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UNFOLDING NARRATIVITY: TOWARDS A BALANCE BETWEEN NARRATIVE
AND PARADIGMATIC THINKING FOR CLIMATE CHANGE EDUCATION

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Abstract

Climate Change demands that science education evolves beyond the transmission of concepts to foster deeper forms of reasoning, imagination, and ethical engagement. Yet, within Climate Change Education (CCE), a persistent tension remains between the data-driven analytical precision of scientific reasoning and the interpretative, meaning-making ways through which learners relate knowledge to experience. This thesis addresses this tension by exploring how narrative, conceived not as a communication device but as a form of reasoning, can expand the scope of traditional science education. Building on Bruner's distinction between narrative and logico-scientific mode of thinking, the research develops the Narrativity Pyramid, a theoretical-operative construct that employs the notion of narrativity as a graded feature to identify layers/clusters of narrative elements that touch key educational dimensions of CCE. Each layer represents a site where the two ways of reasoning can confront and contaminate each other in productive ways, the pyramid thus functions both as an analytical lens and as a design scaffold through which the dialogue between abstraction and experience can become visible and implementable.

The study adopted a Design-Based Research (DBR)-inspired methodology in three phases. The first phase established the theoretical grounds of the first Narrativity Pyramid. The second phase focused on how to translate this model into educational design, through the FyouTURES activity. The third phase—the school-based course— tested narrativity as an explicit scaffold for CCE. The two interventions also offered crucial insights for the refinement of the narrativity model itself.

The findings reveal that narrative and paradigmatic are entangled dimensions of cognition whose interplay can foster sensemaking and agency. Specifically, this research contributes (i) a theoretical model conceptualising narrativity as a bridge between the two ways of thinking, (ii) design principles for learning environments that render such bridge operative, and (iii) empirical evidence of the educational impact on students.

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Introduction

This thesis will begin with a story. Such a choice is hardly surprising, given that the research presented here revolves around the educational role of narratives in the context of Climate Change Education (CCE). The story tells about how a hypothesis was born and how it evolved through time and contingencies. That hypothesis was that narrative may function not merely as a tool to transmit scientific content, but as a way of thinking: one that is capable of rendering Climate Change (CC) complexities and uncertainties meaningful and of opening imaginative and ethical space for sensemaking and action. After this story, a more structured account of the research rationale will follow. This “two-part” introduction is not just a stylistic device but a reflection of the very epistemological tension that underlies this thesis. As will become clearer in the chapters that follow, this work rests upon a continuous dialogue between two “modes of knowing” (Bruner, 1986): the narrative mode, which embraces temporality, contingency, and the singularity of lived experience; and the paradigmatic mode, which seeks coherence, structure, and generality. This introduction, therefore, mirrors this duality, being composed of two distinct but interconnected paragraphs: “*The story of this journey*” provides a chronological and situated account of how the research problem developed, while “*The research project structure*” offers a more systematic overview of its conceptual and methodological architecture. The narrative mode comes first, not to privilege it, but to acknowledge the path-dependent, human and contingent nature of this research endeavor. The hope is that by listening to the story, the reader will later grasp the necessity of that structure.

In the pages that follow, several concepts will recur as key coordinates in this dialogue. Narrative is understood here as a cognitive construct, capable of complementing logic-scientific reasoning and expanding the scope of CCE (Bruner, 1986; Bruner, 1990; Herman, 2009; Fletcher, 2023). This conceptual foundation is reinforced by insights from communication and cultural studies, which have shown how narratives shape public discourse and engagement (Carvalho & Burgess, 2005; Boykoff, 2008; Moser, 2010; Bushell et al., 2017; Constantino & Weber, 2021), and by educational approaches that leverage storytelling as a mode of worldmaking and meaning-making (Solomon, 2002; Wang & Marsh, 2002; Green & Brock, 2000; Gottschall, 2012; Joubert et al., 2019). I will use the terms *storyline* and *scenario*, in the meaning assigned to them by climate *science*, denoting qualitative–quantitative hybrids that render complex futures intelligible (O’Neill et al., 2017; Shepherd & Lloyd, 2021), echoing broader reflections on how narratives mediate complexity (Walsh & Stepney, 2018; Veland et al., 2018; Hulme, 2009). The notion of *narrativity* will be employed to capture the graded presence of narrative features in argumentations and artefacts (Ryan, 2005; Norris et al., 2005), providing the basis for the *Narrativity Pyramid* designed during my PhD. The co-related Fconcepts of *sensemaking* and *agency* are connected to theoretical positions such as those exemplified by Kurtz (2014), BengtTasquer & Pongiglione (2017) and Bengtsson et al. (2020) but that does not imply the adoption of rigid or formalized theoretical frameworks; rather, these terms are used in a broader sense to describe a set of related phenomena. In other words, they serve as descriptive categories to contextualize and describe how learners interpret complex knowledge, position themselves

within it (Levrini et al., 2021; Barelli et al., 2022; Tasquier et al., 2025; Polkinghorne, 1988) and recognize themselves as legitimate actors capable of deliberation and transformation.

The story of this journey

At the beginning there was not a well-defined research problem, but a discomfort and an intuition. They emerged quietly, like a low hum at the edge of comprehension, during the final year of my master's degree. At that time, I was developing my master thesis within the FEDORA project¹ (*Future-oriented Science Education to enhance Responsibility and Engagement*), which was investigating how science education could respond to the increasing “misalignments” between scientific knowledge, educational practices, and the languages and imaginaries of contemporary society. Immersed in an environment where researchers were experimenting with *new languages and narratives* as mediators between science and culture (Troncoso et al., 2023), I explored the use of mockumentary in CCE—a hybrid genre that combines the codes of documentary filmmaking with the imaginative freedom of fiction (Roscoe & Hight, 2001). The intuition that had driven this work lies in the fact that traditional styles of education and communication seemed insufficient to represent the complexity, temporality, and emotional charge of the Climate crisis. Among the theoretical sources that informed the broader FEDORA project was Amitav Ghosh's *The Great Derangement* (2016), where he had described the modern novel's inadequacy in narrating CC (Ghosh, 2016). This idea deeply resonated with me and led me to wonder: if the novel falters, could different, more hybrid forms of storytelling, offer an alternative? Could they enable students to imagine the future without relinquishing their grasp on the real?

Drawing on my personal educational and professional background in science communication and insights from that same research field (e.g. Schmidt, 2009; Nadkarni et al., 2024; Druckman et al., 2025), I proposed to experiment with the mockumentary as a hybrid genre combining documentary aesthetics with fictionalisation. The resulting activity, “Mocku for Change” (D'Orto, 2022), explored how students might exploit this format to convey complex CC issues and produce more engaging and emotionally resonant expressions than traditional educational or academic outputs. At that stage, as I realized later on, my attention was too much focused on the final artefacts produced by students. Part of that was imposed by the fact that the activity had been conducted remotely, in the midst of the COVID-19 pandemic, thus offering limited opportunities to observe the creative process itself. Nevertheless, the experience proved generative and allowed me to explore the coexistence of imagination and realism and to begin identifying the specific educational affordances of mockumentary aesthetics for CCE (D'Orto, 2022; De Zuani et al., 2023). However, I recognised that something in my investigation was missing, not only because the creative process remained largely unobserved, but because the activity was embedded within a

¹ FEDORA - Future-oriented Science EDucation to enhance Responsibility and engagement in the society of Acceleration and uncertainty” (GRANT AGREEMENT No. 872841, September 2020 – August 2023). PI: Olivia Levrini, University of Bologna (www.fedora-project.eu).

pre-existing course that provided extensive conceptual preparation and scaffolding, which did not allow me to isolate the specific contribution of the mockumentary language itself.

Some months after the end of my Master degree, I had the opportunity to redesign and implement a new version of the “Mocku for Change”, this time in person and as an independent activity. This experience was where the question that would have eventually carried me through my PhD began to take form. The implementation took place within the ONSCI² (“Officina di narrazione della scienza”) workshop, an interdisciplinary initiative of the Department of Physics and Astronomy of the University of Bologna that promotes critical public engagement with science through creative and participatory narrative approaches. My activity was part of the set of activities situated within “Workshop 2” organized by the Bologna’s FEDORA network and aimed at reflecting on the role of knowledge as a source of competences to orient us in the complexity of the contemporary world. Unlike the previous experiment, this time during the activity I could observe the process, listen to the discussions, and witness the dilemmas of the participants. It was a turning point. I realised that the most interesting phenomena were not caught by the final videos, they were happening in the conversations that preceded them: the metaphors students used to discuss with each other, the analogies they drew, the info they searched for, the tensions they negotiated, the characters, settings and events they explored and the reasons that brought them to choose specific ones. Narrative was no longer just a container or an output; it was the form through which thinking unfolded. This was a moment of epistemic rupture. I began to understand that narrative might function not only as a representational form, but as a cognitive and relational environment—a space in which students could inhabit complex problems, rather than merely describe them.

All these preliminary studies—my master thesis as well as the laboratories carried out within the ONSCI context—represented for me a research prelude helping to formulate the embryonic research question that would guide the early stages of my doctoral work: *If scientific reasoning were coupled with the kind of reasoning enabled by narrative forms, could learners develop a different way of thinking about CC?* Other questions followed quickly, knotting themselves around the first. What about other narrative genres? Was it mockumentary alone or narrative in general able to open such a space for thinking? How can we define narratives for CCE? Do CC science needs/uses narratives? If narrative is not just a form but was indeed a way of thinking, what kind of thinking was it? How did it differ from the kind of reasoning typically encouraged in science and science education?

The first step in my doctoral journey was an attempt to bring order to a constellation of questions. I turned to the literature with the aim of mapping a terrain that, at the time, appeared both vast and fragmented. Months of exploration across diverse disciplinary landscapes followed, yet one reference quickly emerged as foundational and soon became the cornerstone of my research: *Actual Minds, Possible Worlds* by educational psychologist Jerome Bruner (1986). Bruner’s theory of the two modes of thinking says that there are or we can say two natural ways human use to make sense of the world: the **paradigmatic**,

² <https://site.unibo.it/officina-di-narrazione-della-scienza/it>;
<https://site.unibo.it/officina-di-narrazione-della-scienza/it/principi-e-obiettivi-2023>

which seeks to explain the world through logic, abstraction, and general laws (reasoning typical of sciences); and the **narrative**, which organises experience through stories, focusing on meaning, intention, and human particularity. They are complementary and irreducible to one another: “efforts to reduce one mode to the other or to ignore one at the expense of the other inevitably fail to capture the rich ways in which people “know” and “describe” events around them”. Bruner’s idea of complementarity hinted how integrating narrative thinking could expand, rather than weaken, reasoning for CCE. This insight, however, was not a ready-made solution. On the contrary, it raised an apparent paradox. If the two modes are irreducible to one another—having distinct aims and values—why are narratives embedded at the very heart of climate science? Climate scenarios such as the Shared Socioeconomic Pathways (O’Neill et al., 2017) or the storylines (Shepherd & Lloyd, 2021) are explicitly described as “narratives,” even though they are scientific tools designed to make complex futures intelligible, to frame uncertainty, and to support interdisciplinary work. This seemed to challenge Bruner’s strong claim of irreducibility: if paradigmatic and narrative thinking belong to separate epistemic domains, how can scientists legitimately use narrative artefacts as part of their research? Were climate scientists misusing the word “narrative,” or did Bruner’s theory itself need reinterpretation?

Searching for a way forward, I encountered the notion of *narrativity* in Bevan et al. (2020): a gradient feature suggesting that texts and artefacts can incorporate narrative elements to different degrees, without being fully narrative in a literary sense. The idea that “being a narrative” is not a fixed property, but a gradient feature offered a turning point by helping me move beyond the dichotomy between narrative and scientific reasoning. It suggested that narrativity could operate within scientific thought itself, offering coherence and direction to processes that unfold over time. Before building on Ryan (2005) and Norris et al. (2005) detailed frameworks I initially focused on the triad—*Action*, *Temporality*, and *Causality* (Bevan et al., 2020; Miskimmon et al., 2017)—as the key components of narrativity and to attempt to draw a line between what was or was not a narrative.

Gradually, these reflections coalesced into the first version of the Narrativity Pyramid, a heuristic model designed to trace different degrees of narrativity across educational artefacts. At this stage, the model was mostly a conceptual map, yet as I worked with it, narrativity began to reveal itself as the central conceptual thread of my doctoral research, a unifying idea through which I could connect theoretical reasoning, design practice, and empirical observation.

The first opportunity to bring this model into practice came through the narrative-enhanced redesign of the *FyouTURES* board game, a collaborative activity in science education developed within my Research Group at the University of Bologna³. The original activity invited participants to explore climate policies through the EN-ROADS simulator (<https://www.climateinteractive.org/en-roads/>), optimising parameters and observing quantitative trajectories. By integrating narrative prompts, I invited participants to interpret the outputs as fragments of a shared storyline, connecting quantitative results to human and

³<https://physics-astronomy.unibo.it/en/research/research-areas/physics-education-and-history-of-physics>

ethical dimensions. This redesign represented my first deliberate attempt to use narrativity not merely as a communication aid but as a scaffolding mechanism for meaning-making—an intuition that would later guide the whole doctoral trajectory.

This design phase unfolded within the broader framework of the Climademy⁴ (CLIMAtE change teachers' acaDEMY) project, an Erasmus+ initiative coordinated by the University of Crete and involving partners from Finland, Germany, Greece, and Italy. Climademy aimed to create a European network for teacher education on CC, promoting inquiry-based and competence-oriented pedagogies. For my research, it represented both a theoretical anchor and a practical testing ground. The project's systemic and competence-based vision of CCE resonated with my research questions, providing the conceptual scaffolding to situate narrativity within a larger educational paradigm. At the same time, its collaborative and international network offered the opportunity to translate these ideas into concrete educational experiences.

The first implementation of the narrative-enhanced FyouTURES activity took place during a Climademy Summer School⁵ (Miani et al, 2025), which gathered teachers from across Europe to experiment with innovative pedagogies. The new design suggested that narrative prompts may help reframe scientific reasoning into a more reflective and value-laden process. More specifically, the activity showed: the potential of narrative thinking to interpret and/or explore the “gaps” of data; the presence and coexistence of two cognitive landscapes in students thinking, echoing Bruner's (1991) distinction between the landscape of action and the landscape of consciousness; and the capacity of narrative framing to activate collective foresight. For me, this experience clarified that narrativity might serve not only to communicate complex ideas but to think through them, weaving connections between analysis and imagination.

Encouraged by the reflections emerging from these early phases with adult participants, I felt the need to explore how these processes would unfold with younger learners. The following year, I carried out two new implementations with upper-secondary students: a slightly revisitation of the “Mocku for Change” activity and a second implementation of FyouTURES. These experiences represented a shift in focus—from the reflective stance of teachers to the exploratory reasoning of adolescents—allowing me to observe how narrativity could scaffold learning across different levels of expertise and engagement.

From these explorations, the second version of the Narrativity Pyramid gradually took shape (D'Orto & Tasquier, 2025a). Rather than a fixed model, it became a dynamic structure informed by practice: each layer representing not only a degree of narrativity but a more complex layer of thinking opening new educational opportunities for CCE. The framework now ranged from basic world-making to the formation of complete narrative structures and genres, each associated with distinct cognitive and educational affordances.

⁴ Climademy – “Climate change teacher academy” (Project ID: 101056066, June 2026 - May 2025). PI: Maria Kanakidou, University of Crete (www.climademy.eu).

⁵<https://www.fondazioneegolinelli.it/percorsi-di-formazione/climademy-international-summer-school-the-human-side-of-data-teaching-climate-change-through-a-steam-approach>

The final and most comprehensive phase of this trajectory was the school-based implementation at the Rosa-Luxemburg Institute, involving two full upper-secondary classes. The course was designed as a progressive journey through the layers of the second Narrativity Pyramid, guiding students from abstract scientific models toward the creation of contextual worlds, causal chains of transformation, and eventually genre-specific stories about future climate societies. The analysis of a broader and more diverse set of data revealed the complexity of the interplay between narrative and paradigmatic reasoning, showing how the two modes are not simply distinct or sequential but deeply entangled within both individual and collective cognitive processes. Their interaction appeared fluid and at times conflictual—oscillating between abstraction and embodiment, logic and imagination, explanation and interpretation. Yet, rather than undermining learning, this tension emerged as a productive space of negotiation where meaning was continuously redefined. Within this intricate dynamic, narrative scaffolding proved to offer valuable opportunities to illuminate and mediate the points at which the two modes of reasoning could fruitfully converge. In other words, the Narrativity Pyramid proved as a valuable structure through which the dialogue between the two modes could become more visible and productive—capable of sustaining both sense-making and a growing sense of collective agency.

Looking back, I recognise that each of these phases contributed to refining not only my models but also my own way of thinking about CCE. What began as an exploration of how students tell stories about climate evolved into a broader inquiry into how they think through stories. This trajectory unfolded within the fertile environments provided by European projects such as FEDORA and Climademy, which offered the conceptual and collaborative frameworks through which these reflections could mature.

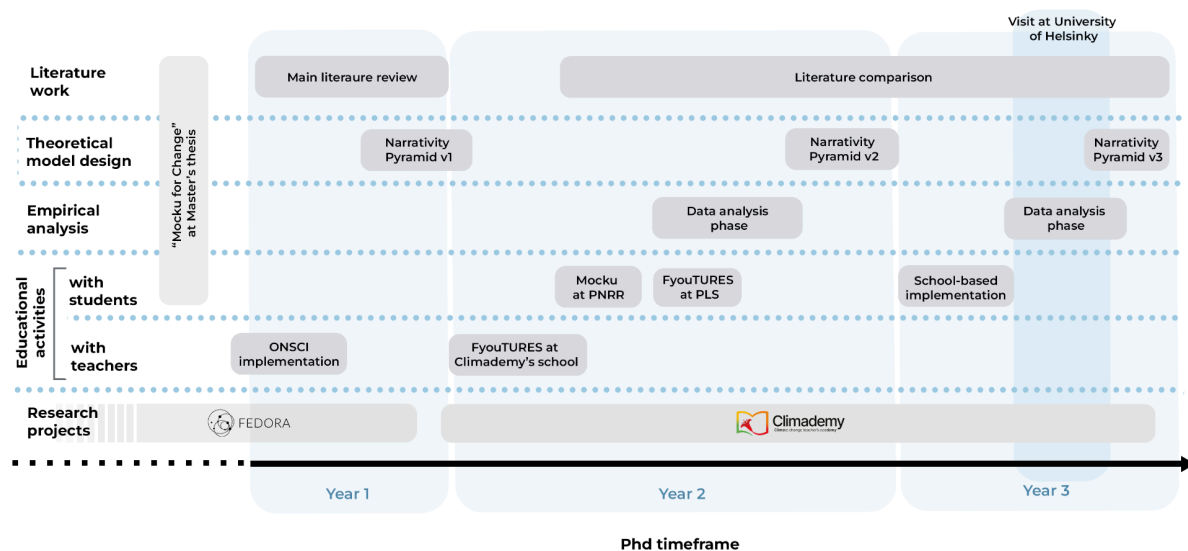


Figure 1.1 *Chronological overview of the PhD research journey.* The figure illustrates the chronological order of the main stages of the PhD research. The relative size of each box is not indicative of the actual duration of each stage, but only reflects its correct temporal order. The labels on the left indicate the nature of the corresponding research activity (e.g., theoretical exploration, model design, empirical analysis) and the row at the bottom situates the work within the broader frameworks of the FEDORA and Climademy projects.

The research project structure

While the previous section narrated the contingent evolution of this research, the following pages present its formal architecture — the conceptual scaffolding, methodological logic, and structure through which that trajectory was translated into a coherent research programme.

The central research problem addressed in this work can be formulated as follows:

GQ) How can narrative thinking be conceptualised and operationalised in dialogue with the paradigmatic way of thinking, so as to function as an educational and epistemic resource for CCE?

As shown in the following diagram (Figure 1.2), this general question emerged from my Master's thesis work and from a preliminary research stage, which I referred to as the "prelude phase".

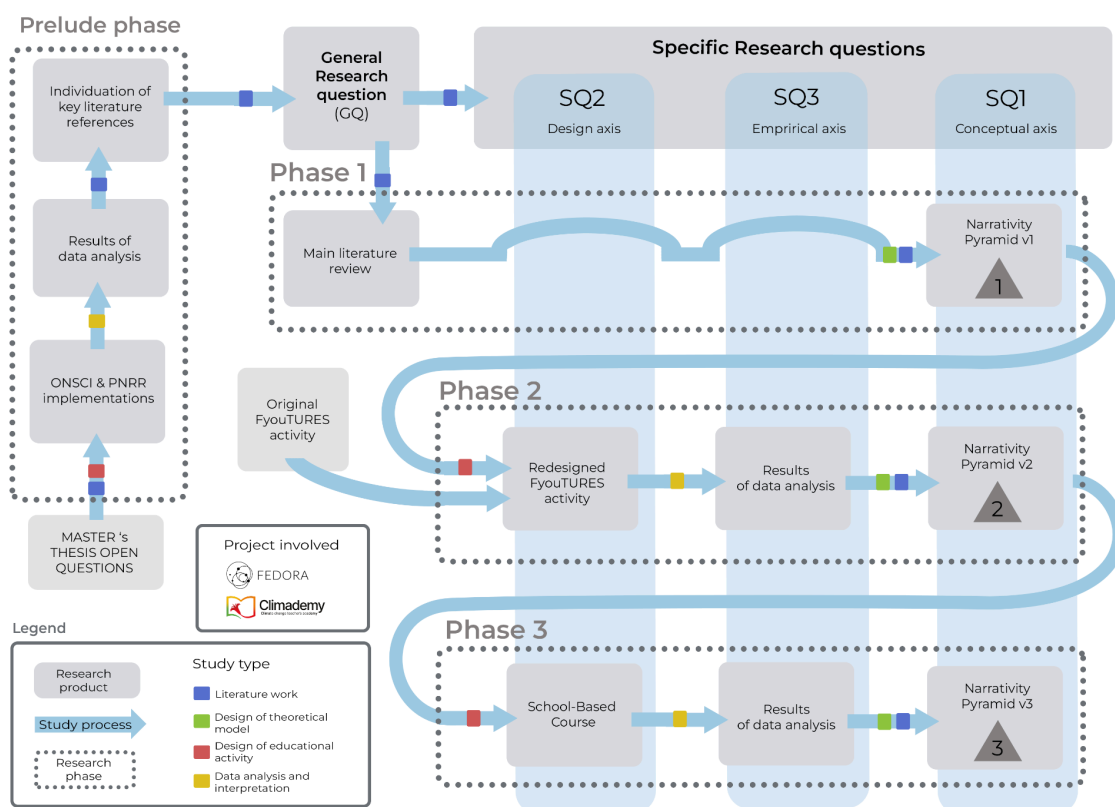


Figure 1.2 *Diagram illustrating the PhD research structure.* The figure shows the overall workflow of the doctoral project, organised into a Prelude phase derived from the master's thesis open questions, which led to the definition of a general research question. It then illustrates how this was subsequently articulated into three specific research questions (SQ1–SQ3) and three sequential research phases (Phase 1–3) addressing them. The diagram also highlights iterative feedback loops between phases and study types, with the progressive integration of literature work, theoretical model design, educational activity design, and data analysis, as indicated in the legend.

The general research question has been conceptually grounded in the theoretical frameworks developed within two major European projects, FEDORA and Climademy, which provided respectively the initial conceptual foundation and the subsequent international testing environment. Although their broader descriptions were presented in the previous section, they are relevant here insofar as they shaped the methodological and institutional scaffolding of the study.

Within these European frameworks, my research evolved in close dialogue with broader efforts to build a shared educational culture around climate literacy, in which science education is conceived as a cultural and epistemic enterprise engaging multiple ways of knowing and imagining the future. From this standpoint, it becomes evident that the epistemological challenge facing CCE is not only what knowledge to transmit, but how it is conceptualised, communicated, and inhabited. Traditional approaches to science communication and education—often transmissive and top-down—are rooted in the so-called “deficit model”, which assumes that providing more information will automatically lead to more informed and rational behaviour (Schmidt, 2009; Simis et al., 2016; Nadkarni et al., 2019). Yet decades of research in science communication and environmental psychology have shown that this model fails to foster genuine engagement or pro-environmental behaviour, since knowledge alone rarely translates into action (Schmidt, 2009; Moser, 2010; Baldwin et al., 2023).

In response to these limitations, more recent approaches within science education have shifted their focus from knowledge transmission to knowledge construction, seeking to cultivate scientific thinking skills such as inquiry, modelling, systems reasoning, and epistemic agency (Duschl, 2008; Levrini et al., 2021; Covitt & Anderson, 2022). These approaches are indispensable for promoting rigour, coherence, and systematic understanding. However, as several authors have argued (Hadzigeorgiou, 2016; Avraamidou & Osborne, 2009; Bushell et al., 2017; Hulme, 2009), even the most sophisticated forms of scientific reasoning remain insufficient to engage learners with the ethical, temporal, and emotional dimensions of the climate crisis.

This recognition points to the need for a broader educational framework—one that integrates rather than replaces scientific reasoning. Climate-related issues, by their very nature, demand forms of thought capable of combining analytical abstraction with personal and collective interpretation. Consequently, this thesis builds on the idea that addressing the challenges of CCE requires not only moving beyond transmissive models of scientific knowledge, but also bridging different ways of thinking. Scientific reasoning offers the analytical and systemic structures needed to understand complexity, yet it must be complemented by modes of reasoning that connect abstraction with imagination, and analysis with interpretation (Bruner, 1986; Fletcher, 2023).

Narrative thinking provides one such complementary mode. It allows individuals to link facts to values, to situate data within lived contexts, and to explore possible futures through symbolic, affective, and ethical reasoning (Dahlstrom, 2014; Veland et al., 2018; D’Orto & Tasquier, 2025a). In this sense, narrative becomes not merely a representational tool but a cognitive and epistemic resource that mediates between understanding and

meaning-making (Bruner, 1990; Norris et al., 2005; Herman, 2009). The dialogue between paradigmatic and narrative modes of thought therefore constitutes both the conceptual core of this research and its educational horizon: cultivating the capacity to think scientifically and to imagine responsibly. By exploring this dialogue, the thesis aligns with the broader vision of projects such as FEDORA and Climademy, contributing to the re-alignment of scientific knowledge with the cultural, ethical, and imaginative dimensions of human understanding.

On the basis of this theoretical and educational framework, the study was designed as a progressive investigation into how the dialogue between narrative and paradigmatic thinking can be conceptualised, enacted, and evaluated. This trajectory was articulated into three main research subquestions, each corresponding to a distinct but interconnected phase of the inquiry.

SQ1) *How can the relationship between narrative and scientific reasoning be explored and clarified, in order to understand how the two modes of thought can interact within CCE?*

The first sub-question defines the **conceptual axis** of the research. It investigates how narrative and paradigmatic reasoning have been related across disciplines, with the aim of building a theoretical language capable of articulating their coexistence and complementarity as forms of knowledge construction. This inquiry guided the design of the first Narrativity Pyramid and its subsequent re-designs, which progressively evolved as mediating constructs between abstraction and educational practice.

SQ2) How can narrativity (conceived as a layered structure bridging narrative and paradigmatic reasoning) be translated into the design and implementation of learning environments that foster integration between the two modes of thought within CCE?

Building on the insights of SQ1, the second sub-question represents the **design axis** of the inquiry. It explores how the conceptual framework of narrativity can be operationalised in educational contexts, guiding the design of learning environments.

SQ3) To what extent and in what ways can a narrativity-based course influence students' learning experiences in the context of CCE?

The third sub-question defines the **empirical axis** of the study. It focuses on evaluating and observing the educational effects of narrative-based designs, analysing how students' learning experiences (such as reasoning, interpretative processes, emotions and/or perceptions of agency) evolve through the explicit integration of narrative and paradigmatic forms of thought, and eventually feeding back into the refinement of the theoretical model.

Together, these three sub-questions form an iterative research architecture in which conceptual elaboration, educational design, and empirical observation continually inform one another. Each of them was further operationalised into specific and more detailed questions (e.g. SQ1a, SQ1b, SQ2a...), which are presented and mapped to the corresponding phases in Chapter 2 (see Section 2.2).

The methodological structure of the study was grounded in a Design-Based Research (DBR)-inspired approach: the study unfolded through iterative cycles of design,

implementation, and analysis, in which the theoretical construct of the Narrativity Pyramid was progressively refined through its enactment in classroom activities. Inspired by Cobb and colleagues (2003), as well as McKenney & Reeves (2013) and Plomp (2008), the design artefacts developed in this research were treated as embodied hypotheses about how students might engage with CC knowledge, serving both practical and theoretical purposes.

While sharing DBR's iterative and interventionist orientation, the primary goal was not to document learning processes per se, but to use empirical cycles as testing grounds for a theoretical construct—that of narrative thinking as a bridge between paradigmatic and interpretive reasoning. Within this framework, the Narrativity Pyramid emerged progressively rather than being pre-defined, functioning as both a conceptual scaffold and a design hypothesis.

This approach unfolded through four complementary **study types**, each reflecting a different mode of inquiry and contributing to the overall coherence of the research:

1. **Literature work** — exploratory, comparative and interpretative work aimed at mapping the conceptual landscape, framing the problem of narrativity in relation to scientific reasoning and compare and interpret results;
2. **Design of Theoretical Model** — the construction and progressive refinement of the *Narrativity Pyramid* as both an analytical and operative tool mediating between theory and practice;
3. **Design and Implementation of Educational Activities** — the translation of the model into tangible learning experiences (the narrativity-enhanced FyouTURES activity and the school-based course) that enacted the theoretical conjectures in authentic contexts;
4. **Empirical Analysis and Interpretation** — the systematic and interpretative examination of students' artefacts, discourses, and perceptions to explore how narrativity mediates reasoning and agency, and to feed back into theoretical refinement.

This recursive movement between theory, design, and evidence constitutes the epistemic engine of the study, ensuring that the *Narrativity Pyramid* evolved as both a **product and a process**—a conceptual model progressively shaped through cycles of educational enactment and empirical reflection.

The structure of the thesis mirrors the structure of the research itself and is composed of five main chapters:

Chapter 1 – The Prelude. This chapter retraces the genealogy of the research problem. It begins with exploration of the questions left open from the Master's thesis and proceeds through the early experiments with the mockumentary genre, culminating in a more precise definition of the preliminary research question. By situating these early explorations as both limited and generative, the Prelude establishes the rationale for the subsequent reframing of narrative from a representational device to a cognitive tool (Norris et al., 2005; Bruner, 1990).

Chapter 2 – The Methodology. This chapter elaborates the theoretical and methodological framework of the study. It situates the study within a design-based research paradigm, highlighting its iterative logic and the intertwining of design, implementation, and theorisation (Cobb et al., 2003; Juuti & Lavonen, 2006).

Chapters 3 to 5 present the three main phases of the study, connected to the investigation of the three research sub-questions.

Chapter 3 – Phase 1: The Narrativity Model. This chapter introduces the first research question, which arises from an apparent paradox: while Bruner (1990) conceived narrative and logico-scientific thought as distinct and serving different epistemic aims, climate science itself relies on narrative artefacts, such as scenarios and shared socioeconomic pathways (O'Neill et al., 2017), to render complex futures intelligible. To address this paradox, the chapter presents the main literature review across many subjects such as narratology, climate science, science education, and CCE and communication (e.g. Avraamidou & Osborne, 2009; Norris et al., 2005; Shepherd & Lloyd, 2021; Veland et al., 2018), which provided the conceptual ground for the first design of the Narrativity Pyramid, conceived as a heuristic framework to investigate the relation between narrative and paradigmatic artefacts in the context of CC and CCE.

The chapter then re-analyses the implementations carried out during the Prelude through the lens of this first pyramid. The analysis shows how mockumentary and related practices, as genre-based interventions, illuminated both the epistemic potential and the limitations of narrative formats in science learning contexts (Ghosh, 2016; Moezzi et al., 2017). As outcomes, this phase clarified the relationship between genre and the broader concept of narrative in CCE, and highlighted the necessity of moving further the focus from artefact to cognitive processes, to investigate the relation between narrative and paradigmatic reasoning and the need (if any) for fostering their interplay as a key condition for enabling richer sensemaking of climate complexity.

Chapter 4 – Phase 2: From Theoretical Framework to Design Practice. This chapter centres on the design of a narrativity-enhanced version of the FyouTURES board game. The original version (developed within a consolidated research ecosystem developed by the Physics Education Research Group at the University of Bologna), despite representing an advanced and mature artefact, primarily engaged students with data-driven paradigmatic reasoning and revealed limitations in fostering deeper forms of sensemaking (Levrini et al., 2019; Covitt & Anderson, 2022; Miani et al., 2025). In response, the re-design introduced an explicit narrative level into the activity, inviting participants to treat data not as mere numbers but as parts of an unfolding human-meaningful storyline (Shepherd & Lloyd, 2021). The first Narrativity Pyramid functioned here both as a design tool and an analytic lens, making it possible to follow the traces of how narrative artefacts complemented paradigmatic reasoning (Norris et al., 2005; Soares et al., 2023). Analysis of the re-designed activity showed that students began to produce more verisimilar and situated accounts of climate futures, linking technical choices to social imaginaries and human perspectives (Veland et al., 2018; Constantino & Weber, 2021). The narrative components also encouraged discussions around uncertainty, values, and trade-offs, thereby broadening the scope of reasoning and highlighting new forms of conflict and negotiation.

The results of this phase demonstrate that narrative thinking can be deliberately integrated into science-based educational interventions, shifting the epistemic posture of the activity from optimisation to interpretation (Avraamidou & Osborne, 2009; Bruner, 1986). The FyouTURES re-design thus represented a crucial step in the evolution of the Narrativity Pyramid, giving new hints on which specific narrative elements can foster specific layer of sensemaking. These resulted in the second version of the pyramid (D'Orto & Tasquier, 2025a).

Chapter 5 – Phase 3: The School-based Course. This chapter presents the final and most comprehensive phase of the study: the design and implementation of a climate education module in a vocational school. Unlike phase 2, where narrative elements were added onto a pre-existing activity (original version of FyouTURES), this course was conceived from the outset as a progressive journey through the layers of the Narrativity Pyramid. Its explicit goal was to investigate whether scaffolding the interplay between narrative and paradigmatic thought could support students' sensemaking and foster forms of epistemic agency (Bruner, 1986; Levirini et al., 2021). The course unfolded over several lessons, each associated with a different layer of narrativity. Starting from scientific models and abstractions, students were gradually invited to construct contextual worlds, develop causal chains of transformation, and ultimately situate themselves within genre-specific storylines about climate futures. This progression was aimed at allowing students to experience knowledge both as abstract and as embodied, linking systemic reasoning with imaginative and situated engagement (Gottschall, 2013; Fletcher; 2023).

Analysis of the course outcomes shows that students began to articulate CC not merely as an external object of study but as a condition calling for positioning and responsibility. Narrative activities stimulated reflection on uncertainty, values, and temporality, while scientific reasoning provided a counterbalance of abstraction and critical distance. The dialogue between argumentative and narrative conflicts became particularly evident, indicating that productive tension between the two modes of thought can be a driver of deeper understanding.

In conclusion, the School-based course demonstrated the transformative potential of narrative scaffolding in CCE. By explicitly integrating paradigmatic and narrative reasoning, it enabled students to construct more coherent and realistic representations of what it means to act in relation to CC, thereby advancing both the theoretical refinement and the empirical validation of the Narrativity Pyramid. The insights gained from this phase informed a further theoretical refinement of the model, leading to an updated version of the Narrativity Pyramid, in which layers retain their individual significance but one of them changes its role to create a slightly more complex structure of interaction. This final version consolidates narrativity as a dynamic structure for reasoning in CCE, bridging scientific explanation, interpretation, and ethical engagement.

Across Chapters 3 to 5, we traced how students' learning experiences unfold through reasoning patterns, metaphors, values negotiations, and temporal constructions. Taken together, these empirical phases show how narrative thinking, when scaffolded alongside paradigmatic reasoning, can enrich students' sensemaking and foster more nuanced positioning in relation to CC. This progression—from initial experiments to a structured

educational intervention—anticipates the central conclusion of the thesis: narrative is not simply an accessory to scientific reasoning but a constitutive dimension of how scientists and students can learn to inhabit, interpret, and act within the complexity of climate futures (Veland et al., 2018; Shepherd & Lloyd, 2021; Miani et al., 2025).

In conclusion, by juxtaposing the story of the journey with the structure of the inquiry, this introduction invites you to engage simultaneously with the narrative and the paradigmatic dimensions of my research from the very outset. It is within their interplay—marked by uncertainty, generativity, and openness—that the epistemic and educational potential of my approach comes to the fore. I therefore wish you an engaging and fruitful reading.

Chapter 1

The prelude: Defining and framing the research problem

The work presented in this chapter represents the link between my master's thesis and the formulation of the PhD research problem. Rather than constituting a mere research problem definition stage—where the open questions emerging from the master's work were consolidated and reframed into a single coherent research question—this phase marked a deeper theoretical reorientation grounded in empirical evidence. Indeed, the transition was not based solely on a literature exploration, but was also informed by insights collected through two educational activities. These experiences expanded the scope of the questions raised in my master's thesis and highlighted the need for a shift in perspective. This shift ultimately led to the identification of two key theoretical references and frameworks (Bruner, 1986; Soares et al., 2024), which led the ground for the formulation of the main research question.

For these reasons, given its substantial and methodological relevance, this phase deserved explicit space within this dissertation.

1.1 Unanswered questions from the Master's Thesis

My doctoral research is rooted in an exploratory study started during my Master's degree, entitled "*Mocku for Change*", which investigated the educational potential of the mockumentary genre in the context of CCE (D'Orto, 2022; De Zuani et al., 2023). That study, while limited in both scope and methodological depth, functioned as an exploratory study in the proper sense: it opened several epistemological and pedagogical issues that would later provide the foundational terrain for the research project presented in this thesis.

This section presents that early work not merely as a chronological prelude, but as a critical moment of emergence, where certain tensions began to surface and certain assumptions were called into question.

The "*Mocku for Change*" study was developed in the frame of the project FEDORA, an EU project aiming at regenerating the ecosystem of science learning in both formal and informal environments. This aim arises from the acknowledgment that nowadays scientific and technological development is progressing at such a fast speed that we are living in what the sociologist Hartmut Rosa calls "the society of acceleration" (Rosa, 2013). Despite that, our educational systems (school and somehow university) often remain static, rigid and do not appear able to keep the pace of change (OECD, 2018). As a result, a serious gap of

knowledge and skills emerges between what the traditional educational organizations are producing and what society requires. Among thinking skills, FEDORA focused on the inter-multi-trans-disciplinary, linguistic, argumentative, and imaginative skills needed to improve the ability to speak about social challenges. Within this broader framework, the project's work packages 2 focused specifically on linguistic skills, addressing the role of language as an epistemic instrument that shapes how ideas are conceived, connected, and shared (FEDORA Consortium, 2023). The "Mocku for Change" activity was developed within this context, targeting a particular form of misalignment highlighted by FEDORA: the mismatch between the formalized and exclusive languages used in schools and the needs for new languages to enhance imagination and the capacity to talk about the contemporary challenges such as CC. In line with this objective, my thesis set out to investigate the educational potential of the mockumentary genre, inspired by Amitav Ghosh's (2016) argument that the modern novel, as a genre, is structurally ill-equipped to narrate the scale, uncertainty, and interconnectivity of the climate crisis and therefore calls for alternative narrative grammars capable of rendering such complexity both imaginable and meaningful.

Drawing on my educational and professional background in science communication, video storytelling, and documentary filmmaking, I identified the potential to address this problem through the exploration of an alternative narrative format: the *mockumentary*, also known as the "fake documentary." The study was grounded in the observation that mockumentary represents an experimental yet established genre that inherently exists on the boundary between fiction and reality. By adopting the aesthetic conventions of factual production, it lends an illusion of authenticity to fictional narratives (Roscoe & Hight, 2001). The research significance of this approach lies in the assumption that, in the audiovisual field, reality is deeply intertwined with its representations (Formenti, 2013). Certain stylistic conventions—such as interviews, hand-held camera movements, or explanatory voiceovers—are culturally encoded as markers of factual discourse (Nichols, 2001). By strategically reinterpreting these conventions, the mockumentary creates a hybrid language that could have had the potential of blurring epistemic boundaries and provoking critical reflection on what counts as "real."

More specifically, the hypothesis was that that genre specificities could offer a promising terrain for students to imagine futures that were simultaneously "credible and imaginative" (D'Orto, 2022). However, the premise of the study was, at the time, primarily inspired by science communication i.e. it was focused on investigating how students could use the mockumentary genre to convey complex climate-related ideas and whether this genre might foster more engaging or emotionally resonant forms of expression compared to traditional academic outputs. This means that the research questions were oriented towards representation: What kinds of stories do students produce when invited to narrate climate futures through the lens of a mockumentary? What elements of climate complexity emerge in their narratives? How do they balance realism and fictionality? The activity was called "Mocku for Change" and was conducted during the COVID-19 pandemic, in a fully remote format. Students worked in small groups over several weeks, asynchronously and without synchronous facilitation. They had access to a brief video lecture introducing the mockumentary genre, a collection of example videos, and a set of technical and narrative

guidelines. At the end of the process, they submitted their final videos accompanied by a short reflection. The analysis was limited to these final artefacts.

Although the scope was limited, the analysis reveals important trends regarding students' capacity to integrate multiple dimensions of CC. Some videos addressed the long-term consequences of today's political choices; others imagined social transformations enabled by collective mobilisation or technological innovation. Several videos engaged with key tensions at the heart of climate discourse, between individual and collective responsibility, between mitigation and adaptation, between hope and fear. Moreover, many students showed an awareness of the narrative structures they were mobilising. They constructed fictional experts, invoked international institutions, simulated archival footage, and employed rhetorical strategies typical of journalistic or institutional communication.

This rich representational landscape, while interesting, raised questions that the methodological tools of the Master's thesis were not equipped to answer. The most fundamental of these was epistemological in nature: to what extent were these narrative artefacts shaped by the mockumentary format itself? Could the structure and conventions of the genre be said to have influenced the students' reasoning processes, or were they merely a creative surface layered over conceptual understandings previously acquired during the course? In other words: was the narrative form of mockumentary enabling a different kind of sensemaking, or was it simply a container for ideas already fully formed? This question points to a deeper tension. Throughout the analysis, I was implicitly treating narrative as a means of communication, as a more or less effective strategy for making scientific content accessible or engaging. The underlying assumption was that learning had occurred elsewhere (during the course itself) and that the mockumentary served primarily to showcase or synthesise that learning. Yet, as I rewatched the videos and re-read the students' commentaries, I began to perceive something else at work: moments of negotiation, of positioning, of speculative reasoning. In some videos, students seemed to use the genre not only to represent what they had learned, but to explore what was still uncertain, unresolved, or emotionally charged. They enacted dilemmas, invented fictional solutions, imagined long-term consequences. There was a kind of cognitive work taking place: tentative, situated, and deeply narrative in nature. At the time, I lacked the conceptual tools to interpret these phenomena. I could not yet distinguish between narrative as a representational output and narrative as a cognitive process. I had not yet encountered the theoretical distinction between paradigmatic and narrative modes of thought, as articulated by Jerome Bruner (1986, 1991). Nor was I familiar with the growing body of research in science education and cognitive psychology that explores how storytelling, metaphor, and narrative framing shape reasoning in contexts of complexity and uncertainty. Nevertheless, emerging evidence suggested that narrative might not be a peripheral or decorative element in climate education, but something more fundamental: a way of thinking, a way of making meaning in the face of systems too large to see and timescales too vast to inhabit through data alone.

This emerging intuition gave rise to a second layer of questions, methodological as much as conceptual. If the mockumentary genre was indeed shaping students' sensemaking, how could that process be studied? How might one capture the epistemic movements that occur

as students imagine, decide, revise, and narrate? Could the narrative form itself provide clues about the underlying reasoning?

In my master's thesis study, the very structure of the educational course where "Mocku for Change" was embedded played a significant role, having already provided students with a rich conceptual repertoire (Tasquier, Knain, & Jornet, 2022). Scientific knowledge, policy debates, socio-political framings, and emotional perspectives had been progressively built over weeks of structured instruction. The mockumentary was the culmination of this path: a space of synthesis, but also of expression and invention. I wanted to disentangle the role of the mockumentary language from the role of prior knowledge and didactic scaffolding. Would the same genre, introduced at the beginning of a course or in a different context, elicit different types of reasoning?

These unresolved questions marked the beginning of the research presented in this thesis. They did not yet constitute a research problem in the strict sense. They were still loosely articulated, speculative, and, to some extent, intuitively driven. But they revealed a shift in orientation: from narrative as communication to narrative as cognition; from product analysis to process tracing; from educational output to epistemological stance. They pointed towards the need for a different research design, one that could hold together the analysis of artefacts and the observation of reasoning, taking into account both the form of expression and the structures of thought it might activate.

In retrospect, what the Master's thesis had produced was not a conclusion, but a generative rupture. It revealed a gap between what the students had created and what I was able to understand as a researcher at the time. That gap became the space in which the present research would take shape. And it also revealed the need for a more rigorous theoretical grounding, capable of accounting for the complex interplay between narrative structures, scientific reasoning, and educational design. This thesis is, in many ways, an attempt to inhabit that space: not to close it, but to render it intelligible and productive for science education.

This epistemic stance resonates with the vision articulated in the FEDORA project results about the "language misalignment" between scientific knowledge and society (FEDORA D2.5). Fedora conceptualised innovation in science education not as the closure of gaps, but as the conscious inhabiting of them—transforming zones of misalignment into spaces for reflexivity, imagination, and the co-construction of meaning. The FEDORA Handbook (2023) explicitly frames this as a *design attitude* toward education: one that acknowledges uncertainty and heterogeneity as productive conditions for learning, fostering the emergence of "new languages and narratives" capable of aligning science education with the evolving cultures of research and society. In this sense, the present thesis contributes to that same endeavour, by exploring narrativity as a cognitive and epistemic environment through which such alignment can be enacted.

1.2 Mocku for Change as an independent activity

The PhD trajectory was built upon the conceptual and empirical space opened by my Master's thesis, which had explored the educational potential of the mockumentary as a hybrid language for CCE. That exploratory study revealed the genre's capacity to foster engagement and creativity by blending factual credibility and imaginative fiction. However, its design—embedded within a pre-existing course that provided extensive conceptual preparation and scaffolding—did not allow me to isolate the specific contribution of the mockumentary language itself.

At the beginning of the PhD, I therefore aimed to disentangle the role of the genre from the role of prior knowledge and didactic mediation. Would the mockumentary, if introduced at the beginning of a course or in a different learning context, elicit different kinds of reasoning? Would it still support students in thinking about climate complexity, or would its cognitive potential depend on the conceptual groundwork laid beforehand? These questions defined the first explorative-experimental phase of my doctoral research, conceived as a re-design study inspired by the methodological logic of Design-Based Research (DBR) (Cobb et al., 2003; Design-Based Research Collective, 2003). That means that the intuitive insights from the Master's study were transformed into a structured module that could be observed and refined. It maintained the mockumentary as the central educational artefact but reconfigured the activity's temporal and conceptual positioning: instead of being an outcome of a broader course, it became a self-standing module designed to test the genre's autonomous cognitive affordances.

The new version of the “Mocku for Change” activity (D'Orto, 2022), that was structured around the core theme of uncertainty, conceived as a hinge concept connecting science, ethics, and imagination. The learning sequence was articulated into three main steps:

- 1) A framing lecture on CC,
- 2) A specific lecture on the mockumentary genre;
- 3) A hands-on creative lab.

Step 1: Framing lecture on CC

The first lecture was intentionally structured by creating a balance between narrative and argumentation. It reconstructed the “history of climate change” as a dramatic plot made of uncertainty, political struggle, and scientific negotiation. Iconic moments (such as the formation of the IPCC, the adoption of the Paris Agreement, and successive reports on emissions trajectories) were presented not as isolated facts, but as situated acts within an evolving storyline from past to present. In critical moments of this timeline, the lecture addressed key CC concepts and educational knots from a disciplinary and epistemological perspective related to uncertainty and scenario building. Table 1.1 shows in more details the structure followed by the first lecture.

Table 1.1. *Narrative–argumentative structure of the first lecture about the history of CC as a storyline.*

Period / Event	Scientific development	Concept(s) introduced	Epistemic shift / status	Educational lens
1896 – The Greenhouse Effect: the birth of a scientific hypothesis	Svante Arrhenius calculates that increasing CO ₂ concentrations could raise Earth's temperature.	<i>Greenhouse effect</i> — the first scientific framing of the climate as a physical-chemical system sensitive to human influence.	Low evidence, high uncertainty → <i>science in the making</i> .	Illustrates how theoretical imagination precedes measurement.
1958 – The Keeling Curve: from hypothesis to observation	Charles David Keeling starts continuous CO ₂ measurements at Mauna Loa.	<i>Empirical confirmation</i> and <i>trend detection</i> — data begin to “tell a story” of anthropogenic change.	From hypothesis to data-driven confidence; uncertainty narrows.	Shows how observation transforms belief into knowledge and narrative evidence.
1960s–1980s – Modelling the climate system: understanding complexity	Development of <i>climate models</i> , later <i>Earth System Models (ESMs)</i> .	<i>Model</i> as representation of complex interactions among atmosphere, ocean, cryosphere, and biosphere.	<i>Epistemic uncertainty</i> — linked to limited understanding of system dynamics.	Distinguishes epistemic uncertainty (reducible by knowledge) from aleatoric uncertainty (intrinsic variability).
1988 – IPCC: institutionalising climate knowledge	Creation of the <i>Intergovernmental Panel on Climate Change (IPCC)</i> .	<i>Evidence, Agreement, Confidence</i> — the IPCC's formal <i>language of uncertainty</i> .	From individual research to <i>collective epistemic assessment</i> .	Shows science as a social and linguistic practice; knowledge requires shared frameworks.
1997–2007 – From knowledge to global governance	<i>Kyoto Protocol</i> (1997); <i>IPCC Nobel Prize</i> (2007).	<i>Consensus</i> — alignment between scientific communities and political institutions.	High evidence, high agreement → <i>very high confidence</i> .	Marks the passage from “knowing” to “acting”; science enters moral and political discourse.
2015 – The Paris Agreement: from projection to commitment	Adoption of the <i>Paris Agreement</i> (2015), setting goals below +2°C.	<i>Projection</i> and <i>Pathway</i> — new narrative of future-oriented science.	<i>Reflexivity</i> — humans recognise their capacity to change the very future being modelled.	Introduces the idea of <i>agency</i> in scientific modelling; humans as co-authors of the future.
2018–present – The Storyline Approach and scenario pluralism	Development of the <i>Storyline Approach</i> (Shepherd et al, 2018) and <i>Shared Socioeconomic Pathways</i> (O'Neill et al., 2017).	<i>Aleatoric, Epistemic, Reflexive uncertainty</i> ; <i>Storylines</i> as physically consistent narratives of possible futures.	<i>Uncertainty</i> reframed as a <i>space of exploration</i> rather than a limitation.	Bridges paradigmatic and narrative reasoning — models as stories of complexity, not predictions of destiny.

As shown in table 1.1, the historical unfolding of CC knowledge can be read as a storyline in which each phase of scientific development introduces new concepts, new epistemic configurations, and new opportunities for reflection through an educational lens. The *period and events* mark the temporal progression of this storyline — from the first theoretical intuition to the present narrative approaches — while the *scientific developments* describe how knowledge was produced, through calculations, measurements, models, or institutional collaborations. Each step introduces distinct *conceptual tools* that have progressively transformed the understanding of the climate system: from the greenhouse effect as a physical hypothesis, to the language of uncertainty and confidence developed by the IPCC, to the recent emergence of storylines and pathways that reframe uncertainty as a space for meaning-making. Alongside this conceptual evolution runs a parallel *epistemic shift*: from individual exploration to collective assessment, from seeking certainty to embracing complexity, from prediction to reflexivity.

Through the *educational lens*, these historical transformations can be interpreted as invitations to think about the nature of science itself — its methods, its limits, and its relationship with society. Arrhenius’s imaginative reasoning exemplifies the generative role of theoretical speculation; Keeling’s data reveal how observation can transform belief into shared evidence; the birth of models opens a reflection on the epistemic function of representation; and the establishment of the IPCC exposes the linguistic and social dimensions of knowledge-making. Later, the global agreements and the narrative turn in climate science invite reflection on human agency and on the capacity of science to imagine futures rather than merely predict them.

Taken together, these episodes offer a multilayered view of climate science as an evolving epistemic ecosystem, where data, language, and imagination co-evolve. Reading this history through an educational lens means understanding it not as a linear accumulation of facts, but as a sequence of interpretative acts — each revealing a different way of constructing, questioning, and communicating knowledge. It thus becomes fertile ground for exploring how CCE can engage with the same epistemic challenges that shaped science itself: uncertainty, reflexivity, and the tension between paradigmatic reasoning and narrative understanding.

Step 2: The mockumentary lecture

The second lecture focused on the idiosyncratic specificities – by highlighting stylistic and rhetorical features – of the mockumentary genre.

Drawing on film studies (Roscoe & Hight, 2001) and science-communication literature (Moezzi et al., 2017), participants analysed how the genre blends documentary realism with fictional construction. The discussion focused on three key characteristics:

- its use of *documentary codes* (interviews, voice-over, handheld camera) to build credibility;
- its *reflexive dimension*, which exposes the process of representation itself; and

- its *potential for irony and estrangement*, which disrupts passive consumption and invites critical interpretation,

Through examples such as *This Is Spinal Tap*, *The Office*, and *The Age of Stupid*, students were encouraged to recognise that the mockumentary does not simply imitate reality but *constructs it discursively*, prompting reflection on how truth, evidence, and belief are negotiated. In an educational context, this reflexivity was seen as an opportunity to explore how communication forms influence what is considered plausible, desirable, or even thinkable about climate futures.

This lecture therefore provided not only stylistic inspiration but also epistemic framing: it encouraged students to approach the genre consciously, understanding its capacity to question authority and to connect critical reasoning with imaginative exploration.

Step 3: the mockumentary lab

The last step placed students at the centre of a participatory narrative experiment. A fictional premise was introduced: : in 2075, the international community celebrates the successful stabilisation of global temperature rise below 1.5°C. Participants were then asked to collectively imagine the trajectory that might have led from our present to that positive outcome, and to narrate it in the form of a mockumentary. The instruction was deliberately open-ended, aiming to stimulate future thinking, decision-making, creativity, and interpretive plurality. The task drew inspiration from *participatory scenario-building* traditions, such as the *Future Workshop* model (Vidal, 2005) and the *Shared Socioeconomic Pathways* (O'Neill et al., 2017), but reinterpreted them through a narrative lens. The creative process—storyboarding, writing, filming, and editing—was approached as a form of collective reasoning, where the constraints of the genre and the freedom of fiction intersected to stimulate systemic thinking about climate action.

This newly designed module was then implemented in two distinct experimental contexts, which constituted the first empirical foundation of the PhD:

1. **ONSCI implementation** (university students and pre-service teachers)
 - a. Aim: to explore the cognitive and epistemic effects of the mockumentary genre when introduced without prior disciplinary scaffolding.
 - b. Setting: higher-education workshop, structured as an autonomous activity with minimal conceptual preparation.
 - c. Focus: qualitative analysis of the types of reasoning and sense-making strategies that emerged when the genre was used as the primary learning environment.
2. **PNRR implementation** (high-school students)
 - a. Aim: to test the adaptability of the same design to a different audience and institutional setting.
 - b. Setting: informal education programme centred on creativity, collaboration, and science communication.

- c. Focus: to investigate how age, context, and communicative aims influenced the cognitive and emotional engagement elicited by the mockumentary activity.

Although both implementations were grounded in the same design principles, they addressed complementary questions. The former sought to *isolate* the effect of the genre on reasoning processes, while the latter aimed to *extend* its educational applicability to broader communicative and motivational dimensions.

1.2.1 The ONSCI Implementation

The first implementation of the new version of “Mocku for Change” was held in the context of ONSCI, “Officina di Narrazione della Scienza”: an interdisciplinary initiative organized by the Physics and Astronomy department at University of Bologna, aimed at fostering critical public engagement with science through creative and participatory narrative approaches. The local FEDORA network participated in ONSCI by organizing the “Workshop 2”, with the objective of expanding and strengthening FEDORA's open schooling network, by involving, above all, teachers and educators, but also doctoral and master students. Within this framework, I was granted the opportunity to design and facilitate a workshop focused on CC. This implementation became, retrospectively, the first moment in which I started to move from genre to narrative and from representation to thinking.

