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The foundations and applications of teaching environmental problems: paradigms, learning domains, worldviews, and how they interact

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ABSTRACT

While environmental problems are urgent in modern society, they are especially difficult to tackle because of their normative and politically controversial nature. Universities may choose different theoretical paradigms for the teaching of environmental problems. However, limited theoretical and/or practical analysis has been undertaken of the theoretical and normative paradigms underlying education on environmental problems. How do we know if educational approaches sufficiently equip students to deal with environmental issues? This article provides a taxonomy for mapping both environmental paradigms and learning outcomes, allowing for a thematic content analysis of the programs of a Dutch university that focuses on environmental problems. The main findings are that, while the course guides are overall highly internally coherent, there are disciplinary silos where the different disciplines teach from different paradigmatic presuppositions. Furthermore, the programs are very cognitive-centered, leaving little room for affective, social, and behavioral learning outcomes, despite the importance of these in higher education. This cognitive bias is relevant for all paradigmatic outlooks, but especially for the more mechanistically oriented paradigms. While understandable from the substance of these paradigms, multimodality in pedagogy and learning outcomes is needed for a comprehensive education.

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Introduction

Environmental problems are uniquely challenging in their complexity both in the sciences and society. Furthermore, higher education forms an important bridge between the sciences and society. Therefore, the way in which environmental problems are taught in higher education greatly affects the attitudes that students have toward these problems (Shephard et al. 2014). In teaching environmental problems, educators must be equipped with both the ability to teach technical knowledge as the ability to translate knowledge into practices in society (Tassone et al. 2018). Both of these aspects, the technical and the societal, are to some extent normative. Normative here refers to *ought* statements, or a value-laden theory about the way the world *should be* and *how* to get there. So, apart from being technical experts in the field, educators are responsible for teaching normatively controversial topics, especially when it comes to environmental problems (Tassone et al. 2018). Environmental problems are included in many

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programs, but there is currently no clear theoretical standard for defining and approaching these problems in higher education (Fisher and McAdams 2015; Aikens, McKenzie, and Vaughter 2016). This means that there is no shared problem conceptualization of environmental issues in higher education. This is problematic for teachers, as it results in a lack of coordination between courses in different disciplines and scattered theoretical logic in education.

The lack of a theoretical basis is reflective of a broader theoretical and practical difficulty. An example of this is climate change, which is an important driver of environmental problems. However, the scientific consensus on the anthropogenic nature of global warming does not constitute a coherent problem definition of climate change (i.e. Long 2011; Morrow 2023). Nonetheless, these environmental problems constitute a crucial point of focus in higher education (Castellanos and Queiruga-Dios 2022). Consequently, universities are searching for ways to innovate the curriculum and enable students to understand and respond to environmental problems. For example, theoretical and empirical research has been conducted that focuses on enhancing students' environmental knowledge, skills, attitudes, and behavior (for an overview see Wetering et al. 2022). However, this goal-oriented research outlook has left a research gap when it comes to understanding how various normative paradigms, assumptions, and interpretations about environmental problems implicitly shape the development of higher education courses. There is a lack of understanding about how environmental problems are normatively understood, taught, and learned in higher education practices (i.e. Fisher and McAdams 2015). When our normative paradigmatic assumptions remain implicit in the design and implementation of courses, universities run the risk of perpetuating a normative framework that is limiting, unhelpful, or even harmful to the possibility of an environmentally sustainable world.

In educational and ethics research, an influential concept is the theory-action gap, referring to the gap between a theory of how to act in the world on the one hand and the actions performed in the world on the other (i.e. Kretz 2014). This article supposes another interpretation of this theory-action gap; that is, a tendency to instrumentalize education by focusing on teaching people to act differently in the world without an explicit normative theory. This article examines the normative theoretical frameworks and the dominant ways of conceptualizing environmental problems in higher education practices. It does not propose a model of how courses ought to be designed; rather, it makes explicit the implicit theory and normative assumptions behind courses, using a Dutch university as a case study. This is important for a critical reflection on paradigms in education. With that arises the possibility for cognitive and paradigmatic shifts in teaching and learning, which are deep leverage points for the transformation to a more sustainable world (Davelaar 2021).

By unveiling the normative paradigms underlying university programs and tacitly conveyed to students when participating in a course, the implicit normative presumptions become explicit. This is important for awareness and critical reflection on the paradigmatic presuppositions of education: skills that are central in cultivating the necessary attitudes and skill sets for responding to environmental problems (Ling et al. 2020). This is underpinned by the United Nations (UN) report on education for sustainable development, which stress the importance of 'the ability to question norms, practices and opinions' and 'the overarching ability to apply different problem-solving frameworks to complex sustainability problems' (The United Nations Educational, Scientific and Cultural Organization 2017, 10).

This article starts by operationalizing paradigms, followed by an overview of the normative paradigms and learning domains that are drawn from the literature and serve as a basis for the empirical part of this study. A thematic content analysis of the course guides is then carried out. Finally, we reflect on this qualitative exploration of normative paradigms.

Paradigms, learning domains, and why they matter for deciding what matters

The concept of paradigms, popularized by the philosopher Thomas Kuhn (1962), is influential in the understanding of implicit theoretical premises that serve as a heuristic for understanding

the world. In the context of education, paradigms are important as they represent our assumptions and interpretation of the world, which in turn inform our teaching and learning practices. Learning happens within a paradigm, and theory is processed in relation to its paradigmatic foundations.

