

# Towards a meta-ontology of sustainability. An educational perspective

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## Abstract

In this paper, I reflect on the theoretical interconnection between different ontological interpretations of sustainability by exploring the possibility of establishing a meta-ontology of sustainability. I try to shape the fundamental features of such meta-ontology, assuming an educational perspective. More precisely, I consider which theoretical preconditions the education to sustainability should satisfy to be effective, by focusing on the development of a “transdisciplinary” epistemology and the achievement of an “integral ecology” as essential aspects of a meta-ontology of sustainability.

## Keywords

sustainability, ontology, meta-ontology, education

## 1. Introduction

Since in September 2015 the General Assembly of the United Nations has adopted the “2030 Agenda for Sustainable Development” [33], the idea of “sustainability” has more and more become a fundamental conceptual category, through which the most relevant aspects of the contemporary world can be globally and systematically understood [11, 15, 17, 22]. In this regard, the concept of “sustainability” is not a merely ecological, economical, or sociological concept but it seems properly *ontological* since it allows to shape a general vision of reality that intertwines the destiny of humankind and that of the environment. In this way, the conceptual perspective of “sustainability” presupposes a pragmatic conception of ontology according to which ontology does not only concern a theoretical knowledge on what there is (material ontology) or on the structure of all there is (formal ontology) [39], but also a practical knowledge that considers what there is from the agent’s point of view and then the structure of reality in terms of dynamic relationships between “speakers” and “environment” [24].

The ontological relevance of the concept of sustainability is attested by the fact that in recent years “sustainability ontologies” have appeared within the multifaceted epistemic framework of “applied ontology” [32]. As is known, applied ontology has been developed from informatics and computer sciences to provide a methodology for building world’s

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<sup>\*</sup>16<sup>th</sup> International Conference on Biological and Biomedical Ontology (ICBO 2025) – Food, Waste, and Sustainability: Synergizing Ontology Efforts 2025 Workshop, November 14, 2025. Virtual conference hosted at the PTH Brixen College, Bressanone, Italy.

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representations in specific scientific contexts through standard definitions and data management [3, 26]. In this regard, applied ontology differs from a properly philosophical approach to ontology since it does not aim to provide a general view on reality establishing a science of being as such [2], but formal criteria to build representations in a specific domain. However, it is precisely this difference that can make the integration of the two ontological approaches particularly fruitful. On the one hand, applied ontology can strengthen semantic clarity and assist data integration in support of philosophical ontology. On the other hand, also the unitary and overall theoretical perspective of philosophical ontology can support applied ontology in achieving the semantic univocity to which it aims. In fact, in the specific case of sustainability ontologies there is still a polysemy that does not allow us to clearly define what sustainability is, its theoretical relationship with the idea of sustainable development and its systemic complexity [32, pp. 3–7]. For example, if we consider the “Sustainable Development Goals Interface Ontology” (SDGIO) [30] that is a sustainability ontology included in one of the pilot project in applied ontology – the “Open Biological and Biomedical Ontologies (OBO) Foundry” [16, 23, 31] – “no insights into covering sustainability polysemy seem to emerge from the ontology structure” [32, p. 14]. However, it is important to point out that there are initiatives seeking to deal with such shortcomings. To provide an example, the “Sustainability Core Ontology” (SCO) [29] is trying to work through a possible approach to deal with semantic polysemy and multiple views while still maintaining the goal of data interoperability and representation regarding sustainability.

In order to integrate applied ontology and philosophical ontology, it could be useful to integrate the “common top-level structure” [3, p. 86] defined by the “Basic Formal Ontology” (BFO) [5] with a further meta-theoretical level. What might such a metatheoretical level consist of? If the BFO already represents the most general formal properties underlying the various applied ontologies, a further metatheoretical level seems to have to be “metatheoretical” in the literal sense of the term, that is, it must go beyond theory and involve a practical perspective. In this sense, a meta-ontology is, on closer inspection, a pragmatic ontology.

