative economic system that is self-organizing and self-sustaining. Consequently, he formulates an economic transition toward “regenerative capitalism.” This concept has strong implications for the modern economy, since it opens a new paradigm that leaves behind centuries of efforts to dominate and control nature, and focuses on generating and distributing abundance. This idea allows a philosophical opening in the development of the teaching professional profile because it provides new approaches to environmental economics.

Within the spectrum of theoretical frameworks shown in Figure 3, conventional economies have been shown to bring social inequality and ecological devastation, while green economics proposals are unfeasible because they increase the costs of production and, therefore, of retail sales (Pearce et al., 1989). The idea of sustainable economies on responsible consumption that allow biophysical restoration has historically failed

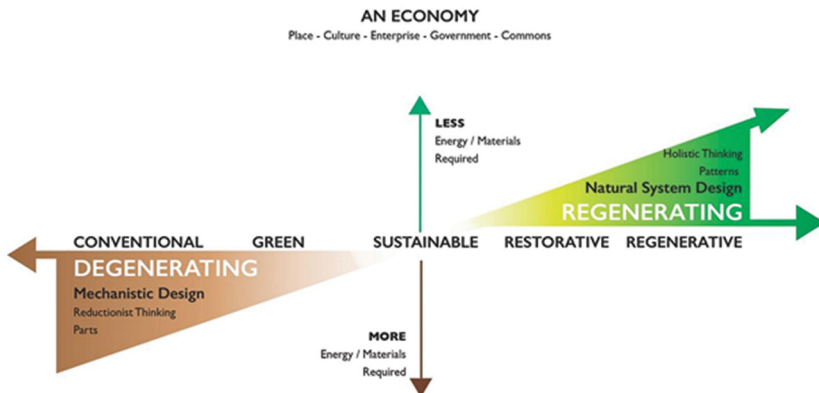


Figure 3. Regenerative economies. Source: Fullerton (2015, 43).

because Western countries have globalized their “imperial lifestyle” (Brand & Wissen, 2017).

From a philosophical point of view, the regenerative economies approach gives rise to a paradigm of companies that operate resiliently in a complex and interdependent world (Morin, 2011). Although there are no magic formulas to move from a conventional economy to a regenerative one, environmental education practices can significantly promote the creative potential of people and show the multiple benefits generated by mimicking the natural world. Figure 3 shows that restorative and regenerative economies have a holistic vision that is inspired by the systematic design of nature (Fullerton, 2015; Brown et al. 2018). These regenerative economics models break the linearity displayed by conventional economics, and make efficient use of material and energy resources because they follow the eco-efficient wisdom of nature (Pauli, 2010).

However, Korhonen et al. (2018) warn us not to confuse these approaches with “circular economy.” Influenced by technological optimism, the circular economy produces the feeling of being able to reuse and all resources forever. Theoretically, the circular economy does not take into account the basic laws of physics, and more specifically of thermodynamics, which means that it is not possible to recycle 100%. Nor does it take into account the Jevons paradox. This paradox affirms that technological improvement increases the efficiency with which a resource is used and thus increases the consumption of said resource because it produces better results. In any case, the economic models in Figure 3 are still framed in the capitalist paradigm, despite seeking more resilient transitions with nature.

Here, Collado and Malo (2019, 339) argue: “While the notion of sustainable development is focused on minimizing the negative human impact on the planet, regenerative development focuses on maximizing the positive impact of human beings on Earth.” This philosophical horizon means that designing regenerative cultures must be rooted into educational curriculum to prompt citizens to feel, think, and act in harmony with nature. This implies a transdisciplinary inclusion between the theoretical principles of ecological economics and regenerative cultural practices (Collado, Madroñero, & Álvarez, 2019).

In a similar way, the “regenerative economy theory” proposed by Fullerton (2015, 34) has also a transdisciplinary philosophical vision that integrates “both the solid empirical understandings of the laws and patterns of systemic health, and in wisdom traditions that have stood the test of time and which are remarkably aligned with this new scientific understanding.” For this reason, schools must include regenerative cultural practices based on the integration of knowledge from both their communities and scientific advances.