1.2.1.1 Context and implementation details

The “Officina di Narrazione della Scienza” (ONSCI) is an annual initiative hosted by the department of Physics and Astronomy at University of Bologna that brings together a diverse community of researchers, science communicators, educators, and students to collectively explore the role of narrative in science. Rooted in a transdisciplinary and participatory approach, the workshop fosters a dialogic space where narrative is not only treated as a vehicle for communication, but as a cognitive and epistemic mode capable of supporting reflection, critique, and imagination. ONSCI is structured around a week-long intensive program that alternates lectures, collaborative activities, and experimental formats. Its guiding principles include the valorization of plural forms of knowledge, attention to emotional and embodied dimensions of learning, and the cultivation of inclusive and transformative narratives.

On the occasion of the 2023 edition, the Bologna group of FEDORA organized “Workshop 2: Nuovi linguaggi e forme di interdisciplinarietà per l'educazione STE(A)M (New languages and forms of interdisciplinarity for STE(A)M education)”, involving three interdisciplinary activities guided the participants into reflecting on the role of knowledge as a source of competences to orient us in the complexity of the contemporary world and on how it is transmitted in a moment of profound transformation. After an initial shared reflection on FEDORA themes (interdisciplinarity, new languages, and future), participants were involved in educational activities focused on the intertwining between the languages of science and arts. Specifically, the participants could choose between three kinds of activities that were based on materials and approaches elaborated by teachers of the high school “Liceo Einstein” in

Rimini (in collaboration with local teachers Sara Moresco, Paola Fantini and Maurizio Giuseppucci, Michela Clementi e Fabio Filippi LABORATORIO SU AI ATELIER). In particular, the activities proposed were “Mocku for Change” originally designed by me for my master thesis work, KAIROS⁶ and AI Atelier⁷, previously tested by the teachers in the school context.

The “Mocku for Change” workshop brought together a heterogeneous group of 12 participants, including university students, early-career researchers, and secondary school teachers. This composition introduced a valuable diversity of perspectives, disciplinary backgrounds, and pedagogical sensitivities. Unlike the original experiment, which had been carried out remotely and asynchronously, this workshop allowed for direct facilitation, iterative discussion, and collective reflection throughout all phases of the creative process. The shift in setting (from remote task to collaborative workshop) proved to be more than logistical: it opened a conceptual and methodological space in which narrative production could be interpreted as a form of reasoning-in-action.

At the end of this preparatory phase, participants self-organised into two groups based on their thematic interests. One group chose to focus on the topic of energy transition, while the other centred their work on technological innovation. Both groups produced mockumentary videos by the end of the workshop, but the most instructive insights did not come from the final artefacts, but from the process of their construction. The dynamics observed during the scriptwriting and discussion phases revealed a complex interplay between narrative invention, epistemic negotiation, and identity positioning: dimensions that had remained largely invisible in the previous experiment.

In the energy-focused group, for instance, the decision to structure the video as a future talk show gave rise to significant epistemological tensions. Participants attempted to simulate a televised debate between two fictional characters, each representing opposing views on the role of nuclear versus renewable energy. While the format encouraged confrontation and dramatization, it also introduced some challenges: the dialogue frequently slipped into caricature, and the conflict was often resolved through rhetorical victory rather than epistemic negotiation. The students instinctively adopted what could be described as a “dialectical” logic—arguing positions rather than exploring systemic interdependencies. Yet, during facilitation, several participants reflected critically on this limitation. They recognised that their choices of genre and format had not only shaped the structure of the story but had also constrained their ability to represent complexity. The medium was not neutral; it was epistemically generative, but also epistemically limiting.

This reflection was, for me, a key moment of realisation. It became evident that mockumentary was functioning not only as a communicative product, but as a thinking device—a cognitive and affective matrix within which students were organising knowledge, projecting futures, negotiating values, and situating themselves in relation to societal

⁶<https://www.fedora-project.eu/kairos-exploring-the-physical-and-anthropological-features-of-time/>

⁷<https://www.fedora-project.eu/ai-atelier-a-co-teaching-school-activity-inspired-by-fedoras-principles/>

dilemmas. Moreover, these processes were not fully accessible through an analysis of the final videos alone. They emerged in the interstices of discussion, in the uncertainties expressed during group deliberations, in the re-writing of scripts, and in the embodied gestures of disagreement or alignment. The mockumentary was operating at multiple levels: as structure, as practice, and as reflexive medium.

In this sense, the final activity began to reveal itself as an epistemic environment. It constituted a space in which students could not only express what they learned or knew but also reconfigure that knowledge through the act of storytelling. The cognitive operations involved—selecting salient actors, defining causal links, staging conflicts, choosing endings—were not reducible to the reproduction of disciplinary content. They required students to engage in world-building, not just as a literary exercise, but as a scientific and civic task.

Another significant insight from the workshop concerned the role of facilitation. Because the process was collaborative and guided, I was able to intervene at various points—not to direct the content, but to prompt reflection on narrative choices. Questions such as “Whose voice is missing?”, “What assumptions underlie this solution?”, or “What kind of future is being made possible or impossible here?” were not posed as evaluative critiques, but as epistemological provocations. These questions helped surface latent tensions and allowed students to revisit the framing of their narratives. They also revealed the fragility of narrative authority: many participants hesitated to speak “on behalf of the future,” expressing discomfort with the act of inventing when it involved ethical or systemic dimensions. This discomfort, far from being an obstacle, became a site of learning. It exposed the limits of prior knowledge and the need for new interpretive resources.

The ONSCI experiment thus marked a turning point in the development of this research. It provided not only empirical material, but also conceptual reorientation. The focus shifted from genre as a container to genre as a form of inquiry. It became clear that any future research would need to attend not only to what students say, but to how they construct meaning in the making of stories.

Furthermore, it became evident that mockumentary could serve as a bridge between what later I could label as paradigmatic reasoning—characterised by abstraction, generalisation, and formal logic—and the kind of situated, affectively charged, temporally embedded narrative reasoning that is often required in socio-scientific contexts such as CC.

The insights generated by this workshop raised further methodological questions that would shape the next phase of the research, leading to a more systematic exploration of the literature on narrative reasoning and a rethinking of research design in terms of iterative, intervention-based inquiry. But the foundations were laid here: in a workshop that revealed genre not only as a form of expression, but as an environment in which learners could think, feel, imagine, and take epistemic responsibility.

The ONSCI workshop thus served as a first testing ground for the redesigned activity, offering both empirical insights and practical feedback that informed the subsequent PNRR implementation. Working with a mixed group of university students and in-service or

pre-service teachers provided valuable feedback that helped to refine both the educational design and the research focus of the next intervention. In particular, the reflections and suggestions collected from participating teachers offered insight into how such an activity could be adapted to school contexts—where time constraints, curricular integration, and students' prior knowledge require a more structured and guided approach. These observations informed a re-calibration of the activity. While the overall design and aims remained consistent, the PNRR implementation introduced adjustments to better suit the school setting and the shorter duration of the sessions. In this sense, it can be seen as a continuation and refinement of the ONSCI experiment—replicating its core principles while adapting them to a new audience and context.

1.2.2 The PNRR implementations

The second round of implementations followed a structure and set of objectives closely aligned with those of the earlier ONSCI workshop but was positioned later within the overall timeline of the doctoral project. Conducted between September and October 2024, this intervention represented the first implementation involving students and marked an intermediate phase in the study. While maintaining the conceptual underpinnings of the ONSCI design, the activity was slightly adapted in its format and facilitation to suit a school context, allowing the emerging theoretical framework to be tested in a more educationally situated environment. The experience proved crucial for refining both the research questions and the operative translation of narrativity into classroom practice. Chronologically positioned after the *FyouTURES* implementation and before the PLS course (as illustrated in Figure 1.1 in the introduction), this phase served as a bridge between exploratory design and more structured, theory-informed interventions. The insights gained from this student workshop—particularly regarding the dynamics of engagement with narrative prompts—directly informed the design and implementation of the subsequent PLS course, consolidating the methodological direction of the research.

1.2.2.1 Context

The PNRR implementation involved high school students and was part of the *Scuola Futura* program, a national initiative supported by the Italian Piano Nazionale di Ripresa e Resilienza (PNRR), specifically under the line of funding dedicated to "Edugreen" and "laboratori per la transizione ecologica." The program aims to strengthen environmental education, sustainability awareness, and digital competences in Italian schools through innovative and extracurricular learning opportunities. Within this framework, Fondazione Golinelli was tasked with offering thematic workshops for high school students on CC and sustainability, using participatory and inquiry-based approaches. The workshop format proposed by our research group was integrated into this offering as a pilot course.

Activities were held at Fondazione Golinelli, a private foundation based in Bologna that operates in the fields of education, culture, and scientific dissemination. Established in 1988, the foundation supports initiatives aimed at fostering scientific awareness, innovation, and cultural development, with particular attention to younger generations. Over time, it has

consolidated a programmatic focus on interdisciplinary education, combining science, technology, and the humanities through experiential and laboratory-based formats. Its educational activities are carried out at the Opificio Golinelli, a dedicated space that integrates classrooms, laboratories, and exhibition areas, conceived to support diverse learning modalities and to host public and school-oriented events. The foundation collaborates regularly with schools, universities, research centres, and public institutions, and its educational offering includes short-term workshops, summer schools, and curricular integrations. The spatial and organisational setting of the Opificio—characterised by modular workspaces and access to digital equipment—enabled the alternation between collective discussion and autonomous production.

A total of nine classes from different high schools participated in the activity, each attending a single four-hour in-person session at the Opificio Golinelli. The participating students were in their fourth or fifth year of high school (aged 17–19), and the sessions were distributed across several days with rotating participation.

1.3 Data collection

The empirical corpus of this study was generated through the two implementations described above — the ONSCI workshop and the PNRR implementation — which together provided complementary contexts for exploring the cognitive and epistemic affordances of the mockumentary genre. The data collection strategy was designed to capture both the products and the processes of participants' engagement, in order to investigate how narrative creation can operate as a site of reasoning, imagination, and epistemic positioning.

The two main categories of qualitative data collected through the implementations were of two kind:

- **Artefacts produced by participants:** a total of 21 mockumentary videos were produced and collected across the ONSCI workshop (2) and the PNRR implementation (19). Some participants submitted also the “script” they wrote before filming the video;
- **Researchers notes:** during and after each lesson I wrote down impressions, observations, and preliminary reflections in order to document the dynamics that emerged and support subsequent analysis.

Data collected from both implementations were subjected to a qualitative, bottom-up analysis, grounded in interpretive methodologies commonly used in design-based and narrative research (Erickson, 1986; Riessman, 2008; Cobb et al., 2003). The aim was not to quantify or categorise participants' outputs in predetermined terms, but to reconstruct the epistemic and narrative logics that guided their creative processes.

More specifically, data was subjected to a first phase of collection and structuring of the raw data, that consisted in carefully examining of the scripts and of the videos, producing a written description of all videos and a detailed transcription of the dialogues for some

interesting ones whether their script was not submitted by the participants or it differed significantly from the final video dialogues.

Then, the second phase consisted of a careful re-reading and re-watching aimed at identifying recurring patterns that could shed light on how students engaged with the mockumentary genre typical features to make sense, frame or represent CC. Up to this point, the process unfolded in ways that echoed the analytical trajectory of my Master's thesis. Yet, in this case, a further step became possible: the investigation of the mockumentary not merely as a representational product, but as a thinking device within the creative process itself. This shift was enabled by the analysis of field notes, which allowed me to observe how the genre shaped students' reasoning and meaning-making dynamics. The interpretation of field notes in conjunction with the analysis of the produced artefacts generated the results presented in the following section.

To ensure credibility and trustworthiness (Lincoln & Guba, 1985), several strategies were adopted. First, data triangulation was used to cross-validate insights emerging from different sources (videos, scripts, field notes). Second, the analysis proceeded through iterative cycles of reflection, with early interpretations continuously revisited in light of new observations. Third, analytic memos were maintained to document interpretive decisions and to make explicit the influence of my positionality as both facilitator and researcher.

This methodological transparency was essential given the dual nature of the inquiry, situated at the intersection of educational design and qualitative interpretation. Rather than seeking generalisable outcomes, the analysis aimed to produce theoretical insight into how the mockumentary format operates as a cognitive and epistemic space — one where reasoning, emotion, and imagination intertwine in the process of learning.

The following section (1.4) presents the main analytical results that emerged from this process, focusing particularly on two key phenomena identified across datasets: the epistemic role of irony and satire, and the narrative function of conflict.

1.4 Results

Two key elements emerged from the analysis, both of which confirmed and expanded the results of my Master's thesis while opening up new interpretative directions: the role of irony and satire, and the nature and function of narrative conflict.

1.4.1 Irony and Satire as Cognitive Tools

In several videos, irony and satire, typical features of the mockumentary genre, played a notable role in enabling students to approach CC from a critical and emotionally manageable angle. Irony often created a space of reflective distancing that allowed participants to transform the emotional burden of the topic into analytical engagement. In these cases, students employed exaggeration, parody, and mock-serious tones to highlight contradictions in public discourse, institutional responses, and individual behaviours.

One notable example produced during the earlier thesis implementation depicted the warming of the Mediterranean through a fictional documentary on the disruption of Italian fish markets. The students adopted the stylistic codes of popular science programs, inventing new tropical species and promotional campaigns to market them. The video's ironic tone made visible the paradox of adaptation-through-commercialisation, criticising the tendency to normalise ecological disruption within a capitalist logic of profit and consumption.

Another group produced a mock television segment featuring a caricatured conspiracy theorist opposing a rational and calm climate scientist. The exaggerated juxtaposition exposed the logical fallacies of climate denial while underscoring the scientist's argument with reference to authoritative sources. The use of satire in this case served to deconstruct pseudo-scientific discourse and reveal the structural incoherence of anti-climate narratives.

In the ONSCI workshop, both groups incorporated ironic tones, but one group in particular produced a video set in a near future where scientists proudly presented “revolutionary green technologies”—which turned out to be everyday objects renamed with exaggerated scientific terminology. Examples included a standard bicycle rebranded as “passive human-powered mobility” and a tree described as a “natural CO₂ capture device.” The comic effect relied on the mismatch between language and object, resulting in a subtle critique of techno-solutionism and the cultural devaluation of low-tech, sustainable practices. In these cases, irony appeared not only as a stylistic choice but as a strategy for revealing alternative narratives, inviting viewers to question dominant imaginaries of progress and innovation.

1.4.2 Forms and Functions of Conflict

A second set of observations emerged around the role of conflict in students' narrative constructions. Two qualitatively different types of conflict were identified. The first was an argumentative or dialectical form, in which opposing characters were set in direct verbal confrontation, often adopting adversarial roles. The second, more properly narrative form of conflict, was largely absent or underdeveloped.

In particular, the mockumentary produced at ONSCI by a group simulating a future televised debate featured two characters—one supporting nuclear energy, the other advocating for solar power—engaged in a dramatized public argument. While the initial framing suggested a critical comparison of energy options in a climate-constrained world, the resulting narrative devolved into a caricatured clash. The dialogue escalated into personal attacks and rhetorical confrontation, offering little exploration of systemic interdependencies, value trade-offs, or possible compromise. In contrast, several mockumentaries produced during the thesis phase presented the opposite issue: the complete absence of conflict. These narratives either depicted idealised future worlds with no internal tensions or resolved initial disagreements too quickly through moralistic or reductive conclusions.

Such patterns suggest that students tended to reproduce familiar discursive models—debate formats and simplified moral resolutions—rather than exploring conflict as a generative narrative mechanism. From a narrative theory perspective, this reveals a missed opportunity.

As literature on storytelling suggests, narrative conflict is not equivalent to argumentative disagreement: it is defined by tensions that drive characters to act, make choices, and undergo transformation. Properly structured, narrative conflict can function as a laboratory for confronting moral dilemmas, exploring consequences, constructing justifications, and testing hypothetical courses of action. In the context of CCE, this could offer a valuable framework for simulating complex decision-making processes and fostering a deeper engagement with uncertainty and value pluralism.

The overall analysis therefore highlights a double finding. On one hand, students showed a remarkable capacity to appropriate the genre's ironic potential to question cultural assumptions and dominant narratives. On the other, the narrative function of conflict remained largely unexplored, with most groups falling back on familiar oppositional formats or avoiding tensions altogether. This asymmetry points to a need for more explicit scaffolding in the design phase to support the development of deeper narrative structures capable of activating cognitive, ethical, and anticipatory dimensions.

1.4.3 Discussion of the results

The analysis of the two implementations revealed how participants engaged with the mockumentary format both as a communicative and cognitive practice. Two core interpretative threads emerged — the use of irony and satire as epistemic resources, and the construction (or avoidance) of narrative conflict — each shedding light on different dimensions of how students reasoned through storytelling.

Irony and satire, as observed across both contexts, operated as tools of critical distancing. They enabled participants to transform the emotional charge of CC — often associated with helplessness or moral anxiety — into a manageable and reflective engagement. Through humour, exaggeration, and parody, students questioned dominant cultural narratives about technological salvation, progress, and responsibility. This finding suggests that irony, rather than trivialising complex issues, may serve a cognitive function: it allows learners to deconstruct emotion-heavy discourses and to re-signify them through play and exaggeration. In this sense, irony worked as a hinge between affect and reflection, enabling analytical engagement through emotional modulation.

The second analytical thread, narrative conflict, highlighted a complementary yet less developed dimension. Most videos adopted dialectical structures — debates between opposing characters or moral juxtapositions — without evolving into genuine narrative tension or transformation. Conflict tended to remain at the level of argumentation rather than narrative development, thus limiting opportunities for exploring moral complexity or systemic interdependence. The prevalence of this pattern indicates that, while students could mobilise genre conventions effectively, they required further scaffolding to engage with conflict as a generator of inquiry rather than as a rhetorical device.

Together, these findings point to a tension at the heart of the mockumentary as an educational medium. Its hybrid nature — oscillating between parody and realism, critique and fiction — creates fertile ground for reflection but also demands a sophisticated form of

narrative awareness. Participants appeared able to appropriate its aesthetic codes but were less able to mobilise its structural affordances for deeper epistemic exploration. The genre thus functions as both an enabler and a limit: it opens reflective distance yet requires intentional design and facilitation to convert that distance into sustained reasoning.

To sum up, we can argue that this exploratory phase demonstrated that the mockumentary format can succeed in eliciting creativity, critique, and emotional reappraisal, yet it also exposed it as something like a layer on top of a bigger structure, that is the narrative structure itself, that was managed intuitively.

From a methodological standpoint, the study confirmed the value of analysing both artefacts and processes: the combination of video analysis and field observations allowed the identification of subtle forms of reasoning that occur during collaborative storytelling. These insights justify the need for further research into how narrative practices can be designed and scaffolded to support meaning-making in contexts of complexity and uncertainty.

The results thus fulfil the exploratory aim of this initial phase: to test the cognitive and educational potential of the mockumentary and to identify the dimensions that require deeper theoretical and design-based investigation. The following section builds directly on these findings, tracing how the emerging questions from this study informed the subsequent conceptual reorientation of the doctoral research.

As we will describe in the next paragraph, the results emerging from the activities undertaken during the Prelude phase, when interpreted in light of the unresolved questions that originated in the Master's thesis, led to a decisive theoretical reorientation that was at the base of the genesis of the PhD question.

1.5 Genesis of a PhD research question

At the beginning of the prelude phase, the focus had been on the mockumentary as a genre—its hybrid structure, its communicative potential, and its capacity to foster a balance between facts and fictionalisation. As the empirical material began to accumulate and patterns emerged across it, it became increasingly clear that underneath the layer of genre was a deeper structure of cognitive activity. While creating their stories students were not only using a tool (the mockumentary) to express ideas about CC—they were exploring, negotiating, and crafting those ideas through a specific way of thinking. This realisation prompted a theoretical shift from narrative from the shape of thoughts into narrative as a thinking structure: not only what students narrated, but how narrative thinking structures shaped their reasoning processes.

At this stage, two theoretical concepts played a particularly crucial role:

- Jerome Bruner's distinction between paradigmatic and narrative modes of thought (Bruner, 1986; 1991);

- the role of genre as defined in the text-linguistic framework (Adam, 1997) as articulated by Soares et al. (2023).

Bruner's work offered a framework for interpreting narrative not as a less rigorous alternative to scientific discourse, but as a distinct and complementary mode of thinking—one particularly suited to navigating uncertainty, temporality, and moral complexity and therefore the one we use more instinctively to guide our actions. His perspective allowed me to reframe the mockumentary activities as spaces where students engaged not only in communication, but in the construction of meaning through narrative thinking. Their recreation of familiar and un-sustainable patterns make clear that those activities exposed the fragility of narrative reasoning when left unstructured.

The text-linguistic framework as articulated by Soares et al. (2023) provided an operative tool for distinguishing genre-specific features (such as irony and satire) from more general texts and narrative elements (such as conflict, transformation, and resolution). It was particularly valuable in interpreting the asymmetry that emerged from the analysis: students appeared confident in using stylistic devices to frame critique (e.g., through humour), but struggled to mobilise narrative mechanisms capable of activating epistemic depth. For instance, conflicts were often enacted as superficial confrontations rather than as structured tensions capable of generating ethical dilemmas or narrative development. Soares' framework helped to clarify this distinction and pointed toward the need for more targeted scaffolding in future implementations.

Together, these two theoretical perspectives made it possible to articulate a theoretical reorientation: from mockumentary as a hybrid genre to narrative as an epistemic environment. This redefinition reframed the research not around questions of representation alone, but around how narratives operate as dynamic spaces of reasoning—where scientific concepts, social values, and personal imaginaries intersect and evolve. This theoretical insight, grounded in the empirical observations and refined through critical literature engagement, ultimately led to the formulation of the overarching research question that guides this dissertation:

GQ) *How can narrative thinking be conceptualised and operationalised in dialogue with the paradigmatic way of thinking, so as to function as an educational and epistemic resource for CCE?*

Chapter 2

Methodology

2.1 Research Design and methodological orientation

As already mentioned, this PhD inquiry has guided by the following overarching research question:

GQ) *How can narrative thinking be conceptualised and operationalised in dialogue with the paradigmatic way of thinking, so as to function as an educational and epistemic resource for CCE?*

The research design conceived to reply to this question was inspired by the methodology of Design-Based Research (DBR) (Cobb et al., 2003; McKenney & Reeves, 2013; Plomp, 2008), while extending and reinterpreting it to meet the epistemic and theoretical goals of this inquiry.

DBR is widely recognized as a robust framework for investigating learning processes in authentic, complex contexts such as classrooms, as it conceives theory and practice as mutually constitutive (Brown, 1992; Collins, 1992; The Design-Based Research Collective, 2003; Cobb et al., 2003; Barab & Squire, 2004). Its distinctive feature lies in conceiving theory and practice as mutually constitutive: theory informs design, and design, in turn, refines theory through iterative experimentation in real educational settings (Cobb et al., 2003). Within education research, this cyclical and reflexive process has been widely adopted to produce local theories of learning and design principles that can guide future pedagogical innovations (McKenney & Reeves, 2013; Plomp, 2008). In the present study, however, DBR was approached as a generative research attitude rather than as a procedural framework. While adopting its key features—iterative cycles of design and analysis, collaboration with practitioners, and contextual validity—the methodology departed from the conventional aim of developing generalisable design principles. Instead, it mobilised the logic of design to advance a theoretical construct: the Narrativity Pyramid as a bridge between paradigmatic and narrative reasoning. The educational interventions served as epistemic laboratories where the model ideas could be tested, refined, and re-theorised.

In this sense, the methodological approach can be characterised as DBR-inspired or “DBR-like”: it mobilises DBR principles, but redirects them towards the development and consolidation of a conceptual model, rather than toward the production of generalisable design principles for classroom practice (diSessa & Cobb, 2004; Kelly, 2004; Sandoval, 2014; Easterday et al., 2014). The objective was not to produce “local theories” of learning or generalisable design principles for classroom practice, but to use the iterative design process as a means to refine a theoretical construct—the Narrativity Pyramid—and to explore its potential to mediate between paradigmatic and narrative reasoning in CCE. Such a theoretical reorientation of DBR has been increasingly acknowledged as a valuable methodological pathway, particularly in research contexts where the aim is to generate

conceptual innovations or refine analytical frameworks rather than to produce transferable design principles (Anderson & Shattuck, 2012; McKenney & Reeves, 2013).

This methodological choice was particularly suited to the present research for three reasons. First, the study was not intended to test a fixed intervention, but to explore the evolving role of narrative in CCE through successive iterations. Second, the research sought to balance conceptual innovation—the elaboration of the narrativity framework—with empirical grounding—the observation of how students engaged with narrative tasks across different contexts. Third, the dual identity of the researcher as both designer of the interventions and interpreter of the outcomes required a methodological paradigm that values reflexivity and recognises the productive interplay between theory and practice.

As DBR-inspired, the approach of this study drew on the principles of Design-Based Research (Brown, 1992; Collins, 1992; Cobb et al., 2003) as a response to the limitations of purely experimental or large-scale correlational studies in education. Therefore, the methodological orientation of this research is rooted in a qualitative and interpretive approach, consistent with the epistemological stance that narratives are not merely vehicles for transmitting information but environments within which meaning is constructed and contested (Veland et al., 2018; Gottschall, 2013; Fletcher, 2023). This perspective requires attention to processes of reasoning, dialogue, and positioning, rather than to outcomes alone.

In sum, the methodological orientation can be characterised by three core principles:

1. **Iterativity and design-based reasoning:** theories are generated and refined through cycles of design and implementation (Cobb et al., 2003).
2. **Interpretive attention to meaning-making:** analysis focuses on the ways in which students construct, negotiate, and reframe meanings around CC.
3. **Integration of theoretical and empirical work:** the study advances conceptual tools (e.g., the Narrativity Pyramid) that are both informed by and tested within educational practice.

In the next paragraph, we present how these principles have been developed into a coherent research structure.

2.2 Research structure, study types and research questions

The overarching question (GQ) that guided this study was as a generative starting point that progressively unfolded throughout the research process. Following the principles of a Design-Based Research (DBR)–inspired approach, the investigation evolved through cycles of theorisation, design, and empirical analysis, in which new needs, tensions, and possibilities emerged. Each iteration refined the scope of inquiry and gave rise to three main sub-questions, which can be regarded as the three pillars structuring the study.

The first sub-question addressed the theoretical foundations of the work:

SQ1) *How can the relationship between narrative and scientific reasoning be explored and clarified, in order to understand how the two modes of thought can interact within CCE?*

This question arose from the recognition that the notion of “narrative thinking,” though increasingly invoked in science education, remains conceptually ambiguous and often reduced to a rhetorical or communicative device. Within a DBR logic, the first challenge was therefore to build a solid theoretical language capable of articulating how narrative and paradigmatic reasoning—two distinct yet complementary modes described by Bruner (1986)—could coexist and interact as forms of knowledge construction. The exploration of this relationship demanded a multi-disciplinary dialogue spanning educational theory, narratology, and climate sciences. It also required translating abstract epistemological insights into an operable model able to inform both analysis and design. SQ1 thus represents the conceptual axis of the whole study, from which the Narrativity Pyramid progressively emerged as a mediating construct.

The second sub-question shifted the focus from conceptual elaboration to educational design:

SQ2) *How can narrativity—conceived as a layered structure bridging narrative and paradigmatic reasoning—be translated into the design and implementation of learning environments that foster integration between the two modes of thought within CCE?*

In DBR terms, this phase corresponds to the interventionist turn of the inquiry: theoretical ideas are not only formulated but enacted and tested through educational artefacts. The aim was to move from theory about narrativity to theory through design—investigating how specific narrative features (temporality, conflict, world-making, genre conventions) can be intentionally mobilised within learning experiences to scaffold both analytical reasoning and imaginative engagement. SQ2 therefore represents the design axis of the research, translating conceptual insights into pedagogical practice.

The third sub-question addressed the empirical and interpretative dimension:

SQ3) *To what extent and in what ways can a narrativity-based course influence students’ learning experiences in the context of CCE?*

While DBR cycles always include evaluation, the focus here was not on measuring “effectiveness” in a narrow sense, but on generating interpretative understanding of how narrative framing shapes students’ learning experiences: founding results about mostly their sense-making and reasoning processes, but also emotions and agency. This required analysing traces of students’ participation—written reports, artefacts, discussions, and questionnaires—as expressions of meaning-making. Within the broader logic of the study,

SQ3 thus represents the empirical axis, grounding the theoretical construct in observed educational practice and feeding its progressive refinement.

Together, these three sub-questions formed an iterative research architecture, where each component—conceptual, design-based, and empirical—served as both an outcome and a source for the next. Each sub-question was further articulated into more specific and operational questions that guided the different steps of the work. The full articulation of these questions and their alignment with the research phases and objectives is reported in the Map of Research Questions (see Table 2.1).

Table 2.1. *Map of Research Questions and their alignment with objectives, phases, and results.*

Map of Research questions							
General question	Main Subquestion	Objective	Specific subquestion	Objective	Phase	Results	Thesis reference
GQ) How can narrative thinking be conceptualised and operationalised in dialogue with the paradigmatic way of thinking, so as to function as an educational and epistemic resource for CCE?	SQ1) How can the relationship between narrative and scientific reasoning be explored and clarified, in order to understand how the two modes of thought can interact within CCE?	Building and refines the theoretical model	SQ1a) What do we mean when we speak of “narrative”, and how has its relationship with scientific reasoning been conceptualised across different disciplinary domains?	Operating a theoretical and literature-based exploration of the concept of narrative and its epistemic relation to scientific reasoning.	1,2,3	Definition of main theoretical framing	Paragraph 3.1
			SQ1b) How can insights from existing research and exploratory data be synthesised to build an operative framework for investigating the interplay between narrative and paradigmatic thinking in CCE?	Designing of the first Narrativity Pyramid as a theoretical and operative model	1	Narrativity Pyramid model version 1	Paragraph 3.3
			SQ1c) How can the theoretical model of narrativity be refined in light of empirical evidence emerging from FyouTURES implementations, leading to the elaboration of a second version of the Narrativity Pyramid?	Integrating the results of the FyouTURES phase to update the theoretical model (Narrativity Pyramid 2)	2	Narrativity Pyramid model version 2	Paragraph 4.4
			SQ1d) How can further empirical insights from the school-based course contribute to the theoretical consolidation of the Narrativity Pyramid and to the articulation of its third and final version?	Integrating findings from the School-based course into the theoretical model (Narrativity Pyramid 3)	3	Narrativity Pyramid model version 3	Paragraph 5.5
	SQ2) How can narrativity—conceived as a layered structure bridging narrative and	Translating the model into educational practice	SQ2a) How can the first Narrativity Pyramid be operationalised within the design of an educational	Translating the first version of the theoretical model into an educational activity and its related artefacts	2	Narrativity-enhanced version of FyouTURES game	Paragraph 4.1

	paradigmatic reasoning—be translated into the design and implementation of learning environments that foster integration between the two modes of thought within CCE?		activity (the narrativity-enhanced FyouTURES) to promote transitions and/or integration between paradigmatic and narrative reasoning?				
			SQ2b) How can the second version of the Narrativity Pyramid inform the design of a school-based course that progressively activates different narrativity layers to support students in connecting scientific reasoning with interpretive and value-laden reflection?	Translating the second version of the theoretical model of narrativity into a full course to implement in the classroom	3	School-based course	Paragraph 5.1
	SQ3) To what extent and in what ways can a narrativity-based course influence students' learning experience in the context of CCE?	Evaluating and observing the educational effects	SQ3a) In what ways did the narrativity-enhanced design of FyouTURES influenced students' reasoning and engagement with the complexity and uncertainties of CC during implementation?	Evaluating the educational effects of FyouTURES implementation	2	Insights about: 1) Narrative thinking as a tool for exploring and filling the "gaps of data"; 2) The emergence of a dual cognitive landscape; 3) The inclusion of narrative framing activated forms of collective foresight.	Paragraph 4.3
			SQ3b) What transformations in students' sense-making and agency can be observed as outcomes of the narrativity-based school course?	Evaluating the educational effects of the school-based course	3	Insights about: 1) Students' conceptual understanding of CC; 2) Students' perception of climate action; 3) Emergence and interaction of the two ways of thinking: 4) Role of Narrativity for sense-making and agency.	Paragraphs 5.3–5.4

Within this evolving architecture, the research required a methodological structure capable of holding together conceptual construction, educational design, and empirical observation in a coherent cycle of iteration. This epistemological stance demanded a diversified methodological repertoire, leading to the employment of **four complementary study types**. Each of them corresponds to a distinct mode of inquiry and plays a specific function within the iterative cycle. Their articulation reflects the need to move back and forth between abstraction and enactment, between the conceptual and the empirical, in a way that preserves both rigor and openness to emergence. Following a Design-Based Research (DBR)-inspired logic, the inquiry was not organised as a linear sequence of separate studies, but as an iterative process, as shown in Figure 2.1.

The first type, **Literature work**, represents the reflective and interpretative dimension of the research. It involves the exploration of conceptual landscapes and the construction of theoretical bridges across disciplinary fields. In the early stages, this inquiry aimed to clarify

what is meant by narrativity and how it relates to scientific reasoning; in later phases, it served to interpret empirical findings and integrate them back into the theoretical model. In DBR terms, Literature work corresponds to the framing phase, where researchers define and progressively refine the problem space.

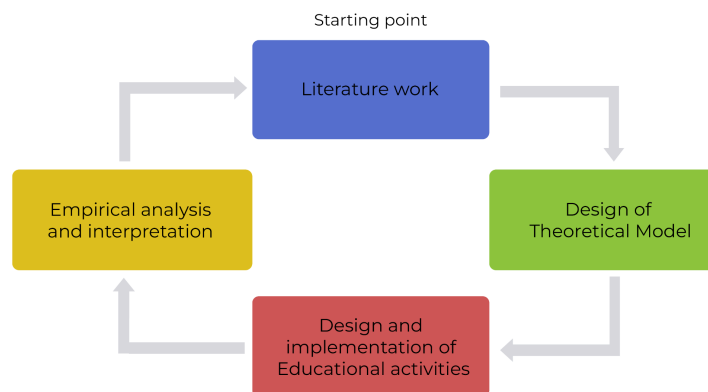


Figure 2.1. *Iterative process of the research design.* The figure illustrates the study types cycle: literature work, model design, educational implementation, and empirical analysis informed each other in a continuous feedback loop. This iterative process reflects the Design-Based Research (DBR) logic guiding the overall PhD methodology.

The second type, **Design of Theoretical Model**, transforms the outcomes of literature work into a model that mediates between theory and practice. In this study, that role was played by the Narrativity Pyramid, conceived as both an analytical framework and a design hypothesis. This model was not fixed from the outset: it evolved through successive cycles, each informed by theoretical reflection and empirical feedback. The process echoes what Sandoval (2014) calls conjecture mapping, where design elements are linked to underlying theoretical conjectures and empirically tested across iterations.

The third type, **Design and Implementation of Educational Activities**, corresponds to the interventionist core of the DBR approach. Here the theoretical model was translated into tangible educational experiences—such as the narrativity-enhanced FyouTURES activity and the school-based course—allowing the theoretical conjectures to be enacted and observed in authentic learning environments. These implementations served both as testing grounds for the model and as sites of meaning-making, where the interaction between paradigmatic and narrative reasoning could manifest through students’ actions and productions.

Finally, the fourth type, **Empirical Analysis and Interpretation**, closes the iterative loop by systematically analysing the data emerging from those implementations. The focus, however, is not limited to assessing performance or effectiveness; rather, it seeks to interpret how learning processes unfold and how narrativity mediates students’ reasoning, emotions, and agency. The findings from this analysis were then reintegrated into the theoretical framework, informing subsequent refinements of the Narrativity Pyramid.

Each of these study types thus contributes to a recursive movement between theory, design, and evidence—a movement that mirrors the epistemic dynamics of the research itself. Table 2.2 summarises the four study types, outlining their respective functions, theoretical foundations, and key references.

Table 2.2. *Overview of the four study types and their theoretical grounding.*

Study Type	Description	Theoretical Foundations	Main References
Literature work	Exploratory and/or interpretative study aimed at mapping the problem space and building the conceptual grounding.	Interpretative and conceptual analysis traditions; early DBR cycles focused on problem framing and theory development.	Sandoval (2014); Levrini et al. (2021).
Design of Theoretical Model	Process of building and/or refining a conceptual model that mediates between theory and educational practice.	Conjecture mapping and model-based reasoning in DBR; epistemic mediators in FEDORA framework.	Barab & Squire, (2004); Levrini et al. (2020).
Design and Implementation of Educational Activities	Translation of the theoretical model into educational activity and classroom enactment.	Design experiment methodology and future-oriented, narrative-based approaches in science education.	Cobb et al. (2003); Brown (1992); Collins (1992); McKenney & Reeves (2019); Levrini et al. (2019).
Empirical Analysis and Interpretation	Systematic examination of data to interpret the model's educational effects and inform further theorisation.	Interpretative methodologies in DBR; thematic and narrative analysis for theory building.	Braun & Clarke (2006); Levrini & Tasquier (2019)

The articulation of the study into three main phases reflects the iterative and cumulative logic described above. Each phase can be regarded as a full cycle of the DBR-inspired process, in which Literature work, model design, educational implementation, and empirical analysis coexisted in different proportions. Across these iterations, the Narrativity Pyramid evolved from a preliminary conceptual sketch into a consolidated theoretical construct, while the research questions gradually deepened and expanded their scope.

The first phase (presented in Chapter 3) coincided with the exploration of the theoretical terrain and the initial construction of the model. It emerged as a continuation of the questions left open by the Master's thesis and by the first attempts to use narrative formats for CCE. At this stage, the work moved from an intuitive recognition of the educational potential of narratives toward a systematic effort to frame that potential within a solid epistemological structure. The phase therefore integrated Literature work and Design of Theoretical Model, producing the first version of the Narrativity Pyramid. This initial version served as a

conceptual compass, mapping the different degrees of narrativity and their relation to scientific reasoning, and laying the groundwork for subsequent empirical enactments.

The second phase (Chapter 4) marked the transition from conceptual construction to operative translation. Here, the first version of the model was enacted through the FyouTURES educational activity, redesigned to include explicit narrative elements. This implementation constituted the first Design and Implementation of Educational Activities, guided by the hypothesis that activating narrative structures could support the integration between paradigmatic and interpretive reasoning. The empirical observations generated during this phase were examined through Empirical Analysis and Interpretation, revealing how students' engagement with narrative elements enabled them to articulate complex causal chains, bridge emotional and analytical dimensions, and collectively imagine plausible climate futures. These findings were not treated as mere validation data, but as sources of theoretical insight, feeding a new round of Literature work and leading to the refinement of the model into the second version of Narrativity Pyramid.

The third phase (Chapter 5) represented the most comprehensive enactment of the research framework, as the model was now applied within a full school-based course. Building on the revised version of the pyramid, this phase sought to explore the model's potential to foster both conceptual understanding and agency in formal education. The Design and Implementation of Educational Activities here involved the creation of a course structured around progressively activated narrativity layers—each designed to prompt a different form of reasoning or reflection. The subsequent Empirical Analysis and Interpretation examined how students appropriated these narrative forms, tracing the transformations in their ways of thinking about CC and their perceived capacity to act upon it. The outcomes of this phase led to the theoretical consolidation of the model into the third version of the Narrativity Pyramid, which encapsulated the cumulative learning of the entire research process.

Throughout these three phases, theoretical, design, and empirical components were not isolated segments but interdependent dimensions of the same process. Each iteration required the mobilisation of the four study types described above, used in varying combinations to address the emerging questions and challenges. In this sense, the research followed the iterative epistemology characteristic of DBR: theory guided design; design generated data; data informed new theorisation. The relationship between phases, research questions, study types, and model development is summarised in the Table of Phases, Study Types, and Models (see Table 2.3).

Table 2.3. *Relationship between research phases, study types, and model development.*

Chapter	Phase	Research questions	Study type	Model used/developed
3	1	SQ1a	Literature work	---
		SQ1b	Design of Theoretical Model	Narrativity Pyramid 1(developed)
4	2	SQ2a	Design and Implementation of Educational Activities	Narrativity Pyramid 1(used)

5	3	SQ3a	Empirical Analysis and Interpretation	Narrativity Pyramid 1(used)
		SQ1c	Literature work, Design of Theoretical Model	Narrativity Pyramid 2(developed)
		SQ2b	Design and Implementation of Educational Activities	Narrativity Pyramid 2 (used)
		SQ3b	Empirical Analysis and Interpretation	Narrativity Pyramid 2 (used)
		SQ1d	Literature work, Design of Theoretical Model	Narrativity Pyramid 3 (developed)

In summary, the research design reflects a continuous dialogue between abstraction and enactment, between the thinking about and the thinking through of narrativity. By intertwining conceptual elaboration, model design, classroom implementation, and empirical interpretation, the study embodies a form of theorisation-in-action, where educational practice becomes a site of epistemic exploration.

The following chapter expands on this methodological overview by presenting the contexts, data sources, and analytical strategies through which each phase was conducted. It briefly describes the educational settings, the instruments for data collection, and the interpretative methods used to analyse the students' artefacts and interactions, before turning in subsequent chapters to a detailed account of each phase of the research trajectory.

2.4 Overview of Contexts, Data, and Analytical Strategies

Across all phases (Prelude included), data collection relied on a diverse and complementary set of sources that enabled a multidimensional exploration of the educational processes under study (Anfara et al., 2004; Denzin & Lincoln, 2000). These included:

- **Students' artefacts**, including written scenarios, reports, and multimedia productions, which provided insight into the ways students represented and narrated CC.
- **Questionnaires and self-evaluations**, designed to capture students' perceptions, epistemic positioning, and sense of agency.
- **Audio-recordings and transcripts** of class discussions, which offered access to the processes of reasoning, dialogue, and conflict negotiation.
- **Researcher field notes**, documenting the design process, facilitation choices, and reflexive observations.

The analytical strategy adopted across all phases followed a mixed inductive–deductive approach (Braun & Clarke, 2006; Nowell et al., 2017). On the one hand, established theoretical constructs—such as the distinction between narrative and paradigmatic reasoning, the layers of narrativity, and the role of conflict—were operationalised into analytical codes and guided the deductive dimension of the work. On the other hand, the process remained open to emergent patterns and unanticipated meanings, ensuring sensitivity to the situated, dialogic, and affective character of students' reasoning.

To visualise and interpret the data, a set of specific analytical tools was developed across the different phases. These included temporal maps of classroom discussions (highlighting the shifts between paradigmatic and narrative reasoning across time) and comparative analyses of narrative artefacts (mapping them onto different layers of narrativity). Triangulation across sources—artefacts, transcripts, questionnaires, and researcher notes—served both to enhance the robustness of interpretations and to capture the multidimensional character of the educational processes under study.

Finally, each phase combined these general principles with its own specific contexts, data sources, and analytical strategies, as summarised in Table 2.4.

Table 2.4. *Overview of research phases, contexts, data sources, and analytical strategies.*

Chapter	Phase	Research questions investigated	Contexts of implementations	Sources/Data types	Analytical strategies
3	Prelude and 1	SQ1a, SQ1b	• Informal and higher-education contexts. • Participants: pre-service teachers, university students, and high-school students.	• Students' artefacts (mockumentary videos, scripts). • Researcher diaries and field notes. • Audio-recordings of group discussions.	• Triangulation between artefacts, field notes, and theoretical sources • Theoretical design reasoning combining empirical interpretation and conceptual construction (Kelly, 2014; Levrini et al., 2020);
4	2	SQ2a, SQ3a, SQ1c	• Mixed formal/informal educational setting. • Participants: pre-service teachers, researchers, and upper-secondary students.	• Students' artefacts (written scenarios, reports). • Questionnaires and self-evaluations. • Audio-recordings and transcripts of class discussions. • Researcher diaries and field notes.	• Mixed inductive–deductive thematic analysis (Braun & Clarke, 2006; Nowell et al., 2017);; • Comparative analysis of artefacts; • Triangulation across artefacts, transcripts, questionnaires, and notes • Theoretical design reasoning (Kelly, 2014; Levrini et al., 2020)
5	3	SQ2b, SQ3b, SQ1d	• Formal school context. • Participants: high-school students engaged.	• Students' artefacts (written scenarios, reports, multimedia productions). • Questionnaires and self-evaluations. • Audio-recordings and transcripts of class discussions. • Researcher diaries and field notes.	• Mixed inductive–deductive approach integrating theory-driven coding (narrativity layers, narrative/paradigmatic reasoning) with emergent thematic analysis. • Cross-dataset comparison to trace conceptual and affective transformations. • Visual and interpretative tools (comparative artefact maps, temporal reasoning

					charts). • Triangulation to enhance validity and capture multidimensional learning processes. • Theoretical design reasoning (Kelly, 2014; Levrini et al., 2020)
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2.5 Ethical Considerations and Reflexivity

Given the involvement of students and teachers in educational settings, the study was conducted with careful attention to ethical standards. All participants were informed of the aims and procedures of the research and provided consent prior to their participation. For minors, parental consent was obtained through the hosting institutions. Anonymity was preserved in all published outputs by replacing personal identifiers with pseudonyms and by ensuring that students' creative artefacts could not be traced back to individuals. Moreover, when visual or multimedia productions were collected, explicit consent was requested regarding the possible use of excerpts for research dissemination and educational purposes, in line with the EU General Data Protection Regulation (Reg. UE 2016/679) and the Italian Data Protection Code (D.Lgs. 196/2003, updated 2018).

Ethical considerations extended beyond formal procedures to include the emotional and cognitive dimensions of working with CC in educational contexts. As the activities often invited students to confront uncertainty, complexity, and possible futures, particular care was taken to design learning environments that avoided overwhelming participants or exacerbating eco-anxiety. The choice of narrative as a mediating framework responded, in part, to this concern: by embedding scientific reasoning within imaginative and story-like forms, students were encouraged to explore alternative futures in a constructive and dialogical manner.

The research also required explicit attention to reflexivity. My position as both designer of the interventions and observer of the educational processes placed me in a dual role, at once shaping the context and interpreting its dynamics. This proximity to the field was acknowledged as a constitutive element of the inquiry rather than as a limitation to be overcome. Reflexive practices included the systematic use of a research diary, where decisions, impressions, and emerging interpretations were recorded throughout the process. These notes served both as a tool for transparency in the design choices and as an additional layer of data for the interpretation of the educational interactions.

In addition, data management followed the principles of FAIR data—Findable, Accessible, Interoperable, and Re-usable—as promoted by the European Commission (2018) and endorsed by the Università di Bologna's Research Data Management Policy (2023). All data

were stored and processed in accordance with the University's ethical and legal guidelines for research, ensuring privacy, accountability, and long-term preservation.

Finally, the research conformed to the University of Bologna's Code of Ethics and Conduct (Università di Bologna, 2023), which prescribes respect for human dignity, integrity in research practices, and transparency in the dissemination of scientific results.

By integrating institutional ethical frameworks, reflexive practice, and open-science principles, the study aimed to create research conditions that were respectful of participants, attentive to the affective dimension of CCE, and transparent about the researcher's own influence on the process.

2.6 Methodological Challenges and Limitations

As with any qualitative and design-based inquiry, this study encountered a number of methodological challenges that must be acknowledged in order to situate the validity and scope of its findings.

A first limitation concerns the scale and generalisability of the results. The scope of this research was intentionally not oriented toward statistical generalisation. The interventions were conducted with relatively small groups of students, in specific institutional contexts, and under the direct facilitation of the researcher. This design choice reflects the interpretative and design-based nature of the study, which sought not to measure effects on large populations but to understand processes and generate theoretical insight. In this sense, the findings should not be interpreted as limited in validity but as valid within a different epistemological paradigm—one that values transferability over generalisability (Lincoln & Guba, 1985). The aim was to construct a conceptual and methodological model capable of being adapted, reinterpreted, and further tested in diverse contexts, rather than to establish universal statistical trends. The value lies in the depth and interpretative richness of the insights produced, which illuminate mechanisms that might otherwise remain invisible in large-scale quantitative approaches.

A second methodological challenge concerns the multiple roles assumed by the researcher throughout the study. Acting simultaneously as designer, facilitator, and analyst of the activities implies a close and dynamic relationship with the research context, raising legitimate questions about bias and subjectivity. Within qualitative and interpretative paradigms, however, this proximity is not regarded as a threat to validity but as a resource that enables richer, more situated understanding (Lincoln & Guba, 1985; Malterud, 2001; Fantini, 2014). The key lies not in eliminating subjectivity, but in rendering it visible and accountable through systematic reflexive practices.

To ensure transparency and methodological rigour, several strategies were employed.

- **Triangulation** was carried out across data sources, theoretical perspectives, and researchers, allowing the integration of complementary insights and the identification of convergent and divergent interpretations (Denzin & Lincoln, 2000).

- An explicit **audit trail** was maintained, documenting all phases of the research—from design decisions and data collection to analysis and interpretation—so that the reasoning process could be retraced and externally evaluated (Lincoln & Guba, 1985; Anfara et al., 2002).
- Regular **peer-debriefing sessions** and research meetings provided spaces for critical discussion, helping to surface implicit assumptions and strengthen the coherence between design and interpretation (Fantini, 2014).
- A continuous **research diary** was used to record methodological choices, impressions, and interpretative shifts, supporting a reflexive awareness of how personal positioning influenced observation and analysis.
- Through these combined procedures, the study pursued **credibility, dependability, and confirmability**—the qualitative counterparts of internal validity, reliability, and objectivity (Lincoln & Guba, 1985). The integration of triangulation, audit trail, and collaborative reflection thus transformed the researcher’s multiple role from a potential source of bias into an essential component of a transparent and trustworthy inquiry process.

A third limitation stems from the inherent complexity of narratives as objects of analysis. Narratives function at multiple levels—structural, epistemic, affective—and their interpretation cannot be fully captured by rigid analytical frameworks. This study sought to balance deductive coding of pre-defined categories (e.g., narrativity layers, narrative vs. paradigmatic reasoning) with openness to emergent themes. However, the interpretive nature of the analysis means that alternative readings of the same data remain possible.

In acknowledging these limitations, it is important to stress that they do not undermine the study, but rather delineate its character. The research was not designed to produce universal claims, but to open conceptual and methodological ground for understanding how narratives can operate as cognitive and epistemic environments in CCE. Its value lies precisely in the *exploratory and generative character* of the findings, which suggest directions for further inquiry and practical experimentation.

2.7 Concluding Remarks

This chapter has outlined the methodological architecture that guided the present research, clarifying how the study was designed to explore the epistemic and educational potential of narrativity within CCE. Grounded in a Design-Based Research (DBR)-inspired orientation, the methodology was characterised by iterative cycles of theorisation, design, implementation, and interpretation. Each phase mobilised a combination of study types—ranging from Literature work to empirical analysis—thus embodying a dynamic dialogue between abstraction and enactment.

The methodological choice to privilege depth over breadth and transferability over generalisability reflects a deliberate epistemological stance: the aim was not to produce universal teaching principles, but to generate conceptual and methodological tools capable of being adapted, reinterpreted, and further developed in future studies. Within this

perspective, the Narrativity Pyramid emerged as both a product and a process—a theoretical construct progressively shaped through design-based reasoning and empirical reflection.

Ethical awareness, reflexivity, and methodological transparency were integral to this process. Through triangulation, audit trails, and collaborative peer discussions, the research sought to balance proximity to the field with interpretative rigour, ensuring that the researcher's multiple role remained a source of insight rather than bias. Similarly, attention to participants' emotional engagement and data protection aligned the inquiry with the ethical standards of qualitative educational research and the institutional frameworks of the University of Bologna.

In summary, the methodological framework presented in this chapter defines the logic through which the subsequent analyses should be read: as an evolving inquiry, in which theoretical reflection, educational design, and empirical observation continually inform and refine one another. The following chapters illustrate how this framework was enacted across the three main phases of the study, tracing the progressive development and validation of the Narrativity Pyramid through its application in diverse educational contexts.

Chapter 3

Phase 1: The narrativity model

The first phase of this research, as anticipated in the introduction and then discussed in the present chapter, represents a systematic and reflexive endeavour to reconstruct and conceptually frame the theoretical and empirical shifts that emerged during the initial stages of my doctoral inquiry (see Chapter 1). This process was not merely introspective but methodological, aimed at establishing a coherent alignment between my evolving research questions, the epistemological assumptions underpinning them, and the methodological choices that could validly sustain their exploration (Lincoln & Guba, 1985; Clandinin & Connelly, 2000). In the prelude phase (see Chapter 1) it became increasingly evident that the notion of *narrative*—both in my earlier work and within much of the science education literature (D'Orto, 2022)—had been predominantly conceived as a *didactic container*, a means for structuring or communicating disciplinary content, rather than as an *epistemic mode* through which meaning, reasoning, and experience are constituted (Bruner, 1990; Polkinghorne, 1988; Norris et al., 2005). The recognition of this limitation represented the trigger for a methodological reorientation: to investigate narrative not as a pedagogical accessory but as a form of inquiry capable of generating and validating knowledge about the ways individuals and communities make sense of complex phenomena, such as CC (Tasquier et al., 2022; Tasquier et al., 2025). This shift required exploring and clarifying the *grammar* of narrative and situating it within a broader theoretical apparatus that could articulate its cognitive, affective, and social dimensions and its *epistemic* (Jaber & Hammer, 2016). Accordingly, the ensuing methodological development involved a process of conceptual clarification, theoretical triangulation, and empirical validation through engagement with both

the literature and initial data sources. This phase thus laid the groundwork for framing narrative not only as an analytical lens but also as a legitimate epistemological space within science education research, opening pathways for exploring how narratives shape agency, identity, and understanding in the context of sustainability and CCE (Ricoeur, 1984; Bruner, 1991; Jaber & Hammer, 2016).

The conceptual tool that enabled this reorientation emerged from a re-reading of Jerome Bruner's work on narrative and paradigmatic thought (Bruner, 1986; 1991) aimed at a closer examination of the tension that this very distinction seemed to contain. What struck me during this second encounter with Bruner was a tension at the core of the two modes distinction—a paradox that seemed both conceptual and methodological. This tension, as I will describe later, would become the point of departure for the first phase of my PhD theoretical development.

Simultaneously, I was engaging with a wide and interdisciplinary corpus of literature—from science education and literary theory to climate communication and scenario modelling—that have explored the epistemic and pedagogical functions of narrative (Avraamidou & Osborne, 2009; Soares et al., 2023; Ryan, 2005; Gould, 1992; Norris et al., 2005; O'Neill et al., 2017; Bushell et al., 2017; Bevan et al., 2020; Walsh & Stepney, 2020; Nikoleris et al., 2017). Some of these texts offered definitions and typologies; others offered provocations and critiques.

Gradually, a need emerged for a more operational model—a conceptual tool that could help identify, analyse, and compare different forms of CC narrative artefacts. So I began to sketch what would later evolve into the first version of the Narrativity Pyramid (D'Orto & Tasquier, 2025a): a model organised around layers of narrativity features, moving from basic structural narrative elements to genre-specific configurations. This conceptual construction was not intended to fix a definition of narrative, but to provide an analytical scaffold—a *provisional tool of inquiry* through which narrative complexity could be examined and tested.

This chapter documents the theoretical exploration and the development of that early model, including its epistemological foundations and its relation to Bruner's conceptual architecture. It did not fix a definition, but prepared the ground for further iterations. The pyramid that emerges in this phase was a provisional structure, an artefact of inquiry rather than a final product. And yet, as later phases of this research would confirm, the layered logic of the model offered a powerful lens both for design and the analysis of the educational interventions object of this PhD research. More specifically:

- Section 3.1 introduces the aims and rationale of the main exploratory literature review: how it stemmed out of the need to resolve an apparent paradox and what was its methodological approach;
- Section 3.2 presents the results of the review;
- Section 3.3 describes how the results were interpreted and synthesized into the design of the first version of the Narrativity Pyramid;
- Section 3.4 reinterprets the results of the prelude phase through the lens of the narrativity model, highlighting the emerging understanding of narrativity as a cognitive scaffold;

- Section 3.5 discuss and concludes the chapter, summarizing the conceptual and methodological insights that informed the subsequent phases of the research.

3.1 Main literature review

After the prelude phase, the research reached a pivotal juncture where it became necessary to address a foundational question that would orient its theoretical trajectory:

RQ1a) What do we mean when we speak of “narrative”, and how has its relationship with scientific reasoning been conceptualised across different disciplinary domains?

Facing this question required moving beyond disciplinary boundaries and engaging in a process of conceptual exploration. The aim was not to search for a single definition of narrative, but rather to map its multiple meanings and epistemic functions, as they emerge across different fields of study. This effort was guided by the conviction — central in science education research — that theoretical clarity is not an initial condition but a goal that must be progressively constructed through the dialogue among diverse traditions of thought.