Kuhn defines paradigms as 'models from which spring particular coherent traditions of scientific research' (Kuhn 1962, 10). This is to say, paradigms are socially constructed but nonetheless fundamental understandings, axioma, interpretations, and procedures through which the world and humans' relationship to it are understood scientifically. If a curriculum is found to be strongly internally coherent, this can indicate that there is a coherent set of presuppositions from which it arises. If it is not internally coherent, it is less clear that it starts from a defined paradigm. This would imply that the curricular outlook is both very open and unstructured.

Paradigms are 'firmly embedded in the educational initiation that prepares and licenses the student for professional practice,' and provide the 'conceptual boxes' into which 'nature is being forced' (Kuhn 1962, 5). The practice of applying a paradigm to the world is mirrored in education where students do not familiarize themselves with concepts passively. Rather, they learn by application, constructing a paradigmatic model of the world and applying this to real-life cases. This process can take place consciously or unconsciously. However, learning takes place within a certain paradigm, and the paradigm is reinforced in the process of educating (Kuhn 1962, 46–47). Learning is, in other words, not something that happens individually and abstractly, but rather a process of applying a shared understanding of how the world works to novel cases, in the same way as in scientific practice. This social construction in scientific domains is examined by analyzing the dominance of specific paradigms in different programs in the results and discussion sections of this article.

Kuhn's view of education as the application of models of the world has been mostly influential in the theory of transformative learning. In theories of transformative learning, learning is 'the process of using a prior interpretation to construe a new or revised interpretation on the meaning of one's experience in order to guide further action' (Calleja 2014, 119). In this sense, paradigms relate to the worldview, which 'guides one's understanding of reality and provides the foundation by which one gives meaning to experiences and thoughts' (Huitt 2011, 2). The notion of worldview relates to paradigm but is more individual in its manifestation. A worldview is based on what a subject learns, but also on their experiences, upbringing, social surrounding, and so on. Worldviews 'define desired outcomes for students and children, influence decisions such as selecting curriculum, defining appropriate teaching methods, and measuring progress' (Huitt 2011).

In educational sciences, the notion of paradigms is important both when discussing the content of education (what is taught) as when discussing the style of education (how the content is taught) (i.e. Ling and Ling 2017). This article builds on the theory of paradigms, but not in a dogmatic Kuhnian sense. This means mainly that there is no strong commitment to upholding that different paradigms are completely incommensurable. The notion of incommensurability is controversial, and especially when it comes to the social sciences. This article follows the notion that 'incommensurability is typically neither global nor total, and that the corresponding form of scientific change occurs incrementally' (Barker 2001, 433). This article remains agnostic on fundamental philosophy of science questions and rather uses Kuhn as a starting point for the analysis of different paradigms on dealing with the living environment and how they relate to courses in higher education.

Learning domains

There are different ways to teach, and thus different ways to convey a paradigm in teaching. It is therefore important to analyze the relation between paradigms and learning domains. Understanding the ways in which paradigms are conveyed in education is important for

understanding the relation between paradigm and pedagogy in education. The focus on a specific learning domain is a focus on the development of a particular set of competences and in this sense normative: competences are goal-oriented. In the literature, three different learning domains are discerned: the cognitive domain, the affective domain, and the behavioral domain (i.e. Bloom et al. 1956; The United Nations Educational, Scientific and Cultural Organization 2017). These are, according to the UN report, three important domains in which to categorize essential learning objectives for sustainability education. These domains can be further specified in a cognitive domain, affective domain, psychomotor domain, metacognitive domain, and social skills domain (Tassone et al. 2021).

This analysis juxtaposes the learning goals with the paradigms to understand whether: (1) one of the learning domains is dominant in teaching environment education overall, and (2) whether the learning domains are related to the paradigms in any meaningful way.

The cognitive domain in the context of environmental problems is about the understanding of the environment and its functioning (Hansmann 2010). In learning in the cognitive domain, the relevance of paradigms is perhaps most obvious, as these are models of the world that lend themselves to explanation on a cognitive level. Furthermore, the cognitive domain includes metacognition; this is about the competences necessary for cognitive learning. Metacognitive learning is about the awareness of cognitive abilities and the ability to use these strategically and effectively to achieve a certain goal (Mevarech and Kramarski 2014). In this sense, there is a self-referential element to the concept of metacognition, in that it is learning to learn. In the context of environmental education specifically, metacognitive learning is important as it fosters critical thinking and deep conceptual understanding, which is necessary in the complex multifaceted topoi of environmental collapse (Adler, Zion, and Mevarech 2015).

The emotional or *affective domain* is about the valuative, emotional, and attitudinal aspects of learning (Sipos, Battisti, and Grimm 2008). It is about fostering values, norms, emotions, self-control, and other non-cognitive competences that are nonetheless an important driver of personal and academic progress. The affective domain is especially relevant when it comes to teaching about environmental problems (i.e. Verlie 2019). Affective pedagogy on these topics has multiple goals, of which fostering feelings of responsibility and a sense of care for the environment is an important one (Littledyke 2008). More philosophically, there is an increasing recognition that emotions may inform true moral judgments (Roeser 2013). As is argued in the previous sections, the paradigms are intrinsically normative and valuative. Normative teaching should therefore have an affective component to it.

The *behavioral and social skills domains* are not only about cultivating physical competences, such as sports, working in the lab, or fine motor skills, but more broadly about behavioral skills in general (Tassone et al. 2021). More concretely, they are about the 'ability to do acts relevant to the field of study' (Ferris and Aziz 2005). In this study, behavioral skills encompass for instance learning to present or model complex environmental systems. It is clear how this is relevant for this study, as the ability to act is the ability to turn thought into concrete reality. When discussing ethics or normativity more broadly, the endpoint is always that students' conceptions of the world shape how they act in the world. This is why the behavioral domain is of utmost importance for normative environmental education. The social skills domain focuses on interpersonal skills, especially in the areas of communication and collaboration (which are of course dependent on each other) (Tassone et al. 2021). These skills are fundamentally important for environmental education, as dealing with environmental problems is often a collective endeavor that requires a high level of coordination and cooperation (Chawla and Flanders 2007). The social skills domain is important in the normative sphere, as it forms the foundation of democratic competences and values and being able to navigate in institutions that shape the natural world and our place in it.