In fact, designing regenerative cultures are not new in the social, cultural, or educational field. The principles of permaculture, theoretically established by Holmgren (2010), show that Australia's traditional aboriginal communities built a philosophy of life based on mimicry the ecological models and strategies of their environment. Since the end of the 19th century, Steiner's anthroposophy already proposed that schools with "Waldorf Pedagogy" carry out pedagogical practices with biodynamic crops.

Therefore, regenerative cultures may establish a new collective imaginary based on what we can learn from nature, and not on what we can extract from it (Benyus, 2009). It involves changing the ecocidal economic patterns that have destroyed nature for centuries, to found economic patterns inspired by the intrinsic eco-efficiency of life in nature (Finley, 2019). After more than 3.8 billion years of intersystemic coevolution, nature has discovered what works and lasts over time. Here, Pauli (2010) postulates more than 100 business model innovations inspired by the wisdom of nature. This biomimetic vision emulates the regenerative processes of nature to generate business innovations that do not produce waste. Then, how could we develop the professional profile of environmental educators to stimulate the creativity of their students toward regenerative horizons?

To answer this challenging question, it is necessary to continue the academic debate of this article and collectively think about how to introduce the regenerative practices of environmental education into the business world. In this sense, Gadotti (2000) claims the need to create a "pedagogy of the Earth" or an "ecopedagogy" that is concerned with the promotion of life, relational content, experiences, attitudes and environmental values. Although there have been entrepreneurs that have sought to improve the health of the planet, it has never become the hegemonic economic norm that regulates everyday practices. For Sanford (2017), regenerative businesses require responsible entrepreneurs who redesign material and energy flows. Her job is to educate and advise companies around the world on the importance of focusing their strategies toward a new paradigm of regenerative businesses that transform the deficiencies of the economic system into general prosperity. This regenerative business vision shows that our schools and universities need to deeply rethink their scholar curriculum and training programs.

Conclusions

As an initial conclusion, developing a transdisciplinary educational philosophy that improves the professional profile of environmental educators is an urgent challenge. For this reason, it is necessary to continue

reflecting on how the epistemological foundations of ecological economics enrich environmental educational practices. The experience of the TiNi's program in Ecuador shows that students have better understood that the Earth acts as a meta-system made up of biophysical systems that interact with each other (Ministerio de Educación del Ecuador (MinEduc), 2018b). Furthermore, they also better understand the complexity of global change, which involves multidimensional and interconnected changes in the Earth System: loss of biodiversity, nitrogen cycles, climate change, phosphorus cycles, land use change, global water use, ocean acidification, ozone depletion, chemical pollution, atmospheric aerosols, etc. (Bowman et al., 2009; IPCC (Intergovernmental Panel on Climate Change), 2014). By understanding the interdependence of natural and social phenomena in coevolutionary terms, links are created between schools and communities that allow the development of regenerative cultures for better world futures.

Another important conclusion, many intellectuals and activists claim for degrowth as a new era (D'Alisa et al., 2015), where a global Green New Deal could promote human well-being and environmental justice (Barbier, 2010). Here, there is a great adversity toward the SDGs, because target 8.1 assumes that global growth will address poverty, hunger, and education goals. However, the SDGs are written with internal contradictions, because this growth violates goal 12.2 and 13, among others. Klein (2014) remembers that WikiLeaks published evidence on how certain governments and transnational companies filtered negotiating agents that influence the terminology of United Nations reports and declarations. That is the reason why SDGs need to be rethought from a decolonial and regenerative approach.