To this end, I conducted an exploratory review of the literature spanning several disciplinary domains, from science and CCE to science communication and literary studies. The objective was to trace the conceptual boundaries and underlying tensions that shape the notion of narrative, and to understand how these different framings can contribute to rethinking its role in educational contexts characterised by complexity, uncertainty, and the need for meaning-making.

The following section presents the methodological principles that guided this review, while paragraph 3.2 discusses its main outcomes, showing how each disciplinary lens contributed to the gradual construction of a multifaceted understanding of narrative. Finally, paragraph 3.3 introduces the theoretical framework developed to address this question, integrating key insights and references that emerged from the literature review into a coherent conceptual structure guiding the subsequent phases of the research.

3.1.1 Methodological approach

Given the novelty and conceptual openness of this research topic, the review conducted for this study was exploratory in nature — a form of literature review particularly suited to emerging fields where conceptual boundaries are still fluid and theoretical foundations are under development (Torraco, 2005; Snyder, 2019). The aim was not to provide an exhaustive or systematic mapping of all existing publications, but to identify, through iterative exploration, the main conceptual frameworks and disciplinary traditions relevant to the role of narrative within CCE (CCE) and Science Education.

The process began with a broad search across academic databases such as Google Scholar and Scopus, combining the term narrative with other key concepts, including CC, science, science education, CCE, and science communication. This initial phase served to

delineate the range of disciplinary contexts in which “narrative” had been investigated in relation to science and climate, and to identify the most recurrent theoretical and methodological approaches.

Alongside peer-reviewed literature, the review also incorporated non-academic and science communication sources, such as essays and books written by science communicators and scholars discussing storytelling and narrative as tools for public engagement. Including these sources allowed for a broader understanding of how the notion of narrative circulates across academic and professional domains, an approach consistent with exploratory reviews that seek to integrate diverse forms of knowledge (Snyder, 2019).

From the first set of relevant publications, a snowballing strategy was applied (Webster & Watson, 2002): the reference lists of key articles were systematically explored to trace foundational and influential works, as well as recent studies expanding the field. This recursive, network-based approach enabled a progressive refinement of focus — moving from a general mapping of the use of “narrative” across disciplines to a more specific conceptualisation of narrativity within educational and communicative contexts.

Rather than following a linear procedure, the review evolved as a continuous and reflexive process throughout the doctoral project. Periods of more intensive exploration, particularly at the beginning of the PhD, were followed by targeted searches prompted by the need to clarify specific constructs or interpret emergent empirical findings. Such iterative refinement is a defining feature of exploratory literature reviews, which evolve in dialogue with the research process itself rather than preceding it as a detached preparatory phase (Booth, Sutton, & Papaioannou, 2016).

In this sense, the review aligns with interpretive and theory-building perspectives in the social sciences, which regard literature reviews as generative tools for constructing understanding rather than for aggregating evidence (Torraco, 2005; Snyder, 2019). The resulting corpus of literature thus represents a theoretically grounded yet flexible synthesis, structured around major disciplinary perspectives — including science education, CC communication (CCC), science communication, literary studies, and psychology of education — each contributing to refine the conceptualisation of narrative and narrativity developed in this thesis.

3.2 Literature review results

3.2.1 Psychology of Education: narrative as a way of thinking

The main framework adopted by this study is the one proposed by Jerome Bruner (1986; 1990), who postulated a fundamental distinction between two primary modes of human thought: the logico-scientific (or paradigmatic) mode and the narrative mode. The paradigmatic mode seeks universal truth conditions and explanations based on reasons, while the narrative mode focuses on organizing human experience and attributing meaning to actions and events in a temporally and culturally situated form. Bruner stressed that human psychology cannot be understood in isolation from culture, as “man’s participation in culture and the

realization of mental powers through culture" are foundational. In this framework, narrative is portrayed as inseparable from identity construction and social reality, as individuals are "expressions of a culture" and meaning is "rendered public and shared" through cultural participation. Narrative is a "natural vehicle" for "folk psychology"—a culture's account of "what makes human beings tick," including theories of mind, motivation, beliefs, desires, and intentions. It mediates between the canonical world of culture and the idiosyncratic world of individual beliefs, making the exceptional comprehensible and reiterating societal norms. The temporal organization inherent in narration is believed to aid memorization and learning because it resembles the way the human mind naturally organizes experiences. While logico-scientific thinking aims for general laws, narrative thinking allows for the exploration of particular connections between events, even engaging with hypothetical "what if" scenarios. The relationship between these two modes of thought, according to Bruner, is one of both complementarity—where narrative is essential for grasping the human and cultural dimensions of knowledge—and irreducibility, meaning it cannot be fully explained or replaced by scientific reasoning alone. Ultimately, achieving a balance involves integrating the rational, objective, and verifiable aspects of the world with a meaning-making process deeply rooted in human experience and oriented toward action.

3.2.1.1 Narrative thinking connection to sensemaking and agency

As it will be better explained in paragraph 5.2.1, this thesis frames sensemaking and agency as co-emergent processes within narrative-based educational practices. Sensemaking is understood as a dynamic interpretative and affective trajectory through which learners construct meaning about climate change by negotiating coherence between experience, knowledge, and values (Kurtz, 2014; Bengtsson et al., 2020). Agency is conceptualized as students' positioning within climate change issues, enabling them to recognize themselves as legitimate and causal actors capable of linking individual decisions to systemic consequences (Bengtsson et al., 2020; Tasquier & Pongiglione, 2017).

In the literature, narrative thinking has been connected to the two co-related dimensions of *sensemaking* and *agency* by stances exemplified by Kurtz (2014) and Fletcher (2023). As Fletcher explains in its "Storythinking: the new science of narrative intelligence", the historical biological function of narrative thinking (or storythinking) is producing "creative action, or in scientific lingo: reproducible new functions. That innovative conduct enabled the earth's first species to adapt and out-adapt each other." That means narrative thinking is what empower us *"to respond to unpredicted challenges and opportunities by linking creative actions into new plans— which is to say, new plots. That hatching of plots was narrative cognition. Aka, storythinking. Storythinking is contemplating why and what if. It's conjecturing from causes to effects. It's envisioning the consequences of different rules for action. It's mentally modeling hypotheticals, possibles, counterfactuals, and other kinds of could happen. It's using our cerebral machinery to stick original characters into never- before*

storyworlds and speculate on what happens next. It's natural selection, imaginatively accelerated" (Fletcher, 2024; Story chapter, pag.4). In Climate Change education environments that translate in understanding narrative thinking as a cognitive tool we need to use to find creative solutions about how we can— both collectively and individually— act in the world. And it is detached by logical-scientific ways of thinking because “creative action isn't derived, logically, from data. It comes about nonlogically through trial and error. A trial and error that occurs insentiently as synaptic improvisation and sentiently as storythinking” (Fletcher, 2024).

According to Kurtz (2014) sensemaking and narrative thinking are both cognitive processes that pertain to things we make decisions about; that connect to our practical needs; and that bring play into our thinking. However, *“storytelling and sensemaking are not synonymous, nor does either contain the other. There is storytelling outside of sensemaking, because there are reasons to tell and hear stories that don't connect directly to decision making. Stories can bind a community together, for example, or explain complex concepts, or entertain with humor, or communicate rules. There is sensemaking outside of storytelling too: the comparison of options, the presentation of arguments, the discovery of connections between facts. Still, the two activities do connect and influence each other, like intersecting sets in a Venn diagram. When I speak of narrative sensemaking, I mean the place where the two sets intersect”* (Kurtz (2014).

3.2.2 Science Education: The Role and Effectiveness of Narrative Texts

Two key contributions in Science education research can represent the interpretation and role of narrative as a tool for this field: *“The Role of Narrative in Communicating Science”* by Avraamidou and Osborne (2009) and *“Narrating science: Can it benefit science learning, and how?”*, a theoretical review by Soares et al. (2023).

Both studies emphasise the capacity of narrative to make science more meaningful, accessible, and emotionally engaging, particularly in addressing the challenges posed by the abstract and formal nature of traditional scientific discourse. Avraamidou and Osborne describe the language of science as an “exotic” and exclusionary code, often experienced by students as foreign and impersonal—a barrier that distances them from the subject matter and fosters alienation. Soares et colleagues echo this concern, citing Bruner (1986) itself, to argue that scientific discourse is cognitively and culturally distinct from everyday modes of thinking, and therefore demands significant scaffolding for learners to engage with it meaningfully. Narrative, in this context, is seen as a mediating tool that aligns more closely with the natural ways in which the human mind organises experience, with both studies highlighting its universal and cross-cultural dimensions: Avraamidou and Osborne, drawing on White (1981), describe narrative as a “metacode”, i.e. a fundamental human mechanism for meaning-making, while Soares and colleagues stress its temporal structure as cognitively resonant with human memory and comprehension. Based on that, empirical findings reviewed by Soares and colleagues suggest that narrative texts can significantly improve concept retention, especially in delayed assessments and long-term interventions. These

effects appear across a broad range of educational levels, from preschool to university, with particular benefits noted when narratives are integrated into extended, multi-session formats.

They also address common critiques of narrative—such as the risk of oversimplification of scientific content—by citing Gould (1992), who argued that any conceptual complexity can be conveyed in plain language, so long as pedagogical intent and epistemic integrity are preserved. In contrast to Avraamidou and Osborne, Soares places bigger against risks of overgeneralisation. Their review shows that the effectiveness of narrative is not uniform, nor is there evidence of a single, stable “narrative effect”. Rather, outcomes depend on a complex interplay of factors, including the nature of the text (e.g., fictional or factual content, representation of scientists, use of discovery stories), the characteristics of the activity (e.g., its goals, duration, and integration with other tasks), and the background of the learners (e.g., prior knowledge, cultural identity, socioeconomic status). Narrative appears especially helpful as a cognitive and affective scaffold for learners with limited prior exposure to scientific discourse, offering a more approachable entry point that can reduce anxiety and build self-efficacy.

Beyond cognitive gains, narrative texts have been shown to positively affect students' emotional dispositions toward science. Soares et al. report increased engagement, enjoyment, and a sense of relevance, while Avraamidou and Osborne link narrative to motivation and the humanisation of scientific knowledge. Narrative also stimulates imagination and visualisation—critical tools for making sense of abstract or invisible scientific phenomena—and supports divergent thinking by encouraging students to explore multiple perspectives and possibilities. These findings suggest that narrative enables a richer, more embodied form of science learning, in which facts are contextualised within meaningful, value-laden, and temporally structured experiences.

Both reviews conclude with recommendations for future research and educational practice. Soares et al. call for a focus on identifying “specific narrative effects”, emphasising the importance of asking not only whether narrative works, but how, for whom, under what conditions, and why. Similarly, Avraamidou and Osborne advocate for the development of a narrative-based pedagogy that moves beyond anecdotal enrichment to a more structured and intentional use of storytelling as a central tool for constructing scientific understanding.

In sum, while it is not a panacea, narrative offers distinctive affordances in science education for linking cognitive, emotional, and cultural dimensions of learning. To harness its full potential, educators and researchers must attend to the nuanced conditions under which narrative supports learning, and move toward pedagogical frameworks that view storytelling not as a marginal or decorative feature, but as a powerful epistemic tool capable of making science more human, more relevant, and more open to diverse ways of knowing.

Among the wide range of scientific concepts that students are required to engage with in order to make sense of CC, the notion of complexity occupies a particularly central position. Complexity is not merely an additional topic to be learned, but rather the very texture through which climate phenomena acquire meaning, demanding that students confront non-linearity,

emergence, and uncertainty. For this reason, before turning to the exploration of narrative within CCE and CCC, in the next paragraph we present what the literature has highlighted about the potential of narrative in representing complexity.

3.2.2.1 The Challenge and Potential of Narrating Complexity

My main reference for this topic was the book “Narrating Complexity”, edited by Richard Walsh and Susan Stepney in 2020 and gathering the perspective of more than 16 authors between narratologists and climate scientists. The image depicted by this book is that the relationship between narrative and complexity is marked by both tension and potential: while narrative is a deeply fundamental tool for human understanding, it often proves ill-equipped to fully capture the emergent, non-linear, and multi-scale nature of complex systems. That should suggest we reconsider narrative’s role from a representational device to a more generative and reflexive mode of engagement with complexity.

But why is narrative not suitable for representing complexity? As Walsh (2020) argues, narrative is always at its core a semiotic articulation of linear temporal sequence that inherently favours pattern recognition and coherence over systemic causality. That is a risk of epistemic blindness: we grasp the emergent behaviour of a system narratively, while neglecting the underlying interactions that produce it. What is interesting is that it is not just a challenge for students, but for any human being, Climate scientists included. This cognitive limitation places us, as Walsh describes, at the “edge of sense”—a threshold where complexity can be intuited but not fully grasped, evoking both epistemic wonder and frustration. Stepney (2020) further clarifies that in complex systems, solutions are not additive and causality is not linear; what emerges cannot be decomposed into the behaviour of parts. Poulaki (2020) extends this notion to the aesthetic domain, suggesting that certain narrative forms—such as complex films—can resist anthropocentric causality and instead foreground distributed agency and pattern-based emergence.

Time, as a constitutive element of both narrative and complex systems, further complicates this relationship. Caves, Stepney, and Uprichard (2020) stress that complex systems operate across multiple temporalities, which often exceed the scale of human experience and resist narrative linearity. Edwards (2020), through a performative layering of historical, personal, and scientific conceptions of time, reveals the narrative tensions inherent in attempting to synchronise non-linear temporalities. These insights point toward the necessity of developing new narrative forms—what Stepney and Walsh (2020) call *complex narratives*—capable of accommodating feedback, emergence, openness, and reflexivity.

As we said at the beginning, these challenges invite a reconsideration of narrative’s role not merely as a representational device, but as a generative and reflexive mode of engagement with complexity. Bernini (2020) proposes that certain literary forms—such as the works of Samuel Beckett—function as fictional cognitive models, using narrative devices to simulate the dynamic and distributed processes that constitute subjective experience. His concept of a “narrative dynamic core,” composed of language, time, agency, and imagination, offers a theoretical framework for exploring how narrative can model, rather than merely describe, the emergence of self and meaning in complex systems.

Other authors have investigated the interplay between narrative and complexity in applied contexts such as CC and systemic design. Moezzi, Janda, and Rotmann (2017) show how stories, narratives, and storytelling practices provide not only alternative forms of data, but also methodological tools and participatory processes that allow researchers and stakeholders to engage with the “hyperobject” of CC in situated, affective, and culturally resonant ways. Similarly, Nikoleris et al. (2017) illustrate how literary fiction can complement scientific scenario modelling—such as the SSPs—by embedding policy dilemmas, societal tensions, and imaginaries of the future within concrete human narratives. In the field of drug design, Bown and Goltsov (2020) demonstrate how narrative-informed visualisation tools can support clinicians in interpreting complex signalling networks, suggesting that narrative-like structures can serve as interfaces between human cognition and systemic dynamics.

While traditional narrative tends to domesticate complexity through closure and coherence, the emerging dialogue between narrative theory and complexity science suggests the possibility of transforming narrative into a more dynamic, exploratory, and experiential medium. Interactive narrative technologies, speculative fiction, and performative frameworks are among the experimental arenas in which this transformation is taking shape. As Stepney and Walsh conclude, complex narratives may not offer totalising explanations, but they can provide a form of *knowledge by acquaintance*—a situated, reflexive, and embodied mode of knowing that is particularly suited for navigating the uncertainties and pluralities of our complex world.

3.2.3 Climate Change education and communication

Narratives play a crucial epistemic and educational role in addressing the multifaceted challenges of CC. In CCC, as Veland et al. (2018) argue, overcoming the limitations of the traditional “information deficit model” requires more than the dissemination of scientific facts: it demands addressing a “narrative deficit,” which entails engaging with protagonists, temporalities, and situated places that enable people to navigate uncertainty and risk. In this view, stories—whether drawn from literary fiction, qualitative data, or participatory practices—become powerful instruments for world-making. They do not merely illustrate abstract knowledge but actively shape how individuals perceive, relate to, and act within complex socio-environmental systems.

Unlike generalised and often neutral climate scenarios such as the Shared Socioeconomic Pathways (SSPs), which aim for broad applicability, fictional narratives offer situated perspectives anchored in specific times, places, and characters. Nikoleris et al. (2017) show how narratives allow for the articulation of motivations, fears, and beliefs that shape adaptive or maladaptive responses to CC—elements often absent in quantitative models. For example, works like *Flight Behavior*, *The Rapture*, or *Science in the Capital* serve not just as speculative futures but as experiential laboratories that explore the emotional, ethical, and psychological complexities of climate action. These stories render CC tangible, shifting it from a distant, abstract problem to a proximate and personal reality, often through the reader’s identification with protagonists.

Furthermore, narratives are not only reflective tools but performative agents of change. Moezzi et al. (2017) emphasise that storytelling—particularly when used in participatory formats—can unsettle dominant paradigms, amplify marginalised voices, and foster new imaginaries. Narrative practices such as scenario workshops and climate fiction can create affective and cognitive spaces where stakeholders collectively imagine and rehearse alternative futures. Indigenous and non-Western narrative traditions, often decentring the human and embedding spirituality in environmental relationships, offer ontological diversity that challenges anthropocentric assumptions and broadens the horizons of sustainability.

Importantly, narratives provide a means to grasp the psychological, cultural, and political dimensions of CC. They reveal how inequality, trust, disbelief, and apathy intersect with vulnerability and agency. By weaving together the global and the local, the scientific and the experiential, narratives can bridge epistemological divides and create resonance across diverse audiences. They help expose the limitations of prescriptive approaches to wicked problems and instead offer exploratory modes of sense-making that embrace ambiguity, complexity, and pluralism.

In this sense, fiction and storytelling do not simply convey messages; they reconfigure what is imaginable and thus what is possible. When read alongside scientific scenarios, narratives can enrich our capacity to understand systemic futures while offering concrete, emotionally meaningful pathways for engagement. Rather than seeking a singular master story, the task becomes to foster a plurality of narratives that reflect diverse identities, values, and epistemologies. Only by embracing such narrative multiplicity can climate communication and education begin to address the deep structures of belief, hope, and motivation necessary for transformative change.

3.2.4 Science communication: Strategic Narratives and the Action Gap

Within the field of science communication, increasing attention has been devoted to the role of narratives not only as tools for translating scientific knowledge, but also as strategic instruments for mobilizing public engagement and collective action. Two particularly influential contributions in this area are the works of Bushell et al. (2017) and Bevan et al. (2020), which explore the notion of *strategic narratives* in the context of CC. These studies approach narrative not merely as a communicative format, but as a powerful sociopolitical device capable of shaping perceptions, values, and behaviours across different audiences.

Both Bushell et al. (2017) and Bevan et al. (2020) address the role of strategic narratives in CCC, positioning them as essential tools to bridge the persistent gap between scientific knowledge and meaningful action. Referred to respectively as “stories with a purpose” (Bevan et al., 2020) and as “stories that define a disrupted order and propose its resolution” (Bushell et al., 2017), strategic narratives are seen as key to translating the complexities of climate science into engaging frameworks for public and policy engagement. While Bushell et al. emphasize the need for a coherent top-down narrative capable of coordinating large-scale responses, Bevan et al. draw attention to the recent rise of bottom-up narratives emerging from civil society, arguing for their higher resonance and perceived authenticity.

Both articles underscore the communicative challenges posed by CC as a “super-wicked problem.” Among its features are a time-lag between causes and consequences, hyperbolic discounting in public perception, and its nature as a global public good vulnerable to the “tragedy of the commons.” Additionally, cognitive dissonance, psychological distancing, cultural barriers, and the low newsworthiness of slow-onset issues all hinder public engagement. In this context, strategic narratives offer not only explanatory frameworks but also motivational resources, creating structures that link personal values to collective futures.

A strategic narrative must meet four criteria: it must be agentive (involving actors), temporal, causal, and interpretable (Bevan et al., 2020, drawing on Miskimmon et al., 2010). It operates both as a persuasive and coordinative instrument, able to connect small-scale events to larger storylines. The narrative process unfolds in three recursive phases: formulation by actors, projection through media, and reception by publics, each shaped by their sociocultural worldview. According to Fisher’s narrative paradigm, humans are “homo narrans”, evaluating stories less by logical coherence and more by narrative rationality—that is, narrative coherence and narrative fidelity to their existing values.

Bushell et al. (2017) identify various narrative archetypes that either support or hinder climate action. While narratives such as the “Gore narrative” (emphasizing scientific certainty) or “polar bear narrative” (emphasizing distant victims) aim to foster concern, they often backfire due to emotional disengagement, mismatch between problem and proposed solution, or the credibility gap of institutional narrators. Conversely, obstructive narratives like “climate change is a hoax” or “decarbonization threatens economic growth” are effective precisely because they align with dominant social norms and exploit public skepticism. Bevan et al. (2020) extend this analysis with five post-IPCC 2018 narratives in the UK, including the “12 years to save the world” framing, Extinction Rebellion’s collapse narrative, school climate strikes, parliamentary declarations of climate emergency, and consumer-oriented narratives such as plastic reduction. These narratives vary in their capacity to mobilize action depending on the strength of their narrative breach, transport, moral clarity, and credibility of the narrator.

A key point of divergence between the two sources lies in the role of narrators and the organization of narrative authority. While Bushell et al. recommend a unifying, centralized narrative—ideally disseminated by credible institutions—Bevan et al. argue that bottom-up narratives have proven more effective in the current media ecosystem. They suggest that institutional actors such as the IPCC, constrained by political neutrality and lacking narrative legitimacy, may be ill-suited to lead this communicative effort. In contrast, grassroots narratives—such as those advanced by the Extinction Rebellion or the Fridays for Future movement—benefit from a perception of authenticity, emotional resonance, and digital connectivity, enabling spontaneous yet coordinated global diffusion.

However, the embrace of pluralistic, bottom-up narratives introduces its own challenges. Fragmentation, co-option, and misinformation can weaken collective impact. Nonetheless, Bevan et al. (2020) argue that the current media landscape favors narrative pluralism over top-down coherence. The effectiveness of climate narratives, therefore, depends not only on

their content and structure but also on the identity, trustworthiness, and relational positioning of the narrator.

In sum, these studies reveal that strategic narratives are not ancillary to climate action but integral to its possibility. Whether emerging from institutional or grassroots origins, narratives must be crafted with attention to temporal structure, narrative coherence, cultural resonance, and epistemic credibility. Future research should further explore the interaction between narrative form, messenger identity, audience values, and sociopolitical context, particularly in relation to the rise of counter-narratives and disinformation. A nuanced understanding of these dynamics is critical to designing narrative interventions capable of mobilizing diverse publics toward collective climate futures.

3.2.5 Literary Studies: Three complementary perspectives

In literary studies, narrative is widely recognized as a multifaceted and dynamic concept that extends beyond the confines of any single medium or discipline. Although its interpretation varies across different theoretical traditions, there is a shared understanding of narrative as a fundamental mode of human meaning-making. This synthesis draws upon three influential perspectives—Richard Walsh, Marie-Laure Ryan, and Jean-Michel Adam—to explore the key elements and theoretical contributions that shape contemporary understandings of narrative.

Richard Walsh conceptualizes narrative as "the semiotic articulation of a linear temporal sequence," emphasizing its role as a cognitive and interpretive logic rather than a mere textual or event-based category. Walsh argues that narrative is a fundamental cognitive operation through which humans make sense of temporal and causal relationships. It is not merely a passive form of representation but an active process of signification that emerges through the interplay between production and reception. Crucially, Walsh underscores the semiotic nature of narrative: it is not confined to language but manifests across diverse media, including visual art, film, and performance. Narrative, for Walsh, always implies a spatiotemporal perspective shaped by the subject's context of action and interpretive framework. This perspectivity entails an implicit attribution of causality and agency, even in minimally structured sequences. While acknowledging the anthropocentric basis of narrative understanding, Walsh also identifies a paradox: narrative is itself a nonlinear dynamic system, yet it often struggles to represent the complexity of such systems explicitly. This tension, however, is not a limitation but a generative feature that enhances narrative's cultural and cognitive utility.

Marie-Laure Ryan advances a transmedial and cognitive approach to narratology. She critiques earlier models that narrowly define narrative in linguistic or literary terms, noting that such definitions exclude non-verbal and non-retrospective narrative forms. Ryan proposes a more inclusive and medium-independent definition, building on H. Porter Abbott's formulation of narrative as "the representation of an event or series of events." She adapts this definition to encompass narratives that unfold in real time, such as live broadcasts and interactive media. Her framework rests on a cognitive checklist with three

core features: the evocation of a world inhabited by agents and objects; the occurrence of unpredictable changes of state caused by either external events or deliberate actions; and the integration of these events with mental states such as goals, plans, and emotions, which provide coherence and intelligibility. Ryan draws a distinction between being a narrative—a semiotic artifact intentionally crafted to trigger a narrative schema—and possessing narrativity, which refers to the capacity to evoke narrative understanding regardless of authorial intent. She emphasizes the importance of distinguishing between medium and genre: while media impose specific material and technological constraints, genres emerge from social conventions and expectations. Her approach thus facilitates the comparative analysis of narrative structures across diverse platforms and formats.

Jean-Michel Adam, a leading figure in textual linguistics, offers a sociocultural and pragmatic perspective on narrative. He treats texts as socially embedded objects shaped by both their internal textual features and the broader communicative contexts in which they are produced and received. Central to Adam's theory is the role of textual genres, which serve as abstract, culturally situated templates guiding the construction and interpretation of texts. He argues that genres such as fables, scientific reports, or procedural manuals establish expectations about content, purpose, and audience, thereby shaping the narrative character of a text. Adam further highlights the interplay between pragmatic and textual components: narrative coherence emerges not solely from formal narrative sequences but from the integration of enunciative features, communicative aims, and sociocultural expectations. He underscores that most texts are hybrid in nature, combining narrative and non-narrative elements in response to contextual demands. Narrativity, therefore, is not an inherent property of a text but a situated phenomenon arising from the interaction of multiple discursive layers.

Despite their differing emphases, the perspectives of Walsh, Ryan, and Adam converge on several foundational principles. First, they all affirm the centrality of temporality and eventfulness: narrative is fundamentally concerned with the organization of events across time. Second, they emphasize that narrative is a structure of meaning, not a mere sequence of happenings. It organizes experience into intelligible configurations that support memory, communication, and reflection. Third, all three scholars highlight the necessity of active interpretation in narrative comprehension. Whether through cognitive engagement, social negotiation, or semiotic decoding, audiences play a crucial role in constructing the meaning of narrative texts. Fourth, they recognize narrative as a tool of sense-making, instrumental in rendering complex phenomena comprehensible and relatable.

3.2.5 Climate Science: Narratives for Scenario Modelling

In the domain of climate modelling, O'Neill et al. (2017) define the Shared Socioeconomic Pathways (SSPs) as coherent narratives of alternative futures. These SSPs are a new generation of scenarios, developed as part of a larger framework that includes Representative Concentration Pathways (RCPs) and Shared Policy Assumptions (SPAs). They are characterized as exploratory scenarios that aim to construct plausible representations of the future, integrating both qualitative elements (such as storylines and narratives) and quantitative data to create distinct "future worlds". The purpose of SSPs is not to predict the future, but rather to serve as "learning machines" or "thought-experiments"

that help envision alternative future contexts against which current climate policy strategies can be articulated and tested for robustness. They are designed to "portray worlds that have varying challenges to mitigation and adaptation". While grounded in quantitative models, SSPs are structured as plausible stories featuring causal dynamics and collective actors, specifically designed to explore scenarios of mitigation and adaptation. This integration means that narrative is not merely an external communication tool but is fully integrated with science, serving as the means through which science can express and communicate complex uncertainties in accessible and comparable forms. For instance, SSP1 (Sustainability) describes a world with low mitigation and adaptation challenges due to inclusive development, while SSP3 (Regional Rivalry) presents a future with very high challenges driven by nationalism and fossil fuel dependency. Unlike literary fiction, which is "always situated" with specific characters and perspectives, SSPs tend to be more general and strive for neutrality. However, their narrative features allow them to be compared with climate fiction, providing a constructive method to systematize and categorize these imagined worlds. The utility of such climate storylines, similar to SSP narratives, extends to acting as a "pidgin language" that simplifies complex concepts for effective interdisciplinary collaboration between climate scientists and broader society, enhancing the meaningful interpretation of data.

3.2.7 Discussion

At this point in my research, the literature I had reviewed across disciplines offered a set of diverse yet convergent conceptualisations of narrative. Narrative emerged as a construct that transcends disciplinary boundaries and media constraints, yet whose internal coherence seemed to rest on a shared functional core: its power to organise temporally structured meaning and foster human engagement. However, my own reflection still proceeded along two distinct conceptual tracks. On the one hand, I approached narrative as a representational artefact—a product, whether textual, audiovisual, or multimodal. On the other, I was beginning to think of narrative as a cognitive mode—a way of thinking and making sense of the world. These two threads coexisted productively, although, at this stage, not fully or clearly integrated. While I did not yet developed the conceptual clarity to fully address this issue, I began to treat it as a generative tension. The provisional definition I was working with, loosely inspired by Bruner's distinction between paradigmatic and narrative cognition, posited narrative thinking as "the ability to construct or critically evaluate a narrative, just as scientific thinking involves the ability to construct or assess a scientific theory." This definition was useful as a heuristic but clearly limited. Yet this basic definition allowed me to address the apparent paradox of Bruner's thesis of two modes irreducibility (as discussed at the beginning of the Chapter).

The specific sub-question that guided this next phase then was:

SQ1b) *How can insights from existing research and exploratory data be synthesised into an operative model for investigating the interplay between narrative and paradigmatic thinking and resolving the irreducibility paradox?*

3.3 Towards a theoretical model: the First Narrativity Pyramid

The three-layer Narrativity Pyramid that I am going to present in this paragraph emerged naturally to respond to the SQ1b question.

The key concept that allowed me to address Bruner's paradox of irreducibility was the idea of narrativity as a continuum. It made it possible to conceive the two modes of thinking—the paradigmatic and the narrative—not as mutually exclusive categories but as the opposite poles of a graduated scale. To identify which steps along this scale were relevant for CCE, I proceeded by tracing the conceptual knots that had recurrently emerged in the literature and linking them to the artefacts in which they were most typically embodied.

I started precisely from the artefacts that had triggered the paradox in the first place: the Shared Socioeconomic Pathways (SSPs) and the storylines that accompany them. If one considers, following Adam's T-L framework, that a narrative must contain a full textual configuration with enunciator, narratee, and an organised sequence of events leading to closure, then SSPs and storylines cannot be regarded as proper narratives. As discussed by Nikoleris et al. (2017), they lack narratorial agency, character development, and emplotment: their temporal progression is descriptive rather than experiential, and their coherence stems from consistency criteria rather than causal necessity.

Nevertheless, they display the three fundamental components of narrativity identified by Miskimmon and colleagues—temporality, action, and causality—since they arrange events along a timeline, depict actors undertaking actions, and articulate cause–effect relations within the dynamics of socio-technical change. This observation suggests that paradigmatic reasoning can operate effectively at low degrees of narrativity, where explanatory coherence and systemic representation dominate, while higher degrees of narrativity correspond to forms of reasoning closer to the narrative mode, oriented toward meaning-making, empathy, and value-laden interpretation.

Within this perspective, the field of future-oriented science education offers a crucial reference. As theorised by Levrini and colleagues (Levrini et al., 2019; Tasquier & Levrini, 2020; Levrini et al., 2021), future-oriented education aims to develop students' capacity to engage with the future as an epistemic object. It emphasises the integration of scientific reasoning with socio-ethical reflection and imagination, promoting futures literacy and anticipatory competence as core components of scientific literacy. Activities such as scenario-making or the narrative construction of future worlds exemplify this approach: they represent high-narrativity practices that allow students not only to imagine but also to reason within constructed futures, exploring the epistemic and ethical dimensions of uncertainty. In doing so, they show how narrative thinking, when fully enacted, can foster anticipatory imagination and integrative sense-making about complex socio-scientific issues.

Among the elements that define narratives (Adam, 1997, 2011), genre assumes a particularly significant role for CCE. As Ghosh (2016) argues, dominant literary and cultural genres often constrain the imagination of the climate crisis, relegating it to the domains of science fiction, dystopia, or catastrophe. In contrast, educational scenario-making practices

typical of future-oriented science education are generally not bound to a specific style or genre. They invite the construction of futures through open, collective, and hybrid narrative forms, where plausibility is prioritised over aesthetic coherence. This difference reveals the complementary relationship between artistic and educational narratives: while the former crystallise the cultural imaginaries of CC, the latter can act as laboratories for reconfiguring them. Exploring genre as an educational variable thus becomes a way to question and reshape the collective frameworks through which futures are conceived and narrated—turning narrativity itself into a space for epistemic and cultural transformation.

The synthesis of this reflection led to the definition of a model of narrativity capable of describing, categorising, and relating different forms of narrative artefacts within CCE. The choice of the term model emphasises the goal to construct a structured and operational tool. While a framework generally delineates conceptual boundaries, a model—as in scientific practice—entails a system of relations that can be applied, tested, and progressively refined through empirical work.

The Narrativity Model was aimed firstly to classify CC narrative artefacts that could be used in educational contexts, according to their degree of narrativity and their distinctive representational features and through that to clarify the relationship between such artefacts and Bruner's two modes of thinking, identifying how each form may elicit different cognitive and interpretative processes. Finally, it was designed to provide an operative lens for hypothesising and investigating how narrativity-loaded artefacts may influence students' engagement with the core dimensions of CCE—including complexity, uncertainty, values, and agency. In this sense, the model positioned narrativity not only as a theoretical construct but as an analytical and design tool to explore the interplay between reasoning, imagination, and meaning-making in educational practice.

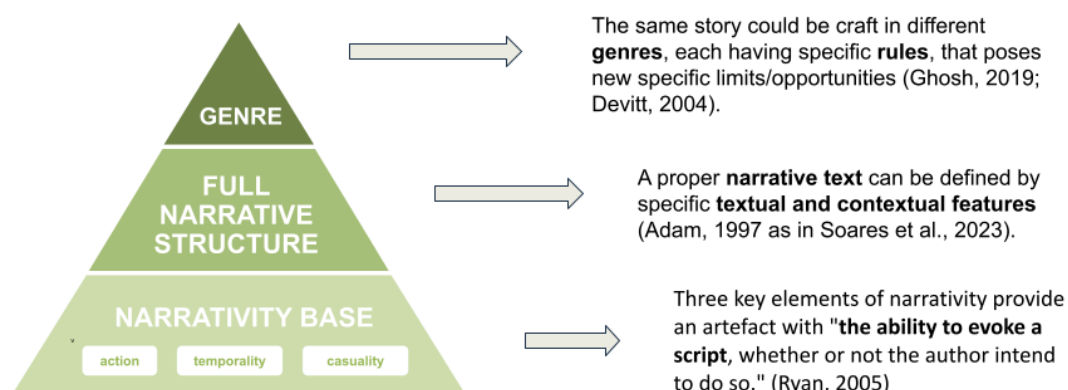


Figure 3.1 *First design of the Narrativity Pyramid for CCE.* This figure illustrates the first version of the theoretical model, in the form of a multi-layered tool to categorize CC narratives for CCE through the concept of narrativity. It is structured into three hierarchical layers, each defined by typical narrativity elements. A "complete" narrative text, as a novel, has all layers. However, the concept of each of the layers makes sense without the upper ones and they can be recognized and employed independently.

As shown in Figure 3.1, the pyramid was structured into three progressive layers:

Layer 1 – Narrative Base

This foundational layer includes artefacts that, by embodying the three key elements of narrativity—action, causality and temporality—are able to evoke narrative scripts without fully enacting them. Climate storylines (Shepherd et al., 2018) and the SSPs scenarios (O'Neill et al., 2017) exemplify this layer: they organise events into causal and temporal chains, yet they lack the employment and characterisation of fully developed stories. Crucially, they offer rigorous, systemic representations that remain compatible with paradigmatic reasoning. These artefacts inhabit a hybrid zone—between explanation and imagination—where scientific logic meets proto-narrative structure.

Layer 2 – Full Narrative Structure

This is the layer where narrative enacts its full features, as described in the T-L framework (Adam, 1997). Specifically, the artefacts of this layer have a linear structure made of codified sequences (textual features) that introduce characters, settings, plot, conflicts and themes (contextual features). At this layer, actions are not abstract outcomes of systemic forces, but context-bound choices made by agents with partial knowledge and conflicting goals. This layer, embodying the aim of narrative thinking, traces a threshold for pure paradigmatic thinking compatible artefacts (narrative as scientific tools, have not usually such a high level of narrativity). An example of artefacts of layer 2 are CC scenarios created by students in future-oriented activities (Barelli et al., 2022). Those artefacts allow learners not only to imagine what might happen, but to explore what it means to live within those futures.

Layer 3 – Genre

The third layer expands the scope of analysis beyond structure and content, focusing instead on how a story is told and what is the cultural load linked to this literary choice. That means that tone, medium, aesthetic codes, and narrative conventions all become meaningful elements that shape interpretation. The same future can be rendered as dystopian nightmare or as solarpunk utopia: the genre does not simply decorate the story, it positions it ideologically, framing what is imaginable, desirable, or inevitable. In this sense, genre is not just a literary concept but a cultural tool: it participates in the construction of what society can hope for, fear, or collectively strive toward. An example of artefact of this layer is “The Ministry for the Future” by Kim Stanley Robinson (2020), a near-future novel that envisions the global political, scientific, and moral struggles of humanity as it confronts the escalating climate crisis, blending dystopian realism with cautious optimism about collective transformation.

The Narrativity Pyramid in this version marked a first step toward bridging the representational and thinking dimensions of narrative. In this sense, the Narrativity Pyramid laid the basis for formulating a set of hypotheses about the educational roles that different degrees of narrativity may play in CCE. Each layer, distinguished by specific features, was associated with a potential pedagogical function derived from the literature on narrative thinking (Bruner, 1990; Norris et al., 2005), science education and communication (Avraamidou & Osborne, 2009; Bevand et al. 2020) and climate scenario storytelling (Moezzi, Janda & Rotmann, 2017; O'Neill et al., 2017).

At the narrative base, artefacts built around action, temporality, and causality were hypothesised to foster understanding of climate complexity and uncertainty, supporting paradigmatic reasoning in CC-related dynamic and systemic contexts.

At the level of full narrative structure, where stories include characters, settings, conflicts, and plots, narrative thinking starts to “prevail” on the paradigmatic. Engaging with this layer is expected to promote emotional and empathic connections and to enable reflection on conflict and values, in line with proposals that narrative can humanise science and connect abstract phenomena to lived experience (Avraamidou & Osborne, 2009).

Finally, the genre-specific layer, characterised by aesthetic conventions, tone, and cultural stereotypes, was associated with the ability to challenge dominant imaginaries and to stimulate critical and creative re-imaginings of socio-technical futures (Moezzi et al., 2017).

As summarised in Table 3.1, taken together, these hypotheses conceptualised narrativity as a layered representational and thinking dimension and outlined its multifaceted role within CCE.

Table 3.1. *Summary of the Narrativity Pyramid’s structure and hypothesised roles for CCE.*

Degree of Narrativity	Artefact Indicator	Specific Features	Hypothesis of role for CCE
Layer 3	Specific genre	Tone, style, themes, stereotypes, aesthetic conventions, narrative techniques	Challenge dominant imaginaries
Layer 2	Full narrative structure	Textual features (text-plan), contextual features (settings, characters, plot, conflicts, theme)	Develop emotional and empathic connections, recognise and reflect on conflict
Layer 1	Narrative base	Action, temporality, causality	Understand climate complexity and uncertainty

Even in its initial and still somewhat immature form, this pyramid proved to be a generative tool. It opened up numerous theoretical and pedagogical questions, many of which became the foundation for the analysis and redesign of the *FyouTURES* activity. As we will analyze in detail, the game already contained the features of Layer 1 and some of Layer 2, but it lacked a “motive force”: the emotional drive, the conflict, the voice. The redesign emerged precisely from this gap—the attempt to integrate a narrative space capable of guiding students toward a more complete educational experience. Not to replace systemic thinking, but to accompany it, place it under tension, and make it resonate with the human, historical, and moral dimensions of CC.

3.4 Re-analysis of prelude's results through the first Narrativity Pyramid

Revisiting the results of the prelude phase—which encompassed both the ONSCI workshop and the PNRR implementation —allows for a deeper understanding of the role that narrativity, even in its embryonic form, played in shaping learners' engagement and reasoning about CC. Viewed through the first version of the Narrativity Pyramid, these early experiences reveal a crucial pattern: students were working within a specific narrative genre, activating the interpretive and emotional repertoires culturally embedded in that genre, yet without consciously engaging with the more foundational layers of narrative thinking.

In both contexts, students were introduced to the mockumentary as an unconventional way of representing CC. The genre's hybrid nature—oscillating between fact and fiction—provided a powerful aesthetic and communicative stimulus. It invited them to play with the codes of scientific communication, to blur the boundary between realism and imagination, and to use irony and parody as instruments of reflection. Following Ryan's (2005) insight that different media afford different "degrees of narrativity," the mockumentary offered a fertile middle ground between scientific explanation and narrative world-making. Students quickly appropriated its tone and stylistic conventions, showing creativity and humour, but also a tendency to remain confined within the expressive possibilities that the genre itself culturally provided.

At this level—the upper layer of the first version of the pyramid, corresponding to genre—the stories produced were coherent and engaging, but they reflected the cultural templates of the mockumentary more than the students' own cognitive constructions. The irony typical of the format served as a safe distance from the anxiety of climate futures, yet it also limited the possibility of developing deeper forms of identification and reflection. As Bruner (1990) reminds us, the narrative mode is not simply about telling stories; it is a mode of meaning-making that allows one to interpret human action, temporality, and intentionality. In the prelude activities, irony often replaced this interpretive function: rather than interrogating the moral or temporal implications of climate issues, students played with their representation.

The mockumentary thus acted as a cultural mediator rather than a cognitive one. It provided an accessible stage on which participants could dramatise climate debates, but without the structural scaffolds necessary for narrative reasoning to emerge. In the ONSCI workshop, for instance, the group that developed a futuristic talk show around the opposition between nuclear and solar energy constructed their narrative around a polarised argumentative structure. The two characters were designed as rhetorical opposites—caricatures of opposing ideologies—whose confrontation unfolded as a logical debate rather than as a narrative arc. The conflict was about ideas, not through them. Similarly, in the PNRR implementation, where high-school students produced short videos imagining positive climate futures, most artefacts presented idealised or moralising endings, where conflicts were resolved through sudden consensus or technological optimism. In both cases, the stories remained anchored to what Bruner (1986) would call the paradigmatic

mode—focused on problem-solving and rational justification—while the narrative mode, oriented toward ambiguity and moral tension, remained underdeveloped.

The absence of explicit scaffolding at Layer 2, the full narrative structure, helps explain this outcome. This layer corresponds to the level at which narrative thinking organises meaning through plot, character, causal connections, and temporal progression (Norris et al., 2005). Without structured guidance at this level, students relied on the surface codes of the genre rather than on the inner logic of narrative construction. They did not explicitly work on how events lead to consequences, how characters evolve, or how conflicts transform into understanding. As a result, their stories often displayed a fragmented logic, alternating moments of strong emotional expression with abrupt resolutions or moral conclusions.

The same limitation applies to Layer 1, the narrative base, which concerns the basic sense of action, temporality, and causality. These principles were implicitly present—every story unfolds in time—but they were not consciously used as tools for thought. Students tended to focus on representing what the future should look like rather than on exploring the dynamics of how it might come to be. The future thus appeared as a goal, not as a process. The underlying causal chains, uncertainties, and tensions that define climate complexity were often reduced to linear progressions or simple cause-effect relations.

To systematise this interpretation, Table 3.2 summarises the analysis of the students' artefacts across the three layers of narrativity, highlighting for each level its characteristic features, empirical evidence, and educational implications.

Table 3.2. Analysis of students' artefacts through the three layers of narrativity

Layer	Core narrative features	Empirical evidence (ONSCI / PNRR)	Observed epistemic function	Limitations / missing elements	Educational implications
3	Genre, style, conventions, aesthetic codes	Use of <i>mockumentary</i> format; irony, parody, play with fact/fiction; strong creativity and humour	Genre as <i>cultural mediator</i> enabling engagement and emotional distance	Reproduction of cultural templates; limited moral reflection and identification	Genre alone insufficient to foster reasoning; needs integration with deeper cognitive scaffolds
2	Plot, conflict, causal progression, character development	Linear and argumentative structures; absence of evolving conflict (e.g. <i>talk show</i>); idealised or moralising endings in PNRR videos	Limited emplotment; events linked by logic rather than by experiential transformation	Fragmented narratives; lack of causal and temporal depth	Necessity of explicit scaffolding for plot construction and conflict resolution

1	Action, temporality, causality	Futures depicted as goals rather than processes; time used descriptively, not dynamically	Implicit temporal and causal reasoning; intuitive grasp of complexity	Simplification of systemic relations; linear cause–effect reasoning	Need to activate temporal-causal reflection and process-based reasoning about futures
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In retrospect, this reveals how, in the prelude phase, students engaged narratively at the expressive level but not yet at the cognitive one. They were able to translate scientific or social issues into story form, but they did not use narrative as a reasoning structure. Bruner (1990) describes this gap as the difference between storytelling about the world and constructing a world through storytelling. The latter requires precisely the kind of scaffolding that the Narrativity Pyramid would later articulate: a progression from the implicit logic of events (Layer 1), to the explicit construction of plot and perspective (Layer 2), up to the adoption of specific stylistic and cultural conventions (Layer 3).

By working exclusively at the top of this structure, students in both the ONSCI and PNRR activities were limited to the discursive affordances of the genre. In the talk show, the conflict was treated as a competition between ideas rather than as an evolving tension between values or worldviews. In the high-school videos, utopian and dystopian tones replaced nuanced moral reflection. The result was a form of narrative flattening, in which the stories effectively communicated a message but failed to represent the inner contradictions of acting within uncertainty. Nikoleris et al. (2017) point out that in climate education, meaningful narratives emerge precisely when learners confront these contradictions—between knowledge and action, optimism and paralysis, progress and loss. Without this structural dimension, students’ reasoning remained rhetorical rather than interpretive.

This interpretation also clarifies why the integration between paradigmatic and narrative thinking—later identified as the core objective of the research—was not yet observable. The paradigmatic mode dominated the reasoning process, while the narrative mode was confined to the outer layer of expression. The two modes coexisted but did not interact: argumentation served as structure, and narrative form as decoration. Only later, when the Narrativity Pyramid became a design framework, would it become possible to intentionally orchestrate these two modes in productive tension.

Seen from this perspective, the prelude phase represented a fertile but transitional stage in the development of the theoretical model. It demonstrated the intuitive potential of narrative genres to stimulate engagement and emotional resonance, while also revealing their limits when not grounded in deeper narrative reasoning. The creative enthusiasm of both university and high-school students confirmed that narrative formats can act as powerful entry points into complex issues such as CC, but also that genre alone is not enough. Without guidance in constructing plots, conflicts, and transformations, students risked reproducing dominant imaginaries instead of critically challenging them—a risk particularly evident in the recurrence of stereotypical endings and idealised futures.

At the same time, these early experiments were instrumental in exposing the need for a theoretical model capable of distinguishing between narrative language and narrative thought. The first version of the Narrativity Pyramid emerged precisely from this insight: that working with narratives requires supporting students in navigating multiple layers of meaning, from the causal organisation of events to the moral and aesthetic conventions that give those events cultural resonance. As Walsh and Stepney (2018) note, narrative thinking enables one to “domesticate complexity” by linearising experience without erasing its circularity. Yet this epistemic function of narrative can only emerge when learners are guided to engage with its internal mechanisms rather than its external forms. Table 3.3 synthesises the main findings and implications for the subsequent design phase.

Table 3.3. *Summary of insights emerging from the re-analysis.*

Analytical level	Findings	Implications for research design
Conceptual	Students operated mainly at the expressive level (genre), not at cognitive levels (structure/base)	Validation of the <i>Narrativity Pyramid</i> as an analytical and design framework
Methodological	Lack of scaffolds prevented the activation of narrative reasoning	Future interventions must include tasks guiding causality, temporality, and conflict
Educational	Narratives engaged students emotionally but did not foster epistemic reflection	Design activities that make the <i>process</i> of story construction explicit, not just its product

In summary, the reinterpretation of the prelude phase through the Narrativity Pyramid reveals that the early activities succeeded in activating narrativity as form but not yet as process. Students adopted the aesthetic language of the mockumentary to explore the climate issue, but the absence of explicit scaffolds at the foundational and structural layers limited their capacity to integrate paradigmatic reasoning with narrative sense-making. At this stage, conflicts remained argumentative rather than generative, and imagination served expression rather than cognition. However, these very limitations were generative for the research: they laid out the groundwork for the articulation of the Narrativity Pyramid as both an analytical lens and a design tool. They showed that, when the foundational layers are made explicit, narrative conflict can emerge as a generative structure—within the story and in relation to the world—connecting data, values, and imagination.

3.5 Discussion and conclusion

The first phase of the research marked a conceptual turning point, moving from an exploratory experimentation with narrative forms toward the formalisation of narrativity as a theoretical construct. Building on the insights derived from the prelude phase, this chapter articulated the epistemological and methodological foundations necessary to position narrativity as a legitimate construct within science education research.

The theoretical and empirical work presented here established narrative not as a mere vehicle for communicating science but as a way of knowing and reasoning that intertwines cognition, emotion, and culture in the construction of meaning around complex phenomena

such as climate change. Furthermore, the analysis of the early interventions revealed the limitations of working at the level of genre alone: while fostering creativity and emotional involvement, the activities did not yet activate the deeper structures of narrative reasoning.

Through an interdisciplinary exploration encompassing science education, literary theory, climate communication, etc., the chapter identified a set of recurring conceptual tensions: between explanation and experience, structure and meaning, paradigmatic and narrative thinking. Addressing these tensions required moving from scattered conceptual insights to a coherent operational model.

The construction of the first version of the Narrativity Pyramid stemmed precisely from this recognition. It provided a framework to articulate the different degrees of narrativity—ranging from the foundational layer of action, temporality, and causality to the more complex levels of structure and genre—and to clarify their respective cognitive roles. By distinguishing three progressive layers, i.e. narrative base, full narrative structure, and genre-specific articulation, the model conceptualised narrativity as a continuum connecting representational and epistemic dimensions. It thus enabled a reframing of Bruner's (1986, 1990) distinction between paradigmatic and narrative thought: rather than viewing them as separate or incompatible modes, the pyramid provided a structure through which their interaction could be observed, scaffolded, and empirically explored. This theoretical move allowed the research to define narrativity not only as a cognitive form but as design principles capable of informing educational practice.

Re-analysing the preliminary empirical work through this lens revealed the central insight of this phase: the activities conducted in the prelude (the “Mocku for Change” project, the ONSCI workshop, and the PNRR implementation) activated *narrative expression* but not *narrative reasoning*. Students engaged with the aesthetic and communicative potential of genre but lacked the structural scaffolds necessary to mobilise narrativity as a cognitive tool for exploring uncertainty, conflict, and complexity. This analytical finding directly informed the next phase of the research design. The Narrativity Pyramid emerged not as a retrospective interpretation, but as a prospective framework, a heuristic for guiding the design and analysis of subsequent interventions aimed at integrating narrative and paradigmatic reasoning in students' sense-making processes.

The model reframed narrative not as an aesthetic choice but as a mode of thought capable of integrating with paradigmatic reasoning. In this sense, it represented both a synthesis of theoretical insights from Bruner (1986, 1990), Ryan (2005), and Norris et al. (2005), and an interpretive lens emerging from empirical observation.

This phase thus served a double purpose. Conceptually, it grounded the theoretical foundation of the research, defining narrativity as a multilayered construct mediating between imagination and rationality. Empirically, it identified the design conditions necessary for narrative thinking to become a productive cognitive process rather than a decorative form.

In sum, Chapter 3 represents the point at which the research transitioned from conceptual exploration to the formulation of a generative theoretical model. The Narrativity Pyramid, in its first version, functioned as both a synthesising outcome and a starting point: it

synthesised the conceptual advances achieved so far, while laying the groundwork for the design of the subsequent experimental implementations analysed in Chapters 4 and 5. In those phases, the model would evolve from an interpretive artefact into a design principle, guiding the creation of learning environments that operationalise narrativity as a driver of agency, complexity reasoning, and transformative engagement with the climate crisis.

Chapter 4

Phase 2: From theoretical model to Design Practice

This chapter presents the second phase of the doctoral research, which marked the transition from theoretical elaboration to design-based inquiry.

The research question addressed in this phase of the research have been:

SQ2a) *How can the first Narrativity Pyramid be operationalised within the design of an educational activity (the narrativity-enhanced FyouTURES) to promote transitions and/or integration between paradigmatic and narrative reasoning?*

SQ3a) *In what ways did the narrativity-enhanced design of FyouTURES influenced students' reasoning and engagement with the complexity and uncertainties of CC during implementation?*

SQ1c) *How can the theoretical model of narrativity be refined in light of empirical evidence emerging from design-based implementations, leading to the elaboration of a second version of the Narrativity Pyramid?*

Taken together, these questions outline a continuous trajectory that moves from conceptual modelling to design operationalisation and empirical refinement: the narrativity framework was translated from a conceptual tool into a pedagogical design principle, examined through classroom practice, and eventually reformulated in light of observed learning processes.

This phase was situated within a consolidated research ecosystem developed by the Physics Education Research Group at the University of Bologna⁸, whose long-term agenda on *Future-Oriented Science Education* (FOSE) has been advanced through several European projects – e.g. *I SEE* (<https://iseeproject.eu/>), *FEDORA*, and *Climademy*— as well as through the national *Piano Lauree Scientifiche* (PLS) programme (e.g. Levrini et al., 2019; 2021). Across these initiatives, the group has progressively shaped a coherent framework for integrating the dimension of *futures*— together with research reflections on *complexity* and *uncertainty*— into physics and science education, aiming to equip learners with the tools to navigate the challenges of our society.

Within this framework, the FyouTURES game emerged as one of the key educational prototypes designed to implement FOSE in a practical way (Miani et al., 2025). The game, originally conceived by Lorenzo Miani and Francesco De Zuani under the supervision of Professor Olivia Levrini, was first developed as part of an orientation course for high school students entitled “*Towards New Future Scenarios: The Role of Physics in the Challenges of Climate Change*” (De Zuani, 2025; Miani, 2025; Miani et al., 2025). Its theoretical foundations lay in exploring how fundamental features of physics—such as modelling,

⁸<https://physics-astronomy.unibo.it/en/research/research-areas/physics-education-and-history-of-physics>

uncertainties, complexity, the capability of making accurate predictions and making decisions— could be reframed as thinking tools for developing sustainability competences. The game is thought as a collective decision-making exercise, where participants build their own future climate scenarios by interacting with the En-ROADS climate simulator (<https://www.climateinteractive.org/en-roads/>) and explore the implications of such scenarios for possible future societies. From an educational research perspective, *FyouTURES* represented an advanced and mature artefact capable of creating spaces for critical reflection about the societal implications of CC and demonstrated the pedagogical power of future-oriented modelling. However, what emerged from the results of the first implementation of the game (De Zuani, 2025; Miani, 2025; Miani et al., 2025) is that the structure of the game and the way in which students interacted with it tended to privilege paradigmatic reasoning – e.g. analytical, data-driven, and model-based— over other forms of reasoning that could capture the affective, ethical, and interpretive dimensions of learning. These underexplored areas opened a fertile terrain for extending the research toward an investigation of how *narrative reasoning* might complement and enrich paradigmatic thought within CCE.

It is precisely in this interstice, between a robustly validated design and the emergence of a new theoretical hypothesis, that the present phase of research is situated. Rather than developing a new activity from scratch, this phase involved introducing an original narrative layer into the *FyouTURES* game. This operation can therefore be regarded as the first genuine design intervention of the doctoral project: an opportunity to translate the *Narrativity Pyramid* model, elaborated in the previous chapter, into a real educational environment, thereby testing its heuristic and pedagogical potential.

The design aimed to integrate narrative reasoning not as an ancillary or communicative device, but as an epistemic structure capable of transforming how participants construct, interpret, and inhabit future scenarios. To this end, the research focused on identifying and enhancing the narrative affordances already implicit in *FyouTURES*, developing a set of new scaffolds, specifically an introductory video, a set of reflective reports, and a final scriptwriting task, to progressively activate narrative thinking alongside data-driven reasoning.