In the discussion of these learning domains and their relation to environmental education, the most central aspect is their interconnectedness. The different domains rely on each other

and the set of competences embedded in these domains should therefore be balanced for a comprehensive approach to environmental education (Chawla and Flanders 2007; Littledyke 2008; The United Nations Educational, Scientific and Cultural Organization 2017). This interconnectedness follows from the functioning of the domains. Cognitive competences rely on metacognitive competences to be utilized in a goal-oriented manner. These goals are in turn set partly or wholly affectively and in collaboration with a political/institutional community. Furthermore, the paradigms are conveyed in education in the broad sense, so not only through education focused on the cognitive domain, as paradigms are in nature normative and intersubjective (social). Table 2 shows examples of learning outcomes that were coded in specific domains. As Table 1 shows, the *how* of learning is related to the *what* of learning. The environmental paradigms that are the starting point of this analysis are the second theoretical focus of this study.

Paradigmatic taxonomy

The following taxonomy (based on Loonstra and Tassone 2024) provides a broad and contingent overview of paradigms. The theoretical basis for this taxonomy is educationally informed. That is, the selection of relevant literature came about iteratively by snowballing through literature on paradigms in dealing with environmental problems and selecting papers that aim to encompass a broad sample of literature and are specifically relevant for environmental education. Thus, the goal is not to provide an overview of the different assumptions and interpretations of how we understand and relate to environmental problems, but rather a theoretical starting point for a critical reflection on educational practices. It is a means to make explicit the paradigm that courses are embedded in, without being an end-all essentialist account of what it means to describe and prescribe the world. An understanding of the paradigms is important for analyzing the internal paradigmatic coherency of the course and for analyzing the relationship between disciplinary and paradigmatic focus.

Table 1. Paradigms and descriptions.

		Description
Meta- level (ontology)	Mechanistic	A view of the living environment as a machine composed of different discernible parts that interact in predictable ways. Nature can be controlled towards our goals.
	Ecological	A view of the living environment as a complex whole that is beyond our control (but not our influence). A paradigm built around relationality and dynamic change.
Macro- and Meso-levels (policy and economics)	Mechanistic	
	Green Governmentality	The living environment as a set of parameters that need to be controlled. Administrative logic, top-down policy and bureaucratic solutions.
	Ecomodernism	The living environment as a set of resources/environmental decline as driven by inefficient resource use. Focus on technological change driven through market mechanisms.
	Ecological	
	Civil Environmentalism	Environmental problems as the outcome of an unjust, complex societal system. Bottom-up model of change often paired with abandonment of injustice and focus on changing societal norms.
Micro-level (worldviews)	Mechanistic	
	Modern	Humans as homo-economicus: rational agents maximizing the efficiency of resources for our own gain.
	Ecological	
	Postmodern	Humans in cautious relationship with the world, focused on deconstruction, anti-essentialism and multiple socially constructed meanings of the living environment.
	Integrative	Humans as part of, and co-creators of the living environment.

For a comprehensive paradigmatic taxonomy that is applicable for a broad set of disciplines dealing with environmental problems, the taxonomy covers three levels of description (meta, macro/meso, and micro). These three levels of description build on each other. This means that an ontological view of the living environment (meta level) implies a view of how to deal with this environment politically (macro level). The levels thus refer to different levels of description, but are not in a conceptual vacuum. Table 1 shows the paradigmatic overview that is further elaborated upon below.

Meta level (ontology)

The first level of description is the level of ontology, the meta level. It is a paradigm on what the living environment is and how it functions. Du Plessis and Brandon (2015) argue that perspectives of nature can be divided into a *mechanistic* and an *ecological paradigm*. In this article, it is called the ontological level as it describes the nature of nature; that is, our categories of what constitutes the natural-environmental and how its constituents relate.

The *mechanistic paradigm* is about understanding the world as a mechanism, a machine, with different discernible parts that interact in predictable ways and can be modeled abstractly to a reasonable degree. It centers around: (1) technology, (2) a faith in science and rationality, (3) a search for universals, (4) a methodology of breaking down the world into constituent parts, and (5) a descriptive discourse (Wheeler 2004, 27). This understanding of the world starts from the presumption that nature can be fitted to a model through science and controlled and manipulated through technology. Humanity and its environment are conceptually divided in this paradigm.

The *ecological paradigm*, on the other hand, provides an understanding of the living environment as a set of relationships where: (1) the biophysical and the societal mutually reinforce each other, (2) the parts of the whole are defined by their relation to the whole, rather than parts in themselves, and (3) the set is dynamic and in constant non-linear change. The ecological worldview is one of wholeness, relationships, and change (Du Plessis and Brandon 2015, 6). The ecological paradigm focuses more on the complexity than the complicatedness of nature. In this paradigm, humanity and environment are one socioecological whole.

Macro- and meso-level paradigms

Within the meta paradigms introduced above, it is possible to distill macro and meso paradigms, which are perspectives on policy and economics related to environmental problems. For instance, politics and economics are based on a value system at least partly derived from an ontological conceptualization of nature. A mechanistic or ecological perception of nature provides the context for policy paradigms. Bäckstrand and Lövbrand (2019) provide three policy paradigms for environmental problems that are linked to respective economic positions and embedded in the ontological paradigm here. They are the green-governmental, ecomodernist, and civic-environmentalist paradigms.