It seems possible to synthesize the different practical perspectives involved with the ontology of sustainability – political, sociological, economical, ecological, etc. – assuming the educational one. In fact, education to sustainability seems presupposed by all the other perspectives, since without education to sustainability it does not seem possible to guarantee political, sociological, economic, ecological, etc. development. One might wonder whether such commitment to education may turn up a strong constraint for a meta-ontology, transforming it into an artefact that, instead of supporting interrelation and harmonization of perspectives on sustainability, comes back to be positioned according to a specific perspective (that of education), limiting the attempt itself of the proposal. More precisely, assuming a different background and view on sustainability, someone may propose one of the other dimensions cited to establish the practical meta-level. For instance, someone may start with the political or the economic dimensions. In this regard, it should be borne in mind that, from the point of view of the pragmatic meta-ontological integration between applied and philosophical ontology, education, politics, and economics are not separate specialist disciplines but rather “perspectival” expressions of a unitary worldview [21].

In the following sections of this paper, I will take the first steps towards a pragmatic meta-ontology of sustainability by considering which theoretical preconditions the education to sustainability should satisfy to be effective.

## **2. Epistemology of sustainability**

The concept of sustainability can represent the theoretical barycenter around which to integrate humanities and natural sciences, overcoming a long-standing dichotomy, inherited by nineteenth-century Positivism [7, 9, 28]. In fact, showing that the human development – moral and material – and the environment protection are closely related but irreducible, the seventeen “Sustainable Development Goals” of the Agenda presuppose and require an anti-reductionist, pluralist and systemic epistemological approach. On the contrary, since the beginning of the industrial revolution, the positivistic epistemological and ontological monism – that aimed to apply the method of the natural sciences to humanities and so to reduce the human world to the natural one – came with the environmental exploitation, that finally led to our “unsustainable” era. The explanation of the contemporary environmental exploitation is obviously complex and involves different historical-political causes, but here the focus will be on its epistemological premises. For example, it is possible to understand how a positivistic view on knowledge and reality can imply an indiscriminate use of the environment, by highlighting that if the scientific and the technological progress is not related to the idea of a more general and fundamental human development, there is no external ideal end that can guide and control the technological manipulation of the nature.

In this regard, a meta-ontology of sustainability should reflect more generally on the epistemological basis of a culture of sustainability, interpreted as a global, systemic, or metaphysical view on reality. The central idea is that without a reference to an overall framework able to comprehend and connect the human and the natural sphere – by also recognizing their peculiarity and so their relative and multiple hierarchies – it isn't possible to build a real sustainable thought of sustainability, because the parts of the system of knowledge – ethical, sociological, political, economical, ecological, etc. – would be disaggregated and there couldn't be coherent aware understanding nor incisive transformative actions of the world.

## **3. Sustainability and global education**

The epistemological need for a culture of sustainability as a complex, global and integrated system of knowledge is at the same time an educational need. Rethinking Education for the twenty-first century, the United Nations Educational, Scientific and Cultural Organization (UNESCO) highlights the importance of a global and integral education, according to which the personal growth doesn't simply result from a notional collection of separated information, but from a global and critical vision on reality that also involves skills, competences, and attitudes useful for life [36]. In this regard, UNESCO seems to especially suggest the “citizenship education” as the main practical context through which it is possible to really shape a culture of sustainability, by integrating formal and informal knowledge, that is, theoretical and experiential learning, in order to consciously and skillfully face the dangerous environmental and social risks to which new generation are exposed [37].

In recent years, also local Governments of different developed countries are implementing citizenship education within their educational programs [14]. For example, in 2019 the Italian Government has introduced a law that aims to renew the teaching of the citizenship education, just in the light of the above global epistemological and educational needs. Indeed, the Law 92/2019 of the Italian Government establishes that Citizenship Education must be conceived as a transversal teaching shared by all the class teachers, concerning not only theoretical knowledge about legality, environment, digital education, etc., but also concrete experiences of active citizenship in order to connect school and life.

In 2020 I took part as scientific coordinator in an experimental project funded by the Presidency of the Council of Ministers of the Italian Government (@PE Project – Alliance for Citizenship Education) that aimed to support ten north-western Italian high schools to realize the innovative epistemological principle of the citizenship education as a transdisciplinary new field of learning and knowledge, and the educational principle of the integral and global education as the starting point for a sustainable development. This experimentation highlighted that without a real epistemological transdisciplinary renovation in the academic and scholastic culture there could not be any effective teaching of global citizenship education, deterring consequently the sustainability culture's credibility among young people [4].