This chapter is organised into four main sections, documenting the research trajectory and its outcomes:

- Section 4.1) the analysis of the original *FyouTURES* activity and the design of the new narrative layer: the narrativity-enhanced version of *FyouTURES*—its structure, materials, and facilitation strategies—represents the operative result of SQ2a, concretising the first version of the *Narrativity Pyramid* within a classroom activity.
- Section 4.2) the implementation and data collection across two educational contexts;
- Section 4.3) the qualitative analysis of participants' outputs and discourses: the analysis of students' reasoning during the implementation revealed three main phenomena that represents the operative result of SQ3a and provide the empirical foundation for the subsequent refinement of the *Narrativity Pyramid*

- Section 4.4) the redesign of the Narrativity Pyramid: informed by empirical insights, the second version of the Narrativity Pyramid constitutes the outcome of SQ1c, providing a refined theoretical model that integrates the observed dynamics between paradigmatic and narrative reasoning.

4.1 Analysis of the original activity and design of the new narrative layer

This section presents a critical analysis of the original implementation of the *FyouTURES* game, followed by an account of the theoretical rationale and methodological choices that informed the subsequent design of the new narrative layer.

4.1.1 The *FyouTURES* game and its original context

The *FyouTURES* game was originally designed by Lorenzo Miani and Francesco De Zuani Cassina— under the supervision of Professor Olivia Levrini – as part of the course “Towards New Future Scenarios: the role of physics in the challenges of climate change”. The course has been developed as part of Miani and De Zuani PhD thesis, had a length of 20 hours, and had as a target students from the 11th to the 13th from the surrounding schools of the University of Bologna. The course, described in detail in the PhD thesis of Miani (2025) and De Zuani (2025) is set in the general literature framework of Futures-Oriented Science Education (FOSE), and is part of the series of initiatives promoted by the Physics Education Research group of the University of Bologna under the umbrella of the Piano Lauree Scientifiche (PLS).

PLS is a project started in 2004 on the initiative of the Italian Minister for Education, University and Research (MIUR) together with other partners, that focuses on developing courses, activities and Research in Science Education materials for students and teachers to provide them with active guidance opportunities with respect to scientific disciplines. PLS courses aim to conduct self-assessment activities for upper secondary school students to verify their preparation for university access and increase their awareness of their knowledge to choose an educational pathway. In our research group, PLS courses have been used as an opportunity for designing, carrying out, testing and improving teaching modules, to address Research Questions or to inspire new questions, to deepen disciplinary and epistemological aspects of physics topics or to test pedagogical models, working directly with students, teachers and other collaborators.

The *FyouTURES* game is a role-based scenario making activity that engages participants in collective decision-making under conditions of uncertainty and complexity, simulating the governance of global climate action over several decades. The simulation is structured around the En-ROADS climate simulator, namely Energy-Rapid Overview and Decision Support (Chikofsky et al., 2024), a global climate simulator developed by Climate Interactive in collaboration with MIT Sloan Sustainability Initiative and Ventana Systems. The simulator allows users to explore how various policies, such as electrification of transport, carbon pricing, or improved agricultural practices, can influence other factors like energy prices, global temperatures, air quality, or sea level rise in a time span that uses the 2100 benchmark as an upper limit to compare changes with respect to current policies. The

simulator is based on a set of differential equations in time, representing physical processes and human decisions on climate, environment, economy, and energy systems both at the “global level of aggregation and at the system-wide level of analysis” (Siegel et al., 2024, p. 6).

The simulator represents a good example of the complexity of CC, as it uses different equations to represent the climate-energy system as a “high-dimensional dynamic system characterized by long time delays, multiple feedback loops, and nonlinearities” (Kapmeier et al., 2021, p. 334).

In *FyouTURES*, the En-ROADS simulator is not meant to be used only as a tool to gather information about the consequences of each decision but requires a shift in the students' approach. This shift is due both to the inner specificities of the simulator and the role that it covers in the game. The simulator provides multiple information related to the simulations produced by users, from which different levels of interpretation can be derived. The game and course exploit these features through a combination of forecasting and foresight, asking students to develop scenarios based on the simulations and the resulting interpretations that can be developed (Miani et al., in press).

Going into detail about the game structure, participants are organised into small working groups, each representing a decision-making body tasked with governing global climate action. The game is typically structured into three main rounds, each corresponding to a specific period that changes over time in a hypothetical timeline, thus simulating decision-making under conditions of temporal progression and cumulative impact. The first round starts from the present and asks the participants to make decisions for the following five years (2030), the second round asks them starting from the consequences of the first and to make decisions for the year 2050, while the third round places them in the 2050 and asks them to make decisions and investments for the following 50 years, reaching in this way the final 2100 benchmark. In each round, groups are asked, as a first step, to draw a set of wildcards, i.e. possible and plausible events connected to the different types of uncertainty connected to CC (Miani et al., 2025). These wildcards simulate real-world uncertainties such as technological breakthroughs, geopolitical crises, environmental tipping points, or shifts in public opinion. Their purpose is twofold: on one hand, they increase the complexity and realism of the simulation by disrupting linear planning; on the other hand, they provide narrative stimuli that encourage participants to reassess strategies, negotiate priorities, and imagine plausible futures beyond deterministic modelling. In order to respond to the context created by the wildcards, and keeping in mind the final goal of the game (respecting the temperature increase decided from the Paris agreements), the group deliberates on a set of policy measures to implement, adjust variables in the simulator accordingly, and analyse the projected outcomes. During the game, the facilitators typically talked with the different groups so as to understand their strategies and to compare results across groups, encouraging brief reflections on the consequences of selected strategies.

The game is built on the sectors identified in the En-ROADS simulator: specifically there are six areas (Conventional energies, Emission Control, Nature based solutions, Renewable energies, Electrification, Energy efficiency), and for each area a set of 2, 3 or 4 sectors. The

core decision-making mechanic consists in choosing a set of policy levers to invest (increase support) or tax (reduce support) in each sector, with each choice directly impacting model projections related to global temperature rise, emissions, energy consumption, and other key indicators. This binary mechanism—financing or definancing policy options—requires players to consider trade-offs, synergies, and systemic effects across the sectors.

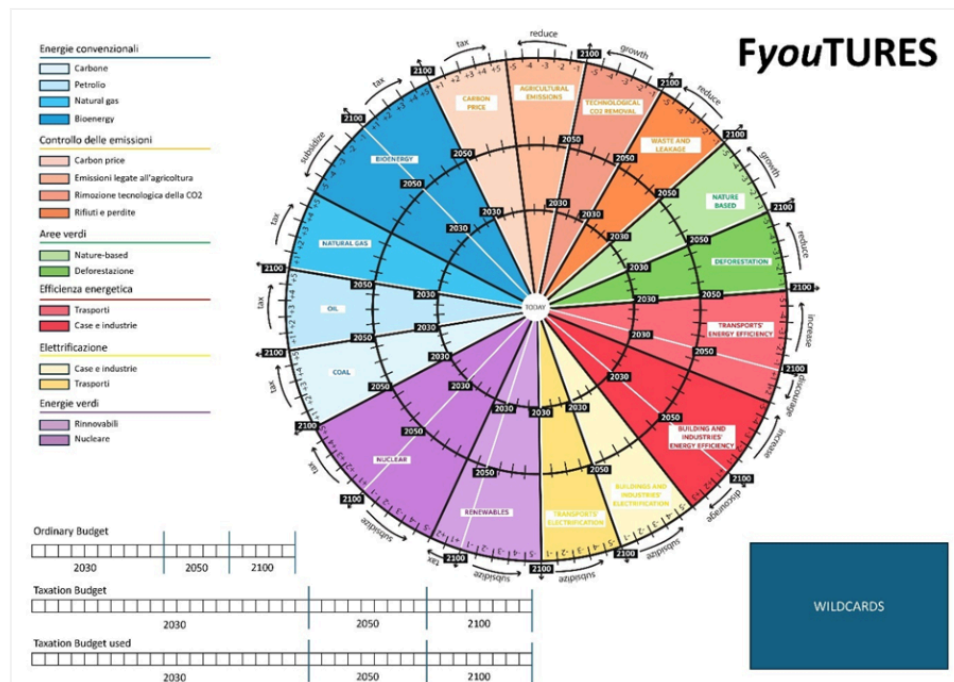


Fig 4.1 [Picture retrieved from De Zuani, 2025; Miani, 2025] *Game board used during the implementation*, originally designed by Miani and De Zuani within the framework of their doctoral research (De Zuani, 2025; Miani, 2025). The board includes the list of intervention areas and sliders, a section for wildcards and a grid to track each group's budget per year. At its centre, a large multi-sector circle allows players to visualise and draw the timeline of their choices.

The educational purpose of the activity is multifold. First, it aims to cultivate systems thinking, by making visible the interdependencies, trade-offs, and non-linear effects that characterise climate systems. By observing how a change in one domain (e.g., fossil fuel taxation) produces cascading effects across others (e.g., energy demand, land use, economic growth), students are encouraged to think beyond isolated variables and develop a more integrated understanding of sustainability. Second, the activity seeks to foster data literacy and scientific reasoning, as participants must interpret graphical outputs, identify meaningful indicators, and justify decisions based on quantitative evidence (Miani et al., 2025).

From the first implementation of the game and from the analysis conducted by Miani and De Zuani in their PhD thesis (De Zuani, 2025; Miani, 2025) emerged that the comparison of the main strategies employed by the groups to achieve the game's objective reveals two significant aspects that, while highlighting current limitations, also indicate directions for further enhancement.

The first concerns a general inclination among students to adopt a reductionist and “solutionist” mindset. Their efforts were largely oriented toward optimising strategies in pursuit of a rapid resolution, often achieved by isolating the different dimensions of the problem and prioritising short-term mitigation over systemic reflection. In doing so, participants tended to overlook the broader social and economic implications of their choices, favouring technically efficient but ethically and politically narrow solutions. This frequently resulted in dystopian scenarios where environmental targets, such as temperature stabilisation, were met at the expense of severe socio-economic disparities. Such outcomes underline the persistent risk of interpreting sustainability primarily as an environmental challenge, detached from its social and ethical foundations. The course and, in particular, the game experience were designed to bring these tendencies to light, encouraging students to confront the constraints of classical, linear approaches to problem-solving. The activity effectively exposed the inadequacy of reductionist reasoning when dealing with complex phenomena such as CC, where interdependencies among environmental, social, and economic systems cannot be disentangled.

The second aspect emerging from the comparison highlights the game’s potential to reveal the inherent complexity and multidimensionality of sustainability challenges. This realisation manifested in two ways: either as a “reality shock” experienced after the construction of overly simplified scenarios, or as a gradual awareness developed through the adoption of more systemic, critical forms of reasoning during gameplay. The course thus provided a meaningful setting for students to engage with the interconnections between social, political, ethical, economic, natural, and technological dimensions, underscoring the richness and intricacy of sustainability decision-making. As discussed in Miani et al. (in press), the En-ROADS simulator played a pivotal role in shaping this learning process. Initially, students approached it as a neutral, instrumental tool, focusing predominantly on achieving environmental targets while disregarding social and ethical considerations. This revealed a persistent “technical” orientation, rooted in traditional conceptions of knowledge that separate facts from values. Post-normal science (Funtowicz & Ravetz, 1993) reminds us, however, that addressing complex, value-laden issues such as sustainability requires precisely the opposite: an integration of ethical reflection and participatory reasoning.

Over the course of the activity, the game’s design showed its potential to challenge this mindset. Its structure invited collective reasoning, fostering an environment in which the simulator became a shared medium for inquiry rather than a mere computational tool. Students who began by seeking solutions gradually shifted toward *reasoning with* the simulator, using it as a scaffold for framing problems, exploring tensions, and navigating uncertainty. The resulting scenarios revealed that envisioning desirable futures requires engaging with intertwined ethical, social, and ecological considerations, reflecting the inseparability of the three sustainability pillars (Purvis et al., 2019).

Nevertheless, as noted by Miani and De Zuani, while the game effectively prompted systemic thinking, several limitations emerged. The simulator itself is grounded in a conventional economic framework that constrains the modelling of alternative paradigms. For example, even when implementing a “de-growth” option, the underlying structure

remains linked to continuous economic expansion, albeit at a slower rate. This reveals the difficulty of envisioning transformative futures within existing model architectures. Furthermore, the simulator offers limited possibilities for representing human behaviour, collective action, or cultural dynamics, dimensions crucial for a more holistic understanding of sustainability.

Recognising these constraints, the work presented in the following sections sees these aspects not as shortcomings but as opportunities for refinement. The work presented in the next sections focuses on strengthening the narrative and social components of the game to deepen engagement with the human dimension of sustainability. These improvements aim to expand the pedagogical potential of the activity, enabling it to better capture the ethical, political, and affective layers of climate decision-making, thereby moving closer to a genuinely systemic and reflexive model of sustainability education.

4.1.2 Narrative analysis of the original game

The narrative analysis of the original FyouTURES activity was conducted through a dual interpretative lens:



Narrativity Lens

The first interpretative lens was grounded in the Narrativity Pyramid model, developed during the previous phase of my doctoral research and articulating narrativity through three layers, each defined by specific features and indicators. Used as an analytical lens, it enabled me to examine the activity to assess the presence and degree of narrativity elements it embodied.



Bruner's Modes Lens

The second interpretative lens drew on Bruner's (1990) distinction between paradigmatic and narrative modes of thought. The aim was to shift the focus from the activity to the reasoning processes it fostered. This lens allowed us to interrogate how the activity engaged participants in different forms of meaning-making—whether through the logical, abstract, and generalising stance of paradigmatic thinking, or through the situated, value-laden, and interpretive stance of narrative thinking. In doing so, it created a "map" of the interplay between these modes, and the extent to which the game could serve as a terrain for their productive integration.

In a nutshell: while the narrativity lens searches for narrative *elements* or basic narrative structures, Bruner's modes lens traces the *processes* and aims of reasoning. In this way, the interpretative framework was anchored in both a structural and a cognitive perspective.

At a structural level, the analysis revealed that the game, in its first version, displayed several elementary features of narrativity. The sequential organisation of rounds and the presence of collective decision-making processes introduced a minimal temporal and causal order. Each team decision could be read as an "episode" contributing to the evolution of the simulated world, providing the basic skeleton of a narrative sequence. However, this

temporal chain remained largely functional and procedural: subordinated to instrumental goals rather than to the construction of meaning. Events were connected through cause–effect relationships instrumental to the gameplay, but they did not develop into a plot in the narratological sense: events followed one another without the emergence of motives, conflicts, or transformations that could re-orient the participants’ understanding of action and consequence (Ryan, 2005). The structure thus resembled a chronology rather than a story: time was represented, yet not experienced as a space for moral or emotional deliberation.

From the perspective of Bruner’s (1990) *Acts of Meaning*, this configuration primarily mobilised the **paradigmatic mode of thought**, which seeks to explain reality through logical coherence, abstraction, and generalisation. This provides an interpretation of why students’ reasoning was oriented towards optimisation—selecting efficient strategies and managing variables—rather than towards interpretation or sense-making. Their actions reflected what Bruner calls the *landscape of action*, in which sequences of events are evaluated in terms of success or failure, but the *landscape of consciousness*—the reflective domain where motives, doubts, and values are explored—remained mostly silent, especially on the first stage of the game. During the gameplay, the simulator fostered cognitive engagement with the mechanics of climate dynamics, but offered little space for reflection on agency and the ethical stakes of decision-making.

This observation aligns with Norris et al.’s (2005) notion that narrative explanations in science differ from logical ones in that they link events through human intentionality and consequence rather than through isolated causality. While the FyouTURES game allowed players to *model* change, it did not enable them to *explain* it narratively—that is, by situating actions within meaningful trajectories of choice and responsibility. The absence of an explicit protagonist or moral conflict could have limited the students’ capacity to identify with the system they were managing. In narrative terms, they were *designers* of the world but not *inhabitants* of it.

From an educational standpoint, this imbalance had clear implications. The predominance of paradigmatic reasoning supported analytical understanding but constrained the development of what Bruner would define as narrative rationality—the capacity to negotiate ambiguity, imagine alternatives, and attribute meaning to outcomes. As Avraamidou and Osborne (2009) argue, narrative forms are essential in science education because they render scientific knowledge accessible and emotionally resonant, bridging the gap between abstraction and lived experience. In the absence of such forms, learning risks remaining detached from students’ own systems of belief and value.

The analysis also resonates with Kurtz’s (2014) participatory narrative inquiry framework, according to which meaning in communities emerges through the collective negotiation of stories. Within FyouTURES, however, collaboration was primarily instrumental and led many students to approach the game with the attitude of reaching a “winning” configuration rather than on constructing shared interpretations. The epistemic stance induced by the game was that of control more than inquiry. Some groups treated uncertainty—an intrinsic feature of climate complexity—as a variable to be minimised, instead of a condition to be interpreted. In that case, as a result, the experience reproduced the logics of prediction

typical of scenario modelling but not the interpretative, value-laden deliberation that characterises narrative understanding.

In summary, the dual-lens analysis highlighted an imbalance: while the original activity effectively nurtured analytical competencies and systemic reasoning, it offered limited scaffolding for narrative imagination and interpretive sense-making. In Bruner's terms, the paradigmatic mode overshadowed the narrative, constraining the epistemic ecology within which students could position themselves in relation to the futures they were modelling. The original design thus embodied a form of *chronotopic* but not yet *narrative* engagement with the future. Recognising this gap was not a merely descriptive outcome; it became a generative step, informing the design of a narrative layer aiming at providing a more integrated balance between the rigour of paradigmatic analysis and the ethical, emotional, and meaning-making potentials of narrative reasoning.

The specific question that guided this design was:

SQ2a) *How can the first Narrativity Pyramid be operationalised within the design of an educational activity (the narrativity-enhanced FyouTURES) to promote transitions and/or integration between paradigmatic and narrative reasoning?*

4.1.3 Design of the narrative layer

The narrative layer design consisted into two main interventions:

- **Design of new educational materials**, capable of balancing analytical inquiry with narrative exploration.
- **Revision of the original gameplay structure**, slightly reconfiguring its sequence and mechanics to sustain a dynamic interplay between data-driven reasoning and narrative sense-making, moving participants from strategic simulation towards richer, more integrated forms of future-oriented thinking.

Through these interventions, the redesign directly addressed the imbalance revealed by the dual-lens analysis, seeking to construct an epistemic environment where paradigmatic rigour and narrative imagination could inform and reinforce one another. Following the analysis phase, the two interpretative lenses were thus reformulated as *operative design principles*, translating the theoretical and analytical insights into operational strategies for educational design. These principles were conceived as boundary mechanisms (Akkerman & Baker, 2011) between theory and practice, tools to mediate between conceptual reasoning and pedagogical implementation.

The two principles have been formulated as described in the following table (Table 4.1).

Table 4.1 *Design principles guiding the design of the narrative enhanced version of the FyouTURES game.* The table summarises the two main principles underpinning the new design, each articulated through its operative application and associated learning goals.

Design principle	Operative application	Learning goals
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1 – Balancing Paradigmatic and Narrative Reasoning. Building on Bruner’s (1986, 1990) distinction between paradigmatic and narrative modes of thought, the first design principle aims to cultivate a dynamic balance between analytical and interpretive reasoning, acknowledging at the same time their irreducibility. According to Bruner, these two modes represent indispensable yet distinct ways of knowing: each operates according to different criteria of validity—coherence versus correspondence—and neither can be reduced to, or fully translated into, the other. Previous analyses of the original FyouTURES activity (Miani, 2025) revealed that its structure strongly fostered paradigmatic reasoning, focused on data, models, and logical causality, while offering limited affordances for narrative imagination and ethical reflection.	To address this imbalance, the redesigned version of <i>FyouTURES</i> was structured into separate yet complementary phases, each explicitly oriented toward one mode of reasoning while preparing the ground for the other—thus preserving their distinctiveness while enabling interaction. Rather than merging paradigmatic and narrative processes indistinctly, the design orchestrated an intentional alternation between them, beginning with analytical decision-making grounded in model-based simulation, followed by reflective and narrative re-elaboration.	This alternation enables learners to move fluidly between different epistemic stances, using scientific reasoning to ensure coherence and plausibility, and narrative reasoning to construct meaning, values, and ethical orientation. The goal is to cultivate their reciprocal reinforcement as complementary yet irreducible forms of sense-making in CCE.
2 – Progressive and cyclical use of Narrativity Layers. The first version of the Narrativity Pyramid developed in the first phase of this research (See Chapter 3) conceptualises narrativity and narrative reasoning as a three-layered construct, ranging from basic structural coherence to complex interpretive and affective dimensions. The second design principle translates this theoretical model into a pedagogical scaffold that progressively activates these layers through targeted learning tasks	The new version of FyouTURES was structured around a progressive and cyclical use of narrative layers (preventing the simultaneous activation of “full” modes) and allowing students to gradually strengthen their narrative reasoning. The progressivity builds on the original no-narrativity and low-narrativity (1st layer) features already present in the original version and provides the new version with new phases at medium (2nd layer) and high narrativity (3rd layer). The cyclical use of narrative layerexploit the rounds-based structure of the game to provide cycles of progressive narrativity	This progressive and cyclical use of narrative layers expands the representational space available to participants, supporting a shift from abstract modelling to situated and value-laden reasoning. By traversing multiple layers of narrativity, learners are encouraged to integrate cognitive, affective, and ethical dimensions of understanding, thereby enhancing both the depth and the sustainability of their learning experience.

	enhancement (from 1st to 3 rd layer in each round).	
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The operative implementation of these principles required the development of new educational materials specifically designed to scaffold the alternation between paradigmatic and narrative reasoning. Specifically:

- A **video introduction** that framed the simulation within a fictional narrative. Inspired by the mockumentary genre, the video depicted a speculative future scenario in which, following massive public mobilisation, the United Nations had created a “Ministry for the Future” (Robinson, 2020). The video introduced the character of Mary Murphy and presented a global climate emergency based on real data (e.g., Copernicus, IPCC). It outlined the urgency of meeting the Paris Agreement goals and explained that the *FyouTURES* activity would simulate the work of the Ministry. The full script can be found in the Appendix (A.1.1).
- Two **report templates** to be completed after each round. These asked students to describe not only the technical choices made during the simulation, but also the type of future scenario they were constructing. The reports were structured around the six key dimensions of the SSPs (Shared Socioeconomic Pathways) (O’Neil et al, 2014; 2018): demographics, human development, economy and lifestyle, policies and institutions, technology, and environment and natural resources. The aim was to guide students in attributing narrative meaning to simulation data, encouraging them to reflect on the type of society their decisions were shaping. The template can be found in the Appendix (A.1.2).
- A **final creative task** in which each group had to write a short script to be enacted in the form of a future documentary interview. Here, the students had to retrospectively narrate their journey, embodying the perspectives of different stakeholders and imagining the motivations, dilemmas, and consequences that had shaped their decisions.

In designing these materials, particular attention was paid to keeping the narrative level coherent with the structure and educational objectives of the activity. The goal was not to “gamify” the activity or to prioritise engagement for its own sake, but to open a space where emotional, ethical, and political dimensions could be explored alongside systemic reasoning.

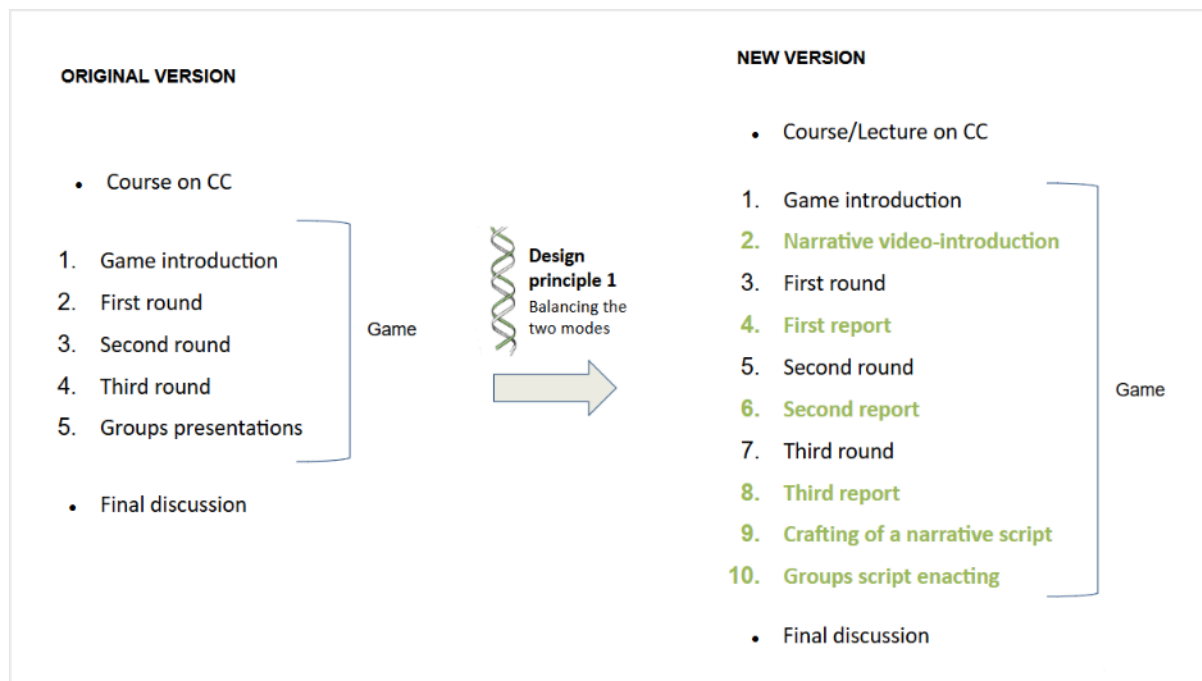


Figure 4.2 Revision of the original FyouTURES gameplay structure according to Design Principle 1. The diagram compares the original version of the FyouTURES game with the new version, redesigned to foster a dynamic balance between paradigmatic and narrative modes of thought. The updated structure introduces five new narrativity-enhanced phases (Narrative video introduction; First, Second and Third reports; Crafting of a narrative script), while the original 'Group presentations' phase was replaced by a performative activity (Group script enacting). These changes operationalised Design Principle 1 by balancing paradigmatic and narrative reasoning.

The two principles guided not only the design of the new materials, but also, in parallel, their integration within the gameplay and the consequent revision of its structure. This means that the redesign was not conceived as a simple addition of narrative elements to a pre-existing framework, but as a process of structural negotiation between epistemic intentions and pedagogical form. The principles acted as conceptual anchors that oriented both the what and the how of the design: they informed the creation of tools capable of activating different modes of reasoning, and simultaneously governed the rhythm and positioning through which these tools would enter the flow of the activity. In this sense, the evolution of FyouTURES emerged from a co-development of artefacts and structure, where the interplay between paradigmatic and narrative reasoning became the very logic shaping the sequence of phases.

The operative application of design principle 1 to the original gameplay structure has been grounded in Bruner's view that each mode of thought is mobilised by specific prompts and that different representational forms do not emerge spontaneously but require intentional cultivation. Designing the activity as a sequence of paradigmatic and narrative steps thus served a dual purpose: it created cognitive variety and rhythm, and it ensured that the affordances for each mode were explicitly signaled and supported.

As illustrated in Figure 4.2, the first version of the game consisted of five phases: *Game introduction* – *First round* – *Second round* – *Third round* – *Group presentations*. The game

was embedded at the end of the course “Verso nuovi scenari futuri” (Miani & De Zuani, 2025) and was followed by an open discussion on the game and its role within the course.

The narrative-enhanced version expanded this structure to ten phases: *Game introduction – Narrative video introduction – First round – First report – Second round – Second report – Third round – Third report – Crafting of a narrative script – Group script enacting*. As in the previous version, the narrativity-enhanced version of FyouTURES was preceded either by the full course (in the PLS context) or by a shorter introductory lesson on CC (in the Summer School context) and concluded with a collective reflection.

Five new narrativity-enhanced phases were introduced (Narrative video introduction; First, Second and Third reports; Crafting of a narrative script), while the original “Group presentations” phase was replaced : the final presentation of results was transformed into a performative activity (Group script enacting), in which students were asked to “stay in character” and perform the interview they had been asked to script in the previous phase (Crafting of a narrative script). This change reflected a shift from reporting outcomes to inhabiting perspectives, prompting students to recontextualise their decisions within lived, value-laden narratives.

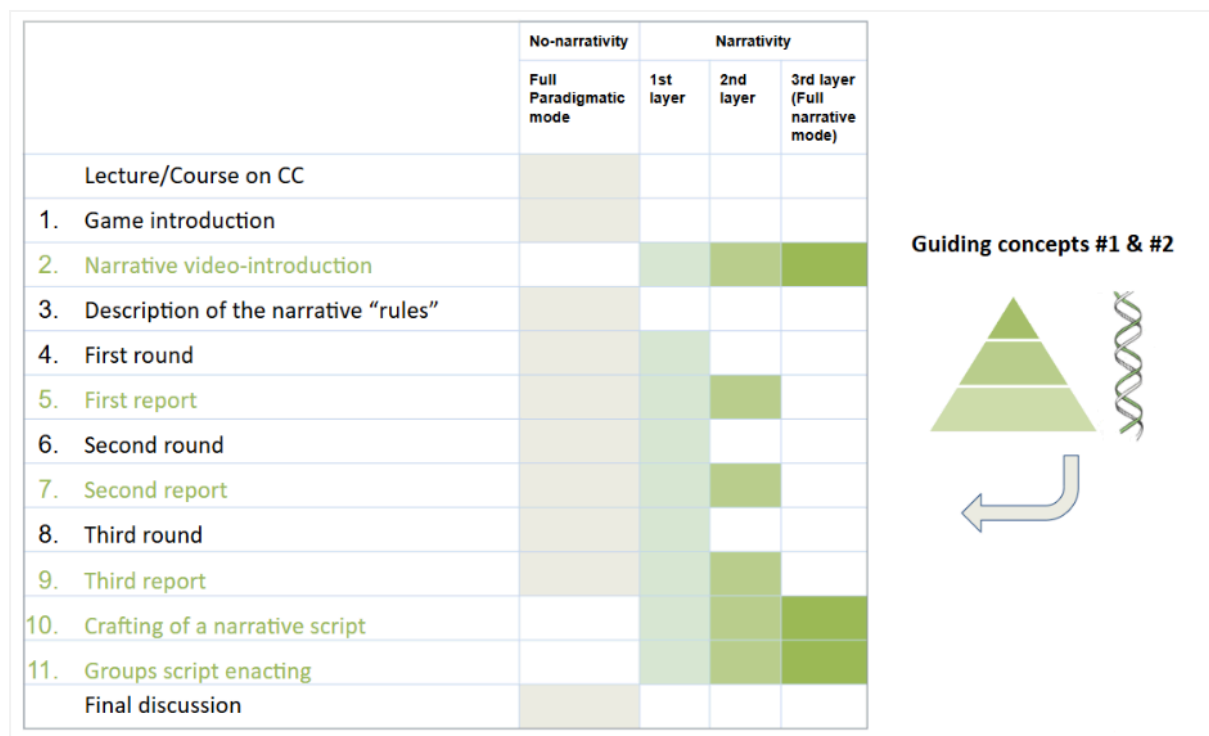


Figure 4.3 Maps of narrativity layers in the narrative-enhanced structure of FyouTURES. The diagram illustrates how each phase engages different degrees of narrativity, from paradigmatic to full narrative mode. The alternation between analytical and imaginative phases was guided by Design Principles 1 and 2 and conceived to foster a dynamic and gradual balance between explanatory and interpretive reasoning.

Guided by both design principles, and as illustrated in Figure 4.3, the new sequence of phases was conceived to introduce narrativity layers progressively and cyclically, with the objective of preserving their irreducibility (preventing the simultaneous activation of “full” thinking modes) and allowing students to gradually strengthen their capacity for narrative

reasoning and to navigate fluidly between explanatory and interpretive modes. The resulting structural rhythm—alternating between analysis and imagination—was designed to foster an iterative movement between paradigmatic and narrative engagement, consistent with Bruner’s conception of learning as a dialogue between different ways of constructing meaning.

4.2 Implementation and data-collection

The narrativity-enhanced version of the *FyouTURES* game was implemented in two distinct educational settings, allowing for a comparative exploration of its adaptability and impact across different participant profiles and temporal structures.

1. The first context was a summer school organised inside the Climademy teacher academy project: the game has been used in its new version as the core activity of a single, condensed day. Participants were teachers from different countries (Italy, Greece, Finland, Brazil, Turkey);
2. The second implementation occurred within the second edition of the “Towards New Future Scenarios” course, in the same institutional and demographic setting of the first original version of the activity.

Further contextual and methodological details regarding these two implementations are provided in the following two paragraphs.

A variety of data collection instruments were employed to capture the richness and complexity of participants’ experiences across the different implementations of the activity. These included pre and post questionnaires, simulation reports, audio and video recordings, field notes, and student-generated artefacts. Further details in paragraph 4.2.2.

4.2.1 Context of the implementation

The first implementation of the new version of *FyouTURES* took place in the summer school of the European project Climademy (2022-2025), held in Bologna between the 26th and the 28th of June 2024.

For this first implementation the game was delivered as the core component of a single-day activity. The participants in this setting were primarily in-service teachers and researchers engaged in professional development with a focus on climate education. The compressed timeframe and the participants’ professional background introduced specific dynamics into the enactment of the activity, particularly concerning metacognitive reflection and pedagogical translation.

A total of 4 groups has been set for the first implementation of the game, composed of a number between 4 and 7 teachers/researchers, for a total amount of circa 25 participants.

The second implementation involved the whole course and took place between October and December 2024, as part of the second edition of the “Towards New Future Scenarios: the role of physics in the challenges of climate change”. Together with Miani and De Zuani, I participated with an active role in the course, which for its second edition has been slightly

reshaped so as to give more space for the narrative re-elaboration of the activity. Nonetheless, the modified version has been implemented in the same institutional and demographic setting in which the original version of the activity had been implemented the first time. This continuity enabled an almost direct comparison between the original and revised formats, with particular attention to changes in student engagement, forms of reasoning, and expressions of agency.

The second version of the course counted a total of 34 students between 16 and 19 years old, equally distributed between females and males. The students were part of 6 distinct schools, mainly scientific high schools, located in the Bologna area and in the Romagna region. Considering the fact that not all students attended the lesson in which we played the game, we organised 5 different groups of 6 players each.

4.2.2 Methodology and data collection

The main research question that this part of the study investigated is:

SQ3a) *In what ways did the narrativity-enhanced design of FyouTURES influenced students' reasoning and engagement with the complexity and uncertainties of CC during implementation?*

To address this question, a variety of data collection instruments were employed. The use of multiple and diverse sources allowed for a triangulated analysis of the learning processes and supported the identification of both cognitive and affective dimensions of student engagement. Table 4.2 provides an overview of the data collection tools, specifying for each implementation the timing of administration, the corresponding research purpose, and the type of data gathered.

The pre- and post-course questionnaires, adapted from those used in the original course “Verso nuovi scenari futuri” (Miani et al., 2025), already provided a comprehensive framework for exploring sustainability competences and future-oriented thinking. In this study, they were slightly expanded by adding a short open-ended section in which students were asked to write a brief story about CC. This addition aimed to observe possible changes in narrative imagination and meaning-making between the beginning and the end of the course. Reports written during the activity were used to trace the evolution of students' narrative sense-making and reasoning across the three rounds of the game. Audio recordings—focused particularly on the small-group discussions during the gameplay—captured the dialogic processes and the emergence of narrative explanations. Video recordings of the final sessions documented how groups collectively expressed forms of narrative foresight and synthesis. Finally, researcher field notes complemented these sources with reflexive observations on classroom dynamics, while the final artefacts produced by students offered an overall picture of the degree of narrativity achieved and of the integration between paradigmatic and narrative thought.

Table 4.2 *Overview of data collection instruments and dimensions investigated.* The table summarises the different tools employed across contexts and phases of the research, indicating their moment of use, main analytical focus, and data type.

Instrument	Context	Moment of Use	Main dimension Investigated	Data Type
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Questionnaires	PLS	Beginning and end of course	Cognitive and affective orientations; reasoning modes.	Qualitative and quantitative
Reports	Summer school, PLS	During the activity	Narrative sense-making.	Qualitative
Audio recordings	PLS	During the activity	Dialogic reasoning and emergence of narrative explanations.	Qualitative
Video recordings	Summer school	Final part of the activity	Expression of narrative foresight and synthesis of collective reasoning.	Qualitative
Researcher field notes	Summer school, PLS	Through all the course	Group dynamics and reflective observations.	Qualitative
Final artefact	Summer school, PLS	End of the course	Degree of narrativity and integration between paradigmatic and narrative thought.	Qualitative

4.3 Data analysis and results

Written data (researcher notes, questionnaires, reports and final interviews scripts) were collected and organized using anonymised Google Sheets and Microsoft Excel.

The initial phase of analysis employed a qualitative, theory-driven (top-down) approach, guided by the theoretical frameworks adopted for the study. This phase aimed to identify meaningful "signals" within the corpus of data that could shed light on how the redesigned activity influenced participants' learning processes. Rather than attempting an exhaustive coding of the entire dataset from the outset, the strategy was to use the theoretical lenses as filters to detect emergent patterns (signs of epistemic or cognitive shifts) provoked by the redesigned intervention. Three such signals emerged during this exploratory stage. Two of those became the focal points for subsequent, more detailed analyses, which were conducted through structured categorization procedures and interpretive discourse analysis. The following paragraphs provide a detailed account of these in-depth analyses and the insights they generated regarding students' evolving modes of reasoning and engagement with complexity. Finally, although the absence of targeted data prevented a systematic and in-depth analysis of the third "signal," it was nonetheless considered of interest from a research perspective. For this reason, it will be presented and discussed in Section 4.4.3.

4.3.1 Filling and exploring the gaps of data

The first "signal" emerged from the reports, and it is related to how participants used narrative thinking and narrative representation: filling and exploring the gaps of data through narrative and narrative thinking. It refers to the process by which learners used stories, subjective perspectives, and imaginative projections to make sense of what data alone wasn't able to represent or explain. Rather than merely supplementing information, narrative

thinking was able to let participants explore the lands of uncertainty, ambiguity, and the human dimensions left unexplored by the abstract models. This approach fostered deeper engagement in participants, allowing them to inhabit complex scenarios and construct meaning beyond the visible metrics.

In a nutshell, although the task at hand was to write reports (not to tell stories) we encouraged participants to regard the simulator's graphs and data as inspiration, rather than as limitations, and to use narrative imagination to deal with what data was not able to show. However, this was not always easy to achieve. From the very beginning of the data analysis it was clear that the open-ended format of the reports had led two distinct attitudes to emerge:

1. **Difficulty and reluctance to move away from the simulator data.** Those participants limited themselves to a straightforward review and categorisation of the decisions made during gameplay. Representative excerpt: *"Due to our efforts, GDP per capita has increased by 10%. The ratio of deaths from extreme heat has decreased by nearly 50%."* (Summer school implementation, Report, Group 2)
2. **Ability to interpret the data and "explore the gaps" through personal concerns or aspirations.** Representative excerpt: *"As the taxes are so high, salaries should be high, which means that the workplaces are demanding and the education for those places must be high. On the other hand, we fear that we live in an unequal society, because not everyone can afford to pay such high taxes. That leads for example to people that can't afford electricity, which is most worrying."* (Summer School implementation, Report, Group 1)

In this second example participants went from data, to context, to values, to lived experience, to the plausible. This kind of conflict, identified at the social level, can become narrative in nature, in the sense that recognising it as an ethical issue may become a driving force for players' actions in the following round. A systematic analysis searched for those attitudes in the reports of all groups in both implementations, obtaining the following distribution of attitudes: 62% had attitude 1, while the remaining groups (38%) showed attitude 2.

What emerged from the overall picture of this second type of attitude was a noticeable shift toward more reflective and responsible accounts of the consequences of participants' decisions, accompanied by richer, socially grounded, and value-laden descriptions of the futures they created (in the previous phase of the game) or aimed to construct. When triangulated with field notes, the data suggest that this shift was facilitated by the introduction of the report templates, which effectively segmented the scenario-making process into two distinct yet interrelated phases. The first phase was dedicated to simulation and decision-making, anchored in gameplay dynamics and En-ROADS data; the second phase was structured around the reflective completion of reports, which prompted participants to articulate the societal features of their scenarios using the six SSP dimensions. These two phases—one more paradigmatic, the other more narrative—did not operate in isolation. Rather, they became increasingly interwoven, and it was precisely this intertwining that revealed the generative potential of the activity to create an educational space where both modes of thought could be actively and meaningfully co-activated.

4.3.2 Meaning-making through the interplay of the two landscapes

Through the narrative scriptwriting activity during the final phase of *FyouTURES*, one group of players demonstrated the ability to reinterpret and assign new, situated, and socially relevant meaning to the three forms of climate uncertainty (epistemic, aleatoric, and reflexive) as originally introduced from a scientific perspective (Shepherd et al., 2018). An emblematic example is found in the following excerpt:

“Which was the most difficult policy that you had to tackle?”

Definitely, it was the reduction of deforestation measures because we weren’t absolutely sure that our efforts would make such a good change. Farmers weren’t in favour of the appliance of new agricultural technologies at first because they thought there were policies against them. Later on, as the positive effect began to rise, they discovered that those innovations benefited rural communities by bringing more income and avoiding migration fluxes to the cities. We are glad that in the end they became supportive of our policies.”

(fictional interview written by Group 2)

This, first of all, is a process of worlding. The world depicted involves two social groups (politicians and farmers) and a place where the activities of one of those social groups (farmers) are linked to deforestation practices.

In this passage, epistemic uncertainty is not simply presented as the objective limits of scientific knowledge, but is reframed as a divergence in subjective knowledge and trust between different actors, in this case, between policymakers and farmers. Aleatoric uncertainty is expressed through the awareness of the unpredictability of the outcomes of implemented policies, due to temporal distance and the complexity of causal relations between decisions and impacts. Lastly, reflexive uncertainty emerges in the policymakers’ concern over the future attitudes of farmers: whether or not a shift in their intentions and outlook would eventually occur.

Constructing this web of actions, conflicts, motivations, and insights is emblematic of the capacity of narrative thinking to interweave, in Bruner’s terms, the landscape of action with the landscape of consciousness. In this capacity, narrative thinking reveals itself as a powerful tool for interpreting the relational dimension of change, showing how political decisions are deeply entangled with the uncertainty surrounding the evolution of awareness, values, and attitudes among the actors involved.

In this framework, uncertainty is no longer understood solely as an individual tool for guiding personal or collective decision-making (as happens during gameplay), but also as an interpretive and imaginative lens for exploring and understanding the social, human, and relational dynamics underlying processes of coordination and cooperation across different epistemic positions and value systems, dynamics that are essential for collectively addressing the complexity of the climate crisis.

4.3.3 From paradigmatic to narrative attitude to activate foresight

One of the most significant transformations introduced in the redesigned version of FyouTURES was the inclusion of a video introduction that explicitly framed the simulation within a narrative context. Drawing on the conventions of speculative documentary, the video situated participants in a fictional future scenario, one in which a “Ministry for the Future” had been established following a wave of global civic mobilisation. This narrative framing played a crucial epistemic and affective role: it shifted participants’ orientation from a predominantly paradigmatic engagement with data toward a more integrated stance, where imaginative projection and emotional investment could coexist with systemic reasoning.

The introduction of this shared narrative space appeared to catalyse a collective sense of *foresight*: a future-oriented epistemic stance that, in the context of science education, entails the ability to imagine, evaluate, and reflect upon long-term consequences of actions, in relation to desirable and undesirable futures. As discussed in the literature on *future-oriented science education* (e.g., Levrini et al., 2021), foresight is not reducible to forecasting or prediction; rather, it is a cognitive and affective disposition grounded in ethical reasoning, value-laden reflection, and the capacity to inhabit multiple temporal horizons. Within the redesigned activity, this form of foresight emerged not merely as an individual cognitive skill, but as a socially shared orientation, sustained by the narrative environment and discursive interactions.

Empirical traces of this shift were observed across different forms of student participation. During the simulation, participants more frequently referred to the kind of future world they hoped to construct, rather than focusing narrowly on numerical indicators within the simulator. Phrases such as “this is not the society we want” or “we’re trying to build a livable future” began to surface in place of strictly data-driven arguments, signalling a reframing of goals in narrative and value-laden terms. In final interviews, several participants reported feeling more emotionally involved, describing the experience as “more real” or “easier to connect with.” This suggests that the narrative framing enabled a crucial imaginative leap: the capacity to treat the simulation not as an abstract modelling exercise, but as a symbolic enactment of real-world futures. In this way, the activity fostered a hybrid attitude that held together paradigmatic rigour and narrative sense-making, enabling students to oscillate between systemic reasoning and situated imagination.

Further signs of foresight activation were also visible in the reflective reports and final creative outputs. Some groups spontaneously introduced characters who looked back from the future, evaluating past decisions in moral and emotional terms. Others referred to future generations or imagined consequences beyond the scope of the simulator’s metrics. These narrative choices indicate an expansion of the temporal and ethical horizon of the simulation, one that could not be accounted for solely through the lens of paradigmatic reasoning. They also illustrate the pedagogical potential of narrative scaffolding in making complex futures not only thinkable, but also *feelable*, thus mobilising students’ agency in ways that resonate with both cognitive and affective dimensions of learning.

4.3.4 Conclusive remarks

The insights emerging from the narrativity-enhanced implementations on one hand confirmed the heuristic value of the Narrativity model, but at the same time they also illuminated the limitations of the first version of the pyramid. The main phenomena identified in the analysis of the narrativity enhanced version of *FyouTURES*—narrative filling of data gaps, integration between the landscapes of action and consciousness, and the emergence of foresight—suggested that narrativity operates through at a finer "grain" than that originally captured by the model and that narrative thinking in CCE could not be understood solely as a gradual increase in narrativity elements, but rather as a layered negotiation of sense and meaning within each stage of learning.

The following section illustrates how these empirical findings informed the conceptual refinement of the model, leading to the elaboration of a second version of the Narrativity Pyramid.

4.4 Redesign of the pyramid model

This section takes findings from narrative-enhanced *FyouTURES* implementations as a point of departure to refine the theoretical model of narrativity itself. The specific sub-question addressed in this phase of research was:

SQ1c) *How can the theoretical model of narrativity be refined in light of empirical evidence emerging from FyouTURES implementations, leading to the elaboration of a second version of the Narrativity Pyramid?*

To answer this question, the analysis moved from empirical observation toward a new conceptual synthesis, supported by a renewed dialogue with the literature — including Ryan (2005), Norris et al. (2005), Shepherd and Lloyd (2021), Gould (2002), Fletcher (2023), Kurtz (2014), Wilk (2022), and Devitt (2008). Among the most significant findings, two seemed particularly relevant: the *first* concerns the emergence of a **fine grain of narrativity**, highlighting the need for more layered narrative scaffolds within educational design; the *second* relates to the epistemic interplay between paradigmatic and narrative reasoning, revealing that the educational value of narrativity lies more in its **mediating function** than in its role as a threshold for the two reasoning modes activation/affordance.

The following discussion briefly discusses these insights, identifying those elements that proved most generative for theory-building and that ultimately informed the redesign of the second version of the model.

The need for a finer grain of narrativity layers emerged both from students' reasoning during the implementation and in the necessities that surfaced during the design phase, and specifically consisted in: the need for the introduction of a "verisimilar objective" (an "imaginable" world you want to reach) to support anticipatory thinking, and the use of periodic "pit stops" to verisimilarly assess the world that was being constructed through the gameplay. The introductory video proved essential in this sense: a worlding operation that activated foresight, shifted students' framing from a step-by-step logic to a broader

anticipatory posture, and encouraged them to "own" the problem. This aligns with Bevan's concept of owning the problem and resonates with Norris's notion of narrative appetite. At the same time, these moments made visible students' ability to navigate both the landscape of consciousness and that of action, enabling them to grasp complex ideas—such as uncertainty—in a way that linked inner and collective dimensions. Both trajectories can be interpreted as transitions from "sustainable thinking" to the emergence of "sustainable agency." I grouped these insights under the term "fine grain of narrativity," referring to the micro-layers of narrative engagement needed to enable such cognitive and affective operations. These in-between steps did not fully align with the existing categories of the original pyramid and called for a refinement of its structure.

The second need emerging from the empirical findings was a clarification and at the same time complexification of the way we interpret the interplay between paradigmatic and narrative thinking. It became clear that the educational value of narrativity lay precisely in its capacity to mediate this interplay. Not by merely putting a threshold for modes of thinking activation or affordance depending on the artefact on use, but exploring and mapping the ground where the two could coexist: where formulas, graphs and data could be interpreted through personal, cultural, emotional and value-driven exploration. This mediation happens through two dimensions:

- 1) It mediates *between artefacts and thought*: drawing on Ryan's (2005) concept of mental templates, narrativity can be understood not merely as an attribute of a narrative artefact, but as a cognitive construct that transcends the medium through which a story is expressed. In Ryan's transmedial narratology, narrativity is conceived as a property that can manifest across different representational forms—verbal, visual, symbolic—because it fundamentally resides in the mental operations that enable humans to make sense of experience. Each layer of narrativity can thus be interpreted as a mental image or template that we use to structure, interpret, and navigate the world around us.

From this perspective, narrativity—and the layers that articulate it—can act as a bridge between artefacts and thought. It connects the external representations through which knowledge is conveyed with the internal cognitive and imaginative processes through which meaning is constructed, allowing learners to move fluidly between perception, reasoning, and imagination. In educational contexts, this means that the design of learning environments should not focus solely on the type of narrative artefact being used but on how these artefacts activate and interact with learners' narrative mental templates.

- 2) It mediates *between the narrative and the paradigmatic*: the second dimension can be conceived as extending perpendicularly to the first. This metaphorical perpendicularity reflects the idea that it spans the epistemic continuum between the narrative and the paradigmatic poles—a scale that can be embodied both in artefacts and in cognitive processes. In this sense, narrativity provides a structural space in which the two modes of thinking can coexist and interact. Each layer of the Narrativity Pyramid incorporates narrative elements—such as agents, temporality,

transformation, and contingency—that may be mobilised by either mode of thought. These elements can thus be interpreted as boundary objects (Star & Griesemer, 1989; Akkerman & Bakker, 2011): semiotic and epistemic entities that maintain their identity across different contexts while enabling translation and coordination between them.

From an educational standpoint, this interpretation underscores that narrative features are not confined to storytelling practices. Rather, they can sustain scientific reasoning by embedding abstraction within meaningful contexts, while paradigmatic structures, in turn, provide the logical coherence and plausibility that strengthen narrative imagination. Narrativity thus functions as a mediating framework that bridges the analytical and the interpretive dimensions of sense-making, allowing learners to oscillate between explanation and interpretation without collapsing one into the other. This view aligns with Shepherd and Lloyd's (2021) argument that narratives themselves act as boundary objects, connecting different epistemic communities and discursive practices. Within CCE, narrativity performs a similar function: it establishes a shared ground where scientific models, moral concerns, and imaginative foresight can be jointly negotiated. Further details and examples of how these mediations manifest in practice are discussed in the description of each layer of the model, where the interplay between narrative and paradigmatic reasoning becomes visible in students' artefacts and reasoning patterns..

Further details and examples of how these mediations take place in practice are discussed in the description of each layer of the model, where the interplay between narrative and paradigmatic reasoning becomes visible through students' reasoning patterns and artefacts.

As illustrated in figure 4.5, and discussed in the following paragraphs, to formalize the resulting reflections, the redesigned pyramid proposes five distinct but interrelated layers—each characterized by specific narrative elements and a hypothesized role within CCE.

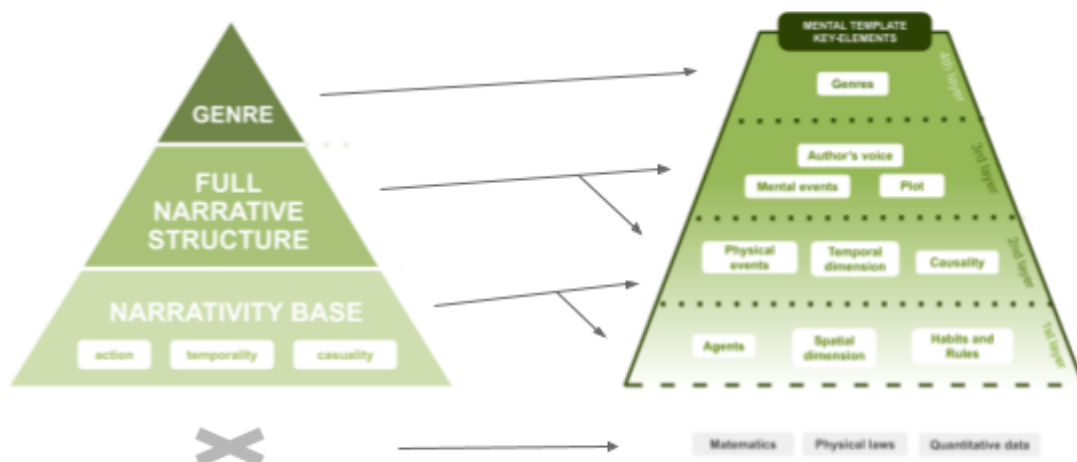


Figure 4.5. *Redesign of the Narrativity Pyramid for CCE.* The figure illustrates the evolution of the model. Arrows indicate how the elements and concepts of narrativity from the first version were repositioned in the new design, while the grey cross at the base of the first pyramid marks the absence, in that version, of the concepts later introduced as layer 0 in the second model.

Layer 0: Nomothetic reasoning

The first step of this design phase was to identify and map, within the model, the core features of CC paradigmatic thinking that operate independently of narrativity. Layer 0 of the new model serves to this purpose by embodying what Norris (2005) terms *nomothetic reasoning*: the pursuit of universal, abstract, and decontextualized knowledge of the physical world. This layer represents artefacts, mental images and mode of reasoning where knowledge is organized through quantitative data, mathematical formalisms, and immutable physical laws that remain constant over time. It entails a conception of space as an infinite Cartesian container and of time as objective, symmetric, and reversible—dimensions in which the laws of nature operate uniformly, enabling both prediction and control of phenomena. Within CC Education, this layer is indispensable because it provides the epistemological foundation for scientific understanding. It equips students with the ability to generalize, abstract, and reason symbolically, and it cultivates the modelling skills necessary to interpret the dynamics of the climate system and to evaluate scenarios of future change.

However, research in science education has shown that when science is presented solely through this abstract, decontextualized register, it risks reinforcing an image of science as impersonal and inaccessible, estranging learners from its relevance to everyday life (Avraamidou & Osborne, 2009). In climate science, this risk is particularly acute: quantitative models and probabilistic projections, while epistemically rigorous, may appear detached from meaning and agency (Shepherd & Lloyd, 2021). This creates a tension between the necessity of nomothetic reasoning for establishing credibility and precision, and the parallel need to connect such abstractions to human contexts, values, and lived experiences.

From this perspective, the role of Layer 0 in CCE is not only to transmit content knowledge but also to act as a reference point against which more situated or imaginative narratives can be “tested” or compared. By anchoring educational practices in the regularities of the non-living world, this layer ensures that subsequent layers of narrativity—where uncertainty, contingency, and agency come into play—remain tethered to scientifically grounded plausibility. In other words, Layer 0 provides both a starting point for more narrative-bounded scientific practises (like scenario-making techniques of the Climate sciences) and a criterion for “reality check” of non-scientific or speculative accounts.

So, while indispensable, Layer 0 cannot on its own account for the multifaceted nature of CC, which is simultaneously physical, social, and ethical. The very abstraction that gives it predictive power also highlights its limitations in fostering sense-making, imagination, and agency. In the context of CC, this gap has been described as the inadequacy of quantitative, probabilistic framings to stimulate meaningful public engagement and action, given that humans more readily connect with situated narratives and experiential accounts (Moezzi, Janda, & Rotmann, 2017; Veland et al., 2018). For this reason, subsequent layers of narrativity progressively introduce contingency, temporality, and other elements of human experience into the learning process.

Layer 1: World-making and contextualization

In the second version of the Narrativity Pyramid, Layer 1 undergoes a significant reconceptualisation. It continues to represent the entry point of narrativity, yet it now does so in a deeper and more functional way. The empirical findings from the FyouTURES implementations, however, revealed that the more fruitful entry point corresponded to a different cluster of narrativity elements—those capable of creating what Ryan (2005) would describe as *the mental template of a world*. This insight reframed Layer 1 not as a simple threshold, but as the level at which learners begin to construct and inhabit verisimilar contexts that make abstraction meaningful and actionable.