The *green-governmental paradigm* is the most influential paradigm. Governmentality is about norm setting and the administering of norms in society (Rutherford 2007). In this paradigm, catastrophes such as climate change and environmental collapse are to be tackled by state actors who manage sustainability parameters through centralized government. In the context of climate change, this means the close monitoring and capping of a predetermined set of emissions (Bäckstrand and Lövbrand 2007, 2019). This approach is mechanistic in its conceptualization of nature in that it supposes a manageability of the living environment through science and rational planning. The operationalization of the problem as an overshoot of comprehensible and quantifiable parameters speaks to the mechanistic nature of this paradigm.

The *ecomodernist paradigm* is the second paradigm embedded in a mechanistic conceptualization of the environment. The main focus of ecomodernism is overcoming environmental problems through technological means developed in competitive markets (Bäckstrand and Lövbrand 2007). This concerns predominantly the decoupling of economic growth (as a proxy for human development) from material throughput (the total flow of materials and emissions used in production) (Hickel and Kallis 2020). So again, rationality and scientism are the backdrop to this paradigm, although the logic of ecomodernism is distinctly different from green governmentalism. Its epistemic focus is more ecological, as the reliance on market mechanisms stems from a suspicion of the ability of state actors to plan markets. Still, its overall outlook is mechanistic in that it focuses strongly on non-normativity, rationality, control, and nature as manageable through technology (albeit in a setting of epistemic decentralization in markets).

Lastly, the *civic-environmentalist paradigm* is one that fits within the ecological paradigm. It is a view on the link between society and its environment that is explicitly normative and holistic. The social and environmental problems are intertwined explicitly, and therefore the role of society in nature is not one that can be changed incrementally through the tweaking of certain parameters, but rather systemically through the transformation of institutions themselves (Bäckstrand and Lövbrand 2019). The civic-environmentalist movement is not characterized by top-down control or efficiency. It is mainly perpetuated by grassroots movements, and therefore expressed through radical politics (Hadden 2015). It is embedded in the ecological paradigm as it consists of notions of relationality and the mutual reinforcement of the biophysical and the social.

Micro level (worldviews)

These policy paradigms contain micro-level paradigms on what it means to be human. This article devises three views on the human, based on De Witt et al. (2016). The micro level concerns a view of humanity, embedded in a political order, in turn embedded in a biophysical universe. The view on the human is thus not the view on any singular human, but a view on humanity. De Witt et al. (2016) distinguishes four categories: the traditional, modern, postmodern, and integrative paradigm on humanity. For the purposes of this article, the first—the traditional—is not as relevant. The traditional anthropology is strongly religiously defined and is therefore not really reflected in modern scientific education curricula (Stolz 2020).

The *modern anthropology* relates to the mechanistic view of the world and is defined by De Witt et al. (2016) as the homo economicus. It is the paradigm in which the human is seen as a calculating machine that acts functionally and rationally in the pursuit of its own self-interest (Read 2009). The modern human is defined by a strong boundary between human and ecology. The environment is seen as a set of resources that can be commodified and are valued only instrumentally. This conceptualization relates this anthropology to both green governmentalism and ecomodernism at the political-economical level, and the mechanistic paradigm at the meta level.

The *postmodern anthropology* is inspired by Lyotard (1979) and translated to the environmental and educational domain by De Witt et al. (2016). It is a critique on the essentialist account of the modern anthropology and follows a strong social constructivism that defines human nature as strongly contextual, unique, and dynamic. Although it is atomistic in its ontology, it still relates to the civic-environmentalist policy paradigm in its bottom-up account of human relationships and dynamic account of human-nature interaction. While the mechanistic meta-ontology presupposes humanity's capability to control and steer the ecological domain, the postmodern anthropology sees humanity as strongly epistemically limited, fitting the ecological meta paradigm.

The final anthropological paradigm described by De Witt et al. (2016) is the *integrative anthropology*. It is a view of humanity in a 'unity and transformational synergy with nature.' This

anthropology focuses on what it is to be human, rather than what it is not to be human. In its relationality and focus on integrating the different domains of human enterprise (the religious, the emotional, the scientific, etc.), this anthropology fits most explicitly with the ecological paradigm at the meta level. In its explicit embrace of normativity and dynamism, it also relates strongly to the civic-environmentalist paradigm.

Methods

The main question addressed in this study is: how are theoretical normative paradigms about environmental problems reflected in university programs? The overarching research question has related goals: to (1) map the internal paradigmatic coherency of the courses, (2) map the extent to which certain paradigms are dominant in certain programs, and (3) map the link between paradigms and learning domains. These three goals culminate in bridging the gap between normative paradigms (theory) and curricular foci (practice). A central value in this article is holism, both in content knowledge (paradigm focus) as in pedagogy (learning domain focus). In line with the value of holism, to provide an in-depth account of how paradigms translate to higher education practices, a single-case study is performed. That is, one higher education institution was selected to make possible a detailed course guide analysis that would not have been feasible for a large group of universities, considering time and personal restraints.