#### **4. Objectives**

In the light of all these elements, it is therefore possible to point out the main objectives of a meta-ontology of sustainability: it essentially aims to

- Define the foundations of a transdisciplinary epistemology able to comprehend the holistic complexity of knowledge, overcoming the epistemological dichotomies inherited by the traditional positivistic view, starting with the reduction of humanities to natural sciences down to the separation between theoretical and experiential learning, that have paradoxically engaged an anthropocentric environmental exploitation;
- Elaborate an integral ecology interpreted as a new metaphysical framework that balances the human and the natural world, establishing a “decentralized anthropocentrism”, able to recognize the mankind dependence on the environment without forgetting the human scope of whatever environmental care action;
- Evaluate the consistency of the 2030 Agenda sustainable goals with respect to the transdisciplinary and integral-ecological epistemological/metaphysical framework, in order to achieve a sustainable education to sustainability, that is, in order to think critically critical thinking.

#### **5. Methodologies**

A meta-ontology of sustainability should achieve these articulated objectives by adopting a multi-methodological approach relying on historical-philosophical recognition as well as on conceptual and empirical analysis. More precisely,

- The foundations of the transdisciplinary epistemology should be defined through a recognition of the main criticism to neo-positivistic epistemology, with particular attention to the overcoming of the dogma of the immediacy of the empirical knowledge within American neo-pragmatist epistemology, looking for an integration of observational and theoretical knowledge, that is, of objective, subjective and pragmatic cognitive factors [10, 12, 13];
- The features of the integral ecology should overcome the ontological dichotomy between realism and antirealism in which applied ontology seems to be stuck [27]. Rather, assuming a pragmatic conception of ontology, the “internal” interpretation of realism [24] could represent the metaphysical framework able to acknowledge the relativity of the ontology to the human point of view without renouncing to the idea of an objective reality, also in line with scientific realism and then with critical thinking [18, 20]. Moreover, internal realism seems to be particularly relevant in order to understand sustainability with respect to food waste processes. In fact, the main criteria for identifying a food waste process (i.e. reversibility, relationality, value-sensitivity, agentivity) [6] are also the main features of reality according to internal realism;
- The conditions of realizability of the education to sustainability as intended by 2030 Agenda and by UNESCO should be evaluated by analyzing models of reasoning about sustainable development with particular attention to the measurement of the sustainable development’s progress by “The Annual Sustainable Development Goals Report” of the United Nations.

## 6. Thinking critically critical thinking

With respect to the last point, the 2023 Report recognizes that “at the midpoint of the implementation of the 2030 Agenda, a sobering reality emerges: the world is falling short of meeting most of the Goals by 2030” [34, p. 8]. This negative overall assessment is supported by a wide “data landscape” but — as it is well known from the field of the methodological research — such quantitative analysis per se cannot involve any evaluation regardless of properly qualitative premises. The fundamental 2030 Agenda value assumptions through which the quantitative data are interpreted seem firstly to concern an utopian or at least very optimistic universalism combined with a radical particularism, according to which the achievement of the “universal” Sustainable Development Goals can “resolve” problems and injustice of the “entire world”, ensuring “rights” and “prosperity”, “for all” and “everywhere”, so that “no one will be left behind” [33, pp. 1–4]. Starting with these utopian goals, it is understandable that the statistics are unsatisfactory and that a sense of helplessness is engendered accompanied by an alarmism at times apocalyptic. In the 2023 Report the Secretary-General of the United Nations António Guterres claims that “unless we act now, the 2030 Agenda could become an epitaph for a world that might have been” [34, p. 2], but from an educational point of view it is not enough “sounding the alarm” [34, p. 8], because this produces a fear that conversely immobilizes action and change. Therefore, the achievement of sustainability does not seem to be fostered by complementary utopian and apocalyptic hype but requires first and foremost a concrete sense of reality that starts with an inner transformation about the way we conceive of ourselves and the world. It is not a case that the