In the redesigned model, Layer 1 embodies the epistemic act of world-making (Bruner, 1990): the process through which experience is organized into meaningful structures and abstractions acquire meaning by being situated within coherent, imaginable contexts that can be experienced, explored, and reshaped. At this level, learners are invited to construct and inhabit environments in which scientific regularities take shape as lived experiences, enabling them to picture “places and ways of living” that make problems tangible and, crucially, ownable. In CCE, such contextualization allows students to perceive how scientific abstractions manifest in everyday life, and to connect them to natural and social environments in ways that stimulate foresight and motivation.

Three elements are central to this level. First, *agents* represent the actors inhabiting these constructed worlds—citizens, institutions, communities, or even non-human entities—whose presence illustrates the interconnections between different components of a system. Second, *space* is no longer an infinite and neutral container, but specific, bounded, and relational: it is marked by ecological limits, resource availability, and human–nature

interdependencies. In this sense, context provides the bridge between abstract models and meaningful interpretation, ensuring that knowledge retains significance rather than becoming detached from lived reality (Shepherd & Lloyd, 2021). Finally, *rules and habits* refer to legal systems, social conventions, economic practices, and cultural assumptions that agents follow, consciously or unconsciously, in order to live together. Making such rules explicit within constructed worlds is crucial, because it allows learners to see the modernity-bound assumptions that otherwise remain invisible. From here, two possible directions emerge: comparing such worlds with alternative ones, or moving to Layer 2, where students can investigate how the past has shaped the present, how persisting in current habits might project into the future, and what other historical or systemic trajectories could be imagined.

By integrating these elements, Layer 1 transforms narrativity into a cognitive and educational device for contextualisation. It establishes the first bridge between paradigmatic and narrative reasoning, enabling learners to move from abstraction toward meaning-making and anticipation, and laying the foundation for the temporal and transformative explorations of the subsequent layers.

Layer 2: Physical landscape and transformation

In the second version of the Narrativity Pyramid, Layer 2 undergoes a significant reconceptualisation. In the first model, Layer 1 was associated with a full narrative structure. However, before reaching such complexity, the theoretical perspectives of Bruner (1990) and Ryan (2005) suggest that two intermediate steps emerge, each characterised by distinct clusters of narrativity features that progressively complexify the mental template of a world. The analysis of the FyouTURES implementations confirmed that these steps are particularly fruitful for CCE, as they represent two complementary dimensions of change: the physical and the mental. Layer 2 represents the first of these steps: it corresponds to the physical dimension of change, the level at which transformation takes form in the material world. Transformation here is not merely a thematic component of climate reasoning, but an epistemic operation in itself—one that enables learners to connect the stability of scientific models with the dynamics of lived and imaginable worlds.

In this sense, Layer 2 marks a new threshold within the model: the passage from world-making to world-changing, from the construction of verisimilar contexts to the exploration of how these contexts evolve, transform, and sometimes collapse. Whereas Layer 1 situates scientific abstractions within verisimilar worlds, Layer 2 asks learners to interrogate how these worlds evolve over time, through both causal dynamics and contingencies. The focus is no longer solely on states of affairs (Layer 1), but on processes of change: how the climate system warms under increased greenhouse gas concentrations, how societies reorganize under stress, and how different pathways project into divergent futures. In this sense, time becomes both the arena for and the principal driver of transformation. Unlike the reversible and symmetric temporality of Layer 0, here time is intrinsically situated and irreversible, marked by trajectories, bifurcations, and path dependencies. To reason within this layer is therefore to grapple with contingency—the fact that small perturbations, political decisions, or cultural shifts can alter the course of systems in profound and unpredictable ways.

The conceptualization of this layer rests on three interrelated elements. *Physical events* embody the concrete manifestations of transformation—extreme weather episodes, technological shifts, or socio-political ruptures—which are not fully predictable yet decisively shape system trajectories. *Temporality* emphasizes that such events are embedded in patterned sequences: they accumulate, reverberate, and interact, revealing both irreversibility and path dependence. *Causality*, finally, provides the connective logic that links events and temporalities into intelligible processes: whether through linear chains (e.g., emissions leading to warming) or emergent feedbacks (e.g., tipping points in socio-ecological systems), causal reasoning allows learners to make sense of transformation dynamics. Together, these elements foster systemic reasoning by highlighting that change is neither random nor entirely predetermined, but emerges from the interplay of contingency and structure.

This temporal reorientation aligns with approaches in climate science that move beyond probabilistic estimates to emphasize physically self-consistent “storylines” of change (Shepherd & Lloyd, 2021). Storylines articulate not just what might happen, but how and why it unfolds, thereby offering students causal chains that render transformation intelligible while foregrounding uncertainty. Narrative scholarship similarly stresses the role of temporal structures in enabling diverse experiences of change to coexist and be negotiated (Veland et al., 2018). In CCE, such framing is crucial to cultivate systemic thinking, because it exposes the non-linear and interdependent character of socio-environmental dynamics (Walsh & Stepney, 2018).

Educational practices situated in this layer often take the form of scenario-based explorations. The Shared Socioeconomic Pathways (SSPs), for instance, exemplify how different societal choices shape contrasting global futures, making visible the consequences of present trajectories (O’Neill et al., 2017). Similarly, the FyouTURES activity operationalized this layer by engaging students in the construction of evolving storyworlds, though in its initial version it tended to leap from abstract models (Layer 0) directly to transformation logics, bypassing the contextual grounding of Layer 1. When scaffolded appropriately, however, such activities allow learners to connect physical causality with human decision-making, developing the capacity to recognize the contingency of futures and the transformative potential of agency.

From a pedagogical perspective, the value of Layer 2 lies in enabling students to interpret CC as a dynamic and contested process rather than as a static “problem to be solved.” It fosters the epistemic habit of asking not only “what is” but “how did it come to be this way, and what might follow?” This opens space for negotiating conflicts, weighing alternative trajectories, and envisioning the conditions under which transformation may occur. By learning to inhabit temporality, contingency, and systemic interconnection, students cultivate both a deeper understanding of climate complexity and the imaginative resources to position themselves as agents within unfolding processes of change.

Layer 3 - Mental landscape and perspective

Layer 3 introduces a further epistemic deepening by embedding transformation not only in physical and social systems, but also in the inner worlds of agents. If Layer 2 foregrounds the dynamics of events and causal processes, Layer 3 focuses on *mental events*—emotions, decisions, discoveries—that root narratives in lived and subjective experience. At this level, the narrative form itself acquires distinctive features: a *plot*, which provides sequential order and coherence to otherwise disparate experiences, and an *author's voice*, which positions a narrator or perspective within the story. Together, these elements add psychological depth and coherence, allowing learners to perceive CC not simply as an external process but as a lived and interpreted reality.

By foregrounding mental events, Layer 3 aims to promote *emotional engagement and positioning*. Learners are invited to explore how values, commitments, and uncertainties shape decisions, and how emotions such as hope, fear, or indignation influence responses to climate challenges. This dimension is pedagogically crucial: research has shown that purely factual framings risk alienating learners, whereas the acknowledgment of affective responses fosters agency and motivation (Avraamidou & Osborne, 2009; Moezzi, Janda, & Rotmann, 2017). Through plot, these experiences are woven into trajectories that generate meaning, while the presence of an authorial voice makes explicit that all accounts are partial, situated, and perspectival. Accepting ambiguity and subjectivity thus becomes part of the learning process: narratives are no longer judged only for their factual accuracy, but also for the perspectives they bring into dialogue.

In this sense, Layer 3 cultivates the practice of *perspective-taking*. By giving voice to diverse human and non-human viewpoints, learners can explore positionalities, conflicts, and values that are otherwise obscured in purely systemic or physical accounts. This not only reinforces empathy and imagination, but also makes visible the ethical dimensions of CC: whose futures are at stake, whose voices are amplified or silenced, and what trade-offs are involved in collective decisions. Narrative conflict becomes central at this level. Unlike argumentative clashes that aim at victory, narrative conflict embodies tensions between goals, values, or visions that propel action and decision-making. It is precisely by grappling with such tensions that students can experience CC as a domain of contested choices rather than as a pre-determined trajectory.

Educationally, Layer 3 enables CC to be interpreted as both systemic and personal, external and internal. It creates a space in which learners can rehearse dilemmas, negotiate values, and experiment with positioning themselves within complex futures. By linking cognitive reasoning with affective resonance and ethical reflection, this layer fosters a sense of ownership and responsibility, encouraging students to see themselves not merely as observers of climate transformations but as agents whose perspectives and choices matter. In doing so, Layer 3 prepares the ground for Layer 4, where narratives crystallize into fully fledged genres that integrate social imaginaries, cultural archetypes, and collective visions of the future.

Layer 4: Implicits

Layer 4 represents the culmination of the narrativity model, where individual plots and perspectives become embedded within broader *genres*. At this level, narratives are not only structured by internal coherence or personal positioning, but also by cultural and literary conventions—such as science fiction, mockumentary, dystopia, or memoir—that provide recognizable frames for interpretation. These conventions establish expectations regarding tone, plausibility, and meaning, thereby shaping how CC is imagined, communicated, and acted upon. Genres function as powerful cognitive shortcuts: they carry tacit social knowledge, situate stories within collective imaginaries, and lend resonance by evoking familiar codes that audiences instinctively recognize.

From an educational standpoint, the critical step at Layer 4 lies in *recognising and interrogating these conventions*. Genres are not neutral containers: they embody cultural assumptions, biases, and ideological orientations that influence how problems and solutions are framed. For instance, dystopian climate fiction may foreground collapse and despair, while utopian or solarpunk narratives emphasize resilience and transformation. Similarly, a mockumentary, by parodying documentary codes, can simultaneously reveal and destabilize notions of scientific authority. Students thus learn to identify how genres embed particular ways of knowing and valuing, and how they can either reinforce or resist dominant imaginaries of the future.

This reflexive engagement with genre has two main educational implications. First, it fosters critical literacy by equipping learners to decode the cultural scripts that underpin climate stories, making visible the assumptions that often remain implicit. Second, it opens space for creative agency: students can consciously adopt, hybridize, or subvert genres to articulate alternative futures, thereby positioning themselves not merely as consumers of cultural forms but as producers of new imaginaries. In this sense, Layer 4 enables a dialogue between individual voice and collective culture, between subjective positioning and social meaning-making.

By situating climate narratives within the domain of recognizable cultural forms, Layer 4 extends the scope of CCE beyond epistemic and affective engagement toward cultural critique and imagination. It highlights that CC is not only a scientific or political problem but also a profoundly cultural one: the stories through which societies represent it shape how futures are envisioned, what actions appear plausible, and which alternatives remain unthinkable. Engaging with genre conventions thus allows learners to embrace or resist them deliberately, challenging inherited imaginaries and contributing to the creation of new cultural repertoires for living with CC. Figure 4.6 illustrates the version of the Narrativity model while Table 4.3 summarizes the pyramid layers characteristics.

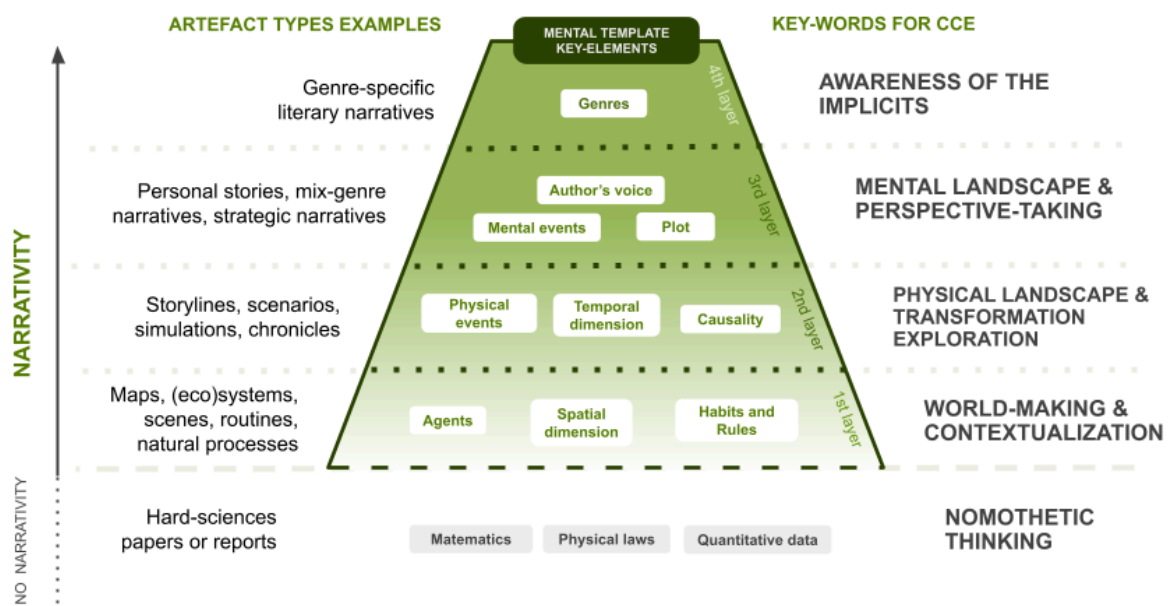


Figure 4.6 *Second version of the Narrativity Pyramid.* The figure presents the redesigned, multi-layered model of narrativity for Climate Change Education. As in the previous version, the pyramid is used to characterise both climate-related artefacts (examples shown on the left) and the increasing complexity of their educational roles (key terms on the right). In this new version, the Narrativity Pyramid is conceived as embodying narrative mental templates—cognitive structures through which learners and educators interpret, construct, and communicate meaning about climate phenomena. It is composed of four hierarchical layers plus one no-narrativity level at the base, each defined by distinctive narrative elements and epistemic functions. The dashed lines indicate the fluid boundaries between layers, reflecting that narratives can hybridise and operate across multiple levels simultaneously. While most artefacts naturally integrate several layers at once, educational design can strategically foreground specific layers depending on the intended learning objectives and epistemic focus.

The no-narrativity ground, out of the pyramid, is paradigmatic thinking anchored in abstraction, generalization and time-invariant laws of nature, but as we ascend the layers, narrative elements gradually activate new interpretive and experiential dimensions. Narrative thinking fills the gaps of abstraction, linking knowledge to meaning, while also opening imaginative pathways toward alternative futures. Following Kurtz (2014), sensemaking is no longer conceived merely as an individual cognitive task, but as "a social, reflective, and generative practice in which groups of people attribute meaning to complex experiences to guide their actions in uncertain or conflictual contexts." Shepherd & Lloyd (2021) reinforce this view, noting: *"It has been argued that the process of abstraction in climate science 'detaches knowledge from meaning'. Perhaps usable climate science is, then, meaningful climate science."* In this light, the Narrativity Pyramid can be understood as a device for reattaching knowledge to meaning. Its layered structure makes explicit that sense-making in CCE cannot be achieved through the transmission of abstract content alone, but requires a progressive scaffolding of epistemic, experiential, and cultural resources. Each layer fulfills a specific role: Layer 0 provides the paradigmatic tools of abstraction, generalization, and modelling that ensure credibility and plausibility; Layer 1 situates such abstractions in verisimilar worlds, where characters, spaces, and rules anchor knowledge in recognizable contexts; Layer 2 highlights the dynamics of transformation, emphasizing contingency, temporality, and causality as the grammar of systemic change; Layer 3 brings the focus to

mental events, values, and positionalities, creating the psychological depth that allows learners to inhabit complexity as lived experience; and finally, Layer 4 embeds narratives within recognizable genres and cultural imaginaries, opening the possibility of both reproducing and critically resisting dominant codes.

Taken together, these layers articulate a model that does not simply classify narrative artefacts, but offers an operational model to design educational practices that deliberately balance different modes of thought. Following Kurtz (2014), sensemaking is redefined not as an individual act of comprehension but as a social, reflective, and generative practice, in which groups collectively attribute meaning to complex experiences in order to orient action under conditions of uncertainty and conflict. The Narrativity Pyramid makes this process visible and teachable: it demonstrates how meaning emerges not in spite of, but through the interplay between paradigmatic reasoning and narrative imagination.

This interplay resonates strongly with current debates in climate science itself. As Shepherd and Lloyd (2021) argue, the reliance on probabilistic abstraction often “detaches knowledge from meaning,” undermining its usability for decision-making. What is needed is not less science, but science that can be meaningfully interpreted across contexts, perspectives, and values. The Narrativity Pyramid provides a conceptual and pedagogical pathway to realize this ambition in educational settings. By organizing learning experiences across layers of narrativity, educators can ensure that abstraction remains grounded in scientific plausibility while also being enriched by world-building, temporal reasoning, affective engagement, and cultural critique.

Table 4.3. *Characteristics of the first version of the Narrativity Pyramid.* The table summarises the main features of each narrativity layer as defined in the first model, outlining their core narrative elements and the hypothesised educational role they play in CCE.

Layer	Narrative Elements	Hypothesis of role for CCE
0 – Nomothetic explanations (No-narrativity)	Quantitative data, mathematics and physical laws. Abstract, decontextualized knowledge grounded in nomothetic reasoning (Norris et al., 2005).	Provides the scientific <i>epistemological grounding</i> of CCE by fostering abstraction, modelling, and prediction skills. It anchors learning in the physical laws and quantitative regularities of the non-living world, ensuring that imaginative or situated narratives remain scientifically plausible.
1 – Worlding & contextualization	Agents (human, non-human, or symbolic actors); Spatial dimension (places, scales, settings); Rules and habits (Factual or fictional). Together, these construct a verisimilar and coherent world.	Contextualizes abstract scientific knowledge within <i>verisimilar worlds</i> , allowing students to link data to lived experiences. It bridges logic and meaning by situating science in recognizable settings and social practices, stimulating ownership, empathy, and motivation toward real-world climate issues.
2 – Physical landscape & Transformation	Physical events (not fully predictable); Temporality (temporal relations and	Enables learners to reason about <i>change over time</i> , causality, and contingency, cultivating systemic thinking. By engaging with processes of transformation and

	patterns); Causality (causal links, linear or emergent) These elements structure how the world changes over time.	scenario-based reasoning, students learn to see CC as dynamic, emergent, and shaped by human agency.
3 – Mental landscape & Perspective	Mental events (emotions, decisions, discoveries); Plot (ordered sequential narrative structure); Author's voice (positioned narrator or perspective) These add psychological depth and coherence.	Fosters <i>emotional, ethical, and positional engagement</i> by connecting systemic processes with inner experiences—values, emotions, and decisions. Through perspective-taking, learners explore conflicts, moral dilemmas, and trade-offs, building empathy and a sense of agency in facing uncertain futures.
4 – Implicits and aesthetic	Genres and styles (e.g., sci-fi, mockumentary, memoir) Cultural and narrative conventions that structure expectations, tone, and interpretive framing.	Cultivates <i>critical and creative literacy</i> by engaging with genres and cultural imaginaries. Learners recognise how cultural narratives shape collective visions of the future and can consciously rework or subvert them, transforming themselves from passive recipients into active authors of new imaginaries for sustainable futures.

In summary, the pyramid does not merely propose a taxonomy of narratives but constitutes a boundary object that connects disciplines, practices, and audiences. It aligns with the broader narrative turn in science education and CCC (Avraamidou & Osborne, 2009; Moezzi, Janda & Rotmann, 2017; Veland et al., 2018), while also responding to calls for fostering learners' capacity to imagine, negotiate, and act within complexities and uncertainties of CC. As such, it offers a double contribution: conceptually, by reframing the relationship between paradigmatic and narrative thinking as complementary rather than antagonistic; and operationally, by equipping educators with a scaffold to design activities that bridge abstraction and lived engagement. Ultimately, the Narrativity Pyramid advances a vision of CCE in which knowledge and meaning are not separate domains but interwoven dimensions of a transformative learning process.

4.5 Conclusions

This chapter has illustrated the transition from theoretical elaboration to design-based research, operationalising the narrativity framework developed in the previous phase within an existing educational context. The *FyouTURES* activity provided an ideal testbed for this translation, as its original design already embodied several features aligned with the aims of my own research and the analysis of the original version revealed an imbalance between paradigmatic and narrative modes of reasoning.

The results emerging from this phase can be interpreted as a coherent response to the three research questions that guided it, each shedding light on a different dimension of the relationship between narrativity and reasoning in CCE.

From a design perspective (SQ2a), the study demonstrated that the first version of the Narrativity Pyramid could be effectively translated into a pedagogical practice. The analysis of the original version of *FyouTURES* revealed an imbalance between paradigmatic and narrative modes of reasoning. While the activity successfully fostered analytical and systemic competencies, it offered limited opportunities for students to engage with the affective, ethical, and interpretive dimensions of CC. The subsequent design intervention addressed this gap through two complementary principles: balancing paradigmatic and narrative reasoning, and progressively activating layers of narrativity. The implementation of these principles through specific materials and structural revision of the original version into a narrativity-enhanced one, demonstrated how narrative reasoning can be intentionally cultivated alongside data-driven inquiry.

At the level of students' engagement and reasoning (SQ3a), the empirical results highlighted three main findings. First, narrative thinking acted as a cognitive bridge, enabling participants to explore and fill the "gaps of data" by connecting abstract indicators to lived, value-laden experiences. Second, the interplay between the landscapes of action and consciousness, as theorised by Bruner (1990), became visible in students' discourses, reflecting their growing ability to integrate systemic reasoning with emotional and ethical reflection. Third, the inclusion of narrative framing activated forms of collective foresight: participants began to imagine, evaluate, and emotionally inhabit alternative futures, demonstrating a shift from descriptive to anticipatory reasoning.

Finally, these insights prompted a theoretical reflection on the model itself (SQ1c). The empirical traces collected across the implementations pointed to the existence of micro-layers of engagement with narrativity and subtle transitions between reasoning modes that were not accounted for in the first pyramid. This recognition led to the elaboration of a second, more fine-grained version of the model, in which narrativity is reconceptualised not as a linear scale of narrative richness but as a dynamic scaffold enabling the balance between paradigmatic rigour and narrative sense-making.

Taken together, these results substantiate the central claim of this research: narrativity, when intentionally structured as a multi-layered educational tool, has potential to mediate between paradigmatic and narrative reasoning. Its integration in CCE enriches conceptual understanding while fostering sense-making, empathy, and agency—dimensions often marginalised in traditional science education. The refined version of the Narrativity Pyramid, developed through this phase, therefore represents both the synthesis and the starting point of a new line of inquiry. It establishes the conceptual foundations for the next phase of the doctoral research, where the model will be further tested, expanded, and discussed in relation to broader theoretical and empirical questions.

Chapter 5

Phase 3: The School-Based Course

This chapter presents the third phase of the research trajectory—the school-based course—which constitutes the culmination of the DBR-inspired inquiry described in Chapter 2. Conducted in a vocational secondary school, this phase extended the previous design experiments into a complete, multi-lesson course, thereby providing a test-bed for examining the educational potential of narrativity when enacted in an authentic classroom environment. Building on the exploratory insights from “Mocku for Change” and the subsequent FyouTURES re-design, the The school-based course represents the first full application of the Narrativity Pyramid as both a pedagogical and an analytical framework. Its purpose was to explore how progressively structured narrativity layers could scaffold the dialogue between paradigmatic and narrative reasoning and support students’ engagement with the complexity of CC.

From a research perspective, this phase was guided by three interconnected sub-questions:

SQ2b) *How can the second version of the Narrativity Pyramid inform the design of a school-based course that progressively activates different narrativity layers to support students in connecting scientific reasoning with interpretive and value-laden reflection*

SQ3b) *What transformations in students’ sense-making and agency can be observed as outcomes of the narrativity-based school course?*

SQ1d) *How can further empirical insights from the school-based course contribute to the theoretical consolidation of the Narrativity Pyramid and to the articulation of its third and final version?*

The first question guided the design of the educational intervention, the second oriented the empirical analysis of students’ reasoning and participation, and the third provided the ground for the final theoretical synthesis of this phase.

The course was co-designed and implemented in collaboration with Luca Luongo, a professional screenwriter for cinema and theatre, whose expertise in storytelling enriched the narrative depth and expressive quality of the activities.

The chapter structure follows the same logic adopted in the previous empirical chapters, documenting the research trajectory and its outcomes:

- Section 5.1 guided by SQ2b, outlines the educational design and its theoretical rationale operationalising the second version of the Narrativity Pyramid within a formal educational setting;

- Section 5.2 developed in coherence with SQ3b, details the methodological procedures and data sources;
- Sections 5.3–5.4 addressing SQ3b, present the analyses and results, revealing to what extent and how narrative scaffolding was able to foster transitions between paradigmatic and narrative reasoning and what were the implications for students' sense-making and agency;
- Section 5.5 addressing SQ1d, presents the third and final version of the narrativity model, which consolidates the theoretical, design, and empirical insights emerging from this phase.

5.1 Design of the course

Design of educational activities is never a neutral act, since it entails a series of epistemic, ethical, and pedagogical choices that shape not only what students learn, but how they come to inhabit knowledge and position themselves within it. This chapter presents the design rationale behind the CC course developed for the Rosa-Luxemburg school, illustrating how a theoretical framework based on the concept of narrativity was transformed into concrete pedagogical principles and then articulated into a structured sequence of lessons.

The course objective was to activate students' narrative and paradigmatic reasoning in tandem, allowing them to explore CC as both a scientific issue and a human story. Central to this process was the idea that narrativity can serve as an epistemic structure capable of mediating between imagination and evidence, emotion and logic, individual perspectives and systemic patterns.

The following sections reconstruct the design process across three levels: first, the theoretical foundations and the formulation of key design principles; second, the translation of these principles into the architecture of the course; and finally, the analysis of how each lesson enacted these principles in practice. Through this layered reconstruction, the chapter aims to offer both a reflective account of the design process and a contribution to the broader conversation on how narrative thinking can be meaningfully integrated into CCE.

5.1.1 From a Theoretical Model to Design Principles

This section addresses SQ2b, which investigates how the second version of the Narrativity Pyramid informed the design of the school-based course. The aim was to operationalise the model within a sequence of lessons that progressively activated distinct narrativity layers, thereby fostering transitions and connections between scientific reasoning and interpretive or value-laden reflection.

Within our framework, two key design principles emerged as pivotal for operationalizing the pyramid model into actionable pedagogical strategies. They represent an interpretive synthesis of conceptual work on narrativity—particularly Bruner's distinction between paradigmatic and narrative modes of thought (Bruner, 1990), Ryan's notion of degrees of narrativity (Ryan, 2005), and the explanatory function of narrative articulated by Norris et al.

(2005)—together with the pedagogical tensions encountered in earlier implementations. These tensions revolved around the need to balance narrative as a top-down communication device with narrative as a cognitive mode of sense-making. This translated into the challenge of designing learning experiences that would neither collapse into overly simplistic storytelling nor remain confined exclusively to abstract logico-scientific reasoning.

An initial formulation of the two principles was presented in a short article included in the ICSL proceedings (D’Orto and Tasquier, 2025b). Here, we offer a more detailed and elaborated version.

Principle 1) *From storytelling to storythinking*: narrative practices should be reframed not merely as tools for engagement or top-down communication, but as cognitive and epistemic structures through which students can think, argue, and take a stance.

This principle reframes narrative practices, conceiving them as a cognitive and epistemic structure characteristic of human thinking, related to but distinct from the paradigmatic reasoning typical of the hard sciences. Science educators need to acknowledge this natural mode of thought and to structure and guide students’ reasoning about CC when it involves narrative elements such as agents, events, and contingency (e.g., Bruner; Norris), as well as narrative cognitive processes such as addressing conflict or exploring the exceptional.

The principle also arises from the recognition that CCE—and, more broadly, science education concerned with future-oriented topics (Levrini, Laherto, and others)—as well as any form of science education explicitly oriented toward preparing learners as agents of change, is inherently entangled with cognitive elements and processes typical of narrative. These include the capacity to situate phenomena within temporal trajectories, to connect events through causal or intentional links, to address uncertainty and contingency, and to make sense of conflicts among alternative futures or value-laden perspectives. Such dimensions highlight a particular need not only to cultivate narrative thinking, but also to educate students in how narrative reasoning interacts with paradigmatic reasoning. By learning to navigate this interplay, students can move beyond rigid or decontextualized representations and engage in forms of reasoning that are both situated and oriented toward action.

This first principle is therefore closely linked to the theoretical findings of the first phase of my study, where several scholars highlighted how narrative, understood as a cognitive process, can support learners in reframing their understanding of climate issues. Such reframing enables a shift from rigid and decontextualized representations to situated, temporally bounded, and more agentic accounts.

Principle 2) *Scaffold learning through narrativity layers*: narrativity layers should be recognized and used as a scaffolding device to provide focal “middle-ground” steps where the two cognitive modes can gradually and meaningfully interact to foster cognitive abilities necessary in CCE.

The principle arose from both theoretical and empirical findings from the second phase of my research. It was shaped through the iterative refinement of the Narrativity Pyramid as both

an analytical and a pedagogical tool, supporting the interplay between students' narrative and paradigmatic reasoning.

First of all, this principle emphasizes that narrativity is not solely characteristic of narrative thinking, but that certain forms of scientific reasoning also rely on narrative features. Recognizing narrativity as a shared dimension between the two modes of thought allows it to function as a middle ground: a space where paradigmatic and narrative reasoning can encounter each other, exchange perspectives, and mutually enrich their epistemic contributions. Secondly, the aim of this principle is therefore to try and establish an operative approach that defines strategic narrativity layers to support the productive integration of paradigmatic and narrative cognition for CCE, enriching climate scientific literacy with what Bruner termed "narrative understanding": a mode of sense-making that foregrounds intentionality, contingency, and the interpretive nature of human action.

The educational orientation encapsulated into this principle is directed toward fostering transitions across cognitive modes and enabling students to construct representations of CC that are both coherent and meaningful. Narrativity, in this sense, functions as a strategic scaffolding device: a means to sustain the co-emergence of systemic awareness, agency (both epistemic and practical), and moral as well as personal positioning within complex socio-environmental issues. This entails inviting learners to recognize the diversity of narrative forms and to navigate the spectrum between high narrativity (as exemplified in genre fiction or historical reconstructions) and low narrativity (as embedded in scientific explanation and scenario modelling), thereby cultivating a form of epistemic bilingualism between the narrative and the paradigmatic.

The two principles together enabled a rethinking of educational design as explained in more detail in the next paragraph.

5.1.2 From design principles to the course

The two designs drove the conceptualization of the course implemented at the Rosa-Luxemburg school, by directly informing the learning objectives, the sequencing of the lessons, and the epistemic posture underpinning the entire experience.

Learning objectives (guided by P1 and P2).

- *Dual literacy*: develop narrative alongside scientific literacy, regarding CC. The role of Luca Luongo as a co-designer of this project was particularly crucial here, to professionally check the narrative literacy content of the course.
- *Agency and positioning*: enable informed, responsible positioning (i.e. epistemic, moral, and practical) in relation to climate issues.

Sequencing and activity architecture (guided primarily by P2, mediated by P2).

- The course was conceived to progressively activate narrativity layers, moving from world-building and temporal sequencing to perspective-taking and genre critique.

- The macro-architecture of the course was organized as a narrative arc that gave coherence across sessions and a shared purpose to the learners' work
- Each lesson combined a paradigmatic anchor (data, models, scenarios), a narrative activation (agents, events, conflict/perspective), and a bridging reflection that try to foster and explore the interplay between the two modes.

Epistemic posture (grounded in P1).

- *Quality criteria for student work* included evidential warrant (paradigmatic coherence) and interpretive coherence (narrative plausibility and meaning), assessed in tandem.

The first principle, *from storytelling to storythinking* required that each activity be designed to foster narrative thinking and meta-cognitive reflection on how narrative thinking shape climate imaginaries. The approach was positioning students not merely as listeners of stories, but as active constructors of meaning, authors of their own situated narratives.

The first principles was thus embodied in the structure of the course that was conceived as an narrative arc in itself, through that students where gradually immersed in and prompted with increasingly complex narrative structures (i.e. increasingly higher in narrativity).

With narrative arc we mean the overarching structure that organizes a story through a sequence of events, tensions, and resolutions, guiding both characters and audience across a temporal trajectory. It functions as a scaffolding device, providing coherence to otherwise fragmented episodes and enabling meaning to emerge through the progressive unfolding of conflict, transformation, and closure (or, in some cases, deliberate openness). Within our educational context, the narrative arc operated not merely as a storytelling technique, but as a cognitive and epistemic frame establishing coherence and continuity across activities and allows participants to situate their reasoning and imaginative explorations within a larger, evolving narrative and imaginative frame.

The arc drew inspiration from Italo Calvino's book "*Invisible Cities*". The narrative frame of Invisible Cities is at once simple and profoundly generative from an imaginative standpoint. Marco Polo recounts to Kublai Khan, the emperor of the Tartars, the cities he claims to have visited during his travels. Yet these cities are not geographical realities but literary inventions, shaped as symbolic and metaphorical constructs. The dialogue between Marco Polo and Kublai Khan, which serves simultaneously as connective thread and metanarrative device legitimises and, at the same time, problematises the stories of the cities, positioning them not as mere descriptions of places but as epistemic instruments for exploring ways of knowing and interpreting the world. For our course design Calvino's narrative frame was transposed into the present and reframed within the lens of climate justice. Moreover, it was briefly dramatized, giving to the frame a narrative tension that would make the events evolve into a plot.

At the core of the course narrative arc stood the Galactic Confederation's Ministry of Environmental Assessment, an intergalactic commission entrusted with monitoring the sustainability of planetary systems, and in particular the figure of Zark, an alien scholar

charged with investigating situations in which planetary equilibrium was at risk. The story starts with Zark's last mission on planet Earth. As always, during the visit he remained invisible and refrained from any interaction with its life forms. From this vantage point, he observed a planet that had long sustained a prosperous climatic balance, now severely compromised by the dominant species—humans—whose actions were inflicting profound and long-term consequences upon all other forms of life. His preliminary report, submitted to the commission, led to the judgment that ecological justice on Earth was under threat. Zark was therefore mandated to undertake a deeper inquiry. In the second phase of his mission, Zark assumed human form and began to interview diverse representatives of humankind, collecting their arguments, justifications, and intentions. This second report portrayed a species simultaneously aware of its responsibility and yet capable of rationalising destructive behaviours, while already envisioning colonisation of other planets—such as Mars—despite the precarious state of its own. Confronted with this evidence, the commission declared humanity guilty of interspecies injustice and a potential danger to the wider galaxy. Consequently, the council resolved to make itself visible to Earth and to impose a condition: unless humanity could credibly demonstrate detailed strategies to repair the damage inflicted and to restore sustainability, the commission would be forced to intervene directly, activating a “planetary recycling protocol.” At this point, representatives of humankind from diverse contexts and generations began producing video testimonies, outlining the initiatives they intended to implement to address sustainability challenges. The story deliberately remained open-ended: its conclusion was to be imagined, negotiated, and enacted after the final educational activities.

During the activities, to foster narrative thinking students were presented with and guided in the use of some of the core tools of this mode of thinking, as defined by scholars such as Bruner, Norris and Fletcher:

- *temporality and sequencing*: understanding how events unfold across time and generate consequences;
- *perspective-taking*: exploring different viewpoints and moral positions;
- *narrative conflict*: recognizing tensions and dilemmas as drivers of events and meaning-making;
- *agency and intentionality*: recognizing/attributing motives and will to actors.

Additional narrative thinking tools include:

- *tropes*: figurative devices or recurring narrative patterns, such as metaphors or archetypal plots (Bari & Gouthier, 2003);
- *genre conventions*.

The second principle, *scaffold learning through narrativity layers*, provided not only the logic for sequencing the course, but a generative structure for organizing the gradual activation of narrative tools. Each layer of narrativity was used to introduce and consolidate specific cognitive operations. These layers were not static descriptors of textual form, but dynamic scaffolds designed to stage increasingly sophisticated forms of reasoning. The construction of a narrative world (Layer 1) activated spatial and causal coherence; the sequencing of

events across time (Layer 2) invited students to reason about consequences and contingency; the introduction of personal perspectives (Layer 3) opened space for moral complexity and emotional resonance; and the recognition of genre frames (Layer 4) encouraged critical interpretation of dominant discourses. At each step, narrative thinking was deliberately brought into dialogue with paradigmatic reasoning: rather than separating scientific explanation from imaginative storytelling, the course staged learning activities where the two modes could reinforce, contrast, or reinterpret one another. In this way, narrativity functioned as a mediating structure that enabled students to navigate between factual complexity and interpretive meaning, between systemic understanding and subjective positioning.

The influence of these design principles was not limited to the overarching structure and epistemic stance of the course but it was made fully tangible in the design of each individual lesson. The following paragraph provides a detailed account, illustrating how the two principles informed specific pedagogical choices and shaped the learning trajectory of each lesson.

5.1.3 Lesson Plan

The course unfolded according to a specific temporal structure (see: Table 5.1), designed to allow for a gradual engagement with the epistemic and symbolic tools provided. The learning path was articulated in six sessions of two hours each (12 hours in total) through which incrementally were introduced new narrative layers, with the purpose of progressively fostering a dynamic interplay between narrative and paradigmatic reasoning in students' thinking and in their representations of CC.

Lesson 1: World-Making and the Grammar of Complexity

The first lesson introduced students to the theme of complexity through a dual lens (literary and scientific) focusing on narrativity Layers 0 and 1. The session opened with a collective reflection on the concept of "world," prompted by the description of Ottavia from Italo Calvino's book "Invisible Cities". This literary excerpt served as a narrative gateway into discussions about context, human-environment relationships, and the rules, both natural and constructed, that sustain a world. Drawing on this fictional world, students were invited to identify key narrative elements of Layer 0 such as settings, constraints, and inhabitants, and to reflect on how these might relate to our planet as an environmental context.

The second part of the lesson shifted to a scientific framing, introducing the concept of systems and distinguishing between simple and complex systems. Climate was then positioned as a paradigmatic example of a complex system, open, dynamic, and interconnected, offering a transition from literary world-making to scientific modeling. The lesson culminated in a paradigmatic-narrative exercise: first we re-read Ottavia's story and discussed how a city could be modeled as a complex system (from narrative to paradigmatic), then students were prompted with the task of writing their own short stories in the style of Calvino, but from the perspective of an alien climatologist visiting Earth, tasked with describing the human-environment relationship (from paradigmatic to narrative).

The design of this lesson was strongly informed by both design principles. The principle “from storytelling to storythinking” shaped the decision to engage students not only in listening or interpreting a story, but in inhabiting and reproducing its cognitive architecture (in both paradigmatic and narrative mode) to make sense of our reality. Rather than discussing the environment in abstract terms, students entered the learning process through a narrative frame that activated core tools of narrative thinking, especially world-making, perspective-taking, genre and tropes (especially in the form of metaphor). The alien visitor itself (typical archetype of the sci-fi genre) was meant as a trope—a narrative device that enabled distancing, irony, and a defamiliarizing gaze.

The second principle, “scaffold learning through narrativity layers”, guided the choice to start from Layers 0 and 1: while the scientific content started at the level of abstract systemic descriptions (Layer 0) it evolved into more specific context related examples (Layer 1) and pairing with the narrative reading created a task that was aimed at making the two modes check and give meaning to the other, by asking students to construct an verisimilar yet coherent agentive world, metaphor of our real world. This initial layering was intentionally kept minimal to allow students to build familiarity with narrative thinking without yet confronting (at least consciously) complex temporalities or ethical tensions. The combination of literary and scientific framings invited students to notice how both disciplines construct models of reality, and how narrative world-building can serve as an entry point into systemic reasoning. In this way, the lesson laid the cognitive and epistemological foundation for the subsequent progression through higher layers of narrativity.

Lesson 2: Temporalities of Uncertainty

The second lesson introduced the theme of uncertainty and marked a shift from spatial and structural representations of climate (Layer 1) to temporal and historical reasoning (Layer 2). Building on the concept of climate as a complex system, the session traced the epistemological trajectory by which the scientific community came to identify the main anthropogenic causes of CC. This historical deepening was not presented as a linear accumulation of facts, but as the outcome of inquiry, controversy, and interpretation—thereby embedding science itself within a narrative arc.

Students explored scientific models and key milestones in climate research, alongside the political and social responses they triggered. Through a dual lens—paradigmatic (“What are the causes of climate change?”) and narrative (“How did we come to know them, and through which struggles?”)—they were invited to reconstruct the development of climate knowledge as a situated, value-laden, and sometimes contested process. This reframing aimed to generate a richer understanding of both the uncertainties and the socio-political stakes embedded in climate science. The lesson concluded with collective reflection on the concept of “business-as-usual” as a narrative default, opening space for imagining alternative trajectories.

The design of this lesson was again guided by the two principles. In line with storythinking, students were not only exposed to scientific explanations, but encouraged to engage with the temporality, intentionality, and contingency embedded in scientific discovery itself. This required recognizing that even data-driven narratives contain implicit narrative elements:

actors (scientists, institutions, societies), turning points (discoveries, reports, agreements), and plot structures (conflict, resistance, resolution). By situating the evolution of knowledge within a temporal and human framework, the lesson supported students in developing causal reasoning alongside narrative sequencing—key components of climate literacy and narrative thinking alike.

The principle of scaffolded narrativity informed the transition from Layer 1 to Layer 2. While the first lesson focused on spatial worlds and systems, this second session introduced a dynamic temporal axis. It invited students to follow chains of cause and effect, to recognize uncertainty not as a deficit but as a structural feature of complex systems, and to historicize both problems and responses. This progression scaffolded students' ability to conceptualize change over time, laying the groundwork for the imaginative engagement with futures that would follow in subsequent lessons.

Lesson 3: From Worlds to Futures

The third lesson marked a turning point in the course, consolidating previous insights while shifting the focus toward future-oriented reasoning. Co-led by a climate researcher, the session reactivated the narrative world built in earlier lessons and introduced scientific foresight tools—specifically, the Shared Socioeconomic Pathways (SSPs) and net-zero transition scenarios. These frameworks, commonly used in climate modeling and policy discussions, were presented not merely as datasets or fixed pathways, but as narrative constructs that connect present choices to divergent long-term outcomes.

Students engaged with the structure and logic of these scenario tools, learning to interpret their components (e.g., demographic trends, technological assumptions, governance patterns) as storylines—plausible yet constructed projections embedded with values, priorities, and tensions. Through discussion and guided analysis, they were encouraged to compare different pathways, assess their internal coherence, and reflect on the socio-political assumptions underpinning each. The session culminated in an imaginative exercise: students were asked to inhabit one of the SSP futures and consider what kinds of decisions, trade-offs, and agents would be needed to sustain or challenge it.

This lesson exemplified the principle of *storythinking* by making explicit the narrative nature of scientific scenarios. Rather than treating the SSPs as abstract models, students were invited to recognize them as structured fictions—cognitive tools that simulate the future not to predict it, but to reason within its uncertainty. By framing the SSPs as “future stories,” the lesson activated narrative tools such as *causality*, *agency*, *temporality*, and *moral positioning*, while anchoring them in scientific plausibility. This dual framing encouraged students to move beyond passive reception of expert knowledge and toward an active, interpretive stance: one in which foresight becomes a form of reasoning and positioning.

The principle of *scaffolded narrativity* guided the layering strategy: Lesson 3 operated at Layer 2 and began to open Layer 3, where internal perspectives, motivations, and tensions emerge. The SSPs offered structured plots that could be expanded into rich narrative worlds, yet remained open enough to invite students to insert subjective viewpoints and value

judgments. This made the lesson an ideal hinge between descriptive reasoning and interpretive, agentic construction. It also laid the conceptual groundwork for the creative phase of the course, by equipping students with an understanding of how future scenarios function both as modeling tools and as narrative frames for action.

Lesson 4: Framing and Genre

The fourth lesson introduced students to the concept of *genre* as both a narrative structure and a cognitive lens. The session centered on the analysis of a mockumentary script, used as a springboard for exploring how form, tone, and framing shape the interpretation of climate-related content. Students collectively read and discussed selected excerpts from the script, focusing on the interplay between factual elements and fictional devices, between irony and seriousness, and between simplification and complexity. These reflections led to a rich philosophical debate—especially among younger students—on agency, responsibility, and plausibility in imagined futures.

The activity revealed how genre conventions implicitly guide meaning-making: for instance, how a dystopian framing might elicit fatalism, while a documentary format might suggest neutrality or authority. Students were encouraged to analyze these effects and to reflect on their own intuitive responses: Which framings felt more “true”? Which invited action, and which provoked disengagement? In doing so, they began to develop a critical awareness of how stories work—not only in what they say, but in *how* they say it.

This lesson exemplified the *storythinking* principle at a higher level of reflexivity. It moved beyond constructing stories to explicitly dissecting how stories function as epistemic and affective devices. Students engaged with *genre awareness*, *tropes* (i.e., recurring narrative patterns or figurative devices—such as irony, redemption, or tragedy—that help structure meaning and shape interpretation), and *framing strategies*, tools that allowed them to perceive the subtle but powerful ways in which narrative form shapes epistemological stance. They were also invited to consider their own position as potential authors: what kinds of genres might better reflect the futures they imagine? What risks are involved in reproducing dominant narrative tropes?

In terms of *scaffolded narrativity*, Lesson 4 corresponded to a full activation of Layer 4. It explicitly dealt with genre conventions and meta-narrative awareness, requiring students to move beyond character perspectives (Layer 3) toward an understanding of narrative as a constructed, culture-dependent system. At the same time, this level of abstraction did not disconnect from scientific reasoning: rather, it made space for questioning the narratives embedded in scientific communication itself, and opened the way for constructing *counter-narratives* that challenge dominant imaginaries. In this sense, the lesson marked the epistemological culmination of the narrative scaffolding, and set the stage for the students’ own narrative productions.

Lesson 5: Staging Climate Futures

The fifth lesson marked the transition from analysis to creative production. Students, working in small groups, began designing and filming their own short mockumentaries. Drawing on the narrative elements explored in previous sessions—worlds, trajectories, values, genres—they were asked to invent and stage stories situated within climate futures of their own imagination. Each group constructed a mini-narrative universe, populated with characters, tensions, and choices, and selected an appropriate narrative tone and genre through which to convey it.

This lesson brought the storythinking principle into full expression: students were no longer just analyzing or reflecting on narrative structures, but performing them. In staging their stories, they had to embody characters, explore their intentions and dilemmas, and bring to life relationships between individuals, systems, and futures. The act of performance activated tools such as perspective-taking, moral positioning, narrative conflict, and emotional resonance in powerful, embodied ways. Taking on a role meant not only imagining another point of view, but negotiating it through dialogue, improvisation, and visual representation. These tasks demanded both narrative imagination and ethical reflection.

From the perspective of scaffolded narrativity, this lesson represented a synthetic moment in which all four layers of the pyramid were in play. Students had to construct coherent worlds (Layer 1), articulate causal trajectories (Layer 2), express inner perspectives and conflicts (Layer 3), and manage genre conventions (Layer 4). However, these layers were now embedded in a collective creative process, rather than imposed through predefined tasks. This open-ended structure challenged students to rehearse complexity in action—not just by talking about climate futures, but by staging and inhabiting them.

Lesson 6: Editing as Narrative Thinking

The final session was devoted to editing the filmed materials. Here, students moved from staging to shaping: they reviewed raw footage, selected scenes, constructed sequences, and negotiated how to assemble their story in a way that was coherent, impactful, and faithful to their intended message. The editing process became a reflective exercise in narrative decision-making: what to include or leave out, how to order events, what tone to convey, and what balance to strike between information, irony, and affect.

This final phase followed the principle of storythinking as a meta-cognitive and epistemic practice. Editing required students to re-engage with all the tools they had activated in previous lessons—temporality, causality, agency, tropes, genre—but from a distanced, authorial perspective. It also demanded negotiation and compromise: different interpretations, opinions and creative visions had to be aligned to produce a shared narrative artefact. In this sense, editing was not a technical appendix, but a form of collaborative reasoning about meaning, responsibility, and representation.

In terms of scaffolded narrativity, the editing phase functioned as a recursive synthesis: students revisited and restructured the four narrative layers, now internalized as flexible resources rather than external prompts. The process required them to critically assess their own work, confront narrative coherence, and take responsibility for the epistemic and affective impact of their choices. In this way, the course closed not with the celebration of a finished product, but with a reflective gesture: students were positioned as authors, editors,

and citizens—capable of navigating complexity through both imagination and critique. Following, a Table summary (Table 5.1).

Table 5.1: Lessons summary of the School-Based Course. The table outlines the six lessons of the school-based course, detailing their thematic focus, main activities, and design principles that guided their design. Together, the lessons progressively activate the narrativity layers—from world-building and causal reasoning to genre awareness and meta-cognitive reflection.

Lesson	Description	Design principles
Lesson 1: World-Making and the Grammar of Complexity	This first session introduced students to the concept of “world” through a literary lens—using a passage from Calvino’s <i>Invisible Cities</i> —and then recontextualized it through scientific reasoning, exploring systems thinking and the climate system as a complex whole. The final exercise asked students to write a short narrative from the perspective of an alien climatologist, blending observation and interpretation.	The principle of storythinking informed the epistemic framing of the lesson: students were not only invited to create stories, but to interrogate what constitutes a “world” and how different world-constructions entail different forms of knowledge. Meanwhile, the narrativity layering principle situated this lesson within Layer 1 (contextual world-building) and Layer 0 (scientific models and abstractions), establishing a dual frame for future learning.
Lesson 2: From past to present (Temporalities of Uncertainty part 1)	This lesson introduced historical and epistemological perspectives on CC. It presented the scientific discovery of its causes as a temporally structured, value-laden, and contested process. Students explored the interplay between evidence, interpretation, and political decision-making.	The principle of storythinking was enacted by asking students to reflect on how scientific facts are embedded in stories of inquiry and controversy. The layering principle supported the transition from Layer 1 to Layer 2, as students began constructing causal chains and historicized understandings of climate knowledge. This progression allowed them to see climate not only as a state to be explained, but as a story to be interpreted.
Lesson 3: From present to futures (Temporalities of Uncertainty part 2)	Co-led by a guest researcher, this session focused on climate scenarios and SSPs, inviting students to imagine how different present choices might shape diverging futures. The lesson drew connections between past learning and forward-looking reasoning.	Storythinking was central here, as students had to interpret formal scenarios not as predictions but as structured storylines open to contestation and reinterpretation. The narrativity framework located this session between Layers 2 and 3, as students moved from causal coherence toward the emergence of values, tensions, and decision points within possible futures.
Lesson 4: Framing desirable futures	This lesson introduced the mockumentary genre and its conventions. A class-wide analysis of a fictional script sparked debate about responsibility, simplification, and the framing of action, prompting students to critically reflect on how genres guide interpretation and emotional response.	Here, storythinking became metacognitive: students examined how narrative frames influence the perception of agency and plausibility. The layering principle marked a clear entry into Layer 4: genre awareness. The genre lens served as a scaffold for reflecting on the narrative choices they would soon make, especially how framing could reinforce or subvert dominant climate discourses.

Lesson 5: Staging Climate Futures	In this session, students began developing and filming their own short mockumentaries. Working in groups, they constructed narrative worlds, defined characters and tensions, and experimented with tone and genre to represent imagined climate futures. The performative aspect of the activity encouraged embodied engagement with complex systems, values, and possible trajectories.	The principle of storythinking was activated through role-taking and staging, as students explored perspective, conflict, and moral agency from within. The narrativity layering principle emerged in the integration of all four layers: world-building (Layer 1), causal progression (Layer 2), internal perspectives (Layer 3), and genre framing (Layer 4), now mobilized in a student-led, creative process.
Lesson 6: Editing as Narrative Thinking	The final session focused on editing the filmed material. Students collaboratively selected, sequenced, and refined scenes to craft coherent, impactful narratives. This phase required critical reflection on narrative structure, tone, and meaning—transforming raw footage into intentional climate stories.	The principle of storythinking shaped this lesson as an authorial and meta-cognitive exercise: students reasoned through narrative, deciding how to represent complexity and position their message. The narrativity layering principle operated as a recursive synthesis, prompting students to revisit each narrative layer with increased autonomy and awareness.

5.2 Methodology and data collection

Consistent with the DBR-inspired methodological orientation described in Chapter 2, the present implementation functioned as a design experiment aimed at refining the Narrativity Pyramid within an authentic school context. The methodology combined design-oriented planning with interpretive analysis, seeking to capture how narrativity layers mediated students' reasoning, sense-making, and agency

5.2.1 Key concepts and frameworks that guided the analysis

The empirical study presented in this and the following sections (5.3 and 5.4) were guided by research question SQ3b, which focuses on the transformations in students' sense-making and agency emerging from the narrativity-based course.

In this thesis, I adopt a perspective on *sensemaking* and *agency* that emphasizes their interconnection and co-emergence within educational practices focused on narrative thinking.

Sensemaking is here understood as the interpretative and affective process through which individuals and groups construct meaning out of the uncertainties and complexities of CC. Following Kurtz (2014) and Bengtsson et al. (2020), I consider sensemaking not as the mere assimilation of scientific information, but as a dynamic trajectory of meaning-making that unfolds across contexts, where learners continuously negotiate coherence between experience, knowledge, and values. In this view, narratives become crucial because they

provide learners with cognitive and imaginative tools to weave fragmented information into meaningful trajectories that integrate scientific, experiential, and ethical dimensions.

Continuing following Bengtsson et al. (2020), this study conceptualizes *agency* in educational contexts as a matter of positioning within Climate Change issues, where students learn to recognize themselves as legitimate actors capable of deliberation and transformation. In parallel, Tasquier & Pongiglione (2017) show that understanding the causal dynamics of climate systems is crucial for enabling students to perceive themselves as *causal agents*—actors whose knowledge allows them to connect personal decisions with systemic consequences. Agency thus extends beyond behavioural change: it entails the epistemic and ethical stance through which learners interpret complexity, imagine alternatives, and negotiate decisions.

From this positioning, sensemaking and agency emerge as two inseparable dimensions. As Kurtz (2014) argues, sensemaking is not complete until it leads to action, since the very act of making sense is inseparable from the capacity to intervene in the world. In CCE, this implies that the construction of meaning cannot be reduced to cognitive alignment or conceptual understanding; it must be directed towards the capacity of learners to take a stance and to perceive themselves as participants in shaping futures. Accordingly, throughout this thesis I investigate how narrative artefacts and practices can scaffold both dimensions—supporting learners in making sense of the complexity of CC and in recognizing themselves as capable of agency within its unfolding trajectories.

5.2.2 Context of the study

The course was implemented at the “Istituto Tecnico di Istruzione Superiore Rosa Luxemburg” in Bologna, Italy, a public upper secondary school offering a variety of technical and vocational tracks. The school is known for its commitment to inclusion and multicultural education, serving a student body characterized by linguistic, cultural, and socio-economic diversity. The intervention took place within the curricular timetable, as part of an educational enhancement initiative funded through the Italian National Recovery and Resilience Plan (PNRR), under the umbrella of the FUTURA project⁹. The project was selected and organized by the teaching board and integrated into the school's official educational offer, although participation in the specific activities was not based on voluntary student enrolment and the course was not subject to formal evaluation.

Two classes took part in the study, reflecting distinct educational focuses: one was a second-year class (students aged 14–15) following a curriculum in audiovisual and cinematographic production; the other was a fifth-year class (students aged 17–18)

⁹ Piano Nazionale di Ripresa e Resilienza – Missione 4, Componente 1, Investimento 3.1 “Nuove competenze e nuovi linguaggi”

specializing in tourism. A total of 45 students were involved. These two learning environments provided contrasting yet complementary contexts for the exploration of narrative-based climate education, with the younger group bringing technical creative skills and the older group contributing more advanced communicative and relational competencies.

Both classes involved in the intervention presented some pedagogical challenges, reflecting the complexity and heterogeneity typical of many technical and vocational schools. Students came from a wide range of cultural and linguistic backgrounds, and several had diverse and challenging educational needs or learning trajectories. Overall, the classes were part of a setting where educational expectations, curricular focus, and cultural capital often offered only partial support for the kind of reasoning and engagement required by CCE. That means that students had limited academic stimulation and constrained opportunities, for example, for the development of abstract or systemic thinking and limited prior exposure to activities fostering critical reflection, interdisciplinary reasoning, or future-oriented imaginative thinking.

Nevertheless, the diversity within the groups also included highly engaged and intellectually curious individuals. A number of students demonstrated remarkable critical thinking, creativity, and interest in the topics proposed, qualities that often emerged during open discussions and narrative activities. These students acted as important catalysts for peer interaction and contributed significantly to the depth and originality of the learning experience.

5.2.3 Data collection

To address the research questions outlined in the previous chapter, a series of data collection tools were developed and employed at different stages of the course. Each tool was intended to capture specific dimensions of the students' learning processes and to trace shifts in their conceptualization of CC, their epistemic positioning, their sense-making processes, and their sense of agency.