This study explores the courses of a Dutch university that focuses on sustainability and human/nature relationships specifically. This means that studying humanity's relation to its natural environment is the central goal of this university. This does not mean that other universities are not dedicated to this goal, but it is not as obvious as it is with this university. The Dutch context was chosen as the researchers are specifically familiar with the Dutch university system. The data gathered for this study was course guides specifically focusing on environmental issues. The courses were selected from the university online database on the basis of a Boolean search by using keywords related to general environmental themes and specifically to climate change, as this is the main driver of environmental problems and inextricably linked to environmental collapse. The following keywords were used in the selection process: *environment, nature, Earth, sustainability, climate, mitigation, adaptation, and the Anthropocene*. These terms were chosen for their explicit relevance to humans' relation to the living environment. Any mention of any of these terms in the course guides' titles was sufficient for an initial selection in the dataset. Later, doubles and irrelevant courses were removed (irrelevant courses were courses on for instance 'financial sustainability' (a course on maintaining corporate liquidity) or the 'indoor climate' (an applied course on building air conditioning)). The database consisted of all course guides on BSc- and MSc-level disciplines. While other terms may also be relevant, this study is an exploratory project to map normativity in environmental education, and these terms are exemplary of the topics relevant to this project.

Dataset

The end product of this selection was a set of 97 course guides (~10% of all courses) that were coded at the sentence level, as well as at the guide level. That is, each relevant sentence was coded according to the taxonomy presented in Table 2 first at the level of description and second on the paradigm within the level of description. In this way, the internal coherence (research goal 1) can be shown (the extent to which different paradigms are captured within course guides), the dominance of certain paradigms in specific disciplines (research goal 2) can be shown (by cross-referencing the paradigms with the disciplines), and the paradigms can be cross-referenced with learning domains (research goal 3). The course guide level is relevant for the analysis of the co-occurrence of paradigms and the learning domains presented in the theoretical framework.

Table 2. Coding-examples from different course guides.

		Examples from course guides
Meta- level (ontology)	Mechanistic	The deterministic part deals with precipitation-runoff relationships using physical-mathematical and conceptual models.
	Ecological	In this course, you will be introduced to the social science and natural science foundations of this field, and learn how the synthesis of these disciplines helps to generate new interdisciplinary solutions.
Macro- and Meso-levels (policy and economics)	Mechanistic	
	Green Governmentality	The course provides the disciplinary background to understand national and international climate policies and explicitly deals with the costs and benefits of various climate options, both for adaptation and mitigation, and the role of discounting.
	Ecomodernism	Technology plays an important role in shaping sustainable development. In fact, many people associate 'development' with the uptake of new technology, and have high expectations of its potential benefits in addressing poverty, diseases, and environmental degradation.
	Ecological	
	Civil Environmentalism	The course adopts a historically situated and contextual analysis. It considers major changes these systems have undergone in the past as a crucial perquisite to discussions on present and future transitions.
Micro-level (worldviews)	Mechanistic	
	Modern	The decision of the individual decision-maker depends on the interaction with and decisions made by other people. This type of decision-making can be either cooperative (a certain decision means a win situation for both actor A and actor B) or strategic (the gain of actor A is the loss of actor B and vice versa).
	Ecological	
	Postmodern	Students are expected to be able to understand how interests and power dynamics of actors in the consumption system influence consumer decisions.
	Integrative	This course focuses on the reciprocal relationships between humans and those built and natural environments that are most relevant for the environmental sciences: nature, wildlife, landscape and places, and the environment in general.

Analysis

The courses were also coded at the course level; that is, the whole course was coded as fitting one paradigm (in the cases of internal incoherence as presented in Table 3 the most frequently used code in that document was used as the course-level code). The course-level paradigms can be juxtapositioned with the educational cluster that the course guide was downloaded from. This approach has the benefit of relative neutrality: the disciplines are those categorized by the university, not by the author. However, there is also a sense of arbitrariness as an academic cluster is somewhat conceptually different from a discipline (i.e. there might be one course on climate science in a cluster on climate policy or vice versa).

The course guides all followed the same basic structure: title, prerequisite courses, course description/content, learning outcomes, activities, and assessment. To examine the internal paradigmatic coherency of the courses (research goal 1), the overlap between paradigmatic signifiers within course guides was analyzed. If there are many contradictory signifiers within course guides, it can be said that the course guides are not strongly paradigmatically embedded. The paradigmatic taxonomy presented earlier under the heading 'Paradigmatic Taxonomy' is used as a coding scheme for a deductive thematic analysis of the courses. To analyze the relationship between disciplines and normative paradigms (research goal 2), the different disciplinary sections were cross-referenced with the paradigm focus of the course guides. Lastly, the balance in focus of learning domains (research goal 3) was analyzed by categorizing the learning outcomes in the five learning domains presented above. This made it possible to see whether there is a dominant focus on one of the learning domains and if there is a relationship between normative paradigm and pedagogical strategy.

The course guides were coded in *Atlas.ti*. To ensure reliability, a small subset of ten courses was first closely read and scrutinized by authors 1 and 2. Subsequently, half of the course

guides were coded by author 1. In a second round, a sample of five course guides (different from the first ten) was co-coded with author 3. In these samples, no significant difference was found in either the text interpretation at the sentence level or the interpretation at the guide level itself. Following this, the second half of the course guides were coded by author 1.

Results

First, the co-occurrence of different paradigms within each level of description was plotted. A co-occurrence means that in one and the same course guide, conflicting paradigms from the same level were coded. As an example, at the meta level, characterized by the ecological and mechanistic paradigm, a total of 70 sentences were marked as fitting either paradigm, 48 as fitting the ecological paradigm, and 22 as fitting the mechanistic paradigm[1]. There were zero occurrences where one sentence was coded as ecological and another as mechanistic within one and the same course guide. So, the co-occurrence is zero. Thus, the co-occurrence simply shows the number of times that conflicting paradigms were presented in course guides. An example from the course guides is presented in Table 2.

The overview of paradigmatic coherence is portrayed in Table 3. There was no co-occurrence at the meta level. At the macro level, there were 11 instances of conflicting paradigms presented in one course. At the micro level, there were five instances.