Finally, the most important conclusion is that the solution to our civilization's problems remains in the same source that feeds and nourishes us: NATURE. After exploring new paradigms to strengthen teacher training in the framework of environmental education, it is concluded that there is a need to break the false dichotomy between humans and nature, since arthlings are part of the Earth, not apart from it. The philosophical integration of ecological economics foundations in environmental education practices have given rise to design regenerative cultures, which understand the economy as a complex system in dynamic equilibrium, within a biosphere with entropic characteristics that contains and sustains it. A good example are the studies developed by Nordhaus (2013), who integrates climate change into his long-term macroeconomic analysis, in order to calculate the potentially catastrophic effects for the well-being of societies and the environment. Let's rethink and revalue the teaching figure in our societies to transform the civilizational course and to face

the global change. There is no time to lose, we have to act today to create regenerative world futures.

Notes

1. List of the Sustainable Development Goals (SDGs): (1) No Poverty; (2) Zero Hunger; (3) Good Health and Well-being; (4) Quality Education; (5) Gender Equality; (6) Clean Water and Sanitation; (7) Affordable and Clean Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation and Infrastructure; (10) Reduced Inequality; (11) Sustainable Cities and Communities; (12) Responsible Consumption and Production; (13) Climate Action; (14) Life Below Water; (15) Life on Land; (16) Peace and Justice Strong Institutions; & (17) Partnerships to achieve the Goal.
2. This program was jointly planned by the Ministry of Education, the Ministry of the Environment, UNESCO Quito, the National University of Education (UNAE), the Amazon Regional University IKIAM, and the Association for Children and their Environment (ANIA).
3. For a full description of TiNi's implementation in Ecuador, see Falconí et al. (2019).

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Appendix A. Literary review of ecological economics and degrowth

ID	Title	Keywords and main concepts treated in our research	Citation in Scholar Google	Reference	Book or article
1	An Essay on the Principle of Population	Degrowth, exponential population growth	7856	Malthus, 1989	Book
2	Principles of Political Economy	Degrowth,	7355	Mill, 1965	Book
4	The Great Transformation. The Political and Economic Origins of Our Time.	Ecological Economics, degrowth	no data	Polanyi, 2001	Book
5	A Sand County Almanac	Environmental ethics	11917	Leopold, 1989	Book
6	The Social Costs of Private Enterprise	Degrowth, reductionist methods	1109	Kapp, 1975	Book
7	Resource Conservation: Economics and Policies	Degrowth, conservation	1360	Ciriacy-Wantrup, 1952	Book
8	The Economics of the Coming Spaceship Earth	Degrowth, evolutionary economics	3805	Boulding, 1966	Book
9	The Costs of Economic Growth	Degrowth	1600	Mishan, 1967	Book
10	The Entropy Law and the Economic Process	Ecological Economics, degrowth, entropy	8849	Georgescu-Roegen, 1971	Book
11	From Bioeconomics to Degrowth	Degrowth, bioeconomics, entropy	107	Georgescu-Roegen, 2011	Book
12	The Limits to Growth	Degrowth, entropy	24750	Meadows et al., 1972	Book
13	Small Is Beautiful: A Study of Economics as If People Mattered	Degrowth, environmental justice	12897	Schumacher, 1973	Book
14	El desarrollo sostenible. Su dimensión ambiental y educativa.	Degrowth, sustainable development	527	Novo, 2009	Book
15	From Uneconomic Growth to a Steady-state Economy	Degrowth, ecological economics	149	Daly, 2014	Book
16	From Empty-world Economics to Full-world Economics: Recognizing an Historical Turning Point in Economic Development	Degrowth, ecological economics	89	Daly 1992	Book
17	The Shallow and the deep, long-range ecology movement. A summary	Ecological economics, ecosophy	3705	Naess, 1973	Article
18	L'Économique et le vivant	Ecological economics, degrowth	999	Passet, 1996	Book
19	Are There Limits to Growth?	Degrowth, entropy	1281	Stokey, 1998	Article
20	A comparison of The Limits to Growth with 30 years of reality	Degrowth, ecological economics, entropy	782	Turner, 2008	Article
21	Is it possible to achieve a good life for all within planetary boundaries?	Degrowth, planetary boundaries	35	Hickel, 2019	Article