The table below (Table 5.2) summarizes the types of data collection tools employed throughout the intervention, specifying the moments of use, the dimension investigated, and the nature of the data collected.

Table 5.2 *Overview of data collection:* last column shows the types of data collection tools (instrument) employed throughout the intervention, the other columns show when each tool was applied during the course (moments of use), the specific aspect under investigation (main dimension investigated), and the nature of the data collected by each of the instruments (data type).

Instrument	Moment of Use	Main dimension Investigated	Data Type
Questionnaires	Beginning and end of course	Sense-making, agency, content knowledge	Qualitative and quantitative
Students journaling	Throughout the course	Students' spontaneous self-reflection upon their learning process	Qualitative

Audio recordings	Throughout the course	Classroom and group project dynamics, emergence of the ways of thinking	Qualitative
Researcher field notes	Throughout the course	Classroom dynamics and contextual elements	Qualitative
Artefacts	Lesson 2, 5 and 6	Representation of CC, Role of narrativity layers, Agency	Qualitative

In the sections that follow, the rationale, structure, and implementation of each data collection tool will be described in detail, with particular attention to their methodological affordances in light of the study's aims.

Two questionnaires were designed and administered as a pre/post in the first and last lessons:

Pre-course questionnaire: it was designed as a multi-section instrument to capture students' positioning with respect to CC, by exploring cognitive, affective, and agentic dimensions, as well as their relationship with narratives. Its construction was guided by previous work in the field, while also undergoing an adaptation process to fit the aims of this research.

The first section addresses students' *interest* in CC and the *emotions* it elicits. The items are based on the climate anxiety questionnaire proposed by Hickman et al. (2021), and on its Italian adaptation recently developed by Chiaraluce (2024). Students were asked not only to indicate which emotions they associated with CC (e.g., affliction, anxiety, motivation, wonder), but also whether such emotions had repercussions on different domains of their everyday lives (diet, mobility, leisure, social relations, and school experience). In this way, emotions were not conceived as a static register, but as an entry point to understanding the embodied and situated nature of CC in students' lives.

The second section investigates students' *relationship with narratives*. Rather than treating stories as an optional embellishment of scientific discourse, the questionnaire probed students' interest in creating or consuming stories in different media, and invited them to narrate, in their own words, a short story about CC—either invented or recalled. This open-ended prompt was intended to elicit the spontaneous narrative resources students mobilize when engaging with complex socio-scientific issues, in line with a view of narrative as a cognitive and epistemic tool (Avraamidou & Osborne, 2009; Norris et al., 2005).

The third section focuses on *students' awareness of CC causes and consequences*. Its structure was inspired by previous questionnaires in science education (Tasquier & Pongiglione, 2017; Tasquier, Knain & Jornet, 2022). It combines self-evaluations on knowledge levels (from "I know nothing" to "I know everything necessary"), with open prompts asking students to provide their own definitions of CC, and to exemplify causes and consequences they were aware of. This design responds to the need to move beyond closed-form assessments and to capture the heterogeneity and fragmentation of students' conceptual repertoires.

The fourth section investigates *action and agency*. Following Tasquier and Pongiglione (2017), students were asked to indicate whether they were currently undertaking any actions aimed at mitigating CC, ranging from “none” to “radically changing my lifestyle.” This part also includes questions on the perceived role of different social actors (e.g., political decision-makers, enterprises, citizens, and oneself) in addressing CC. Such items were meant to elicit how students perceive the distribution of responsibility and the degree to which they recognize themselves as capable of agency within a broader socio-political landscape.

Finally, the fifth section examines *students’ epistemic needs*. They were asked to identify which aspects of CC they felt the need to deepen in order to understand and act (e.g., climate science, social aspects, economic/political dimensions, artistic and literary perspectives, or real stories). This section, deliberately left open to “other” responses, was designed to shed light on how students articulate their own learning trajectories, acknowledging that CCE requires a plural epistemic ground (Shepherd & Lloyd, 2021; Walsh & Stepney, 2018)

Post-questionnaire: After the conclusion of the course, students were invited to complete a post-questionnaire. Its design partly mirrors the structure of the pre-questionnaire, in order to enable comparisons, but it also introduces new items and removes others, so as to capture more precisely the learning trajectories fostered by the educational intervention. The overarching aim of this instrument was to trace how students’ knowledge, emotions, agency, and epistemic positioning had evolved, while also probing their engagement with narrative thinking and their capacity for sense-making of complexity and uncertainty.

The first section focuses on knowledge and emotions. It reprises the scales on students’ interest in CC and on the emotions associated with it, building on Hickman et al.’s (2021) climate anxiety survey and the Italian adaptation by Chiaraluce (2024). At the same time, it introduces reflective items that directly ask students to re-evaluate their knowledge and definitions of CC after the course, thus providing a diachronic perspective on conceptual change (Tasquier & Pongiglione, 2017; Tasquier, Knain & Jornet, 2022).

The second section addresses agency. Here, the items are designed to capture shifts in how students interpret the possibility of action in conditions of uncertainty, moving beyond the pre-questionnaire’s focus on current behaviours. Students are asked to comment on whether their ideas have changed during the course, to evaluate different socio-political scenarios for action, and to position themselves vis-à-vis the role of individual versus collective responsibility. Such items resonate with literature on climate-related agency and with the educational challenges of cultivating future-oriented competencies (O’Neill et al., 2017; Vidal, 2006). The third section explicitly investigates narratives and narrative thinking. These items were purposely designed for this research project, with inspiration drawn from recent scholarship that highlights the epistemic role of narratives in science and CCE (Avraamidou & Osborne, 2009; Norris et al., 2005; Moezzi et al., 2017). Students were invited to reflect on how creating or listening to stories influenced their ability to take different perspectives, to reason about decision-making under uncertainty, and to explore the motivations of fictional characters. While these prompts have no direct precedent in existing surveys, they build on

an established theoretical ground that frames narrative not merely as a vehicle for communication, but as a mode of thought (Bruner, 1990; Ryan, 2005). Their novelty lies precisely in operationalising this dimension in the form of survey questions, thus contributing to methodological innovation in CCE.

Finally, the fourth section investigates sense-making. Here students are asked to compare the explanatory affordances of scientific data versus stories, to reflect on their understanding of complexity and uncertainty, and to comment on the added value of narrative activities. These items are grounded in the literature on narrating complexity (Walsh & Stepney, 2018) and on the storyline approach in climate science (Shepherd & Lloyd, 2021), both of which argue that narratives and storylines can function as epistemic tools to render complex phenomena meaningful.

The complete texts of the questionnaires are reported in the Appendix A.2.2 and A.2.3.

Students Journaling: At the end of each lesson, students were offered the opportunity to contribute with spontaneous written reflections. The shared Journal was accessible through a qr code at the end of each lesson, and they were prompted to leave brief, informal notes capturing their impressions of the lesson, the emotions or questions it evoked, or any other thought it may have triggered. The tool was conceived as an open and process-oriented instrument designed to accompany students throughout the educational pathway. It foregrounded students' voices in their raw, unfiltered form, privileging emergence over coherence.

Audio-recordings: After asking the students for permission (and collecting signed consensus forms in the following days), we record the audio of each lesson to keep track of class dynamics and students' interventions throughout the course and during group activities.

Field notes: I kept some personal research notes, written during or briefly after each lesson. They were used to document observations of classroom activities, focusing on students' interactions, reactions, and emerging dynamics. They served as a situated record of the learning environment, capturing moments of engagement, hesitation, or negotiation. These notes complemented other data sources by offering contextual insights into how agency and sense-making unfolded in practice.

Narrative artefacts: various written and audiovisual products were created by students during the course, which embody their attempts to make sense of CC through narrative forms. They include the short narratives collected in the initial questionnaire (Lesson 1), those later developed through the world-making activity (Lesson 1) and the mockumentary scripts and videos produced at the end of the course (Lessons 5–6). Across these three moments, the artefacts spanned different media—from short written texts and conceptual notes to scripts and videos—thus reflecting the transmedial nature of narrative and its capacity to migrate across formats with distinct cognitive consequences (Ryan, 2005). The artefacts were generated in small groups, with students taking on different roles in writing, acting, and filming, in line with participatory approaches such as the Future Workshop (Jungk & Müller, 1987; Vidal, 2006), where collective critique and creativity are central.



Figure 5.2 Overview of data collection and analysis. The figure summarises the instruments used across the six lessons of the School-based course and their corresponding analyses.

5.3 Analysis

5.3.1 Analytical methods

The methodological framework for this study is grounded in a design-based and interpretative approach typical of educational research in science education, particularly within the tradition developed by Levrini and colleagues. It combines principles of discourse analysis and thematic coding to examine how students negotiate meanings, construct scientific reasoning, and engage in narrative sense-making during classroom interactions focused on CCE. The theoretical point of departure aligns with Bruner's (1986, 1991) distinction between paradigmatic and narrative modes of thought, recognising these as complementary epistemic functions through which students engage with complex issues. This perspective positions discourse as a privileged site for analysis, where different ways of thinking emerge, interact, and evolve in relation to both the content and the socio-cultural framing of the educational activity.

From an operational perspective, the study integrated multiple methods across the data corpus. Quantitative and qualitative questionnaire responses were analysed through a mixed-methods strategy: closed-ended items were statistically processed to detect general patterns, while open-ended items were coded manually and through digital tools (Python and Julius.ai) to identify emerging categories in relation with sense-making and agency. Classroom discussions were audio-recorded, selectively transcribed, and subjected to layered coding based on a dual axis: the mode of reasoning (paradigmatic/narrative) and the degree of narrativity expressed, following a framework specifically developed for this study. The interpretative analysis aimed at capturing the epistemic function of students discursive

moves and their capacity to navigate complexity, uncertainty, and value-laden tensions. Throughout the process, a dialogic interplay between top-down theoretical constructs and bottom-up insights from the data was maintained, in line with the interpretive epistemology that informs this kind of research.

This methodology acknowledges narratives, as previously described, as dynamic devices for thinking and acting in the world—both individually and collectively. As Fletcher (2023) argues, narrative thinking is oriented toward “creative action,” and this study explored how such a mode of reasoning could be activated, scaffolded, and observed in a real educational context dealing with CC. The ultimate goal was thus not merely to assess learning outcomes, but to trace the contours of a cognitive and affective reconfiguration—one in which students could begin to author their own positions and envision alternative futures.

5.3.2 Procedure of data analysis

The process of data analysis unfolded through a sequence of intertwined phases that were not merely technical, but epistemologically situated within the broader aims of the research. The first step entailed the cleaning and structuring of the raw data, a moment of “taming the mess” that required interpretative choices about what to preserve, what to exclude, and how to render the material legible without neutralising its complexity. Once structured, there was a preliminary phase of immersion and attunement to the pstudents’ perspectives. Subsequently, the full-fledge analysis subjected the data to a dual lens: on the one hand, a quantitative analysis was carried out to detect overarching trends and recurrent patterns, often revealing signals that had remained latent to initial observation; on the other hand, a qualitative inquiry sought to interpret these signals by returning to the singularity of the students’ voices, gestures, and narratives. This dialogic movement between synthesis and interpretation, between pattern and meaning, allowed the data to speak in a way that was neither deterministic nor anecdotal, but generative: a space where new questions could emerge and different layers of significance could be negotiated.

More specifically, the process went through the following phases:

- **Data Cleaning and Organization**

The initial phase involved the systematic organization of the collected material into structured files, primarily Excel spreadsheets for quantitative responses and Word documents for qualitative material. This step included a preliminary screening of audio recordings through rapid listening, aimed at identifying the most meaningful segments for transcription. Selected recordings were then transcribed in full, with attention to preserving both the content and the contextual nuances of the classroom interaction.

- **Preliminary Reading and Immersion**

The preliminary reading phase was conceived as a moment of epistemic attunement, in which the researcher immersed herself in the data not to analyse it immediately, but to become sensitized to its internal rhythms, tensions, and signals of significance. Inspired by Grounded Theory (Glaser and Strauss, 1967), this phase followed an open and iterative logic aimed at identifying sensitizing concepts: background ideas

that orient the research without predetermining its outcomes (Glaser & Strauss, 1967; Charmaz, 2003). These concepts served as flexible lenses for noticing emergent forms of reasoning, affective responses, or epistemic shifts within the students' discourse.

- **Quantitative Analysis of Questionnaires**

The third phase focused on the closed-ended items of the questionnaires. Responses were analyzed using basic statistical methods to identify general trends, distributions, and shifts over time. This analysis provided a preliminary map of the students' attitudes, knowledge, and self-perceptions before and after the educational intervention, serving both as a form of triangulation and as an entry point for deeper qualitative inquiry.

- **Operationalization and Inductive/deductive Qualitative Coding**

Parallel to the quantitative work, we carried out a qualitative phase. We assumed the approach of reflexive thematic analysis where a mixed inductive/deductive approach is used (Braun and Clarke, 2006; Nowell et al., 2017). Initially, key theoretical concepts (such as narrative thinking, systemic reasoning, and agency) were operationalized into analytical indicators that guided a theory-grounded coding process applied to the qualitative data, enabling a systematic identification of relevant discursive patterns. At the same time, the process remained open to the emergence of unexpected themes and clustering, coming from a bottom-up analytical process of the data.

- **Interpretation**

The final phase involved a synthesis of findings across data types and levels of analysis. Quantitative results were revisited in light of the qualitative evidence, and vice versa, in order to construct a coherent interpretative narrative. Rather than aiming for definitive conclusions, this phase was guided by the effort to foreground the students' epistemic transformations, sense-making trajectories, and emerging forms of climate-related agency. Interpretation was thus conceived not as the closure of meaning, but as a generative act of meaning-making within the broader arc of the research and aimed at merging and corroborating our results with those coming from related research (Braun and Clarke, 2019).

It is important to note that, despite this sequential outline, the process was far from linear. Iterative loops between phases (particularly between reading, coding, and interpretation) played a crucial role in refining both the analytical framework and the understanding of the data.

To reach an acceptable level of internal validity, each stage of the analysis went through a triangulation process that, in line with recommended practices (Anfara et. al, 2002), included check and peer debriefing with researchers in science education.

5.3.3 Overview of the analysis

While Students' Journal, fields notes, and most audio recordings were primarily used for triangulation purposes, the core of the data analysis focused on questionnaires, student-produced artefacts, and selected audio recordings. Further details are provided below:

- **Analysis of the questionnaires**

The questionnaires were administered via Google Forms at two key moments: the very beginning and the end of the course. Digital delivery ensured accessibility and allowed for efficient aggregation of responses. Upon completion of the administration phase, the data were exported in Excel format and systematically archived. This initial archive was then subjected to a process of refinement: the raw dataset was cleaned—removing duplicates, empty entries, or technical artefacts—and new partial copies were created, each tailored to support a specific strand of analysis.

One of the main bifurcations in this phase was between the quantitative and qualitative responses. Quantitative items were isolated and processed through tabulation and basic statistical operations within Excel, enabling a first level of comparative insight across pre/post responses. In parallel, qualitative answers were extracted and reorganized in Word documents to facilitate manual coding. This stage required a slow, attentive reading of students' words, oriented by the research questions and guided by pre-defined but flexibly applied coding categories.

The process was enriched by the integration of computational tools. Selected portions of the data were imported into Python environments for visualization and pattern recognition. This step—conducted with the support of the AI-powered assistant Julius.ai—allowed the creation of diagrams and code maps, which supported the identification of emergent clusters of meaning and facilitated the interpretation of otherwise hidden dynamics.

Throughout this process, the analytical work oscillated between proximity and distance: between the close reading of individual student voices and the distant vision afforded by data aggregation and visualization. Such oscillation, methodologically sustained and epistemologically necessary, enabled a form of hybrid reasoning capable of holding together the multiplicity of data forms, while remaining attentive to the qualitative richness of students' reasoning trajectories.

- **Analysis of audio-recordings**

The data corpus consisted of a total of 780 minutes, concerning both moments of involvement of the whole class and specific group activities. They were listened to and the two that were valued as the most relevant ones for research purposes were a class debate in lesson 4 (1h) and a group activity in lesson 5 (1h and 24 minutes). They were transcribed verbatim, capturing students' spoken interaction. The main analysis of that transcription was

conducted with the goal of systematically identifying and characterizing instances of paradigmatic and narrative thinking as they emerged in the students' discourse. To this end, I developed and applied a deductive-inductive coding scheme based on an explicit operationalization of the two modes of thought that tried to detach them from the concept of narrativity:

- **PARADIGMATIC:** presence of data, numerical figures, or formulas; logical and rational reasoning based on categories, models, or symbols; a tendency toward objectivity and abstraction; statements aiming to present themselves as absolute or generalized truths.
- **NARRATIVE:** valorization of the exceptional and analysis of contingencies; valorization of partial and/or contextual truths; stronger presence of personal values; confrontation or negotiation of individual perspectives; attention to details enhancing the verisimilitude of lived experience (such as including sensory or emotional elements); use of tropes (e.g., metaphors, personification, hyperbole, oxymoron).

Importantly, these categories were treated as analytical tendencies, not rigid binaries: student utterances could simultaneously exhibit features of both, or shift fluidly between them, acknowledging the hybrid nature of science classroom talk, especially on topic such CC (Levrini et al., 2021).

- Narrativity is integrated as an independent layered lens to deepen the analysis on a different analytical dimension, as the second version of the Narrativity Pyramid (layers from 1 to 4) described in Chapter 4.

This double dimensional approach allowed to reveal not only whether and when students shifted between paradigmatic and narrative modes, but also the depth and complexity of their narrative engagement through analysis of narrativity layers.

- **Analysis of the artefacts**

Artefacts collected from both classes were subjected to a qualitative, bottom-up analysis. Video-artefacts, similarly to the prelude phase, they were subjected to a first phase of collection and structuring of the raw data, that consisted in carefully examining of the scripts and of the videos, producing a written description of all videos and a detailed transcription of the dialogues for some interesting ones whether their script was not submitted by the participants or it differed significantly from the final video dialogues. Then, the second phase consisted of careful re-reading and re-watching aimed at identifying recurring patterns that could shed light on the RQ3. Unlike in the prelude phase, however, the findings were further compared and triangulated with the recordings of the creative process, allowing for a richer contextualization and validation of the results.

- **Cross-dataset analysis**

Finally, a cross-dataset analysis was conducted with the aim of integrating the results obtained from the different phases and sources. This stage entailed revisiting the entire dataset—scripts, videos, transcriptions, and recordings of the creative process—in order to identify connections and overlaps among the themes emerging from the individual artefacts. By comparing findings across classes and data types, this step sought to ensure internal coherence, to highlight recurring interpretative patterns, and to refine the thematic map as a whole. In this sense, the cross-dataset analysis functioned as a process of synthesis, allowing the disparate pieces of evidence to be reassembled into a coherent picture that could more effectively address the research questions.

5.4 Results

As already outlined, most of the analyses outlined in the previous section were initially structured according to the specific narrative artefacts and tools employed throughout the course. However, while this artefact-oriented structure guided the operational phases of analysis, the interpretation of the findings called for a more integrative approach.

During the cross-dataset analysis phase, a set of recurring patterns began to emerge, cutting across artefacts, students, and lessons and pointing toward a deeper level of conceptual coherence. These recurrent themes surfaced through a grounded, iterative comparison between expected and unexpected outcomes, and through a close alignment with the theoretical lenses introduced earlier. Thus, the following section presents the results not as a linear sequence of observations per artefact, but as a synthesis of key patterns that initially emerged through a specific piece of data but then resulted coherent across all or most datasets. In line with that, the Results section is structured into four interrelated parts:

- 5.4.1) The first part examines students' conceptual understanding of CC, with a focus on how their scientific knowledge and interpretative frameworks evolved throughout the course. This analysis aims to capture the shifts not only in factual knowledge, but also in students' capacity to navigate crucial concepts such as complexity, uncertainty, and scale;
- 5.4.2) The second part investigates their perception of climate action, exploring how students positioned themselves as potential agents of change, and how their sense of efficacy, responsibility, and emotional engagement transformed during the educational experience;
- 5.4.3) The third part analyses the emergence and interaction of two ways of thinking—the paradigmatic and the narrative—offering a fine-grained account of how students moved between them and what that implies;
- 5.4.4) Finally, the fourth part focuses on the role of narrativity, aiming to trace how different layers of narrativity can support or hinder sense-making.

To clarify how the thematic areas emerged from the empirical analysis, the following table (Table 5.3) maps each analytical focus to the main data sources that contributed to the results.

Table 5.3 *Overview Results Section and related data sources.* The table summarises the main and complementary data sources informing the findings of Phase 3, organised according to the corresponding paragraphs of the Results section.

Result section	Main data sources	Other data sources
5.4.1) Students' conceptual understanding of climate change	Pre-post questionnaires	Diary, world-making stories, mockumentaries
5.4.2) Students' perception of climate action	Pre-post questionnaires	Diary, world-making stories, mockumentaries
5.4.3) Emergence and interaction of the two ways of thinking for sense-making	Recording of the 17 th of February lesson in the second-year class	Pre-post questionnaires open questions, diary
5.4.4) Role of Narrativity	Artefacts, Recording of the 17 th of February lesson in the second-year class	Recording of groups' activity, field notes

5.4.1 Students' conceptual understanding of climate change

This paragraph presents a brief analysis of students' conceptual understanding of CC. Although not directly related to the study of sensemaking processes or agency, this analysis provides contextual insights into how students framed CC at the beginning and at the end of the course, thereby offering complementary information on their learning trajectories.

A specific set of students' responses will be presented and discussed in this paragraph. These responses were collected through pre- and post-course questionnaires in closed and open-ended prompts and have been selected to show the heterogeneous evolution in students' representations of CC elicited by the course. More specifically, for each student the set comprises:

- A pre-course definition of CC, elicited through an open-ended prompt (questions number 8, Appendix A 2.2)
- A post-course definition of CC, collected via the same prompt after the intervention (questions 5, Appendix A 2.3)
- Description of causes and consequences of CC, elicited through both closed and open-ended questions (questions 9, 10, 11, 12, Appendix A 2.2)
- Post-course self-evaluations of knowledge on CC, closed question (question 4, Appendix A 2.2)
- A closed question to distinguish between deterministic and systemic ways of thinking (question 9, Appendix A 2.2)

To systematically analyze the evolution of students' CC definitions from pre- to post-questionnaire, a coding framework was developed that captures multiple dimensions of conceptual change. Drawing on science education literature regarding conceptual

development and knowledge restructuring, the coding scheme distinguishes between different types of cognitive shifts that students may experience following instruction.

The primary codes employed in this analysis include:

Similar/Unchanged: Responses that maintained essentially the same conceptual framework, level of detail, and explanatory approach across both questionnaires. This category encompasses both tautological definitions that remained circular in reasoning (e.g., "climate that changes") and responses that maintained consistent but already well-developed conceptual frameworks (e.g., sustained focus on anthropogenic causation).

Paradigmatic Improvement: Responses demonstrating fundamental shifts in scientific understanding or explanatory frameworks. This includes transitions from misconceptions to scientifically accurate conceptions (e.g., from attributing CC to natural causes to recognizing anthropogenic drivers), or from fragmented to more coherent scientific models. For instance, one student shifted from "è un cambio di temperature possono venire in modo naturale" (it is a change of temperatures that can come naturally) to "è il clima che muta per colpa delle decisioni umane" (it is the climate that changes due to human decisions), representing a fundamental reconceptualization of causation.

Change of Focus: Responses in which students maintained engagement with CC concepts but redirected their analytical attention to different aspects of the phenomenon. This might involve shifting from causal mechanisms to phenomenological characteristics, from global to temporal dimensions, or from human actions to environmental responses. These changes reflect not necessarily improved understanding, but rather a reorganization of which aspects of CC are foregrounded in students' mental models.

Change in Mode of Thinking: Responses demonstrating shifts in the type of reasoning employed, such as moving from paradigmatic (definitional, scientific) to narrative (historical, contextual) modes of explanation, or vice versa. For example, one student transitioned from a simple definitional statement—"la variazione delle temperature annuali" ("the variation of annual temperatures")—to a historically contextualized narrative: "un tema che ha avuto origine nello scorso secolo... è attuale ai giorni nostri l'innalzamento delle temperature" ("a theme that originated in the last century... currently the rise in temperatures is generating extraordinary atmospheric events").

Narrative Improvement: Often appearing in combination with other codes, this dimension captures increased complexity, detail, and sophistication in how students articulate their understanding. This includes the addition of temporal components, causal chains, specific examples, or consequences, representing what might be termed "complexification of narrativity."

Paradigmatic Worsening: The rare instances where students' post-questionnaire responses demonstrated less scientifically accurate or less coherent understanding than their initial responses.

Other: Responses that did not fit clearly into the above categories or demonstrated unique patterns of change requiring individual interpretation.

It should be noted that these categories are not mutually exclusive; several responses were coded with multiple dimensions (e.g., "cambio di focus, aumento di narratività"), reflecting the multifaceted nature of conceptual change. For analytical purposes, responses exhibiting multiple characteristics were categorized according to their primary or most salient feature of change.

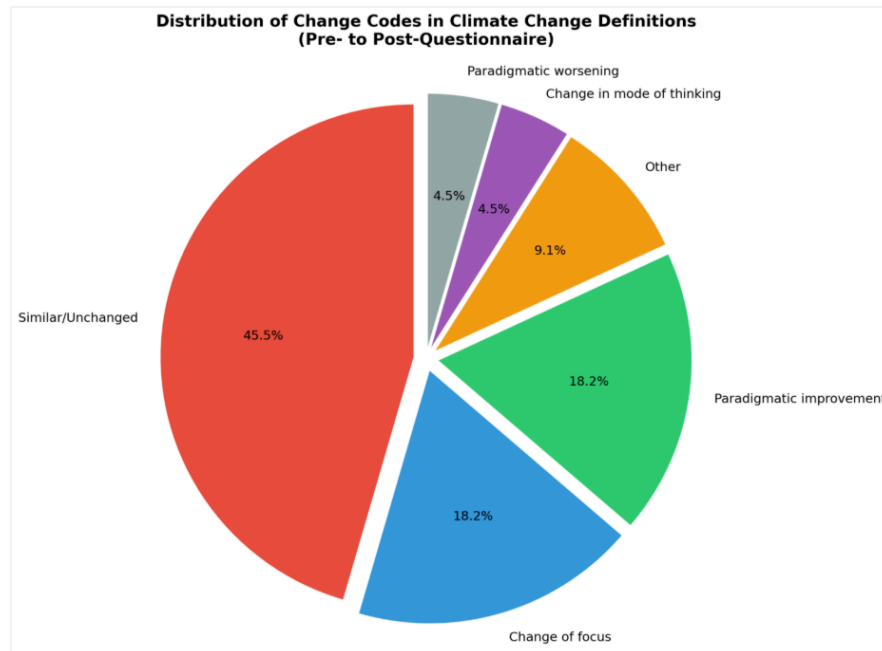


Figure 5.3. Distribution of “change codes” in students’ CC definitions (Pre- to Post-Questionnaire). The figure shows how students’ definitions of CC evolved between the pre- and post-questionnaires, highlighting different types of conceptual shifts. Most responses remained similar or unchanged, while others reflected paradigmatic improvements, changes of focus, or shifts in the mode of thinking.

The analysis of students' pre- and post-questionnaire responses reveals a nuanced picture of conceptual development following the educational intervention. As illustrated in Figure 5.3, 45.5% of students maintained similar or unchanged definitions between the two questionnaires, representing the largest category. This was followed by 18.2% demonstrating a change of focus, 18.2% showing paradigmatic improvement, 9.1% classified as "other", and 4.5% each for change in mode of thinking and paradigmatic worsening.

Similar/Unchanged Responses (45.5%): The predominance of unchanged responses warrants careful interpretation. While this category represents nearly half of the sample, the nature of these unchanged responses varies considerably. Some students maintained tautological definitions throughout both questionnaires, such as "clima che cambia" (climate that changes) evolving minimally to "tempo che cambia" (weather that changes), or "Cambiamento climatico" becoming "Alterazione del clima" (alteration of climate). These responses suggest persistent difficulties in moving beyond circular reasoning to construct scientifically meaningful definitions.

However, not all unchanged responses indicate lack of learning. Several students maintained consistent anthropogenic causation frameworks across both questionnaires. For instance, one student's pre-questionnaire response—"Il clima che cambia a causa delle sbagliate abitudini e sprechi dell'uomo" (The climate that changes due to wrong habits and waste of man)—evolved to "É il cambiamento del clima provocato dalle azioni dell'uomo" (It is the change of climate caused by human actions). While the core conceptual framework remained stable, the language became more precise, suggesting consolidation rather than stagnation. The key themes of "abitudini e sprechi" (habits and waste) and "cause antropogeniche sempre presenti" (anthropogenic causes always present) indicate that these students entered the intervention with relatively robust mental models that were reinforced rather than restructured.

Paradigmatic Improvement (18.2%): Students demonstrating paradigmatic improvement showed fundamental shifts in their conceptual understanding. One notable example involved a transition from attributing CC to natural causes—"è un cambio di temperature possono venire in modo naturale" (it is a change in temperatures that can come naturally)—to recognizing anthropogenic drivers: "è il clima che muta per colpa delle decisioni umane" (it is the climate that changes due to human decisions). This shift from natural to anthropogenic causation represents a critical conceptual restructuring aligned with scientific consensus. Another student exhibited increased narrative complexity and detail, moving from "cambiamento delle temperature nel corso del tempo" (change of temperatures over time) to "la variazione del clima in un arco di tempo e in una certa zona" (the variation of climate in a time span and in a certain area). This evolution demonstrates enhanced understanding of both temporal and spatial dimensions of CC. The most comprehensive paradigmatic improvement was observed in a student who progressed from identifying "il variare di precipitazioni atmosferiche in modo anormale a causa dell'inquinamento" (abnormal variation of atmospheric precipitation due to pollution)—reflecting an initial misconception conflating pollution with CC—to a scientifically robust definition encompassing causes (fossil fuels, deforestation, intensive agriculture), consequences (rising temperatures, glacier melting, sea level rise, extreme weather events), and mitigation strategies (renewable energy, emission reduction, forest protection).

Change of Focus (18.2%): Students in this category maintained engagement with CC concepts but shifted their analytical lens. One student transitioned from emphasizing anthropogenic causes—"il cambiamento dato dall'azione antropologica nei confronti dell'ambiente" (the change given by anthropological action toward the environment)—to focusing on the nature and temporality of the change itself: "l'alterazione a lungo termine del clima globale" (the long-term alteration of global climate). This shift from causal mechanisms to phenomenological characteristics, accompanied by acquisition of temporal components, represents increased narrative sophistication. Another student moved from an action-reaction framework—"A causa dell'impatto che lasciamo sul pianeta, poi provoca delle risposte da parte dell'ambiente" (Due to the impact we leave on the planet, then it provokes responses from the environment)—to emphasizing temporal dynamics: "Un cambiamento del clima in una frazione di tempo troppo rapida" (A change of climate in too rapid a fraction of time). The initial response's conceptualization of environmental responses

as a complex two-way relationship gave way to focus on the unprecedented rate of change, suggesting engagement with different dimensions of the climate crisis.

These findings suggest that conceptual change in climate science education is neither uniform nor unidirectional. The substantial proportion of unchanged responses indicates that single interventions may be insufficient to restructure deeply held mental models, particularly when students enter with either very limited (tautological) or relatively well-developed (anthropogenic causation) frameworks. The diversity of change patterns—paradigmatic improvements, focus shifts, and mode-of-thinking changes—underscores the need for differentiated pedagogical approaches that recognize students' varied entry points and learning trajectories in climate science education.

In parallel, as shown in Figure 5.4 and Figure 5.5, students' self-assessed knowledge levels increased, and they articulated a more mature epistemic positioning: most students endorsed the idea that CC requires strategies negotiated across multiple perspectives, rejecting simplistic or deterministic solutions.

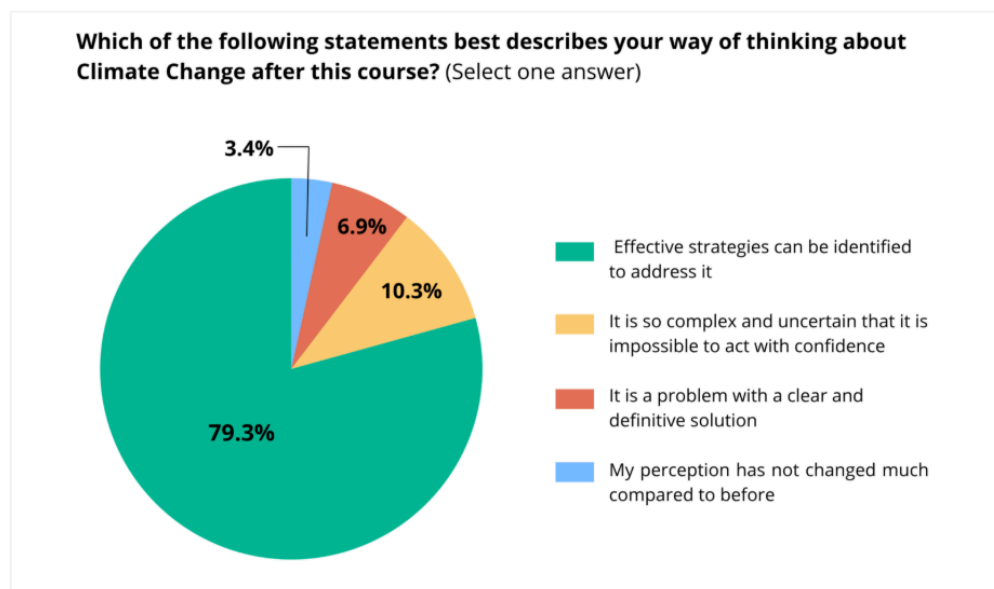


Figure 5.4. *Students' perceived way of thinking about CC after the course.* The figure presents students' responses to a post-course item exploring how their reasoning about CC evolved. Most participants (79.3%) reported that effective strategies can be identified to address it, while smaller groups perceived the issue as overly complex or with a clear solution, or stated that their perception had not significantly changed

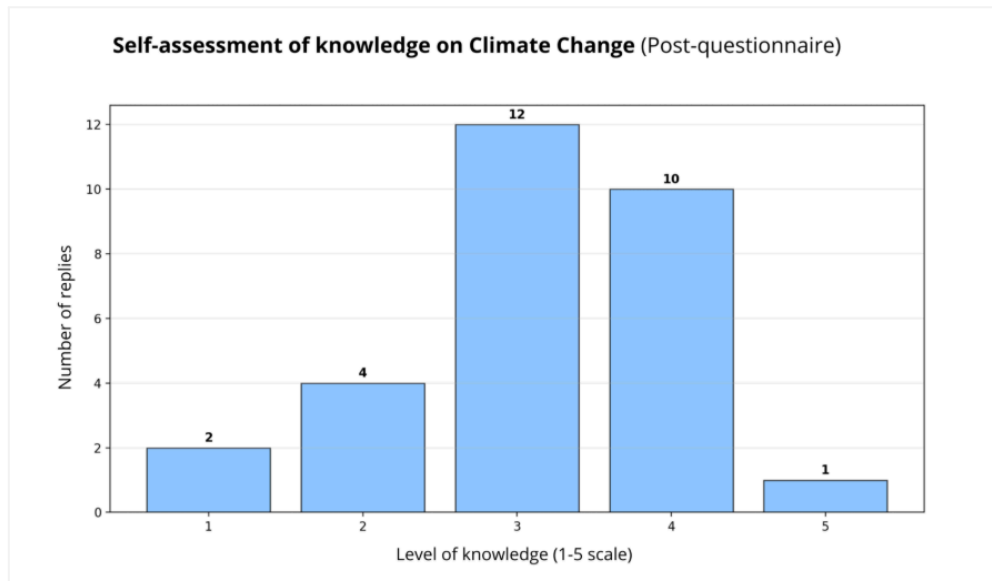


Figure 5.5. *Students' self-assessment of knowledge on CC (Post-questionnaire).* The figure shows how students rated their own level of knowledge about CC at the end of the course on a five-point scale. Most students positioned themselves between intermediate and high levels, indicating a perceived improvement in understanding after the learning experience.

Furthermore, when asked how they would explain CC to a peer, the dominant response was to integrate both scientific facts and narrative forms (Fig 5.6), an explicit endorsement of the dual epistemic register that the course aimed to scaffold.

This progression suggests a twofold transformation: on the one hand, an evolution in conceptual understanding, marked by a growing ability to name processes, actors, and implications; on the other hand, a shift in the epistemological framing, as students seems to have moved from seeing CC as a static condition to recognising it as a systemic and value-laden problem requiring both critical reasoning and imaginative engagement. However, the persistence of some tautological or oversimplified answers in the post-course responses highlights the non-linear nature of this evolution and suggests maintaining space for iterative meaning-making.

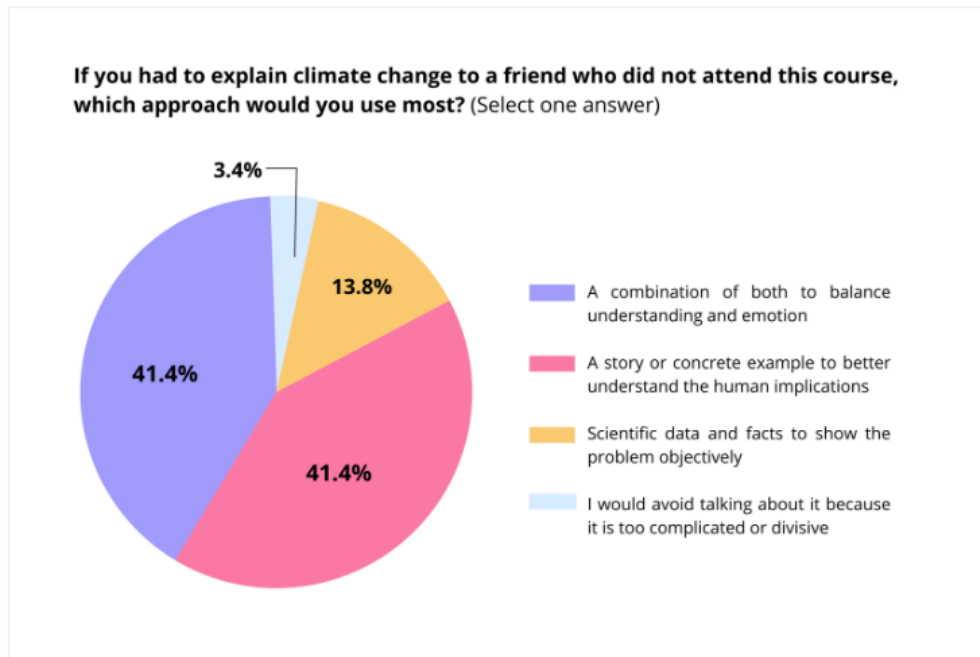


Figure 5.6. *Preferred approach to explaining CC after the course.* The figure illustrates students' responses to a post-course question about how they would explain CC to a friend. Most participants reported they would combine scientific data with narrative elements—either through examples or balanced explanations—while only a few would rely solely on data or avoid the topic.

5.4.2 Students' perception of climate action

Through an analysis of the questionnaires and the artefacts produced by the students, it is possible to infer the image they held of climate action (both at a societal and personal level), how this image evolved by the end of the course, and which factors may have contributed to such a transformation. All the analysis presented in this paragraph started from quantitative data and then searched for interpretation, clarification and or deepening through qualitative analysis of open-ended questions and students' artefacts.

Perception of societal roles and personal engagement in climate action

The comparison between the pre- and post-questionnaire reveals a complex reconfiguration in how students perceive climate action both within sociopolitical ecosystems and on a personal level. In a specific question (same in the pre- and post-questionnaire) we invited students to assess the perceived importance of five categories of actors (citizens, businesses and markets, political decision-makers, oneself, and others) in addressing CC, using a five-point scale from "not at all" to "fundamental."

To what extent do you think the following actors can be a resource in addressing Climate Change? (Pre- to Post-questionnaire)

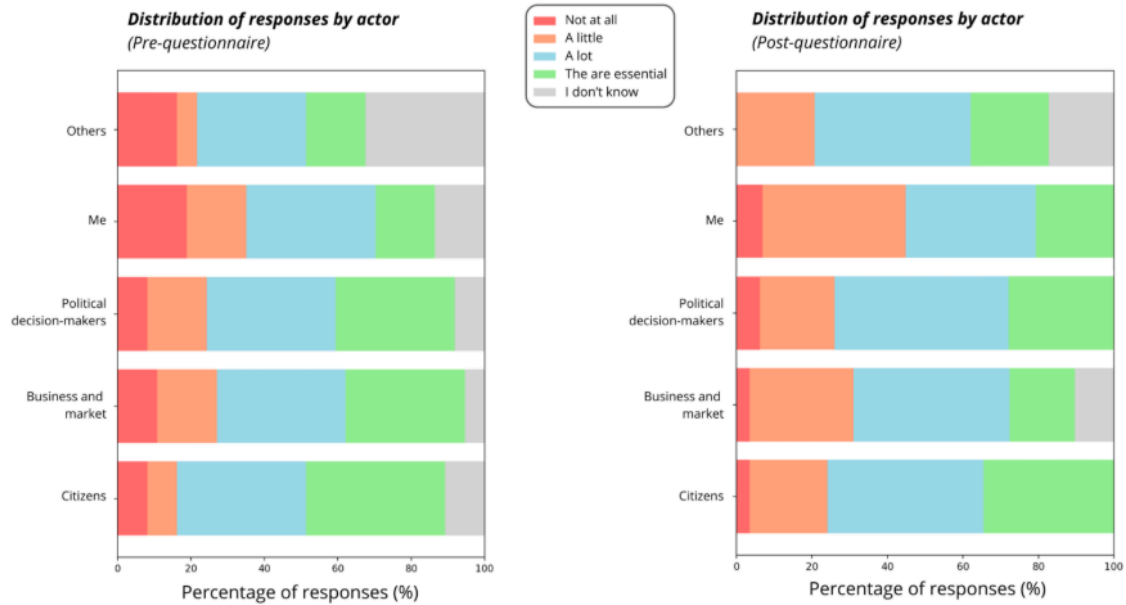


Figure 5.7. *Distribution of actors perceived as resources in addressing CC (Pre- to Post-Questionnaire comparison).* The figure compares students' perceptions before and after the course regarding which social actors can play a key role in tackling CC. After the intervention, a greater proportion of students recognized citizens and political decision-makers as essential contributors, indicating a broader and more distributed sense of responsibility.

To enable quantitative analysis, students' qualitative responses were converted into numerical scores according to a predefined scale. Responses were coded as follows: "Fundamental" was assigned a value of 4 points, "Very important" 3 points, "Somewhat important" 2 points, "Not at all important" 1 point, and "I don't know" 0 points. This transformation facilitated the calculation of mean values and allowed for a more systematic comparison of perceived actor relevance across the pre- and post-course datasets. Then we compared average scores attributed to each actor before and after the course, providing a comparative overview of how students' prioritization of different stakeholders evolved throughout the educational intervention. The results are shown in the following graph.

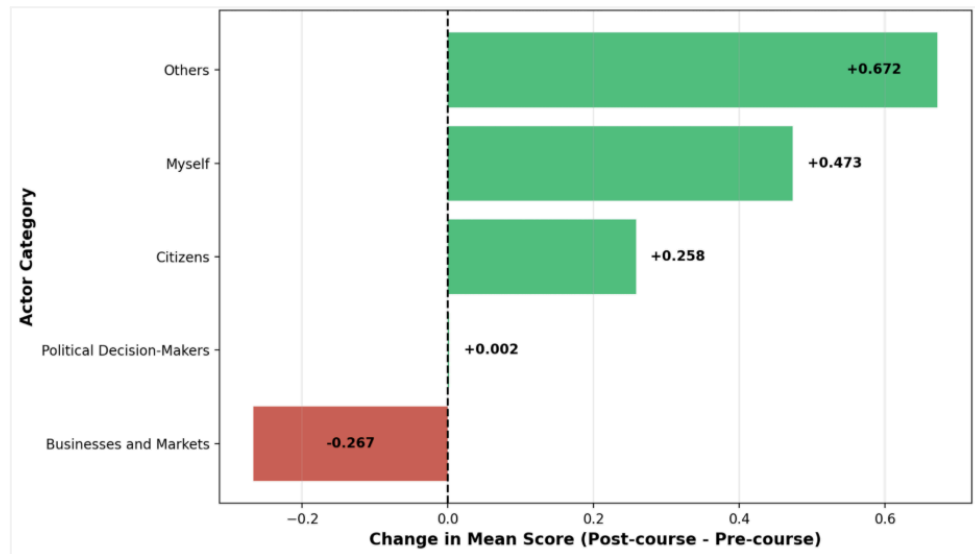


Figure 5.8. *Change in perceived importance of CC actors (Pre- to Post-Questionnaire).* The figure illustrates variations in how students evaluated the importance of different actors in addressing CC after the course. The largest positive shifts concerned “Others,” “Myself,” and “Citizens,” suggesting an expanded and more participatory sense of agency, while the perceived role of “Businesses and Markets” slightly decreased.

The evolution observed in students’ perceptions reveals a subtle but meaningful transformation in how agency and responsibility in climate action are conceived. The increased relevance attributed to “others” and “myself” suggests a dual movement: outward and inward. On one hand, students seem to have developed a broader and more relational understanding of CC as a collective, systemic endeavour, in which multiple and often less-visible actors play a part. On the other, they appear to have internalised a sense of personal implication, recognising themselves as part of that network of interdependencies. This dual expansion—from the self to the social—suggests that the course may have supported an epistemic reconfiguration of agency: from an externalised view of action (delegated to experts, markets, or politics) toward a distributed and participatory one.

This interpretation finds resonance in several open-ended responses collected through the pre- and post-questionnaires. Students frequently referred to an emerging awareness of individual responsibility—“as an individual I can also contribute, not only the ‘big ones’ are important, but also individuals”—and to the need to “take responsibility because the issue concerns everyone”. Others emphasised the importance of distributed action—“if each of us does our part, individual actions are more useful than those of companies or government”—and the coexistence of multiple strategies: “I understood that multiple strategies exist to address the problem”.

A similar broadening of perspective emerges in several students’ reflections on the value of plurality and dialogue: “it helped me hear all characters’ viewpoints to see the issue from perspectives I hadn’t considered”, and “I learned to have different viewpoints and that all opinions, if well expressed, are useful”. These comments suggest a growing capacity for perspective-taking and relational reasoning—two markers of the narrative mode of thought that the course aimed to cultivate.

The moderate rise in the perceived role of citizens reinforces this interpretation, pointing to a growing awareness of civic collaboration as a mediator between individual and institutional levels. The stability in the evaluation of political decision-makers can instead be read as a sign of persistent scepticism regarding formal governance, a feature often observed among younger generations who perceive politics as slow or ineffective in responding to the climate emergency. The slight decline in the role of businesses and markets might also be interpreted in light of the course content, which did not directly address the mechanisms of economic systems or the role of markets within the climate transition. Consequently, the relative decrease in perceived importance of these actors might not signal a rejection per se, but rather the absence of a shared conceptual framework through which to make sense of their agency within the broader system.

At the same time, a few post-course responses seem to hint—albeit in a very germinal form—at an emerging critical awareness, as in the reflection: “I used to think electric vehicles were a good choice, but after discovering that batteries components are not ethical, I’m not so sure”, it might be tentatively suggested that some students began to glimpse a more critical awareness of the simplifications often embedded in market-based discourses of sustainability. While this cannot be asserted with certainty, traces of such awareness may point to an emerging sensitivity toward the structural and ethical dimensions of climate action, alongside its technical and instrumental aspects.

Overall, the pattern seems to outline a shift from a hierarchically organised view of climate responsibility—where authority and efficacy are concentrated in specific institutional actors—to a more polyphonic and dialogical one, in which personal and collective action are interwoven. This resonates with the pedagogical aim of the course: to nurture an ecology of agency where the sense of self-efficacy is neither individualistic nor utopian, but situated within a network of interdependent actors engaged in shared world-making.

Regarding personal engagement in climate action, as shown in figure 5.9, the comparison between the initial and final questionnaires reveals interesting shifts in students' engagement patterns.

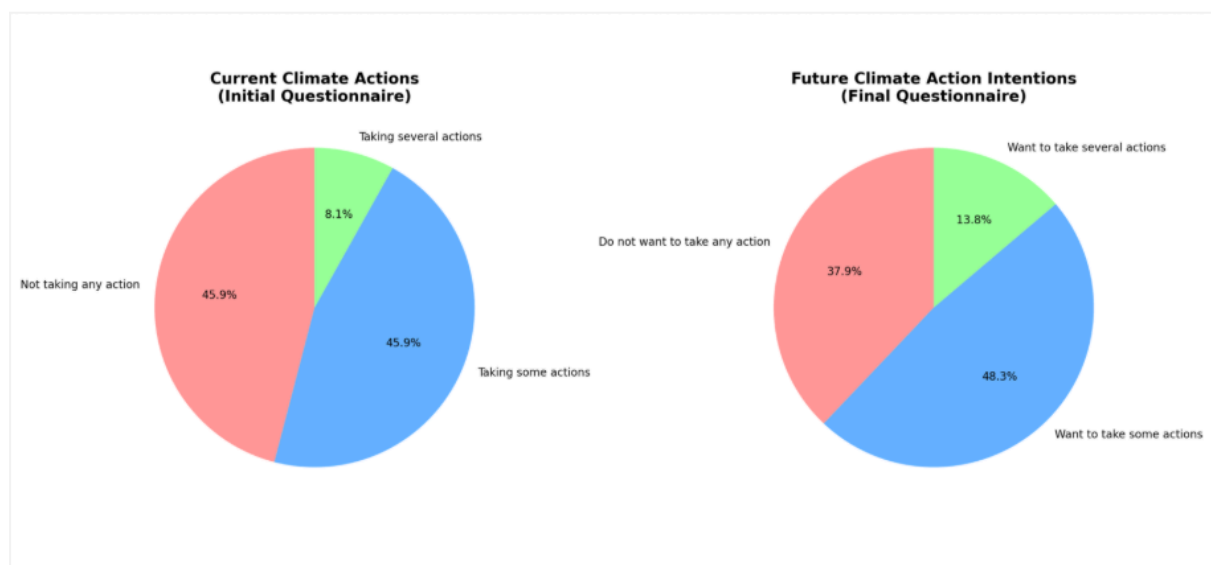


Figure 5.9. Comparison between current and future climate action intentions (Pre- and Post-Questionnaires). The

figure compares students' self-reported climate-related actions before and after the course. While initial responses showed an even split between those taking no action and those taking some, post-course results reveal a shift toward stronger engagement, with more students expressing intentions to take several actions in the future.

In the initial questionnaire, students were evenly split between those not taking any action (45.9%) and those taking some actions (45.9%), with only a small minority (8.1%) taking several actions. The data from 37 students reveals distinct patterns in climate action engagement across two time points. At the initial assessment, students demonstrated a polarized distribution of current climate actions: nearly half (45.9%) reported not taking any action to mitigate CC, while an equal proportion (45.9%) were already taking some actions. Only a small minority (8.1%) were engaged in several climate actions, suggesting that comprehensive climate engagement was relatively uncommon among this student population. The final questionnaire shows a shift in the distribution of planned climate engagement. The largest group (37.8%) expressed intentions to take some climate actions, indicating a moderate level of future commitment. However, a substantial portion (29.7%) stated they do not want to take any climate action in the future, representing nearly one-third of the student body. Meanwhile, 10.8% expressed intentions to take several actions, showing a slight increase in those planning comprehensive climate engagement. This pattern suggests that while a plurality of students maintain moderate intentions for climate action, there remains significant resistance or disengagement among a considerable minority. The data indicates that educational interventions in CC may produce varied responses, with some students developing stronger action intentions while others may become more hesitant about personal climate engagement. The persistence of a substantial "no action" group highlights the ongoing challenge of motivating comprehensive climate action among young people, despite increased awareness and education on the topic.

Factors that might have influenced the observed change

Two pieces of data provide useful insight into the factors that may have influenced the observed change discussed in the previous paragraph. The first set consists of two closed-ended questionnaire items designed to explore students' emotional responses to CC. Emotions were included based on their recognised role in shaping individuals' motivation to act. Accordingly, a follow-up question asked students to reflect on how these emotions affected their daily behaviours. Figures 5.10 and 5.11 present the responses to the first question, comparing data collected at the beginning and at the end of the course.

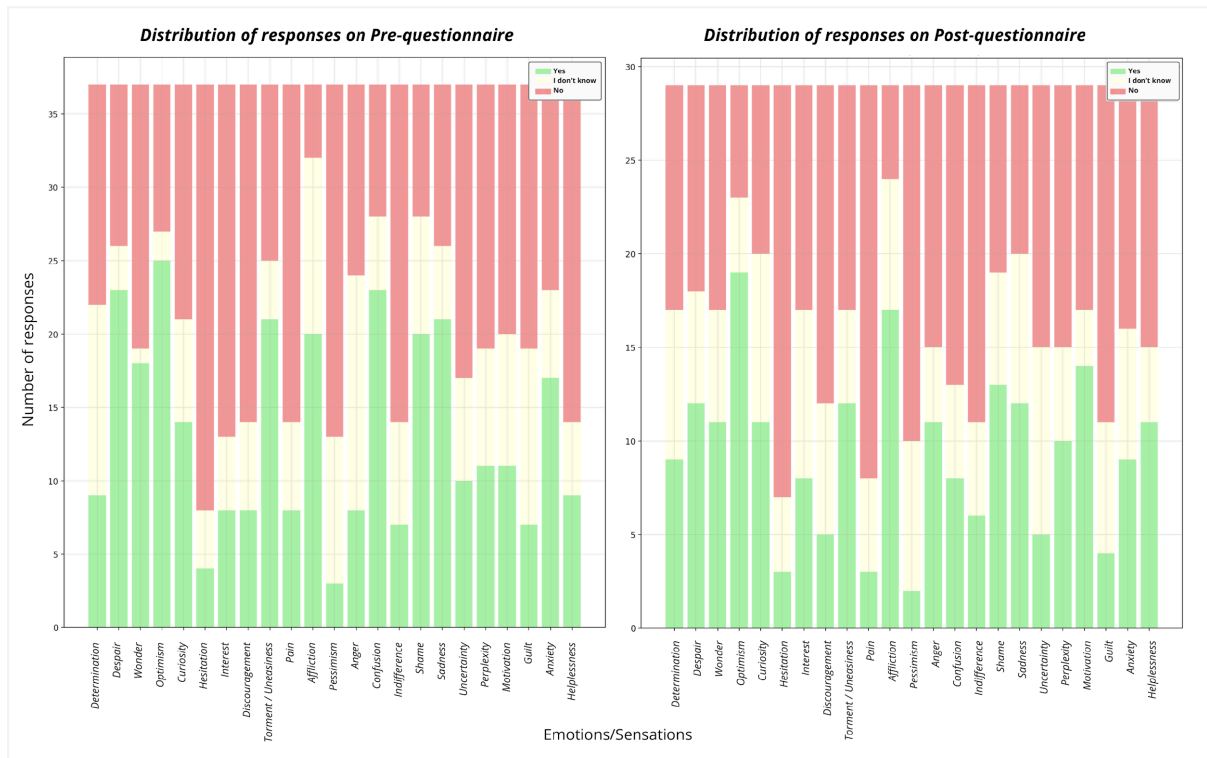


Figure 5.10. Comparison of emotional responses associated with CC (Pre- and Post-Questionnaires). The figure compares the overall distribution of emotions reported by students before and after the course. Although a mix of emotions persisted, post-course data indicate a general increase in positive or action-oriented feelings—such as motivation and curiosity—alongside a relative decrease in negative or paralyzing ones like anxiety and helplessness.