Second, the paradigmatic focus of different disciplines was analyzed. Of course, not all sections offer courses on socioecological themes, so not all sections are represented in this set. Table 4 provides an overview of the paradigmatic balance in the different disciplines (number of courses coded as embedded in a certain paradigm per discipline). It shows that the social sciences focus on very different paradigms from the environmental sciences. The social sciences are more macro-level focused, with emphasis on the mechanistic macro-paradigms (green governmentalism and ecomodernism). The environmental sciences are more meta-level and ecologically focused. Animal and plant sciences focus relatively little on large-scale environmental issues.

Lastly, the learning outcomes were coded by learning domains. In total, 535 learning outcomes were coded, each related to one of the five learning domains. This analysis juxtaposes them with the paradigms to understand whether: (1) one of the learning domains is dominant in teaching environment education overall, and (2) whether the learning domains are related to the paradigms in any meaningful way.

To provide insight into the coding scheme, a coded sentence from a course guide is presented as an example in Table 5 for each learning domain. The interrelations between paradigms and learning domains are presented in Table 6 where the relative weight of the different learning

Table 3. Coding frequencies as cooccurrence at the course guide level.

Meta- level	Mechanistic		Ecological		Sum	Cooccurrence
	22		45		67	0
Macro- and Meso- levels	Green Governm.	Ecomodernism	Civil Environm.			
	64	26	73		163	11
Micro- level	Modern		Postmodern	Integrative		
	4		21	17	42	5

Table 4. Course level paradigms for each program.

	Meta- level		Macro- and Meso- levels			Micro- level		
	Mechanistic	Ecological	Green Governm.	Eco modernism	Civil Environm.	Modern	Postmodern	Integrative
Social Sciences	1	5	20	4	17	0	2	3
Environm. Sciences	8	11	4	0	9	1	3	2
Agriculture, Animal and Plant Sciences	1	1	0	3	0	0	0	0

Table 5. Learning domain and course examples.

Domain		Course example After this course students are able to…
Cognitive	Cognitive	Understand different concepts and dilemmas of sustainability transitions from policy, technological and historical perspectives
	Metacognitive	Critically reflect on the ways in which climate governance can be transformed and further developed
Affective		Have an open attitude towards the broadness of the working field, and have respect for the different disciplines and viewpoints involved
Behavioral	Psychomotor	Design a blue print for urban environmental infrastructures (energy, water, sanitation and waste) for a new city
	Social	Skills of others (both peers and role models) will be analyzed and given peer feedback

Table 6. Learning domain as embedded in paradigms.

Domain	Paradigm	Meta-level		Macro- and Meso-levels			Micro-level			
		Mechanistic	Ecological	Green Governm.	Eco modernism	Civil Environm.	Modern	Postmodern	Integrative	Sum
Cognitive	Cognitive	40	41	60	18	50	2	5	5	
	Metacognitive	11	32	41	15	43	1	8	4	376
		74%	75%	72%	75%	69%	60%	50%	47%	
Affective		1	5	2	1	9	1	3	4	26
		1%	5%	2%	2%	7%	20%	12%	21%	
Behavioral	Psychomotor	17	16	22	8	15	0	4	1	
	Social	0	4	15	2	17	1	6	5	133
		25%	20%	26%	23%	24%	20%	38%	32%	

domains can be seen in the last column. Within every column, the relative weight can be seen for each normative paradigm. So, in the first column, the mechanistic ontology, 74% of the learning outcomes were cognitively focused (either cognitive or metacognitive), 1% were affect-focused, and 25% were focused on behavioral skills. It is therefore only useful to compare the percentages below the absolute numbers, as they serve as a weighted average, to avoid base rate fallacy.

Discussion

The results are discussed in three sections, following the logic of the three foci that are the threads of this article: the internal coherence of the educational programs, the relationship between disciplines and paradigms, and the relationship between learning domains and paradigms.

The paradigmatic coherence of the program

The first table shows the overlap in paradigms within courses. That is, how often courses build on competing paradigms. At the meta level, there was no overlap between paradigms (see Table 3: 67 coded sentences, 0 co-occurrence). That means that there were no courses that built on the mechanistic and ecological paradigm simultaneously. There is some overlap between different paradigms within the macro and micro level (see Table 3: 11 and 5 sentences respectively referring to conflicting paradigms within a course). As this might be unexpected, as scientific paradigms are supposedly to an extent incommensurable, the overlap is examined in further depth. This 'incoherence' is explored on both levels.

For the overlap at the macro level, the main overlap stems from two courses (for clarity, here referred to as ML1 and ML2). ML1 states that: 'the course is organized around grand consumption

trends of our times like the protein transition, one-planet or low-emission lifestyles, consumer responsibility, and minimizing disposal of both food and packaging. These trends are being explored collaboratively with lecturers from different scientific perspectives.' The multidisciplinary nature of this course makes it an interesting exception to the general trend of courses that are firmly embedded within one paradigm. The different paradigms that this multidisciplinarity fosters might be expected to challenge students to switch between different modes of understanding the world; a skill that is highly valuable for environmental challenges (Horn et al. 2024). The course is very multifocal and multidisciplinary and in this aspect an outlier in the set.

ML2 is a course with high overlap that 'centers on the trend in climate governance that is gradually moving from predominantly state-driven negotiations and hierarchical governance instruments to a type of climate governance characterized by diversity and fragmentation.' This is interesting, as it is an active reflection on the paradigmatic shift in policy sciences as recognized in the literature used for the theoretical framework. As Bäckstrand and Lövbrand (2019) note: 'Even though the administrative rationalism of green governmentality was severely challenged [… it] is now effectively combined with the ecomodernist promise of the low carbon society where governments, business and civil society govern in partnership' (p. 3). Therefore, this overlap is possible in theory and pedagogical practice as the two paradigms are embedded in a similar meta paradigm.