22	The economics of degrowth	Degrowth, entropy	508	Kallis, Kerschner, & Martinez-Alier, 2012	Article
23	On Fire: The (Burning) Case for a Green New Deal.	Degrowth, Green New Deal, regenerative development	129	Klein, 2019	Book
24	The Systems View of Life. A Unifying Vision	Regenerative cultures, co-evolution, interdependence	1199	Capra & Luisi, 2014	Book
25	The Ecological Economics of Economic Democracy	Ecological economics	1	Akbulut & Adaman, 2020	Article
26	Does a Discount Rate Measure the Costs of Climate Change?	Climate change	7	Tarsney, 2017	Article
27	Degrowth, postdevelopment, and transitions: A preliminary conversation	Degrowth, postdevelopment	286	Escobar, 2015	Article
28	The Environmentalism of the Poor. A Study of Ecological Conflicts and Valuation	Ecological economics, degrowth, entropy	2638	Martinez-Alier, 2002	Book
29	Un buen encaje en los ecosistemas.	Degrowth, biomimetics, regenerative development	70	Riechmann, 2014	Book
30	An Economy For the 1%. How privilege and power in the economy drive extreme inequality and how this can be stopped	Degrowth, inequality	135	OXFAM, 2016	Book
31	Profit Over People. Neoliberalism and Global Order.	Degrowth	2286	Chomsky, 1999	Book
32	Décoloniser l'imaginaire : La pensée creative contre l'économie de l'absurde.	Degrowth	150	Latouche, 2003	Book
33	Prosperity Without Growth. Foundations for the Economy of Tomorrow.	Degrowth, sustainability	333	Jackson, 2016	Book
34	An Introduction to Ecological Economics.	Ecological economics, entropy, degrowth	1427	Costanza et al., 1997	Book
35	Human Scale Development. Conception Application and Further Reflections.	Degrowth, human development	1865	Max-Neef, 1991	Book
36	Insostenibilidad ecológica y social del 'desarrollo económico' y la brecha nortetur	Degrowth, insustainability	5	Naredo, 2000	Article
37	Empiricism in ecological economics: a perspective from complex systems theory.	Ecological economics, entropy, degrowth	98	Ramos-Martin, 2003	Article
38	Turning Point. The End of the Growth Paradigm.	Degrowth, entropy	227	Ayres, 1998	Book
39	Économie du Bien Commun.	Degrowth, global commons	294	Tirole, 2016	Book
40	The Imaginary Institution of Society.	Degrowth, economic determinism	3694	Castoriadis, 1987	Book

(continued)



Appendix A. Literary review of ecological economics and degrowth Continued.

ID	Title	Keywords and main concepts treated in our research	Citation in Scholar Google	Reference	Book or article
41	¡Basta! Una democracia diferente, un orden mundial distinto	Degrowth, unsustainability, inequality	no data	Mayor-Zaragoza, 2012	Book
42	Regenerative development as natural solution for sustainability	Degrowth, regenerative development	1	Müller, 2020	Article
43	Designing Regenerative Cultures	Degrowth, regenerative cultures	140	Wahl, 2016	Book
44	Solidaridad sostenible: la codicia es indeseable.	Ecological economics, degrowth	12	Falconi, 2017	Book
45	Economics of Environmental Conservation.	Ecological economics, regenerative development	508	Tisdell, 2005	Book
46	Earth in mind: on education, environment, and the human prospect.	Ecological economics, entropy, degrowth	3160	Orr, 2004	Book
47	The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations.	Ecological economics, entropy	863	Kumar, 2011	Book
48	Models of Environmental Behavior in Ecological Economics: A Literature Review.	Ecological economics	no data	Mondéjar & Vargas, 2018	Article
49	Deschooling Society	Degrowth, regenerative cultures	8168	Illich, 2000	Book
50	Economic de-growth vs. steady-state economy.	Degrowth	316	Kerschner, 2010	Article
51	A tale of three paradigms: Realizing the revolutionary potential of ecological economics.	Ecological economics, entropy	21	Spash, 2020	Article

Source: Own elaboration.