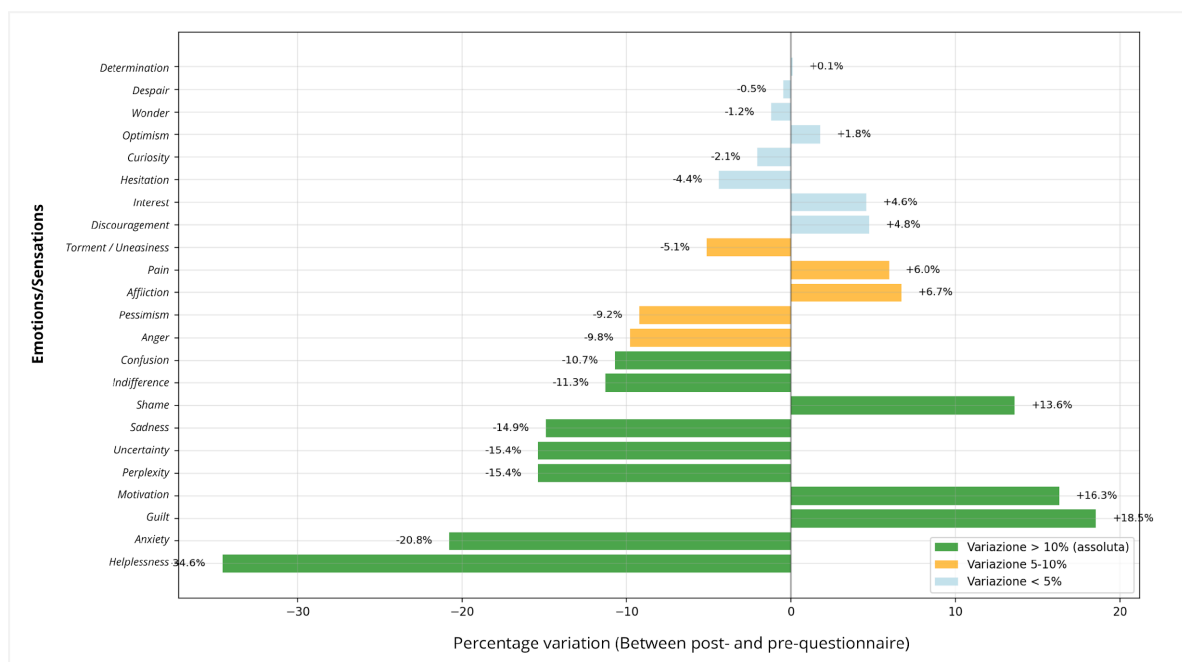


Figure 5.11. Variation in emotions associated with CC (Post- to Pre-Questionnaire difference). The figure displays percentage changes in the emotions reported by students before and after the course. Results show a marked decrease in paralyzing emotions such as anxiety and helplessness, accompanied by increases in motivation, curiosity, and determination—indicating a shift toward more agentic and constructive emotional engagement.

The variation percentages shown in Figure 5.11 were calculated by subtracting the initial questionnaire percentages of "yes" from the final questionnaire percentages for each emotion. For example, if "Anxiety" was reported by 62.2% of students initially and 41.4% finally, the variation is -20.8%. The chart highlights in green all emotions with absolute variations greater than 10%, regardless of direction. The chart reveals significant shifts in students' emotional responses to CC after completing the course. Green bars indicate the most substantial changes (>10% absolute variation), orange bars show moderate changes (5-10%), and light blue bars represent minimal changes (<5%).

The results suggest the course had a profound psychological impact on students' climate-related emotions. The substantial decrease in "Sense of Powerlessness" (-34.6%) and "Anxiety" (-20.8%) indicates that education helped students feel more empowered and less overwhelmed by climate issues. Simultaneously, increases in "Guilt" (+18.5%) and "Motivation" (+16.3%) suggest heightened awareness of personal responsibility and agency. The reduction in "Uncertainty" and "Confusion" demonstrates improved understanding, while the increase in "Shame" may reflect deeper recognition of collective responsibility. These patterns indicate that effective climate education not only informs but also transforms emotional engagement, moving students from paralyzing negative emotions toward more constructive, action-oriented feelings. The complete distribution charts show the full spectrum of responses (Yes/No/Don't Know) for each emotion, providing a comprehensive view of how student attitudes shifted across all response categories.

As already mentioned, emotions are recognized as one of the factors that influence one's motivation to act (Hickman et al., 2021). This is why we asked students about the impact of their emotions on their daily actions was. At the beginning of the course (Fig. 5.12), transportation emerges as the most influenced domain, suggesting that climate emotions directly translate into mobility choices. Leisure activities and academic life show moderate influence. Food habits and social relationships are the least affected. However, the most interesting results is maybe the high percentage of "no" for every area at the beginning of the course that its coherent with the higher percentage of people who declared as unwilling to take action (Fig. 5.9).

We do not have the results of the same question at the end of the course; however, we attempted to construct an interpretation by analysing the open-ended responses. Specifically, we examined which types of emotions were mentioned and whether these emotions were linked to action.

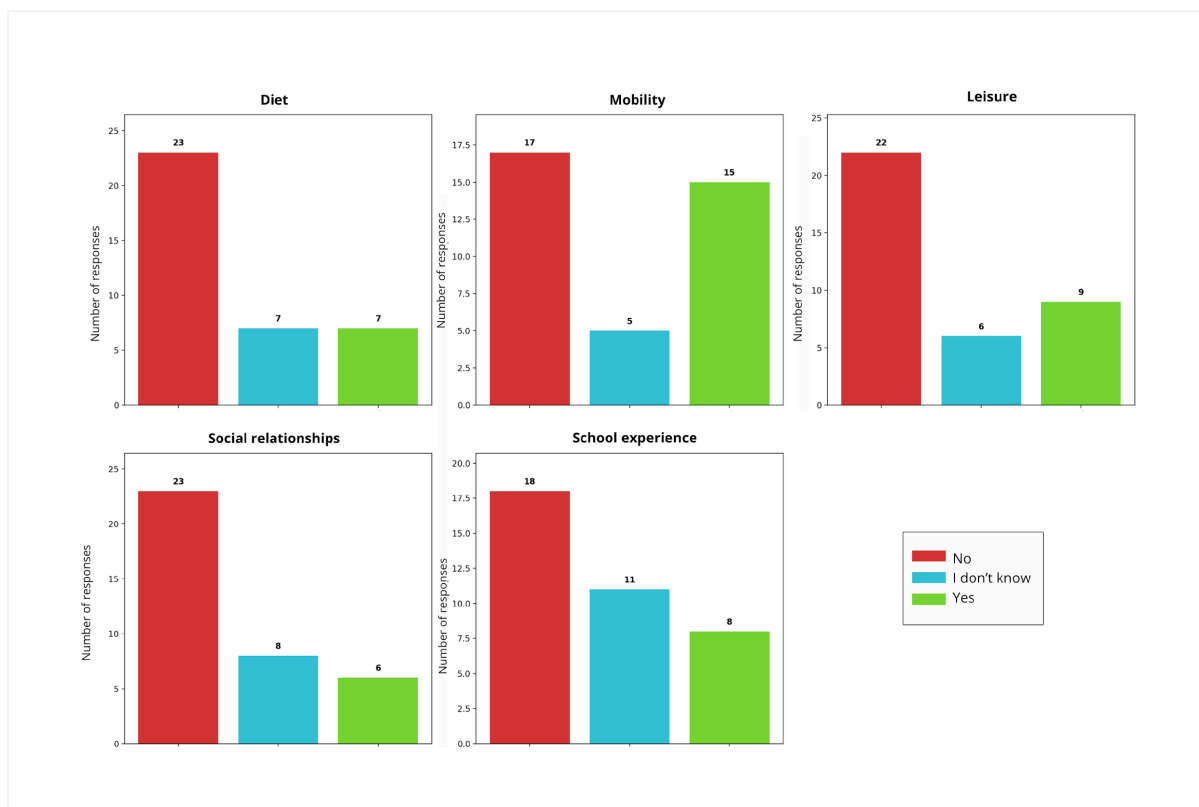


Figure 5.12. *Influence of emotions related to CC on different aspects of everyday life.* The figure compares how students reported that emotions linked to CC affected specific life domains—such as diet, mobility, leisure, social relations, and school. Results show that while a majority perceived little or no influence, a notable share acknowledged an emotional impact particularly on mobility and study-related habits.

The questionnaire also provides insight into which aspects of CC students felt were important to explore more deeply in order to feel equipped to understand and take action. Specifically, students were asked the following questions:

Beginning of the course (blue in Figure 5.13): “Which aspect of climate change do you feel you need to explore further in order to acquire the tools necessary to understand and act on climate change?”

End of the course (green and red in Figure 5.13): “During the course, which aspect of climate change helped you the most in clarifying your ideas?” and “During the course, which aspect of climate change most stimulated you to take action?”

The response options included:

- Climate science
- Social aspects
- Economic/political aspects
- Literature/art on the topic (Pre-questionnaire) / Fictional stories (Post-questionnaire)
- Real-life examples
- None of the above
- Other (open response)

The following figure (Figure 5.13) presents the results.

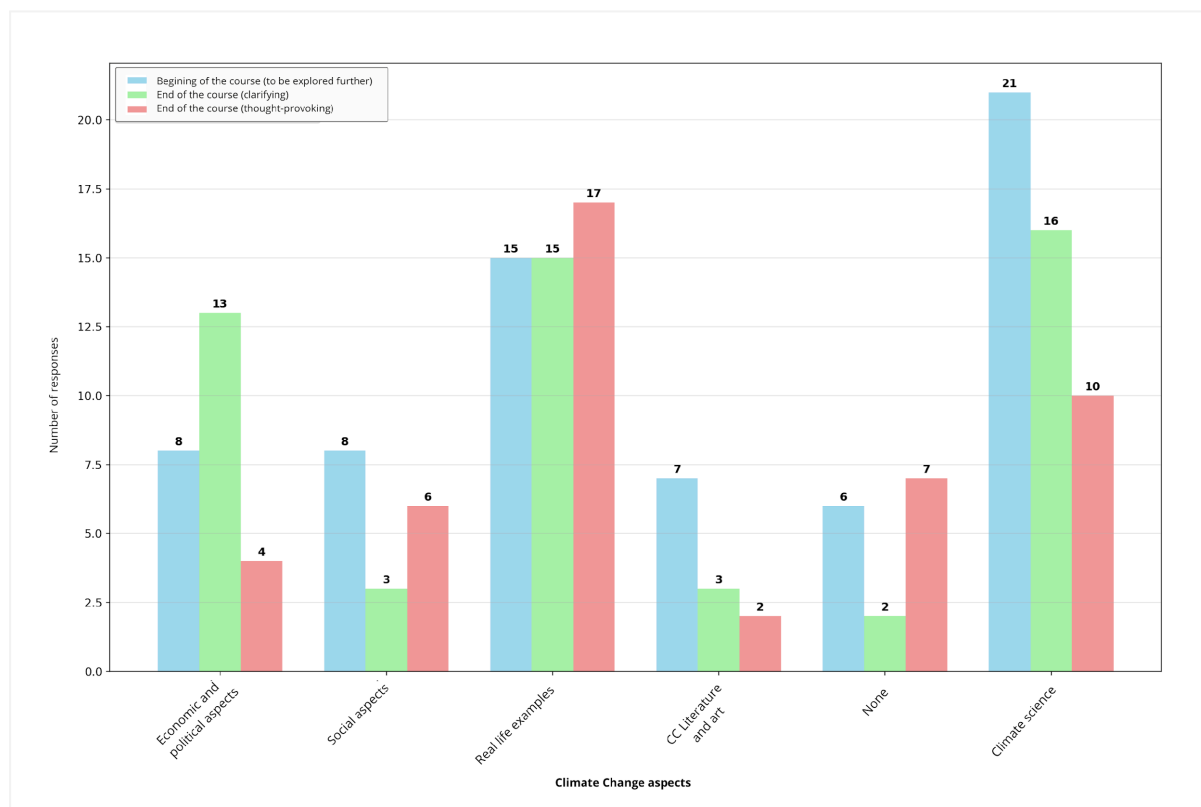


Figure 5.13. *Comparison between beginning and end of the course: aspects of CC mentioned by students.* The figure contrasts the frequency of climate-related aspects cited in the pre- and post-questionnaires. After the course, students more often referred to social and scientific dimensions of CC, suggesting an expanded and more interdisciplinary understanding of the phenomenon.

The data reveals a meaningful transformation in students' relationship with CC knowledge over the course of the intervention. At the outset, climate science was identified as the primary learning need (32.3%), followed by real-life examples (23.1%), reflecting a classical knowledge-deficit model rooted in the assumption that more scientific information naturally leads to action. By the end of the course, this model appears to have been partially disrupted: while climate science remained relevant for clarification purposes (30.8%), real-life examples emerged as the most powerful motivator for action (37.0%). This suggests a pedagogical shift toward narrative-based forms of learning and an increasing recognition of the emotional and experiential dimensions of climate engagement.

Yet, this emerging narrative sensibility is shadowed by a persistent and perhaps problematic reduction of complexity. Economic and political aspects, while gaining importance in clarifying the issue (rising from 12.3% to 25.0%), remained weak in motivating action (only 8.7%). This discrepancy invites a closer interpretation: students may have begun to develop an awareness of structural factors, but still struggle to integrate them meaningfully into their own action-oriented narratives. In other words, the systemic dimensions of CC are recognized intellectually, but not yet emotionally or pragmatically assimilated into students'

sense of agency. The other data further support this interpretation. As shown in previous sections, students progressively shifted the locus of responsibility from political institutions to individual and grassroots actors. While this reorientation may indicate a growing sense of empowerment, it also risks reinforcing a linear, cause-effect framework in which institutional actors are simply dismissed as ineffective, and the burden of responsibility is relocated onto the individual in a decontextualized way. The low motivational impact of political and economic aspects could therefore be read not merely as a lack of interest, but as a signal of incomplete systems thinking—a sign that students have not yet fully grasped the interdependencies between levels of action.

This reading is reinforced by the concerning decline of social aspects in both clarification (from 5.8%) and motivation (to 13.0%), suggesting that the course may not have sufficiently supported students in imagining themselves as part of a collective "we" capable of action. The continued marginality of literature and the arts (falling from 10.8% to 4.3%) further indicates an underexplored potential for emotional and cultural engagement—resources that could have helped students navigate the tension between complexity and action without falling into paralysis.

Most worrying, however, is the emergence of apathy: 15.2% of students reported that none of the aspects explored in the course had any motivational impact on their everyday actions. This raises a fundamental pedagogical challenge. The course appears to have successfully moved students beyond a purely cognitive, information-based model of engagement, opening a space for human narratives and emotional connection. Yet, in doing so, it may also have exposed them to the daunting scale of systemic issues without fully equipping them with the conceptual and emotional tools to engage with such complexity in a generative way. The risk, then, is that personal engagement becomes detached from systemic understanding, leading to either a heroic individualism or a sense of disempowered resignation. A more fruitful direction might involve cultivating forms of "nested agency," in which personal, social, and institutional roles are seen not as alternatives but as coexisting layers of responsibility—interwoven and mutually reinforcing.

5.4.3 Emergence and interaction of the two ways of thinking

At the close of the 17th February lesson, the second-year class engaged in a lively discussion that proved to be one of the corpus's most revealing moments, where the interplay between paradigmatic and narrative thinking functioned as a productive tension mediating how students made sense of CC and their place within it. As described in the Lesson plan paragraph, the activity that preceded the discussion was the interpretation of a narrative script, picturing the Zork alien interviewing fictional human archetypes related to CC (e.g. the billionaire, the activist, and the politician) as part of his in depth study of the human species role in the Earth climate crisis. We assigned roles to both us (the teachers) and students and conducted a read-through of the script, performed aloud with a semi-theatrical interpretation. The activity was led by Luca Luongo, a theatre director with professional experience directing actors in this process. After the reading I asked the students for opinions and feedback. The discussion that followed was not a straightforward

alignment with narrative or paradigmatic modes, but rather a complex, and often unresolved, mix of them and oscillation between them.

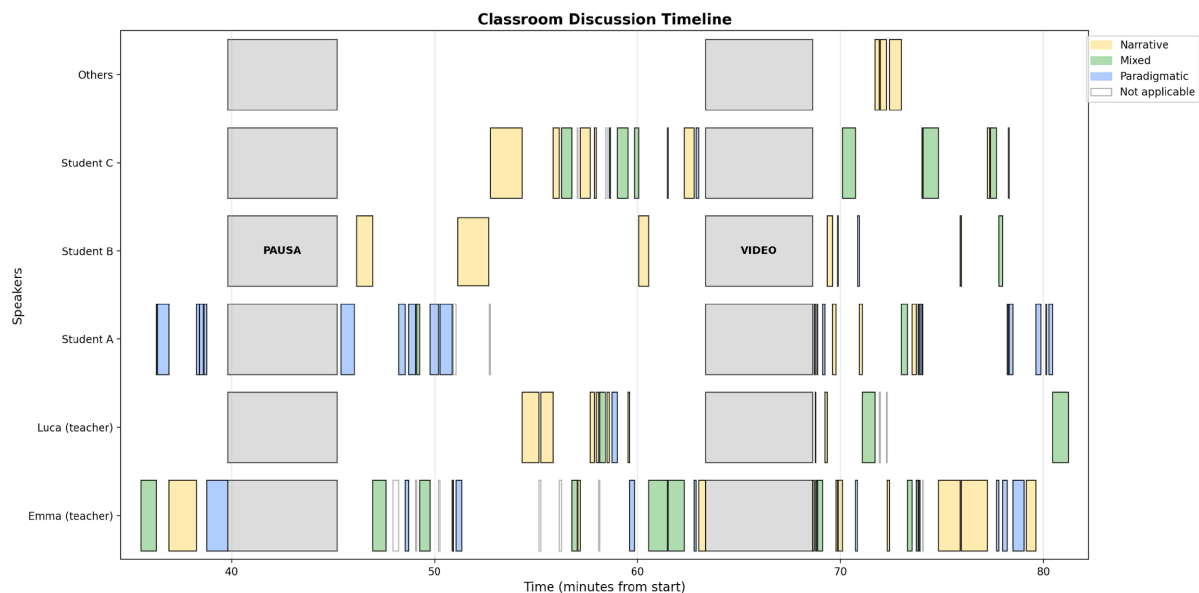


Figure 5.14. *Timeline of the classroom discussion coded by reasoning mode.* The figure visualizes the distribution of students' and teachers' utterances over time during a classroom discussion, coded according to their dominant reasoning mode (narrative, paradigmatic, or mixed). The alternation of colors highlights the dynamic interplay between narrative and paradigmatic reasoning throughout the activity.

To make visible the unfolding of the classroom dialogue and the transitions between paradigmatic, narrative and mixed ways of thinking, a visual representation was created in the form of a discursive timeline. This figure is based on a coded transcription of the classroom interaction and sequentially displays who spoke and the dominant mode of thinking and the approximate duration of each contribution. Each intervention was visually rendered as a horizontal bar, following the criteria outlined below:

- **Bar length** corresponds to the duration of the intervention, allowing for the distribution of speaking time and the alternation between short and extended contributions to be clearly observed.
- **Colour** indicates the mode of thinking: red for narrative segments, blue for paradigmatic ones, and purple for mixed contributions.

For instance, the figure highlights the mostly paradigmatic tendency of Student A, centered on economic arguments and logical-categorical reasoning, grounded in numerical evidence, and political-economic frameworks. Likewise, it shows the two moments in which both Student B and C enter the discussion backing up Student A positioning with narrative reasoning, and when I share a personal story related to my decision to adopt a vegetarian lifestyle and I briefly move Student A toward a narrative/mixed way of thinking.

The timeline thus reveals the rhythm of the discussion and the turn-taking patterns, offering a visual overview of how the group navigates and weaves together the two modes of

thought. It becomes evident how I try to act as a bridge between paradigmatic and narrative segments and how certain students demonstrate the ability to move across registers, at times hybridizing argumentative logic and narrative imagination (mixed segments).

The creation of this figure followed a process of translating the textual corpus into structured data. Starting from the annotated transcript, each speaking turn was converted into a tabular record containing the time frame, speaker, cognitive mode, and narrativity layer. The graphical representation was then generated as a simplified Gantt diagram, developed using Python with the support of the online tool Julius.ai.

Globally the graph shows three different tendencies among students A, B and C (Fig X):

- Student A: mainly paradigmatic thinking
- Student B: mainly narrative thinking
- Student C: mainly mixed thinking

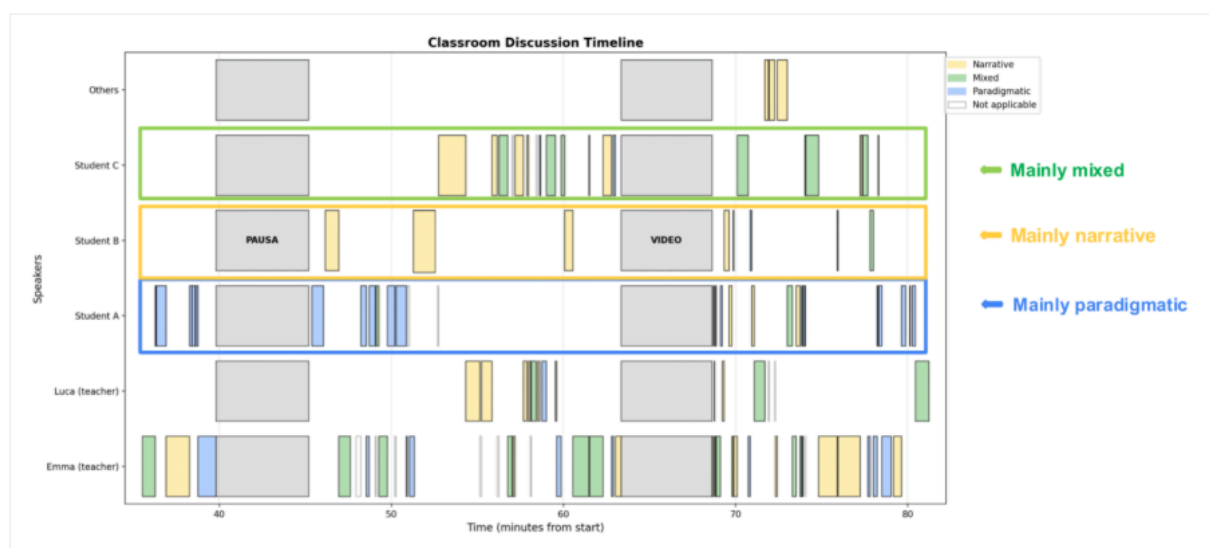


Figure 5.15. *Classroom discussion timeline with highlighted reasoning profiles.* The figure extends the previous visualization by outlining the dominant reasoning mode of each participant: mainly mixed (green), mainly narrative (yellow), and mainly paradigmatic (blue). This representation emphasizes how different students tended to favor distinct cognitive approaches while contributing to the collective discussion.

A first interpretation could suggest the existence of personal predispositions, though the temporal structure of the discussion suggests that these profiles could be not merely individual traits but also interactional positions. Specifically, the order of turns could indicate a counterbalancing dynamic: students entering the exchange later often mobilised the mode under-represented in the immediately preceding contributions, thereby complementing or challenging their peers. This pattern is consistent with a form of epistemic regulation at the group level, whereby participants diversify modes of reasoning to advance the discussion rather than repeat like-for-like moves.

As the transcription shows, Student A's more paradigmatic stance was rooted in proportional reasoning and cost-benefit logic that encapsulates a reductionist view. In his assertion that "a single cargo ship emits more CO₂ in one trip than I will in my entire life", scale and efficiency override ethical positioning or experiential connection. His use of quantitative contrast did not aim to open space for systemic understanding but, rather, to shut down the moral relevance of personal action. This is paradigmatic thinking stripped of systemic vision: precise but myopic. In Student A's discourse, the individual is radically disconnected from the system, so agency is rendered not only futile but illusory. Interestingly, this rejection of personal significance did not emerge from cynicism alone, but from a form of hyper-rationalism that seeks security and truth in logics of magnitude and productivity. In that sense, the paradigmatic mode could be interpreted as a defensive strategy, protecting the student maybe from the disorientation that complex problems inevitably produce, and probably from the latent ethical dilemma of "what should I do?". The price of such protection is the foreclosure of responsibility. What the discussion made visible, is how easily paradigmatic reasoning can collapse into resignation when it lacks the scaffolding of systems thinking – when it fails to articulate the dynamic, multi-level entanglement between individual action, social norms, economic structures, and planetary boundaries.

Student A's reasoning vividly illustrates what Walsh and Stepney (2018) identify as a reduction of complexity through linear, causal logic. By privileging efficiency and quantitative comparison over relational dynamics, his argument collapsed systemic interdependence into a closed computational frame. Narrative interventions, as those authors suggest, serve precisely to reopen such closures by reintroducing uncertainty, perspective, and human significance. The tension observed in the exchange I will present now therefore mirrors the pedagogical challenge of helping learners inhabit complexity without reverting to reductive certainty

Contrarily to Student A, other voices in the classroom – particularly Student B's – brought forth a narrative sensibility that reintroduced the possibility of balancing hyper-rationality with narrative and subjective investment. In this regard, the following extract is particularly significant:

"Student A [00:38:16]: Even if I stop using plastic straws, I won't be the one saving the world.

Emma (teacher) [00:38:24]: You'll do your part...

Student A [00:38:25]: But not even all of Italy would make a difference if it did. A Chinese cargo ship emits, in a single trip, the same amount of CO₂ that I emit in my entire lifetime. And so, I mean, it doesn't make sense for me to act like this and try to be as green as possible — I will never have an impact if the problem is the economies.

Emma (teacher) [00:38:46]: I mean, yes, but... The truth is that politics alone can't magically solve the problem. No one alone can solve this problem. Politics alone can't do it, you alone can't do it... It has to be something shared. And this is the problem of complexity: there is no one who can solve Climate Change alone,

everyone has to do their part. And obviously, your impact is small, and the impact of a billionaire is huge. [...] Everyone, in what they do, has an impact that depends on how much power they have to change things. But this doesn't mean your contribution is useless...

Student A [00:45:23] [...] so is it more convincing, is it more ecological, someone who tells you to stop using plastic bags or someone who tells you that the problem is the big companies that give jobs to people and take jobs away from people?

As it emerges from the tone of the record, the last line in Student A's intervention reveals a mix between a rhetorical statement and a genuine paradigmatic dilemma. On one hand, it carried the tone of a rhetorical question meant to assert the futility of individual actions; on the other, his slight uncertainty suggested an openness to dialogue, as if he was searching for reassurance or a different perspective able to provide resolution to the dilemma. However, Student A reasons within a paradigmatic framework that seeks a single "correct" answer. I replied asking for clarification (was it a rhetorical question or not?) and at this point a different student, Student B, intervened and changed the parameters and the ground of the discussion, moving not only from paradigmatic to narrative kind of thinking but from layer 1 to layer 3 of narrativity.

Student B [00:46:09] I think I got it... If a person comes to tell me, even you...

Emma (teacher): Me?

Student B : Yes, even if you come to tell me like "the problem is America because it's no longer in the agreement, because it does capitalism, and also in Italy... etcetera..." I don't care. Like, after three seconds I don't care anymore... Like, it's not my job. But if little by little, straws become paper, bags are no longer made of plastic but paper... I get used to a society where there is more, like it's less...

Student A [00:46:48] Where there's already a beginning of ecology...

Student B [00:46:51] Exactly... Like I start to realize it and so it interests me more than, like, the United States..."

Student B backed up Student A's perspective, but on a more personal and narrative level, by offering a little story about getting used to paper straws and cardboard bags and getting interested in climate action by inhabiting a world that feels slightly different. Her story did not claim to be an exhaustive description of how the world works; it simply claimed a space of meaning by presenting a verisimilar experience from a specific point of view. This move, subtle yet profound, shifted the frame: from disproving or persuading to positioning, to imagine how it feels. Her narrative reframed sustainability not as a solution to be reached, but as a texture of everyday life to be experienced.

More specifically, Student B did two things:

- she moved from paradigmatic to a slightly more narrative kind of thinking that connect the issue to a lived experience and articulate of a personal point of view ("It's not my job")

- and she raised the narrativity layer by pairing the “mental landscape” (“I don’t care”, “I get used”, “I start to realize”) with the “physical landscape” (“*you come to tell me*”, “*America is no longer in the agreement*”, “*straws become paper*”).

Through these two processes, the abstracted self that Student A had constructed (the rational consumer drowned in an ocean of futility) was rehumanized as someone who does not refrain from acting out of unwillingness, but because he needs direction to act at a level that feels reachable and tangible.

In this specific case, paradigmatic and narrative thinking completed each other rather than competing: paradigmatic reasoning allowed Student A to logically conceptualize roles and impacts of actions about climate issues (although not in a proper systemic way) but got stuck trying to find a definition of “sustainable behaviour” in a contestual situation, while Student B’s narrative thinking helped reconnect abstract concerns to concrete experiences deepening sense-making and opening a space for meaning-making and positioning. In other words, Student B shifted the focus from “there’s no point in acting” to “what would actually motivate me to act?” Rather than turning the perceived small magnitude of individual impact into an excuse or a reason for paralysis, she puts herself, her own motivations, and her intentions at the center of the question. It’s as if she is saying: “Okay, my impact is small, but despite that, what would still lead me to act?”. Student B, through narrative thinking, opened a space for action instead of closing it down.

This interplay between reasoning styles exemplifies Norris et al. (2005) model of narrative explanation, that underlines how narrative reasoning is not anti-scientific but offers a different logic of causation; your data concretely show this interaction. Rather than opposing analytical thinking, Student B’s contribution reframed the discussion through narrative coherence and contingency, demonstrating how causal understanding can emerge through situated storytelling. In this sense, narrative reasoning operated as a parallel epistemic mode, translating abstract knowledge into experiential meaning without abandoning rational accountability. This supports and resonates also with Kurtz’s (2014) conceptualisation of stories as “packages of meaning” that bind together facts, emotions, and interpretations into communicable units that can circulate and be negotiated within a community. Student B’s short account of paper straws and habitual adaptation operated precisely as such a package: by translating an abstract discourse on sustainability into the micro-experience of everyday consumption, she transformed a distant ethical question into a relatable practice of gradual change. This small narrative created what Kurtz would call a shared meaning node—a symbolic point around which collective understanding could coalesce. Within the classroom discussion, it momentarily suspended the impasse generated by paradigmatic reasoning and opened a space where students could emotionally and cognitively inhabit the idea of transformation. In this sense, the story did not merely illustrate an opinion but enacted a process of social sense-making: it allowed the group to renegotiate the meaning of individual action within a broader ecology of agency, shifting the focus from logical correctness to experiential plausibility.

In a nutshell, the interpretation of that extract of Student B intervention suggests how paradigmatic and narrative thinking can arise and interact in the sense-making process and for agency. While Student A’s linear paradigmatic perspective defined the scale of the

problem and highlighted how limited individual actions seem when compared to higher scale systemic forces, while Student B's narrative perspective, despite it arose to sustain the same point, reintroduced personal agency by exploring subjective motivations and situational factors that might inspire action despite that small scale of the impact. Together, they crafted a dynamic negotiation between knowing the limits and finding personal meaning. Student B, with their little narrative, created the opportunity to powerfully illuminate how it feels to translate abstract challenges into manageable, relatable practices, so that personal agency becomes more visible and accessible, resonating with Shepherd and Lloyd (2021) idea of *"meaningful" over merely "usable"* climate knowledge.

Student B's story also implicitly highlighted the importance of feeling part of a community acting together towards a shared goal and doing so it created a space to discuss the middle scale as a connection between individual and global. However, the discussion revealed that students tended to perceive this "collective agency" primarily as something that need to be imposed from above, rather than as a dynamic process that could emerge organically from bottom-up initiatives. This feeling was captured from some of the students that discussed about it in that day journaling:

"People don't change their actions because they think that if others don't take action, then why should they?"

That was probably because, after Student B's intervention, Student A quickly redirected the discussion back onto a paradigmatic plane. Rather than engaging with the ethical and experiential dimension that Student B had introduced, he resumed a reasoning style focused on rigid proportional scales of impact and categorical hierarchies of power. This response highlighted a crucial pattern: narrative thinking, even when activated, probably it influence just those students willing or able to resonate with it by connect it to an ethical perspective. For those, like Student A (and Later Student C), who adopted an overly pragmatic stance detached from any systemic lens, paradigmatic thinking dominated, reducing complex moral questions to simplistic cost-benefit analyses or deterministic conclusions. In these cases, the narrative elements were either trivialized or reabsorbed into linear paradigmatic reasoning, stripped of their potential to reframe the problem.

This tension became particularly visible with Student C's intervention:

Student C [00:52:44]: But let's say, if you were a multi-billionaire with no morals, you would prefer to exploit children and pay €5 for a bag made with, I don't know, some random materials, and then resell it for €2000 so you'd make much more profit, because many people don't care about these things. So in the end...

The discussion on ethics that emerged through L. Luongo (educator)'s provocation about how one might convince someone to abandon exploitative practices, exposed this pedagogical tension. Paradigmatic reasoning alone proved incapable of sustaining moral reflection, reducing complex ethical questions to transactional logic: "if it's profitable, why change?". This dynamic suggests a generational discomfort with moral discourse itself, where speaking ethically risks being labeled as naïve, moralistic, or disconnected from "how the world really works." In these moments, the classroom became a living laboratory of the

challenges inherent to CCE: not only how to understand the science or politics of CC, but how to navigate the moral landscape without falling into cynicism or resignation.

As a teacher-researcher, I did not position myself outside this epistemic and moral tension but attempted to inhabit it from within. When I shared my personal choice (“I became vegetarian because I want to die with a clean conscience”) it was not intended as a rhetorical closure or a moral prescription, but as a narrative intervention embodying both ethical complexity and the humility of partial, situated action. This gesture sought to open a space for students to explore non-heroic forms of agency: acts that may not guarantee systemic change but are meaningful as expressions of integrity and active hope. The efficacy of this narrative move did not manifest immediately in consensus or approval; however, its later echo in Student B’s words (“at least if you die, you die with a clean conscience”) suggests the narrative intervention could have entered the shared symbolic repertoire of the class. This moment was significant because it showed how a personal narrative, articulated with emotional clarity, could be taken up and reframed by students, shifting the conversation from abstract calculations of worth to concrete questions of identity and responsibility. The resonance of this narrative intervention extended beyond the immediacy of the discussion, as evidenced by students’ reflections recorded in their course journals. One particularly telling comment states:

“I think the idea of ‘either I do everything perfectly or I do nothing’ is very interesting, because if some people give up from the start, should we adopt this philosophy even in everyday actions? For example, if I don’t go to the gym on Monday, should I just skip the whole week? When in reality, you could start again the next day. This situation reflects what happens with this project: many people don’t realize the importance of trying to do something to improve the situation, so they end up not even doing the minimum necessary for climate change.”

This reflection reveals how the personal narrative I shared about my vegetarianism helped some students internalize the key message of rejecting the paralyzing “all-or-nothing” mentality. It suggests that the intervention created a conceptual and emotional foothold for students to connect their understanding of climate action with everyday habits, moving beyond abstract ideals of perfection towards a more situated, incremental approach to agency. By using themselves a narrative metaphor articulating the parallel between small personal commitments (starting to go to the gym) and sustained engagement with climate action, the student’s comment demonstrates an emerging capacity for reasoning bridging different domains of experience, and a shift towards a more pragmatic and hopeful stance. This supports the pedagogical potential of narrative interventions not merely as moments of emotional engagement, but as seeds for reframing sense-making around climate action and fostering dispositions oriented towards continuity, resilience, and responsibility.

Yet a limit persists: without scaffolding narrative thinking with epistemic tools for recognizing interdependence and systemic feedback, even emotionally resonant stories risk remaining isolated acts of meaning-making. From a methodological perspective, this episode reinforces the idea that narrative thinking is not inherently transformative. It can serve as a vehicle for ethical alignment and personal positioning, but only when embedded within a dialogic

learning environment where narratives are treated not as slogans but as invitations to negotiate meaning collectively. Otherwise, narrative can be co-opted by paradigmatic modes that use it merely to illustrate predetermined positions or to justify passivity. The oscillation between “is it worth it?” and “who do I want to be?”, hesitant and partial as it was, points to the subtle but critical work of repositioning knowledge from static possession to active, situated stance. It is within these micro-transformations, often invisible in the moment but traceable in discourse over time, that the pedagogical potential of engaging both paradigmatic and narrative thinking in climate education reveals itself.

5.4.4 Role of Narrativity

The analysis of the The school-based course was structured around the framework of the Narrativity Pyramid, which distinguishes four layers of narrative construction. This framework, while conceived as a heuristic tool, is rooted in a broader reflection on the epistemic and educational functions of narrative. Narrativity, as Bruner (1990) argued, is not merely a rhetorical device but a fundamental mode of human meaning-making, through which experience becomes interpretable and actionable. In the context of CCE, the mobilization of narrative elements can enable students to bridge the gap between abstract systemic knowledge and the lived realities of agency, values, and responsibility.

The following subsections explore how each layer of narrativity—world-making (Layer 1), temporal and causal articulation (Layer 2), mental events and authorial voice (Layer 3), and genre conventions (Layer 4)—was activated during the course and contributed to students’ sense-making. The aim is not only to provide a descriptive account of how students employed narrative resources, but also to interrogate the cognitive, ethical, and pedagogical implications of these processes. In line with Kurtz’s (2014) conception of narrative as a tool for participatory sense-making, the focus here is on how students appropriated narrative forms to reframe climate complexity into intelligible and negotiable structures.

Results about Layer 1

To investigate the educational potential of **Layer 1 (world-making)**, I carried out a qualitative coding of two artefacts produced by students: the worldmaking stories and the final videos. Layer 1, as defined in my second pyramid and according to Ryan (2005), concerns the minimal narrative elements required to build a world: spatial dimension, agents, and rules of the world. In the classroom activity, students were invited to construct short fictional accounts in which these elements could be mobilized as cognitive devices to interpret the newly introduced concept of *complexity*. The related analysis aimed to capture how world-making served as a vehicle for sense-making, allowing students to reframe abstract scientific notions into more familiar narrative images. The artefacts were analysed using a coding scheme that intertwined two main dimensions: (i) the structural elements of world-making (space, agents, rules/habits), and (ii) the cognitive and narrative functions mobilised for sense-making that emerged from the stories (metaphors, agency, positionings). Similar analyses were done for the upper layers.

As shown in the exemplificatory Table 5.4, each row corresponds to an artefact (the worldmaking stories in this case); the first column reports the unique code assigned during the cataloguing of the data; the next three columns refer to the coding categories concerning the elements of world-making; columns five and six correspond to the coding categories related to cognitive and narrative functions; finally, the column “Interpretive Notes” was used to add reflections or connections with the literature.

Summarizing:

1. **ID artefact**, used to show the artefact identification code;
2. **Spatial Dimension** (i.e. places, scales, relations);
3. **Agents** (i.e. human, non-human, alien);
4. **Rules of the World** (i.e. natural laws, feedback loops, social habits);
5. **Sensemaking and discursive modes** (i.e. metaphorical, hybrid narrative—explanatory, emotional);
6. **Representations of Complexity** (i.e. systemic connections, anthropogenic impact, unpredictability);
7. **Interpretive Notes**, used to synthesize the main educational insight emerging from each story.

Table 5.4. *Analysis of students’ world-making stories (Layer 1).* Qualitative coding of students’ stories illustrating how spatial, agentive, and regulatory elements of world-making were used to make sense of climate complexity.

ID Story	Spatial Dimension	Agents	Rules of the World	Sensemaking and discursive Modes	Representations of Complexity	Interpretive Notes
SB1	Oceans, deserts, icy mountains	Alien and resilient humans	Extreme natural laws, human adaptation	Contrast, resilience, epic tone	Unpredictability and resilience as distinctive traits	Highlights human adaptation to extreme conditions
SB2	Venice, Prague, Rome as microcosms	Alien, humans in the cities	Interaction climate—culture	Poetic and cultural imagery	Climate as a factor of social connection	Centrality of the climate—culture link
SB3	Atmosphere, mountains, coasts	Natural forces (wind, tides) personified	Solar cycles, natural energies	Metaphor of Earth’s breath	Systemic connections	Climate represented as a living organism
SB4	Antarctica, Sahara, Amazon, temperate regions, coasts	Alien explorer	Adaptation of life to conditions	Landscape description, aesthetic tone	Diversity and resilience	Aesthetic vision of climatic diversity
SB5	World of Rebound	Human inhabitants	Feedback loop between actions and climate	Oscillatory metaphor, echo	Feedback dynamics, instability	Excellent example of systemic world-making

SB6	Entire planet Earth	Alien	Currents and winds as symphony	Musical metaphor	Connections, constant adaptations	Harmonic vision of complexity
SB7	Imaginary city Climatika	Partially unaware inhabitants	Climatic multidimensionality	Complex urban metaphor	Multilayer and interconnections	Highlights the difficulty of perceiving complexity
SB8	Earth's atmosphere	Alien, natural forces	Unstable interactions	Metaphor of living organism	Fragile equilibrium	Clear representation of complexity, though little explained
SB9	Earth observed by the aliens	Aliens and humans as agentive factors	Anthropogenic activities destabilizing the system	Moral dilemma of the aliens	Anthropogenicity, fragility	Centrality of human impact
SB10	Forests, mountains, deserts, oceans	Alien and humans	Natural and anthropic dynamics	Epic-scientific tone	Dynamic balance altered by humans	Balance between natural and anthropogenic forces
SB11	Forests, mountains, deserts, cities	Alien and humans	Connections between nature and society	Living organism, social metaphor	Human-nature interconnection	Emphasizes the dual natural and social dimension
SB12	Earth observed from planet Verid	Alien	Unpredictability as rule	Dance of oceans and clouds	Instability and beauty	Complex yet positive: instability seen as value

About layer 1, what emerged from this analysis of the artefacts is the way in which students represented the human–nature relationship. Focusing on how they mobilised the basic elements of world-making for this purpose, four main observations can be drawn:

Nature as a "moral term"

In both activities, nature seems to have a normative function:

- In the stories, nature "teaches" or "shows" the logic of complexity (echo, symphony, breath).
- In the videos, nature is the element that forces moral or political choices (protecting the island, reforestation, avoiding greenwashing).

Not necessarily dichotomy or integration human-nature, but rather the use of nature as an ethical criterion that measures human action. Through metaphors such as the echo of the climate, the symphony of the winds, or the breath of the Earth, students endowed natural phenomena with a normative charge: these images implicitly suggested that humans ought to act with awareness of reciprocity, harmony, and fragility. In the final videos, this normative role became even more explicit. Nature appeared as the element that compelled characters to take a stance, whether by protecting an island threatened by sea-level rise, committing to reforestation after ecological collapse, or resisting the false promises of greenwashing. In

these cases, the environment was not just a setting but the very horizon against which responsibility was tested and action demanded.

This observation indicates that the human–nature relationship was not consistently articulated as a dichotomy, nor seamlessly integrated. Rather, students employed nature as an ethical criterion that measured human behaviour. In other words, nature became the standard by which moral responsibility and political legitimacy were defined. Such a finding is particularly relevant for CCE: it shows that even when scientific accuracy or causal explanation is partial, narrative activities can prompt learners to frame climate issues as questions of values and justice. By assigning nature the role of normative benchmark, students revealed an incipient ability to move beyond descriptive accounts of CC and to engage with its ethical and societal implications. This moralisation of nature resonates with the interpretation of environmental storytelling proposed by Veland et al. (2018), who argue that climate narratives and metaphors inevitably carry ethical and political weight, shaping how responsibility and justice are conceived. Similarly, Bushell et al. (2017) observe that stories about energy and climate transitions embed normative assumptions about what constitutes a “good” or “responsible” relation to the environment. The students’ recurring use of imagery linked to harmony, reciprocity, and balance (more details in the next paragraph) thus reflects a broader cultural pattern in which ecological equilibrium is equated with moral order. While these representations may risk idealising nature as a moral absolute, they also reveal an emerging ethical awareness: the recognition that environmental understanding cannot be disentangled from questions of value, care, and responsibility.

Difference in the scale of action and the linguistic register

- Stories: nature is captured in macro-systemic metaphors (Earth, oceans, wind).
- Video: nature enters local and concrete settings (cities, islands, museums).

The world-making stories, which gravitated towards **macro-systemic scales** (Earth, oceans, winds), were consistently articulated in an **imaginative–metaphorical register**. The choice of scale appears to have required a corresponding linguistic mode: when students narrated at planetary or cosmological levels, they tended to rely on metaphors—*the breath of the Earth*, *the echo of the climate*, *the symphony of the winds*—that could condense the immensity and abstraction of climate systems into a form accessible to sense-making. At this level, the metaphorical register appeared to function as a cognitive strategy to **domesticate complexity and abstraction**.

The recurrence of metaphors can be read through the lens offered by *Narrating Complexity* (Walsh & Stepney, 2018), which highlights how narrative inevitably linearises phenomena that are intrinsically circular, recursive, or multi-causal. In this perspective, the students’ metaphors acted as cognitive “reducers” that tamed scale and feedback without erasing them, translating non-linear processes into perceptible temporal or sensory sequences. The *echo*, for instance, transforms feedback loops into an audible chain of cause and response; the *symphony* reframes multiple interacting variables as coordinated yet distinct voices; and the *breath* renders the rhythmic oscillation of the climate system in bodily terms. These figurative translations made complexity narratively thinkable—allowing students to maintain a grasp on systemic interdependence while expressing it through imaginative, human-scale

imagery. As such, metaphor served as both an epistemic and an aesthetic bridge between paradigmatic abstraction and experiential understanding. Yet, the very metaphors that enabled students to make complexity intelligible also risked taming its unsettling force. As *Narrating Complexity* warns, when circular or multi-scalar processes are translated into linear, anthropomorphic, or harmonious images, part of their disruptive potential may be neutralised. The *symphony* and the *breath* of the Earth evoke balance and regularity, offering comfort rather than confrontation with instability. In this sense, the figurative domestication of complexity can become a double-edged tool: it fosters accessibility but may encourage a falsely ordered vision of systemic processes, concealing the non-equilibrium and tension that define climate dynamics. From an educational standpoint, this suggests the need to scaffold metaphorical creativity with explicit opportunities to interrogate its limits—to help students recognise when the stories that make complexity thinkable also risk making it deceptively simple.

Moreover, as also discussed by Lakoff and Johnson (1980), metaphors are not neutral vehicles of description but cognitive and moral frameworks that shape how phenomena are understood and valued. In the students' stories, figurative constructs such as the echo, the symphony, or the breath of the Earth did not only render complexity perceptible but also encoded implicit judgments about equilibrium, fragility, and reciprocity. In this sense, the metaphors operated as normative devices, framing the climate system through culturally shared ideals of harmony and mutual care. Similar to what Veland et al. (2018) and Bushell et al. (2017) observe in the broader field of climate storytelling, these images infused the representation of nature with ethical significance—suggesting that the way we narrate complexity also shapes how we imagine our moral relationship to it. This implicit moral orientation of metaphor also paved the way for how nature itself was framed in the students' narratives. By personifying the climate students positioned nature not merely as a descriptive backdrop but as a repository of ethical meaning—a horizon against which human actions could be evaluated. The transition from metaphor to moral stance thus appears almost seamless: once nature is endowed with voice, rhythm, or responsiveness, it inevitably becomes a participant in the moral field. This continuity between figurative imagination and ethical positioning anticipates the recurrent pattern, discussed in the upper paragraph, in which nature assumes a normative role as the measure and mirror of human responsibility.

When operating at local scales, students did not entirely abandon metaphor: the “last tree” conserved in a museum, for instance, was simultaneously a concrete artefact and an allegorical figure, embodying ecological collapse and moral urgency. However, the final videos unfolded in **local and situated scales** (cities, islands, museums) and were articulated in a more **socially embedded register**. Here the narrative language was less metaphorical and more dialogical, oriented to conflicts, negotiations, and explicit decisions (also probably because the videos activity was linked to a more stratified narrative use, i.e. Connecting layer 1 to layers 2 and above, that involves events and time evolution). In the second activity scale and register reinforced one another: when the setting was local, the register shifted to argumentative or testimonial modes, allowing students to dramatize responsibility, expose hypocrisy, or negotiate compromises.

The relationship between the two dimensions can therefore be interpreted as a **dynamic coupling**: abstract scales call more strongly for metaphorical registers, while concrete scales invite social and argumentative registers. From an educational point of view, this coupling is highly significant because CCE requires learners to move fluidly between scales—global complexity and local contexts. The Rosa-Luxembourg results suggest how Layer 1 of narrativity can scaffold such movements: enabling students first to capture systemic processes through metaphor, and then to re-situate them in social settings where agency and responsibility become visible. In this sense, the interplay between scale and register represents not only a descriptive feature of the data but also a **pedagogical pathway** for fostering the integration of narrative imagination with paradigmatic reasoning.

The connection with Genre

In both activities, we could say that the human-nature relationship is never truly integrated: it remains mediated, albeit with different registers (metaphorical vs. situated).

The activity was framed within a science-fictional prompt, requiring students to adopt the perspective of an alien observer. Yet, in their autonomous elaborations, they drew upon a broader repertoire of **narrative traditions**: the allegorical and fable-like device of personifying natural forces, or the echoes of cosmological myth in metaphors of breath, rhythm, and cyclical balance. Despite this diversity, the **dichotomy between humans and nature**, which Ghosh (2016) identifies as a hallmark of the modern novel, remained pervasive. Nature was often cast as an external entity—whether as backdrop, as resource, or as moral teacher—rather than as an interlocutor fully integrated within the same frame of agency.

This observation suggests that the human–nature dichotomy is not confined to the modern novelistic tradition but can **migrate across genres**, reappearing in fable, allegory, myth, and even in speculative science-fiction. In other words, while students creatively experimented with different registers to construct their worlds, the underlying separation of humans from the natural world endured as a structuring device. This persistence points to the robustness of the dichotomy as a cultural template, one that operates beneath genre differences and shapes how CC is imagined. From an educational perspective, this raises a critical challenge: fostering narrative practices that can move beyond inherited oppositions and support students in exploring more entangled representations of human–nature relations.

Trajectory

We could say that the students did not move from a “human vs. nature” vision to a “complex and integrated” vision, but rather they used Layer 1 as a flexible scaffold for reconfiguring the human–nature relationship across registers. In the world-making stories, Layer 1 supported imaginative and metaphorical representations in which nature appeared as an external teacher of complexity, showing interdependence through echoes, symphonies, or breaths. In the final videos, the same layer underpinned more situated and social representations, where nature compelled moral and political choices in concrete contexts such as cities, islands, or museums. The trajectory that emerges is therefore not one of linear conceptual progress, but of **recontextualisation**: Layer 1 enabled students first to construct symbolic worlds in which the logic of complexity could be grasped imaginatively,

and later to translate this logic into social arenas where responsibility, conflict, and ethical judgment became visible.

Results about Layer 2

When considering the role of Layer 2 of narrativity—defined by the temporal dimension, the presence of physical events, and the articulation of causal or casual links—it becomes evident that the Rosa-Luxemburg activity activated this layer in a rather different manner from previous interventions such as *FyouTURES*. In the latter, inhabiting the temporal and causal dimension was scaffolded by the simulator, which explicitly prompted students to engage in counterfactual reasoning and to confront the consequences of different policy choices over time. By contrast, in the school-based implementation the writing of the video script relied mainly on students' spontaneous narrative competence. This shift of medium is not neutral: as Ryan (2005) reminds us, different media afford different narrative resources and thus actualize distinct cognitive potentials.

The group recordings reveal that, in the absence of external prompts such as quantitative feedback or contingent constraints, students tended to rely on highly conventional narrative patterns. Temporal progression was often linear and teleological, with limited exploration of alternative pathways or “what if” scenarios. In other words, while Layer 2 was nominally present—stories unfolded in time and contained events—it was not deeply exploited as a cognitive device for exploring complexity. This finding echoes the concern expressed by Walsh (2018) that narrative's tendency to reduce complexity to linear sequence risks oversimplifying systemic processes.

The contrast with *FyouTURES* is illuminating. There, the “paradigmatic” limits imposed by data and the “narrative” contingencies introduced by cards forced participants to confront both predictability and unpredictability, thereby stimulating counterfactual imagination and systemic reasoning. In the script-writing activity, such external constraints were absent, and this reduced the potential for sense-making of temporal complexity. As Shepherd and Lloyd (2021) argue in relation to climate science, meaningful sense-making of uncertainty requires storylines that package quantitative and qualitative dimensions in ways that preserve contingency while enabling interpretation. The Rosa-Luxemburg narratives, instead, often neutralized contingency, producing simplified causal chains that offered little space for alternative developments.

This result is not to be interpreted solely as a limitation, but also as an indicator of the conditions under which Layer 2 can contribute to educational sense-making. As Norris et al. (2005) highlight, the explanatory power of narrative in science education lies in its ability to render events coherent through causal relations. Yet coherence can easily slide into closure when students rely exclusively on familiar narrative templates. What was missing here was the tension between determinism and contingency that, according to scenario-building practices such as the Shared Socioeconomic Pathways (O'Neill et al., 2017), is essential for imagining climate futures.

In sum, the Rosa-Luxemburg activity shows that “inhabiting” Layer 2 through free story writing does not automatically guarantee engagement with the temporal complexity of CC. While students did articulate sequences of events, these sequences were rarely problematized or opened to counterfactual exploration. Compared to activities structured around simulation or facilitated futures workshops, the pedagogical potential of Layer 2 was here underutilized. This suggests that for narrative temporalities to support deep sense-making of climate complexity, they need to be scaffolded either by external constraints, or by explicit prompts that foreground contingency, causal plurality, and the openness of the future.

Results about Layer 3

In principle, Layer 3 should have allowed students to confront the moral and existential dimensions of CC, enacting dilemmas and ethical tensions alongside pragmatic concerns. However, the data collected reveal a more complex picture. While emotions and decisions are indeed present in the stories, they appear to be predominantly mobilised in response to external pressures, rather than stemming from genuine moral deliberation. Likewise, the plots follow remarkably similar linear trajectories that resolve conflicts through simplistic solutions, leaving little space for ambiguity or open-endedness. Finally, the authorial voice tends to adopt a moralising stance from the outside, directing interpretation rather than fostering interpretive multiplicity. These three dimensions will now be analysed in detail.

With respect to mental events, the videos contain a variety of decisions and emotional expressions. In *Turismo green*, interviewees express personal views about sustainability: the child speaks with naïve hope, the shopkeeper with pragmatic ambivalence, and the volunteer with dedication to the cause. In *Turismo green – agenzia viaggi*, the client demonstrates sincerity and humility, while the travel agent displays arrogance, and the hotel receptionist embodies a more grounded sense of responsibility. In *L'ultimo albero*, sadness, gratitude, and repentance are articulated by the protagonists. The remaining videos also include mental states: indignation in *Zarrick*, doubt and resistance in *Le lanterne*, or concern in *L'isola che affonda*. These examples confirm that the students were capable of enriching their narratives with psychological elements that endowed characters with interiority. Yet a closer look reveals that these mental events are seldom driven by moral reasoning. Rather, they are activated by external causes: social pressure, confrontation with an opponent, exposure to a new idea, or persuasion from another character. The girl in *Turismo green* repeats her mother's words, the shopkeeper changes behaviour for pragmatic reasons, the entrepreneur in *L'ultimo albero* repents because he is confronted with consequences, the mayor in *Zarrick* shifts position after hearing citizens' views. None of these characters undergo an autonomous moral reflection on what is right or just. Their choices are reactive rather than deliberative, determined more by contingent causes than by moral agency. This echoes what was also observed during the class debate of 17 February, where students engaged in narrative reasoning but struggled to articulate explicitly moral dimensions. As Bruner reminds us, narrative is a privileged space to stage not only what happened, but what ought to happen (Bruner, 1990). The absence of this moral dimension suggests that, in this

activity, Layer 3 remained anchored to pragmatic motivations, without fully evolving into a terrain for ethical exploration.

The second dimension concerns the *plot structures*. Across the six videos, one recognises a recurring sequential pattern. Narratives begin with the identification of a problem (unsustainable tourism, greenwashing, deforestation, rising seas, polluting mobility, unsustainable lighting). They then introduce one or more agents of change who propose alternatives or embody resistance. A conflict is staged between the initial unsustainable practice and the new sustainable solution. Finally, the story closes with a resolution, often optimistic: the volunteer inspires collective action, the client exposes greenwashing and finds a truly sustainable hotel, the entrepreneur finances reforestation, the mayor and activists find an agreement, the politician is convinced by the artisan. This canonical structure—problem, confrontation, resolution—bears resemblance to Proppian narrative functions or to classic educational storylines. While such linearity has the advantage of clarity, it also reveals a tendency to oversimplify complexity. As Walsh (2017) notes in *Narrating Complexity*, the imposition of a linear plot is one of the ways in which narrative tames the unruliness of complex systems. In the students' videos, this taming often resulted in closing down tensions too quickly, replacing uncertainty with the reassurance of happy endings. Even in stories that staged initial polarisation (e.g., the arrogant agent versus the sincere client, the entrepreneur versus the artist, the mayor versus activists), conflicts were resolved in didactic fashion, with one side converting or reaching compromise. Missing were more open, tragic, or unresolved endings that might have represented the persistence of dilemmas, trade-offs, or moral ambivalences. The prevalence of linear resolution limits the potential of Layer 3 to stimulate deeper sense-making of climate complexity, which often resists closure and requires living with uncertainty.