utopian approach to sustainability basically results from a positivistic view on knowledge and reality reminiscent of Francis Bacon, according to which science is “powerful”. On the contrary, a realistic approach to sustainability and then a concrete transformation process should begin just by reflecting on the effective possibilities of human knowledge. As we have seen, contemporary epistemology offers useful theoretical tools to face this challenge, especially thanks to the American neo-pragmatist epistemology and its capacity to overcome neo-positivist scientism without falling into the opposite anti-scientific irrationalism [38]. In this regard, we have especially mentioned internal realism since it represents a general conception of reality that acknowledges the relativity of the descriptions of the world to the human point of view without giving up on the objectivity of scientific knowledge [19]. In this way, the combination of scientific realism with internal realism — rather than with a reductionistic metaphysical realism [1] — can offer a theoretical perspective able to support a pluralistic and transdisciplinary conception of knowledge as well as an integral ecology that intertwine the destiny of humankind and that of the environment, taking the first steps toward a meta-ontology of sustainability.

## Declaration on Generative AI

I did not use generative AI tools for writing, translation, or content generation in this paper.

## References

- [1] M. Alai, Scientific realism, metaphysical antirealism and the no miracle arguments. *Foundations of Science* 28 (2023): 377–400.
- [2] Aristotle, *Metaphysics*, translated with Introduction and Notes by C. D. C. Reeve, Hackett Publishing Company, Indianapolis, 2016.
- [3] R. Arp, B. Smith, A. D. Spear, *Building ontologies with Basic Formal Ontology*, Massachusetts Institute of Technology, Cambridge, MA, 2015.
- [4] G. Balduzzi, A. Lizzadri, D. Servetti (Eds.), *Manuale sul Metodo APE per l’educazione civica*, 2024. URL: <https://www.apeprogetto.it/manuale-ape.html>.
- [5] Basic Formal Ontology (BFO). URL: <https://github.com/BFO-ontology/BFO>.
- [6] A. Borghini, N. Piras, Semantic and philosophical approaches for advancing the identification and measurement of food waste, *Nature Food* 6 (2025): 547–552.
- [7] P.W. Bridgman, *The Logic of Modern Physics*, MacMillan Co., New York, NY, 1927.
- [8] R.M. Calcaterra, G. Maddalena, G. Marchetti (Eds.), *Il pragmatismo. Dalle origini agli sviluppi contemporanei*, Carocci, Roma, 2015.
- [9] R. Carnap, H. Hahn, O. Neurath, *Wissenschaftliche Weltauffassung: der Wiener Kreis*, Artur Wolf Verlag, Wien, 1929.
- [10] R. Corvi, *Frontiere aperte. Verso un’epistemologia transdisciplinare*, Scholé-Morcelliana, Brescia, 2023.
- [11] E. Chislenko, E. (2022). The Role of Philosophers in Climate Change, *Journal of the American Philosophical Association* 8, 4 (2022): 780–798.
- [12] A. Crețu, M. Massimi (Eds.), *Knowledge from a human point of view*, Synthese Library 416, 2020.
- [13] M. De Caro, Hilary Putnam on Perspectivism and Naturalism, in: A. Crețu, M. Massimi (Eds.), *Knowledge from a human point of view*, Synthese Library 416, 2020, pp. 57–70.