The overlap in anthropological outlooks stems from the same course as the first course discussed in the paradigmatic overlap at the macro level (ML1). Again, it is likely that the strong multifocal and multidisciplinary outlook of this course underlies the multiparadigmatic outlook. The other course (ML3, for clarity) is a course in communication. ML3 also explicitly describes its multiparadigmatic outlook, stating that: 'This course focuses on persuasive communication in various contexts and in relation to consumer communication for sustainability as a present-day problem context in science and society. Processes underlying persuasion and influence will be studied from a communication sciences perspective and related fields.' The overlap possibly stems from the different fields in which this course is embedded. A further analysis of paradigmatic dominance in different disciplines is the second part of this analysis. The paradigmatic taxonomy that is constructed in the theoretical framework of this article has strong applicability when it comes to meta- and macro-levels of description in categorizing the paradigms in which course guides are embedded. The micro level of description is simply not as prevalent in the course selection in this article.

Disciplines and their paradigmatic embedding

As one might expect, different scientific disciplines focus on different levels of description in their course guides. At the *meta level*, the focus is predominantly on education in the ecological paradigm, especially in the environmental sciences. The embedding in the paradigm is made more explicit in courses in the ecological paradigm than in courses in the mechanistic paradigm. This disbalance is represented in the sentence-level coding, where the ecological level is more prevalent than in the course-level coding. Thus, the mechanistic paradigm is more tacitly conveyed than the ecological, whose paradigmatic premises are made more explicit in the course guides. This fits the observation made by Du Plessis and Brandon (2015, 5), which is that the ecological paradigm is emerging, and contrasted with the mechanistic paradigm, where the latter is still understood as the conventional paradigm.

At the *macro level*, there is a strong contrast between the environmental and the social sciences. The environmental disciplines mainly have courses at the meta level, while the economic and policy disciplines focus mainly on the macro level. Furthermore, the social sciences courses focus very strongly on the green-governmental level (20 courses), compared to the environmental sciences (four courses). The strong contrast in paradigmatic positioning between the environmental sciences and the social sciences at the macro level shows a highly different

approach between the two fields. The strong disconnect in paradigmatic focus between the two disciplines can hardly foster strong communication and interdisciplinarity, as the theoretical premises are vastly different. Empirically, this is in line with the important work of Boon and van Baalen (2019), who theoretically explored the dimensions of paradigmatic differences between disciplines as an important challenge to interdisciplinary work.

Lastly, there are few courses that focus explicitly on the *micro level* of description. As stated above, it could be argued that a certain micro-level anthropological outlook is implicit in the macro-level paradigms, but the lack of explicit focus is interesting. As the selected university is a technical university, this could be an outlier in disciplinary outlook. However, the micro-level paradigms are coded at the sentence level more often than at the course level. The fact that they are coded but overcompensated by other coding at the course level might suggest that the modern anthropology is implicit in other paradigms while not being an explicit presumption itself, at least in higher education outside the humanities.

Disciplinary silos are to be avoided in environmental education, where alignment between the societal and the environmental is necessary (Gilbertson, Craft, and Potter 2019). Different programs build from different paradigms, which frustrates collaboration and interdisciplinarity. Environmental problems, however, are not tackled by different disciplines working in parallel within their own domain. It is therefore necessary that students are familiarized with a wide set of perspectives at different levels of description, to foster alignment thinking between the societal and the environmental.

Learning domains and paradigms

As is clear from the ratios between the different learning domains (Table 6*)*, the teaching of environmental problems is strongly cognitively centered, with the least focus on the affective domain. The cognitive domain enjoys as much attention as the affective and behavioral domains combined and doubled. With the exception of the integrative paradigm, the pedagogical focus in each paradigm is heavily biased toward cognitive learning. However, so few courses in the case study focus specifically on modern anthropology that assigning percentages to the learning domains does not provide a very informative picture.

The meta paradigms do not differ strongly, in the sense that in both paradigms the main outlook is cognitive. Roughly three quarters of the learning domains focus on either cognitive or metacognitive learning. This might be expected for the mechanistic paradigm, as the ontological level is concerned with highly abstract conceptualizations of nature that are conceptually outside the realm of more 'inner world' concepts that the affective domain relies on. This is especially the case for the mechanistic ontology that, by definition, excludes the human from the domain of the living environment.

The logic from the meta level roughly translates to the macro level, where the two paradigms embedded in mechanistic thinking (the green-governmental and ecomodernist paradigms) also focus less on the affective domain (both 2% of the learning outcomes) than the civic-environmentalist paradigm (9% of the learning outcomes), which is grounded in the ecological paradigm. A possible explanation for the remaining cognitive focus on the ecological macro level is that while the ontology of the ecological sciences might be more holistic and relational, the scientific practices are still often strongly positivistic and dogmatic in the higher education context (Korfiatis 2005). Furthermore, higher education itself is strongly cognitive-heavy, also when it comes to environmental education (Dillon and Scott 2002; Yanniris 2021). As such, the relatively stronger focus of courses on the ecological paradigms compared to the mechanistic paradigms might be indicative of an affective tendency against a cognitive current.

An interesting exception to the rule of cognitive bias is the integrative anthropological paradigm, where cognitive, affective, and behavioral are better balanced. This exception could relate to the characteristics of the paradigm. As De Witt et al. (2016) notes, this anthropological outlook

is concerned with transcending the inner/outer world divide and focuses on holism between inner values (affective) and understanding of the world (cognitive). Furthermore, it is an anthropology that is specifically relational, which might explain the increased focus on social skills education. However, few courses clearly fitted this paradigm, suggesting that there is a minority educational countermovement to cognitive-heavy pedagogy in higher environmental education.

The cognitive focus of the programs is not in line with the multimodal learning model recommended in the environmental education literature and UN report on education for sustainable development. A pedagogy targeting not only the 'head' (cognition) but also the 'heart' (affect) and 'hands' (behavior) is a pathway to a more holistic education, in line with competences for environmental awareness and reflexivity (Sipos, Battisti, and Grimm 2008; Singleton 2015). The cognitive aspect is important in this regard, but responsiveness to environmental problems has an important affective and behavioral dimension that is not cultivated in current programs.

Conclusion

This article discusses the research question: how are theoretical normative paradigms about environmental problems reflected in university programs? It does this by examining 97 course guides on environmental problems. The goals of this exploratory research are to: (1) map the internal paradigmatic coherency of the courses, (2) map the extent to which certain paradigms are dominant in certain programs, and (3) map the link between paradigms and learning domains (or the 'how' to the 'what' of teaching).

The course guides are overall highly paradigmatically coherent; the exceptions came from courses that were explicitly multidisciplinary. This means that the paradigmatic consistency is high, and therefore that the taxonomy is a good means to make normative paradigms explicit.

There is a strong difference in paradigmatic outlook between the social sciences and the environmental sciences. The different models through which these disciplines understand the world might partly explain the radically different understanding of climate and environmental risk between economists and climate scientists (see for instance Büller 2022). While the green-governmentalism paradigm can be seen as hegemonic in the economic and policy sciences (in line with the work of Bäckstrand and Lövbrand (2019), discussed in the theoretical framework), this is not the case in the environmental sciences. Furthermore, the ecomodernist paradigm is not dominant at the course level at all. This can be a manner of coding choices, the paradigms not being sufficiently different to count as conflicting paradigms, or because ecomodernism is not a prevalent paradigm at the university studied.

Paradigms are not just ways of representing reality; they are part of the reality itself. In other words, our understanding of the world is a part of the world. As argued in the introduction, how we understand problems shapes our understanding of the solutions. This is what is meant by having to learn the parts to understand the whole. If students are insufficiently capable of understanding the different premises that build up different paradigms, they cannot fully appreciate how these paradigms shape environmental scientific practices and policy. Educators and course designers might therefore use this taxonomy to be explicit about their paradigmatic premises. For instance, the course material can be positioned explicitly with regard to a certain paradigm in the course guide itself at the course level. Further, in designing educational tracks, educators might use a paradigmatic taxonomy such as that provided in Table 1 to compare the weight given to any particular paradigmatic outlook.

There is a recognition in the intersecting field of educational science and philosophy that highly technical discourse, of which the mechanistic discourse is an example, can lead to reductionism in educational practice. This reductionism encompasses a strong focus on quantifiable skills, which are more often cognitive and behavioristic than affective (Wrigley 2019). Reductionistic educational content translates to reductionism in educational practices such as teaching and testing. This cognitive-heavy approach is less expected, however, in courses in

the ecological paradigm, which are supposedly more focused on holism and the intricate links between society and the living environment. Scholars advocating the more ecological approach do so not only in terms of content but also in terms of teaching methods (MacQuarrie and Smith 2009). This link between content and pedagogy is seen in the bigger focus on affective learning, but less so than might be expected in courses taught within this paradigm. Furthermore, this analysis shows the importance of reflecting consciously on learning outcomes, which are currently strongly cognitively biased. True comprehensive education requires a balance in the focus on different learning domains. The link between content and pedagogy thus requires educators to be mindful of diversifying both the learning goals and the modalities, to ensure constructive alignment between the diversity of the educational goals and the learning domains.

This study is explorative in nature. The courses were selected on titles including concepts representative of a broader field of study. Nonetheless, no selection is neutral, especially no qualitative analysis. Courses on for instance ecology and sustainable development were not included. Ecology is a field very much related to the living environment, though not specifically to its relation with human society. Conversely, sustainable development includes topics that go beyond strict environmental themes, such as economic inequality. Different fields have different normative presumptions underlying their paradigms. This article does not include non-human animals and humans' relationship to them, for example, even though this does have an important role in normative debates in ecology. A larger set of courses could improve the scope of this article. Furthermore, a longitudinal study could provide important insight into the development of paradigms in higher education, possibly foreseeing future curricular developments. Finally, this study focused on a specific university centered around the living environment as an important building block in its programs. However, an inter-university study might enhance the applicability of the taxonomy and provide a more complete overview of the normative paradigms on environmental problems in education.

Lastly, course guides are very informative as an empirical ground for analyzing the intended curriculum. That is the step in the educational process centered around what an educational institution aims to convey to its students (Akker 2004). However, the implemented curriculum (what is taught) and the attained curriculum (what is learned) might differ from the intended curriculum. To analyze these steps in the educational process, other methodologies are more fitting than a thematic content analysis. Further research on these educational steps can increase and deepen the insight into trends in environmental education. This article also argues that different paradigms are discursively coherent, meaning that a meta-level paradigm implies a macro-level paradigm, which in turn implies a micro-level paradigm. However, this relation is not as strong as logically necessary, and therefore a more empirical relationship between this vertical level of the taxonomy would provide more transparency on the extent to which the discursive relationship is reflected in the empirical world of academic practice.

Note

1. This might imply a certain balance in the focus between these two paradigms, but this absolute numbers approach might not give an accurate representation.

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