- [14] D. Danks, Governance via explainability, in: J. Bullock (Ed.), *The Oxford handbook of AI governance*, Oxford University Press, Oxford, 2022.
- [15] C. T. DesRoches, The Concept of Sustainability, in B. Williston (Ed.), *Environmental Ethics for Canadians*, Oxford University Press, New York, NY, 2023, 385–390.
- [16] R. Jackson, N. Matentzoglou, J. A. Overton, R. Vita, J. P. Balhoff, P. L. Buttigieg, S. Carbon, M. Courtot, A. D. Diehl, D. M. Dooley, W. D. Duncan, N. L. Harris, M. A. Haendel, S. E. Lewis, D. A. Natale, D. Osumi-Sutherland, A. Ruttenberg, L. M. Schriml, B. Smith, B. Peters, *OBO Foundry in 2021: operationalizing open data principles to evaluate ontologies*. Database, 2021, baab069. <https://doi.org/10.1093/database/baab069>.
- [17] R. O. Kaaronen, *Steps to a sustainable mind. Explorations into the ecology of mind and behaviour*, Unigraphia, Helsinki, 2020.
- [18] A. Lizzadri, *Dal realismo scientifico al realismo interno. Putnam verso il pragmatismo*, Mimesis Edizioni, Sesto San Giovanni (MI), 2023.
- [19] A. Lizzadri, Internal realism and the computational model of the mind: a realist interpretation of ontological relativity, in: E. Ippoliti, L. Magnani, S. Arfini (Eds.), *Model-Based Reasoning, abductive cognition, creativity*. MBR 2023. *Studies in applied philosophy, epistemology and rational ethics*, vol 70, Springer, Cham., 2024, 3–17.
- [20] L. Magnani, Scientific models are not fictions, in L. Magnani, P. Li (Eds.) *Philosophy and cognitive science. Western & Eastern studies. Studies in applied philosophy, epistemology and rational ethics*, vol 2, Springer, Berlin, Heidelberg, 2012, 1–38.
- [21] M. Massimi, *Perspectival realism*, Oxford University Press, Oxford, 2022.
- [22] F. Mazzi, L. Floridi (Eds.), *The ethics of artificial intelligence for the Sustainable Development Goals*, Springer Philosophical Studies Series 152, New York, NY, 2023.
- [23] *Open Biological and Biomedical Ontologies (OBO) Foundry*. URL: <https://github.com/obofoundry>.
- [24] H. Putnam, *Realism and Reason*, in: H. Putnam, *Meaning and the moral Sciences*, Routledge and Kegan Paul, London, 1978, 123–138.
- [25] W. V. O. Quine, Two dogmas of empiricism, *The philosophical review* 55 (1951): 20–43.
- [26] B. Smith, *Ontology*, in: L. Floridi (Ed.), *Blackwell guide to the philosophy of computing and information*, Blackwell, Oxford, 2003, 155–166.
- [27] B. Smith, W. Ceusters (2010). *Ontological realism: a methodology for coordinated evolution of scientific ontologies*, *Applied Ontology* 5, 3–4 (2010): 139–188.
- [28] D. Stoljar, *Physicalism*, New York, Routledge, 2010.
- [29] *Sustainability-Core-Ontology*. URL: <https://github.com/gioUbbiali/Sustainability-Core-Ontology>.
- [30] *Sustainable Development Goals Interface Ontology (SDGIO)*. URL: <https://github.com/SDG-InterfaceOntology/sdgio>.
- [31] The OBI Consortium, B. Smith, M. Ashburner, C. Rosse, J. Bard, W. Bug, W. Ceusters, L. J. Goldberg, K. Eilbeck, A. Ireland, C. J. Mungall, N. Leontis, P. Rocca-Serra, A. Ruttenberg, S. Sansone, R. H. Scheuermann, N. Shah, P. L. Whetzel & S. Lewis, *The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration*. *Nature Biotechnology*, 25(11), 2007, 1251. <https://doi.org/10.1038/nbt1346>.
- [32] G. A. Ubbiali, A. Borghini, M. C. Lange, *Ontologies for sustainability: theoretical challenges*, *Sustainable Development* (2026): 1–14. <https://doi.org/10.1002/sd.70562>.

- [33] United Nations General Assembly, Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015, United Nations, New York.
- [34] United Nations, The Sustainable Development Goals Report 2023: Special Edition. Towards a Rescue Plan for People and Planet. United Nations Publishing, New York, NY, 2023.
- [35] United Nations Independent Group of Scientists appointed by the Secretary-General, Global Sustainable Development Report 2023: Times of crisis, times of change: Science for accelerating transformations to sustainable development. United Nations Publishing, New York, NY, 2023.
- [36] United Nations Educational, Scientific and Cultural Organization (UNESCO), Rethinking education. Towards a global common good?, UNESCO Publishing, Paris, 2015.
- [37] United Nations Educational, Scientific and Cultural Organization (UNESCO), Global citizenship education. Topics and learning objectives, UNESCO Publishing, Paris, 2015.
- [38] P. Valore, A. Tortoreto, Pragmatismo e filosofia analitica: Quine, Sellars, Davidson, in: M. R. Calcaterra, G. Maddalena, G. Marchetti (Eds.), Il pragmatismo. Dalle origini agli sviluppi contemporanei, Carocci, Roma 2015, 191–223.
- [39] A. C. Varzi, On the boundary between material and formal ontology, in B. Smith, R. Mizoguchi and S. Nakagawa (Eds.), Interdisciplinary ontology, Vol. 3, Keio University, Tokyo, 2010, 3–8.