The third dimension is the authorial voice. In the mockumentary-style videos — *Turismo green*, *Turismo green – agenzia viaggi*, *L'ultimo albero*, and *Zarrick* — this voice appears explicitly through interviewers or narrators who frame events, introduce characters, and comment on outcomes. For instance, in *Turismo green* the two documentarists guide viewers through interviews; in *L'ultimo albero* the journalist explains the situation of the last tree; in *Zarrick* the emissary addresses the alien, presenting humanity's case for survival. In the other videos — *L'isola che affonda* and *Le lanterne* — the voice is more implicit but still perceptible: the narrative alignment with the architect, the artisan, or the citizens indicates the stance of the student-authors. In all cases, the authorial voice tends to take a moralising function, signalling clearly who is right and who is wrong. The arrogant agent is unmasked as hypocrite, the hotel receptionist is validated as trustworthy, the repentant entrepreneur is rewarded, the stubborn mayor is corrected. Rather than positioning themselves as explorers of moral ambiguity, the students adopted a perspective that closed interpretation, delivering clear lessons on sustainability. This corresponds to what Kurtz (2014) calls the “moralising function” of participatory stories: they carry implicit didactic purposes rather than fostering negotiation of meaning. While this function is legitimate in educational contexts, it constrains the polyphony that narrative could support (Bakhtin, 1981), reducing students' opportunities to engage in open-ended deliberation.

Taken together, these observations show that Layer 3 played an important but limited role in the students' sense-making. The inclusion of emotions, decisions, and discoveries endowed characters with a certain degree of psychological reality, but these remained mostly pragmatic rather than moral. Plot structures provided coherence and clarity, but at the cost of oversimplifying complexity into predictable resolutions. Authorial voices asserted clear positions, but without leaving room for interpretive multiplicity. This suggests that while students were able to appropriate Layer 3 as a tool for communication, they did not yet fully exploit its potential as a cognitive space for ethical reasoning and complex meaning-making. Bruner (1990) underlined that the cultural power of narrative lies precisely in its ability to stage possible worlds, to negotiate values, and to imagine moral choices. In this implementation, however, narrative remained at the level of staging scenarios for pragmatic action rather than spaces for moral reflection.

The implications for educational design are twofold. First, fostering moral reasoning through narrative may require specific scaffolds that invite students to confront dilemmas, trade-offs, and irreducible tensions, rather than simply conflicts solvable by conversion or compromise. Second, supporting multiplicity of voices may encourage narratives that resist closure, keeping alive the polyphony of perspectives that CC demands. Without such scaffolds, students may remain within the comfort zone of linear plots, pragmatic decisions, and moralising voices, thus missing the opportunity to explore CC as an ethical, uncertain, and deeply complex human challenge.

Results about Layer 4

Finally, the analysis of Layer 4 invites a reconsideration of the place of genre within the narrativity framework. The evidence collected suggests that genre may not be adequately conceived as a mere terminal stage of narrative construction. Instead, it appears to operate as a transversal dimension, shaping students' world-making choices, their temporal reasoning, and their articulation of perspectives and conflicts. Yet, the decision to treat genre as a distinct layer has proven to be a valuable analytical move. By isolating it, it became possible to scrutinize more closely how students mobilized recognizable conventions—such as the codes of reportage, talk shows, or comic sketches—and how these conventions influenced the construction of meaning across all other levels. In this sense, the layer-based framework has functioned not only as a descriptive model but also as a heuristic device: it provided a scaffold to focus attention on specific narrative dimensions, while at the same time opening space to revisit and refine its own categories. This is consistent with Norris et al.'s (2005) observation that conceptual frameworks in education can serve as productive tools precisely because they make assumptions explicit and expose them to empirical testing. Likewise, Ryan's notion of transmedial narratology (2005) highlights that while a core of meaning can travel across different media, the actualization of narrative potential always depends on the conventions of genre. In the context of CCE, this reflection aligns with Ghosh's argument on the limits of the modern novel in narrating the climate crisis and the need for alternative genres to render the "unthinkable" (2016), as well as with Soares's cautionary stance against uncritical generalizations about narrative use. Taken together,

these insights indicate that while genre may ultimately function as a transversal dimension, its inclusion as a separate layer in the narrativity framework was a valid and fruitful choice, allowing the analysis to capture the pervasive influence of genre and to generate a richer understanding of its educational role.

5.5 Implication for the Narrativity Pyramid

The discussion that follows addresses SQ1d, which investigates how the empirical findings from the School-based course can inform a deeper interpretation and educational use of the Narrativity Pyramid, leading to its theoretical consolidation and to a more conscious application within educational design, leading to its third and final version. The five layers identified in the second model—from Layer 0 (Nomothetic reasoning) to Layer 4 (Genre)—retain their conceptual meaning and educational value as clusters of narrativity elements relevant for CCE. What emerged from the classroom analysis, however, was the need to clarify their mutual relations and to refine the model's capacity to represent the dynamic balance between paradigmatic and narrative reasoning.

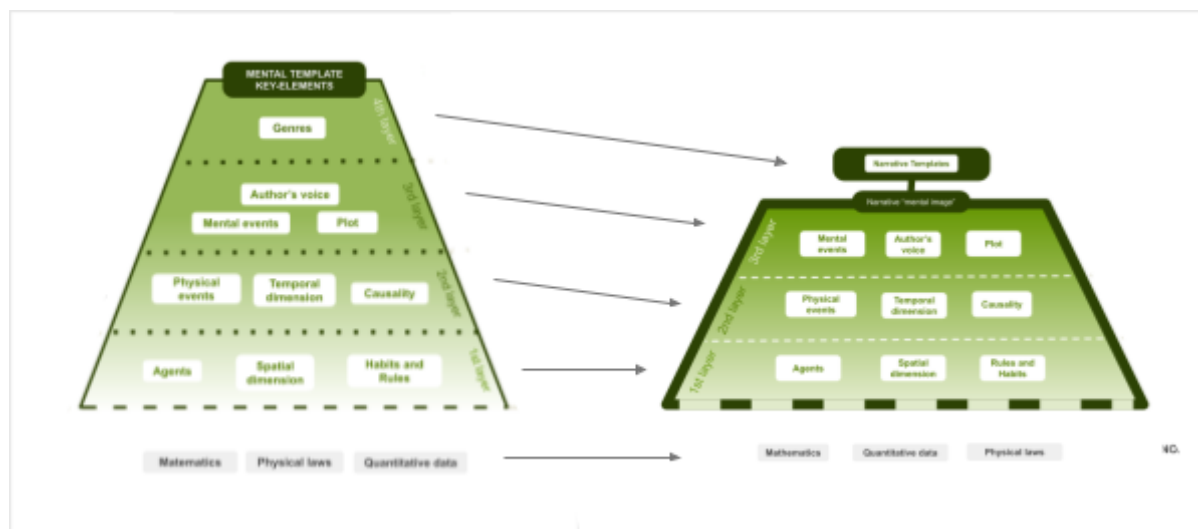


Figure 5.16. *Second redesign of the Narrativity Pyramid.* The figure illustrates the evolution of the model from second to third version. Arrows indicate how the layers of narrativity from the old design were retained in the new one.

The third version of the Pyramid preserves the five-layered architecture of version 2 but slightly reorganises their conceptual relations. Nomothetic reasoning remains at the bottom, anchoring the model to the search for objectivity, regularities, logic, and time-invariant laws of nature as a base for science-based CCE. Above it, the three narrativity layers (world-making, physical transformation, and mental perspectives) form the core of narrative reasoning, representing progressive forms of sense-making that mobilise context, contingency, and subjectivity. Surrounding them, the former upper layer of genre evolves into a shell-like domain of what has been called “narrative templates”—a permeable and encompassing frame that both shapes and is shaped by the other layers. This shell, similarly

to Layer 4 “Genre” in the previous model, symbolises the cultural, psychological, and epistemic conventions that influence how individuals, often unconsciously, select narrative patterns to “connect the dots” of experience or data. The most significant redesign concerns the conceptual shift from layer to shell. In the previous version of the model, genre was conceived as the highest layer of narrativity; in the current version, it becomes a transversal construct that encircles the three-layered Narrativity Pyramid, acting simultaneously as both a constraint and an affordance. The shell is also an enlarged container, representing not only genres but more broadly narrative and cultural “templates” that range from aesthetic conventions (e.g., styles, tones, and narrative voices) to deeper, more structured, worldviews. These templates shape how climate change is imagined, interpreted, and communicated through one or more elements of narrativity (space, agency, temporality, causality) influencing which individuals and communities translate knowledge and experience into recognisable narrative forms (Bruner, 1990; Norris et al., 2005; Walsh & Stepney, 2018).

Yet, precisely because they provide intelligibility and social resonance, they also delimit what can be thought or told. They tend to stabilise meaning, often reproducing dominant discursive frames—such as the heroic, apocalyptic, or technocratic storyline—and thus can narrow the scale of reasoning (from systemic to individual) or confine imagination within culturally dominant horizons. A particularly relevant example is that of strategic narratives (Bushell et al., 2017; Bevan et al., 2020). These are deliberately constructed storylines designed to align values, mobilise collective identities, and guide social action around specific visions of the future. As Moezzi et al. (2017) highlight, such narratives play an ambivalent role in climate communication: on one hand, they offer powerful vehicles of meaning, connecting disparate actors and fostering shared purposes; on the other, they risk turning narratives into instruments of persuasion, reducing their interpretative openness and, in some cases, paralysing rather than enabling action. Within the Pyramid, strategic narratives can thus be understood as high-level templates that operate primarily on the world-making and transformative layers, structuring how agents, events, and causal relations are framed. Recognising their dual nature—as both meaning-makers and meaning-limiters—invites educators to cultivate a critical awareness of genres and templates as mediating structures, to use them not as fixed moulds but as reflexive shells capable of being reinterpreted, hybridised, and problematised in educational practice.

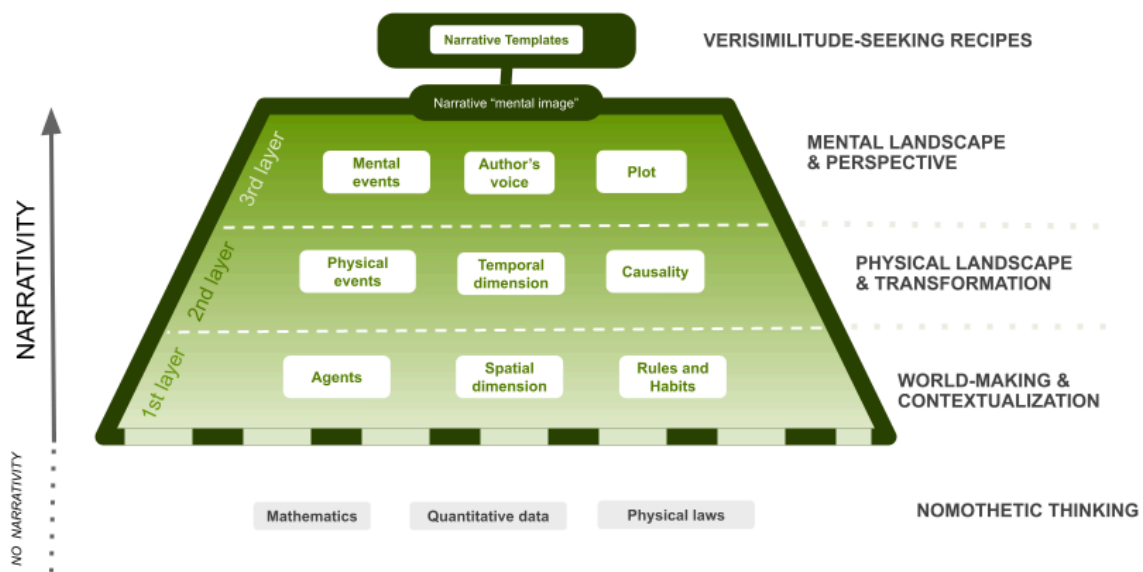


Figure 5.17. *Third version of the Narrativity Pyramid.* The figure presents the final redesign of the Narrativity Pyramid, which integrates insights from the School-based course. The model maintains its five-layered architecture but redefines the relations among layers to represent zones of epistemic tension between paradigmatic and narrative reasoning rather than a linear hierarchy. Nomothetic thinking anchors the structure at the base, while the three central layers—world-making, transformation, and mental perspective—illustrate progressive forms of sense-making. Surrounding them, genres, styles, and worldviews form a permeable “shell” of verisimilitude-seeking recipes, symbolising the cultural and psychological conventions that guide how individuals connect experience, knowledge, and imagination.

Evidence from the school-based course provided important insights for this theoretical repositioning. From the early classroom discussions, it became evident that students’ reasoning—including that of the most paradigmatically oriented participant (Student A)—was mediated by what could be described as an implicit narrative grammar: a background set of assumptions, interpretative habits, and representational preferences through which students made sense of their rational style of thinking. This implicit mediation did not emerge as a deliberate stylistic choice, but rather as a tacit way of structuring meaning, guiding how students approached and interpreted climate-related problems.

This narrative undercurrent reappeared during the creative phases of the activity, where familiar genres, plots, and tropes—such as dystopian futures or individual redemption arcs—were spontaneously employed to render complexity intelligible. Yet, moments of meta-cognitive reflection also surfaced: some students explicitly questioned the realism or stereotypical nature of their stories, demonstrating an emerging awareness of genre as both a resource for sense-making and a constraint that limits interpretative openness.

Taken together, these observations suggest that genre and other implicit narrative templates function as cognitive–cultural scaffolds that prefigure how students engage in reasoning

about climate change. They shape not only what is imagined but also what is deemed plausible, desirable, or thinkable. Hence, rather than being conceived as an upper layer of narrativity, the former Layer 4 can be more accurately interpreted as a *transversal structure of plausibility*—or, in Bruner’s (1990) terms, a structure of verisimilitude. It represents a semiotic and epistemic shell that constitutes the core of narrative thinking beyond narrativity itself, and that—together with nomothetic reasoning—orients cognition across the three layers of the Narrativity Pyramid.

The findings also allowed for a more precise articulation of how narrative and paradigmatic reasoning balance and sustain each other across the layers. This led to reframing narrativity not as a continuum between high and low narrative content, but as a scaffold for thinking: a structure that supports learners in oscillating productively between the two cognitive poles embodied in the model—the ground and the shell. These poles correspond to two complementary epistemic aims: Truth-seeking and paradigmatic thinking: engaging with measurable, logical realities; Verisimilitude and narrative thinking: engaging with plausible, meaningful realities. Each of the three narrativity layers of the Pyramid thus becomes a site of negotiation between these poles—fostering students’ capacity to move both inside and outside of data, navigating between logic and meaning, objectivity and subjectivity, abstraction and situatedness. Specifically, in Layer 1, the epistemic tension lies between abstraction and situatedness—between constructing coherent worlds and anchoring them to lived or imagined realities. In Layer 2, it manifests as a balance between contingency and causality, where narrative sequences allow students to explore causal relationships in climate systems without reducing them to deterministic chains. In Layer 3, the focus shifts to the interplay between dialectical conflict (as a reasoning process) and narrative conflict (as a plot device), both essential for constructing meaning and moral positioning.

The third and final version of the Narrativity Pyramid therefore reframes narrativity not as a hierarchy of representational forms, but as a field of dynamic equilibria between the core of the two modes of thought. It delineates how narrative cognition operates within science education: simultaneously grounded in nomothetic reasoning, articulated through layered of narrativity, and continuously modulated by the surrounding shell of narrative templates that define what counts as plausible and meaningful.

5.6 Conclusions and discussion

The school-based course represented the culminating phase of this doctoral trajectory, bringing together the theoretical reflections developed in the previous chapters and subjecting them to an empirical test in a real classroom setting. Its design was grounded in the idea that narrativity—understood as an epistemic structure rather than a mere communicative device—can provide fertile ground for fostering sense-making and agency in the context of CCE. The analysis of the intervention confirmed both the potential and the limitations of such an approach, while offering crucial insights for the theoretical consolidation of the Narrativity Pyramid.

First, the course highlighted the educational value of staging a dynamic interplay between paradigmatic and narrative reasoning. Students were not simply asked to acquire scientific knowledge or to rehearse predefined solutions; rather, they were invited to move across epistemic registers, navigating between systemic explanations and imaginative constructions. This oscillation, although often unstable and fragmented, revealed moments in which abstract concepts were re-appropriated through personal or collective narratives, thus becoming more meaningful and actionable. Yet, the data also revealed the fragility of this balance: in many cases, narrative elements were reabsorbed into linear paradigmatic reasoning, or, conversely, remained confined to moralising or affective expressions without opening up to deeper ethical deliberation. These tensions, however, should not be seen as shortcomings but as manifestations of the epistemic negotiations that narrativity can activate within learning.

Second, the layered framework of narrativity proved to be a productive heuristic for both design and analysis. Each layer—world-making, temporal and causal articulation, mental events and authorial voice, and genre—illuminated specific dimensions of students' reasoning, showing how narrativity operates as a scaffold that mediates between explanation and imagination. The empirical evidence also refined the understanding of genre as a transversal shell—a set of implicit “recipes of verisimilitude” that shape the cognitive and cultural boundaries of what learners perceive as plausible or meaningful. Students' spontaneous use of dystopian or utopian tropes, their reliance on archetypal figures, and their occasional meta-reflections on realism suggest that narrative forms carry epistemic assumptions which orient sense-making even before conscious reasoning unfolds. This finding consolidates the idea that the Pyramid models not only how stories are built, but also how meaning itself is cognitively and culturally constructed.

Third, the course underscored the importance of viewing narrative interventions as situated and dialogic acts, embedded in processes where ethical positioning, emotions, and responsibility are continuously renegotiated. The moments in which students most vividly connected abstract climate issues with their own lives emerged precisely when narrative and paradigmatic reasoning were brought into productive tension—when uncertainty was not avoided but inhabited. These micro-transformations—partial, provisional, and often invisible in the moment—represent the genuine pedagogical value of narrativity in CCE: the capacity to move knowledge from static possession to an active stance.

In conclusion, the school-based course demonstrates that narrativity can serve as both a design principle and an analytical lens capable of enriching CCE. Yet, it also warns against assuming its transformative power as automatic or inherent. Narrativity becomes educationally meaningful only when it is scaffolded within dialogic environments that value multiplicity, uncertainty, and ethical complexity. The third and final version of the Narrativity Pyramid embodies precisely this vision: a model that does not prescribe a single path but maps a field of dynamic equilibria where scientific clarity and narrative openness coexist. It is within this delicate balance—between knowledge and meaning, between the logic of explanation and the imagination of possible worlds—that education can most fruitfully prepare young people to inhabit the uncertain futures of CC.

Conclusions

Synthesis of research aim and methodological approach

One of the major challenges for science education today is to provide learners with tools to make sense of phenomena that are at once scientific, social, and personal. CC embodies this challenge: it is not only a topic within science but a multidimensional problem that crosses disciplinary boundaries and demands the capacity to think across scales, systems, and values. In this context, science education is called to cultivate forms of reasoning that are at the same time analytical and interpretative, capable of connecting the explanatory power of science with the need to act, imagine, and take responsibility (Knain & Kolstø, 2011; Levrini et al, 2021; Tasquier et al., 2022).

This doctoral research was developed within this educational horizon, acknowledging both the centrality and the limits of scientific languages in addressing complex socio-scientific issues such as climate change. While scientific reasoning provides the indispensable foundation for understanding climate phenomena, it alone cannot equip learners to navigate their epistemic and existential implications. Expanding its epistemic space therefore becomes essential — integrating ways of thinking that connect facts with meanings, and data with lived experience. Within this perspective, this research identified narrative thinking as a promising complement to scientific reasoning—a form of thought that, while different in structure and purpose, can sustain processes of interpretation, imagination, and ethical positioning. Building on Bruner's distinction between the paradigmatic and the narrative modes of thought (Bruner, 1986), the study investigated how these two forms of reasoning might interact within educational contexts, not as alternatives, but as complementary and interdependent dimensions of sensemaking. The central question guiding this research asked how narrative thinking can be conceptualised and operationalised as an epistemic and educational resource for CCE.

To respond to this question, this research developed the Narrativity Pyramid (D'Orto & Tasquier, 2025a), a theoretical-operative construct designed to map and scaffold the interactions between narrative and paradigmatic reasoning. Drawing on narratological studies (Ryan, 2005; Norris et al., 2005) and the recent educational debate on the integration of epistemic dimensions of learning (Tasquier et al., 2022), the Pyramid employs the concept of narrativity as a graded feature that identifies distinct layers of focus. Each layer brings together clusters of narrative elements—such as agents, context, temporality, causality or genres— that resonate with key educational dimensions of CCE. These layers are conceived as cognitive spaces where the two modes of reasoning can encounter, negotiate, and transform each other, giving rise to forms of understanding that are both systemic and meaningful.

Methodologically, the research was grounded in a Design-Based Research (DBR)-inspired approach (Cobb et al., 2003; Anderson & Shattuck, 2012; Sandoval, 2014), conceived as a recursive and reflective movement between theorisation, design, and empirical observation. The study unfolded through three iterative phases within the European projects FEDORA (Horizon 2020) and Climademy (Erasmus+), progressively deepening the conceptual, design, and empirical axes of inquiry. In this framework, theory and practice were not treated as separate domains but as mutually generative processes. Each phase informed the next, transforming theoretical intuitions into educational design and translating empirical insights back into conceptual refinement.

In this recursive movement, the Narrativity Pyramid evolved as both a theoretical construct and a living artefact, shaped through its educational enactments. The empirical phases served not only to validate but to redefine the model, revealing narrativity as a mediating mechanism for sensemaking across disciplinary, cognitive, and emotional dimensions.

Synthesis of findings

Across its three axes — conceptual, design, and empirical — this research progressively showed how narrativity can function as an epistemic and educational bridge for CCE, supporting the integration between narrative and paradigmatic reasoning in students' processes of sense-making and agency. The work demonstrated that narrativity does not simply describe how stories are told, but rather is the structural resource learners' use for reasoning, interpreting, imagining, and acting upon complex phenomena such as CC.

Along the conceptual axis, the results concern the elaboration of the Narrativity Pyramid through three iterative rounds of refinement. The first model identified narrativity as a promising concept to connect narrative and paradigmatic modes of thought within CCE, both theoretically and operatively. The second model refined this understanding by articulating a more fine grain of narrativity, individuating layers as clusters of reasoning and sense-making that resonate with the key epistemic and educational needs of CCE, ranging from abstraction and modelling to contextualisation, transformation, and ethical reflection. Finally, the third version of the Pyramid deepened and complexified the relationship between these layers/clusters and how the two modes of reasoning intertwine within them. This latest version of the model offered new hypotheses on how their balance can be fostered across contexts, thus establishing narrativity as a mediating mechanism for constructing meaning between scientific explanation and interpretive understanding.

Along the design axis, the study operationalised the conceptual insights into educational principles, materials, and activities. The design principles derived from the Pyramid (D’Orto & Tasquier, 2025b) guided the creation of learning environments that intentionally mobilised both narrative and paradigmatic reasoning. The activities developed—ranging from the FyouTURES board game and its narrative enhancement to the school-based course integrating world-making, scenario-building, and reflection—constituted experimental spaces for testing the educational affordances of narrativity. These designs translated the Pyramid into pedagogical action, showing that students’ engagement can be deepened when they are encouraged to move across different representational forms and cognitive registers, from data-based modelling to narrative imagination.

Along the empirical axis, the analysis of the classroom implementations provided evidence of how students spontaneously and collaboratively activated narrative and paradigmatic reasoning in their discourse and artefacts. The data revealed that narrative reasoning tended to emerge as a collective and situated process, often triggered by affective resonance, metaphors, or the search for meaning. When guided through appropriate prompts, students were able to connect abstract climate concepts to concrete experiences, envision possible futures, and position themselves within them. The oscillation between scientific explanation and imaginative construction—although at times unstable—generated moments of deep sense-making, in which knowledge became more personally and socially significant. At the same time, the findings highlighted the fragility of this balance: narrative reasoning was sometimes reabsorbed into linear scientific discourse or remained confined to moralistic or aesthetic dimensions. Yet precisely this tension revealed narrativity’s potential to act as a dynamic interface for fostering epistemic flexibility and ethical awareness.

Taken together, the findings confirm that narrativity can bridge explanatory and interpretive modes of thought in ways that render the complexity of CC both intelligible and educable. By framing learning as a movement across axes of reasoning, the Narrativity Pyramid provides an operational tool for designing and analysing educational practices that cultivate students’ capacity to think systemically, imagine alternative futures, and take responsible action within uncertainty.

Discussion on limitations and future research directions

While the findings of this research provide a coherent and empirically grounded framework for understanding the role of narrativity in CCE, several limitations must be acknowledged. These limitations do not weaken the validity of the results but rather delineate the boundaries and possible extensions of the model developed through this study.

A first and almost inevitable limitation derives from the fact that the concept of narrative is inherently interdisciplinary. The study has drawn upon insights from multiple domains—science education, climate science, narratology, literary studies, and communication theory. While every effort was made to maintain conceptual coherence across these fields, the perspective adopted remained primarily anchored within science and CCE. As a consequence, some constructs originating in the humanities or in climate modelling may not have been explored with the same depth or disciplinary specificity as within their original frameworks. The intention, however, was not to offer exhaustive disciplinary analyses, but to remain faithful and pragmatic, translating and adapting those constructs to the educational purposes of fostering sense-making and agency. In this respect, the interdisciplinarity of the concept of narrative represents both a challenge and a resource: a space of productive negotiation between distinct epistemic cultures rather than a source of inconsistency.

A second limitation concerns the subject matter itself which poses affective and pedagogical challenges: CC is an issue marked by uncertainty, controversy, and emotional weight. Designing activities that stimulated engagement without generating paralysis or despair required ongoing negotiation and sensitivity. The educational interventions were therefore not neutral experimental spaces but ethically and affectively charged encounters, in which emotions, values, and worldviews shaped the collective meaning-making process in ways not entirely predictable. This aspect calls for further reflection on how educational designs can address emotionally complex and morally sensitive topics while maintaining openness, inclusivity, and critical distance. At the same time, it highlights one of the key contributions of this work: the recognition that narrative can serve as a transformative medium for containing and reworking emotional and ethical tensions into shared reflection and imaginative agency.

A further limitation concerns the context-dependence and variability of the observed learning dynamics. Students' engagement with narrative forms of reasoning was highly sensitive to situational factors—group composition, emotional atmosphere, and prior familiarity with socio-scientific issues. The emergence of narrative reasoning appeared as a distributed and collective process, often triggered by spontaneous associations, irony, or moral resonance. These findings suggest that narrative reasoning should not be conceived as a stable individual competence, but as an emergent and relational process, which can be intentionally fostered but not entirely standardised or predicted. Future research could explore these dynamics longitudinally and across contexts, examining how narrative engagement evolves over time and how it contributes to the development of students' epistemic agency.

Looking ahead, future research should aim to expand and refine both the theoretical and empirical scope of these findings. Empirically, larger and more diversified implementations could investigate how the model performs across educational levels, disciplines, and cultural contexts, identifying the conditions that support sustained transitions between narrative and paradigmatic reasoning. Theoretically, further work could deepen the epistemological foundations of the Narrativity Pyramid, integrating perspectives from cognitive psychology, aesthetics, and moral philosophy to enrich its interpretive and ethical dimensions.

Moreover, the results point to the importance of teacher professional development as a crucial site for applying and extending the model. Supporting educators in recognising, eliciting, and sustaining narrative reasoning—especially when dealing with socio-scientific issues that evoke uncertainty and emotion—is essential to ensure that narrativity functions as a genuine epistemic resource rather than as a rhetorical device.

In this sense, the limitations identified here do not undermine the contributions of the study but define the horizon of a continuing research trajectory—one that conceives narrative as a dynamic and generative interface between knowledge, imagination, and ethical responsibility, and as a cornerstone for educational practices capable of preparing students to think and act within the uncertainties of the future. Within this trajectory, a promising direction for future work will be to test and apply the third version of the Narrativity Pyramid within new educational designs and classroom contexts, to further evaluate its capacity to scaffold reasoning, sense-making, and agency in CCE.

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Appendix

A.1 Educational materials

A.1.1 Transcription of video introduction (FyouTURES' narrative layer)

Original version

INTRODUZIONE

Come ben noto, nel dicembre del 2015, la COP21 ha negoziato l'Accordo di Parigi, un trattato storico pensato per rafforzare la cooperazione globale nella lotta alla crisi climatica. In particolare, l'obiettivo di mitigazione del trattato è limitare l'aumento della temperatura media globale a un massimo 2°C rispetto ai livelli preindustriali, preferibilmente sotto gli 1.5°C. I risultati del primo "stocktake" per monitorare l'impegno dei paesi firmatari purtroppo mostra che solo un numero limitato di nazioni ha raggiunto gli obiettivi stabiliti, segnando un inizio poco incoraggiante.

Tuttavia, negli ultimi mesi, una nuova speranza è nata dalla rinascita del movimento globale per il clima. Lo scorso servizio meteorologico dell'UE, Copernicus, ha riportato che il 2024 è già certamente l'anno più caldo di sempre, il primo oltre la soglia di 1,5°C. Questi dati allarmanti hanno rappresentato un campanello d'allarme sull'urgenza di una risposta più sistemica. Questa necessità è stata raccolta con forza dagli attivisti di tutto il mondo, dando vita a un'ondata di mobilitazione senza precedenti. Una folla mai vista prima si è radunata ai piedi delle sedi delle Nazioni Unite in tutto il pianeta. Questa reazione globale è stata coordinata da forze unite per la prima volta in uno sforzo collettivo internazionale. Da settimane, cittadini di diverse nazionalità occupano pacificamente gli spazi antistanti gli edifici, invocando gli articoli 16 e 18 dell'Accordo di Parigi e chiedendo la creazione di una task force dedicata a guidare gli sforzi di mitigazione dei singoli paesi. I manifestanti hanno chiamato questo nuovo organismo "Ministero per il Futuro", sottolineando la sua missione di proteggere i diritti delle generazioni future e di tutte le forme di vita che non possono parlare per sé stesse.

INTERVISTA

Giornalista (G): Benvenuti a una puntata speciale del nostro show dedicata al "Ministero per il futuro". Un nuovo organismo istituzionale delle Nazioni Unite che inizierà il suo mandato oggi. Stasera, abbiamo con noi la persona il cui ruolo, annunciato dalle Nazioni Unite, ha posto fine alla protesta: la presidente del "Ministero per il futuro" Mary Murphy. Buonasera, dottoressa Murphy.

Mary Murphy (MM): Buonasera. Grazie per avermi invitato.

G: Dottor Murphy, può dirci qual è lo stato del nostro pianeta e della nostra società oggi, in relazione al cambiamento climatico?

MM: Lo stato del nostro pianeta è terribile. Abbiamo assistito a un aumento senza precedenti di eventi meteorologici estremi, inondazioni, uragani, incendi boschivi, che hanno avuto effetti devastanti sulle comunità e sugli ecosistemi. Le calotte polari si stanno sciogliendo a ritmi allarmanti, i livelli del mare stanno aumentando e la biodiversità sta diminuendo.

G: Può spiegarci quali sono le conseguenze sociali di tutto ciò?

MM: Socialmente, questi cambiamenti ambientali stanno esacerbando le disuguaglianze. Le comunità vulnerabili sono le più colpite, prive delle risorse per adattarsi o riprendersi. Stiamo assistendo a migrazioni indotte dal clima, perdita di mezzi di sostentamento e crescenti conflitti per risorse in diminuzione. Tuttavia, in mezzo a questo scenario desolante, c'è una crescente consapevolezza e una crescente richiesta di azione. Abbiamo discusso dei futuri indesiderati verso cui potremmo dirigerci e di quelli che vorremmo raggiungere. Le proteste globali e la formazione del Ministero per il futuro sono chiari indicatori che le persone sono pronte per passi audaci e decisivi per combattere il cambiamento climatico.

G: Con una valutazione così cupa, quali azioni intraprenderà il Ministero per il futuro per affrontare queste sfide?

MM: La nostra prima priorità è stabilire un quadro solido per il monitoraggio e la responsabilità. Garantiremo che i paesi non solo si impegnino, ma raggiungano anche i loro obiettivi climatici. Ciò significa sfruttare la tecnologia all'avanguardia per la raccolta e l'analisi dei dati in tempo reale. Sosterremo anche lo sviluppo e l'implementazione di soluzioni innovative per la riduzione del carbonio, come progetti di energia rinnovabile, riforestazione e pratiche agricole sostenibili. Un altro aspetto chiave è l'istruzione e l'impegno, che consentono ai cittadini di agire e di responsabilizzare i loro governi.

G: A quale livello, nello specifico, opererà il vostro ministero?

MM: Il nostro ruolo sarà quello di progettare uno scenario di transizione energetica globale, indicando quali investimenti e tasse sono necessari per mantenere la temperatura al di sotto dei due gradi. Questo scenario servirà come base per guidare i vari governi nazionali. Un primo scenario sarà progettato quest'anno. Poi, nel 2030, ci sarà una prima valutazione della sua efficacia e un primo aggiornamento, anche di fronte a eventi imprevisti, le cosiddette "wild-cards", che potremmo essere costretti ad affrontare. Infine, una seconda e definitiva valutazione dello scenario politico e il suo aggiornamento avranno luogo nel 2050.

G: Non conosciamo ancora i nomi dei ministri che lavoreranno con lei. Puoi dirci di più?

MM: I nomi non sono ancora pubblici, ma le sei aree di intervento che saranno assegnate ciascuna a un ministro specifico sono chiare: energie verdi, energie convenzionali, elettrificazione, aree verdi, rimozione del carbonio ed efficienza energetica.

G: Sembra ambizioso. Ci sono progetti o partnership specifici che il Ministero lancerà presto?

MM: Certamente. Siamo già in trattative con diversi paesi e organizzazioni internazionali per lanciare una serie di progetti pilota. Una delle nostre iniziative di punta è la Global Renewable Energy Alliance, volta ad accelerare la transizione verso l'energia pulita in tutto il mondo. Stiamo anche collaborando con aziende tecnologiche per sviluppare strumenti avanzati di modellazione climatica in grado di prevedere e mitigare gli impatti degli eventi meteorologici estremi. Inoltre, stiamo istituendo un fondo globale per supportare l'adattamento climatico e la resilienza nelle regioni più vulnerabili. È necessaria una strategia sistemica.

G: In che modo i diversi scenari Shared Socioeconomic Pathways (SSP) influenzeranno il lavoro del suo ministero e il futuro verso cui ci stiamo dirigendo?

MM: Gli SSP sono fondamentali per comprendere i potenziali futuri che affrontiamo in base alle nostre scelte e azioni odierne. Il Ministero per il futuro utilizzerà questi scenari per informare le nostre strategie e politiche, mirando a orientare gli sforzi globali verso percorsi più sostenibili ed equi. Il nostro obiettivo è attuare la nostra azione nel presente tenendo d'occhio l'orizzonte verso il tipo di mondi in cui vorremmo vivere come esseri umani nei prossimi decenni e oltre.

G: Dottor Murphy, è chiaro che la strada da percorrere è impegnativa, ma il suo impegno e l'istituzione del Ministero per il futuro ci danno speranza. Grazie per essere stata qui con noi stasera.

MM: Grazie per avermi invitato. Insieme, possiamo creare un futuro sostenibile per tutti.

English translation

INTRODUCTION

As is well known, in December 2015, COP21 negotiated the Paris Agreement, a historic treaty designed to strengthen global cooperation in the fight against the climate crisis. In particular, the treaty's mitigation goal is to limit the rise in global average temperature to well below 2°C above pre-industrial levels, preferably under 1.5°C. Unfortunately, the results of the first stocktake, meant to monitor the

commitment of signatory countries, show that only a limited number of nations have met their targets — marking a discouraging start.

However, in recent months, new hope has emerged from the revival of the global climate movement. The EU's Copernicus Climate Service recently reported that 2024 is already officially the hottest year on record — the first to surpass the 1.5°C threshold. These alarming figures have sounded a wake-up call for a more systemic response. This urgency has been powerfully echoed by activists worldwide, leading to an unprecedented wave of mobilization. Massive crowds have gathered outside United Nations buildings across the globe. For the first time, this global reaction has been coordinated by forces united in a common international effort. For weeks, citizens of many nations have peacefully occupied the areas surrounding UN headquarters, invoking Articles 16 and 18 of the Paris Agreement and calling for the creation of a dedicated task force to guide individual countries' mitigation efforts. The protesters have named this new body the Ministry for the Future, highlighting its mission to protect the rights of future generations and all forms of life that cannot speak for themselves.

INTERVIEW

Journalist (J): Welcome to a special episode of our show dedicated to the Ministry for the Future — a new institutional body of the United Nations beginning its mandate today. This evening, we are joined by the person whose appointment by the UN brought an end to the recent wave of protests: the President of the Ministry for the Future, Dr. Mary Murphy. Good evening, Dr. Murphy.

Mary Murphy (MM): Good evening. Thank you for having me.

J: Dr. Murphy, can you tell us about the current state of our planet and our society in relation to climate change?

MM: The state of our planet is dire. We have witnessed an unprecedented increase in extreme weather events — floods, hurricanes, wildfires — all with devastating impacts on communities and ecosystems. Polar ice caps are melting at alarming rates, sea levels are rising, and biodiversity is steadily declining.

J: Could you explain what the social consequences of all this are?

MM: Socially, these environmental changes are exacerbating inequalities. Vulnerable communities are the hardest hit, lacking the resources to adapt or recover. We are witnessing climate-induced migrations, loss of livelihoods, and growing conflicts over diminishing resources. Yet, amidst this bleak scenario, there is a growing awareness and demand for action. People have been reflecting on both the undesirable futures we may be heading toward and the preferable ones we want to create. The global

protests and the establishment of the Ministry for the Future are clear signs that people are ready for bold and decisive steps to combat climate change.

J: With such a grim assessment, what actions will the Ministry for the Future take to address these challenges?

MM: Our first priority is to establish a solid framework for monitoring and accountability. We will ensure that countries not only commit to but actually achieve their climate goals. This means harnessing cutting-edge technology for real-time data collection and analysis. We will also support the development and implementation of innovative carbon reduction solutions, such as renewable energy projects, reforestation, and sustainable farming practices. Another key aspect is education and engagement — empowering citizens to act and to hold their governments accountable.

J: On what level, specifically, will your ministry operate?

MM: Our role will be to design a global energy transition scenario, outlining which investments and taxes are needed to keep global temperature rise below two degrees. This scenario will serve as a framework to guide national governments. An initial version will be designed this year. Then, in 2030, a first evaluation of its effectiveness will take place — along with its first update, also in response to unforeseen events, the so-called “wild cards” we may have to face. Finally, a second and definitive evaluation and update of the policy scenario will take place in 2050.

J: We still don’t know the names of the ministers who will work with you. Can you tell us more about that?

MM: The names have not yet been made public, but the six intervention areas — each to be assigned to a specific minister — are clear: green energy, conventional energy, electrification, green areas, carbon removal, and energy efficiency.

J: That sounds ambitious. Are there any specific projects or partnerships the Ministry will launch soon?

MM: Certainly. We are already in discussions with several countries and international organizations to launch a series of pilot projects. One of our flagship initiatives is the Global Renewable Energy Alliance, aimed at accelerating the transition to clean energy worldwide. We are also collaborating with technology companies to develop advanced climate modeling tools capable of predicting and mitigating the impacts of extreme weather events. Moreover, we are establishing a global fund to support climate adaptation and resilience in the most vulnerable regions. A systemic strategy is absolutely necessary.

J: How will the different Shared Socioeconomic Pathways (SSPs) influence the work of your Ministry and the future we are heading toward?

MM: The SSPs are essential for understanding the possible futures we face, depending on our choices and actions today. The Ministry for the Future will use these scenarios to inform its strategies and policies, aiming to steer global efforts toward more sustainable and equitable pathways. Our goal is to act in the present while keeping an eye on the horizon — on the kinds of worlds we wish to inhabit as human beings in the coming decades and beyond.

J: Dr. Murphy, it's clear that the road ahead is challenging, but your commitment — and the establishment of the Ministry for the Future — gives us hope. Thank you for being here with us tonight.

MM: Thank you for having me. Together, we can create a sustainable future for all.

A.1.2 Reports template for first round (*FyouTURES*' narrative layer)

Original version

REPORT PRIMO TURNO DI GIOCO

Copiate qui il link del primo scenario che avete costruito (andando su SHARE YOUR SCENARIO e premendo poi su COPY SCENARIO LINK):

.....

Dal vostro primo piano politico sono già passati 6 anni. Adesso è il 2030. Soffermatevi a riflettere sul mondo che avete contribuito a creare con le vostre scelte. Vi verranno date delle frasi da completare, relative a sei ambiti indicatori dello stato ambientale e socio-economico del mondo:

- Demographic changes,
- Human development,
- Economy and lifestyle,
- Policies and institutions,
- Technology,
- Environmental and natural resources.

Per aiutarvi ad immaginare, partite dai dati del simulatore EN-ROADS, esplorate i grafici disponibili e provate a trovare collegamenti con i 6 indicatori di cui sopra. Come sono stati influenzati dalle vostre scelte? Riassumetelo completando queste frasi:

Da un punto di vista demografico (Growth, Fertility, Mortality, Migration, Urbanization Level and Type), nel 2030 si è arrivati a...

.....

Da un punto di vista di human development (Education, Health, Gender equality, Equity, Social cohesion, Societal participation), nel 2030 si è arrivati a...

.....

Da un punto di vista economico e di stile di vita (Growth (per capita), Inequality, International trade, Globalization, Consumption & Diet), nel 2030 si è arrivati a...

.....

Da un punto di vista di policies and institutions (International cooperation, Environmental Policy, Policy orientation, Institutions), nel 2030 si è arrivati a...

.....

Da un punto di vista tecnologico (Development, Transfer, Energy tech change, Carbon intensity, Energy intensity), nel 2030 si è arrivati a...

.....

Da un punto di vista di risorse ambientali e naturali (Fossil constraints, Environment, Land use, Agriculture), nel 2030 si è arrivati a...

.....

NEXT STEPS

- Secondo turno di gioco
- Secondo report: Al secondo turno di gioco, ovvero arrivati al 2050, compilerete un nuovo report con le stesse domande.
- Terzo turno di gioco
- Terzo report: Al secondo turno di gioco, ovvero arrivati al 2100, compilerete un ultimo report con le stesse domande.

FIRST ROUND REPORT

Paste here the link to the first scenario you created (go to SHARE YOUR SCENARIO and then click on COPY SCENARIO LINK):

.....

Six years have passed since you implemented your first policy plan. It is now 2030.

Take a moment to reflect on the world you have helped shape through your decisions.

You will be given several sentences to complete, each referring to six key areas that indicate the environmental and socio-economic state of the world:

- Demographic changes
- Human development
- Economy and lifestyle
- Policies and institutions
- Technology
- Environment and natural resources

To help you imagine this, start from the EN-ROADS simulator data: explore the available graphs and try to find connections with the six indicators listed above. How have your choices influenced them? Summarise your reflections by completing these sentences:

From a demographic point of view (Growth, Fertility, Mortality, Migration, Urbanisation Level and Type), by 2030 the world has reached...

.....

From a human development point of view (Education, Health, Gender equality, Equity, Social cohesion, Societal participation), by 2030 the world has reached...

.....

From an economic and lifestyle point of view (Growth (per capita), Inequality, International trade, Globalisation, Consumption & Diet), by 2030 the world has reached...

.....

From a policies and institutions point of view (International cooperation, Environmental policy, Policy orientation, Institutions), by 2030 the world has reached...

.....

From a technological point of view (Development, Transfer, Energy tech change, Carbon intensity, Energy intensity), by 2030 the world has reached...

.....
From an environmental and natural resources point of view (Fossil constraints, Environment, Land use, Agriculture), by 2030 the world has reached...

NEXT STEPS

- Second round of the game
- Second report: in the second round of the game — that is, in 2050 — you will complete a new report with the same questions.
- Third round of the game
- Third report: in the third round of the game — that is, in 2100 — you will complete a final report with the same questions.

A.1.3 Script (School-based course)

Original version

TITOLO: RICICLAGGIO PLANETARIO

INT.FGIORNO - STUDIO TELEVISIVO ALIENO

Un moderno studio televisivo, in semibuio.

In sovrimpressione appare la scritta: Sostenibilità Galattica: Successi e Fallimenti.

Le luci si fanno più intense. Dietro alla scrivania dello studio, stile TG, c'è un'aliena: è la dottoressa ZARRIK.

ZARRIK

Benvenuti a questa nuova puntata di "Sostenibilità Galattica: Successi e Fallimenti". Io sono la dottoressa Zarrik, responsabile del Settore Valutazioni Ambientali della Confederazione Galattica, e oggi vi guiderò alla scoperta di uno dei casi più emblematici della storia recente: "Il caso Terra".

Sullo schermo appare il titolo della puntata: "Il caso Terra - storia e destino della specie umana".

ZARRIK

La Terra è un pianeta singolare: abbondanza di acqua, biodiversità straordinaria e un equilibrio ecologico che ha permesso lo sviluppo di diverse forme di vita intelligenti, fra cui una civiltà tecnologicamente avanzata, nota come razza umana. Tuttavia, negli ultimi secoli, questa stessa civiltà ha messo alla prova i limiti del proprio habitat. I dati raccolti indicano che il pianeta si trova in una fase critica: l'accumulo di gas serra ha alterato il clima globale, la biodiversità è in forte declino e le risorse naturali vengono sfruttate a ritmi insostenibili.

Un montaggio di immagini mostra deforestazione, inquinamento industriale, città soffocate dallo smog e oceani pieni di plastica.

ZARRIK

Come è noto, la Confederazione Galattica adotta un protocollo rigoroso per la gestione degli ecosistemi a rischio. I nostri radar raccolgono dati fondamentali su tutti i pianeti adatti alla vita appartenenti al nostro settore galattico e, quando questi diventano preoccupanti, ovvero quando indicano che una civiltà non è in grado di mantenere l'equilibrio ecologico, si

procede ad una analisi finale per decidere se procedere o meno al riciclaggio della specie invasiva, per il bene del resto dell'ecosistema. Qual è il verdetto ? Sebbene i dati non siano rassicuranti, il destino della specie umana non è ancora scritto.

Inquadratura sull'aliena che si avvicina allo schermo, mentre compaiono i volti delle persone intervistate: un* miliardari* dall'aria sprezzante, un* scienziat* con espressione riflessiva, un* politic* in posa istituzionale, un* imprenditore/trice con aria preoccupata e un* studente/ssa determinat*.

ZARRIK

Per comprendere a fondo la situazione, la nostra squadra di esperti ha visitato la Terra, acquisendo in incognito le loro sembianze, per intervistare alcuni esponenti della specie. Gli esemplari scelti sono appartenenti a diversi ruoli sociali, ciascuno con la propria visione del problema, ciascuno con una propria ragione e giustificazione. Cosa pensano davvero? Quali ostacoli li frenano?

E, soprattutto, la loro specie ha ancora una possibilità di redenzione, o dovremo attivare il protocollo di riciclaggio? Le nostre ricerche hanno identificato diverse categorie di individui che influenzano il destino ecologico del pianeta Terra. Tra queste, una delle più problematiche è rappresentata da una esigua fetta di popolazione che, pur essendo in possesso di risorse immense, si rifiuta di riconoscere la propria responsabilità nel degrado ambientale.

Musica in crescendo. Lo schermo sfuma sulla prima intervista. INT. - GIORNO - ATTICO LUSSUOSO

Siamo in un attico lussuoso con una vista panoramica su una metropoli illuminata.

L'intervistato, il MILIARDARIO, è comodamente seduto su un divano in pelle. Ha un bicchiere di whiskey in mano e un orologio d'oro al polso.

ZARRIK

Signor* Blackwood, lei è tra i principali investitori nel settore

dei combustibili fossili. Cosa risponde alle critiche che le vengono mosse in merito all'impatto ambientale delle sue attività?

MILIARDARIO

(sorridente, sicuro di sé)

Ah, questa storia del cambiamento climatico... sapete, se ne parla tanto, ma nessuno può davvero dimostrare che sia colpa dell'uomo. Si tratta di cicli naturali! Guardate la storia della Terra: ci sono sempre stati periodi di caldo e di freddo. E comunque, anche se fosse vero, dobbiamo pensare al benessere economico. Il mio lavoro è creare posti di lavoro, dare opportunità alle persone, far crescere l'economia. Chiunque dica il contrario è un nemico del progresso.

ZARRIK

In verità, la scienza mostra prove schiaccianti sull'influenza umana nel riscaldamento globale e sui problemi dati dal sistema economico capitalistico...

MILIARDARIO

Questo è quello che dicono alcuni scienziati. Ma sapete cosa dico io? C'è sempre un'altra opinione. Per ogni studio che dice che il mondo si sta scaldando, ce n'è un altro che dice il contrario. E poi, chi finanzia queste ricerche? Io sono dalla parte del popolo, della gente comune, non di qualche élite che vuole imporci nuove regole per controllare l'economia. Noi produciamo energia, manteniamo in funzione le industrie, garantiamo uno stile di vita che le persone vogliono. È questo che conta.

ZARRIK

Quindi non crede che il pianeta corra dei rischi e non crede che la sua industria debba assumersi parte della responsabilità?

MILIARDARIO

Carissima signorina, lei è una giornalista giovane e bella, non le dona credere nel catastrofismo.

Dovrebbe fare come me. Io credo nell'ingegno umano e nella tecnologia. Non mi preoccupa del

futuro. Chi dice che siamo nei guai, mi creda... vuole solo venderle qualcosa.

L'inquadratura si allontana.

INT. - GIORNO - STUDIO TELEVISIVO ALIENO

Siamo di nuovo nello studio tv.

ZARRIK

Dunque, secondo alcuni esponenti di questa civiltà, il riscaldamento globale non è dimostrabile con certezza e gli scienziati hanno posizioni discordanti. Ma è davvero così? La conoscenza scientifica di questo pianeta è tanto incerta e soggetta a interpretazioni? Per rispondere a questa domanda, abbiamo interrogato uno degli scienziati più esperti in materia. Vediamo cosa ha da dire la comunità scientifica del pianeta Terra.

INT. - GIORNO - UFFICIO DELLO SCIENZIATO

Una stanza piena di libri, con grafici e modelli climatici proiettati su uno schermo. Il/la dottor/essa BIANCHI, con occhiali e un'aria pacata, siede su una poltrona.

ZARRIK

Dottor/essa Bianchi, lei è fra i principali esperti di clima e cambiamento climatico. È vero che i dati sui mutamenti climatici del pianeta sono incerti e contraddittori?

BIANCHI

No. I dati sono molto chiari, e mostrano quello che la scienza afferma da decenni: il cambiamento climatico sta avvenendo realmente. La comunità scientifica è unita, tutti i maggiori esperti concordano. Possiamo affermare con un livello di confidenza altissimo che il riscaldamento globale è causato principalmente dalle attività umane.

ZARRIK

Ciò significa che la scienza ha eliminato ogni incertezza?

BIANCHI

No, non significa questo. Il sistema climatico è stato ben studiato e compreso, ma essendo un sistema complesso c'è una parte di

incertezza, derivante da questa complessità, che è ineliminabile. Lo scopo della scienza è aiutarci a gestire questa incertezza e prendere le scelte giuste verso un futuro sostenibile.

ZARRIK

E come è possibile farlo?

BIANCHI

Abbiamo creato modelli climatici sempre più sofisticati, ovvero rappresentazioni matematico- computazionali del sistema climatico terrestre che simulano l'interazione tra atmosfera, oceani, superficie terrestre e biosfera. Questi ci hanno permesso, da una parte, di confermare che l'uomo è la causa del cambiamento

climatico e allo stesso tempo ci hanno permesso di fare proiezioni di diversi scenari futuri.

ZARRIK

Cosa sono questi scenari?

BIANCHI

Sono possibili evoluzioni del clima a seconda delle emissioni di gas serra e di altri fattori. Attraverso gli scenari possiamo comprendere quali azioni è bene intraprendere oggi per costruire un futuro sostenibile domani.

ZARRIK

Lei è anche un editor dell'IPCC, l'organismo internazionale che valuta le conoscenze scientifiche sul cambiamento climatico. Questo è un insieme di persone che lavorano assieme per trovare soluzioni. Può spiegare meglio come funziona questo sforzo collettivo globale per tradurre la conoscenza scientifica e renderla accessibile ai decisori politici?

BIANCHI

Il processo dell'IPCC è unico nel suo genere. I maggiori scienziati di tutto il mondo collaborano per raccogliere, valutare e sintetizzare le evidenze scientifiche più aggiornate sul cambiamento climatico. Ogni nostro rapporto raccoglie la più aggiornata e affidabile conoscenza

disponibile e la traduce in un linguaggio rigoroso ma chiaro, utile sia ai decisori politici che ai comuni cittadini. A questo punto la palla passa dalla scienza alle decisioni politiche e individuali.

ZARRIK

Se abbiamo a disposizione tutta questa conoscenza perché, a suo avviso, l'umanità non sta riuscendo a muoversi efficacemente verso gli obiettivi dell'accordo di Parigi?

BIANCHI

Il mio parere, non da scienziato ma da cittadino, è che nell'opinione pubblica il cambiamento climatico sia mostrato o come troppo complicato da capire, o solo come una questione di opinioni. Ma la scienza non funziona a opinioni: funziona su prove. E le prove ci sono e sono accessibili a tutti! Il problema, come le dicevo, non è la mancanza di conoscenza, ma la complessità del clima. Questa complessità rende impossibile avere soluzioni univoche e lineari. Gli esseri umani amano le narrazioni semplici, mentre affrontare la complessità richiede sforzo. Per molti ridurre tutto a un "tanto è troppo tardi" o a un "qualcun altro se ne occuperà" è più rassicurante.

Ma affrontare un problema complesso non significa che non esistano soluzioni: significa solo che servono più strumenti e più persone che lavorino insieme, prendendosi la propria responsabilità e facendo la propria parte.

L'inquadratura si allontana.

INT. - GIORNO - STUDIO TELEVISIVO ALIENO

Siamo di nuovo nello studio tv.

ZARRIK

Quindi, riepilogando: la razza umana ha sviluppato una scienza abbastanza sofisticata da individuare il problema e anche i molteplici approcci per gestirlo. Si sta mobilitando per condividere questi risultati e farli arrivare ai decisori politici e ai cittadini terrestri. Purtroppo però, a quanto pare, un tratto distintivo della loro

psicologia è una certa resistenza a pensare in maniera sistemica per affrontare i problemi complessi.

Interessante, non credete? La nostra specie ha imparato a farlo così tanto tempo fa... A questo punto ci chiediamo, come si traduce questa mancanza umana nella loro organizzazione a livello politico?

Per rispondere a questa domanda, intervistiamo una rappresentante della classe politica umana.

INT. - GIORNO - CASA DEL POLITICO

Un elegante ufficio con una grande finestra che mostra lo skyline di una città moderna. Il/la POLITIC* un'aria determinata, è sedut* dietro una scrivania ordinata.

ZARRIK

Onorevole Verdi, lei è not* per il suo impegno nel promuovere politiche climatiche ambiziose. Tuttavia, i progressi globali sembrano lenti e frammentati. Quali sono, dal suo punto di vista, i principali ostacoli politici alla transizione ecologica?

POLITIC*

Ci sono diversi livelli di ostacoli. Il primo è il ciclo elettorale: i governi devono mostrare risultati nel breve termine per essere rieletti, mentre la transizione ecologica richiede pianificazione a lungo termine e sacrifici iniziali. Il secondo è la pressione delle lobby: ci sono interessi economici enormi che frenano il cambiamento, perché il sistema attuale è ancora troppo conveniente per chi ne trae profitto. Il terzo è la percezione pubblica: molte persone comprendono il problema, ma pochi sono disposti ad accettare cambiamenti radicali nella loro vita quotidiana. Infine, c'è il problema della interconnessione globale: il clima non ha confini, ma le politiche sì. Coordinare azioni efficaci tra nazioni con priorità e risorse molto diverse è una sfida titanica.

ZARRIK

Qualcuno potrebbe dire che, nonostante le difficoltà, l'umanità abbia sia la conoscenza scientifica che le soluzioni politiche. Firmando l'accordo di Parigi la maggior parte

dei paesi mondiali si è impegnata ad agire verso una riduzione delle emissioni. Eppure, il cambiamento è troppo lento. Come mai?

POLITIC*

La volontà politica esiste, ma è costantemente messa alla prova da interessi contrastanti e dall'instabilità geopolitica. Come ben saprà, ad esempio, Trump ha nuovamente ritirato gli USA dall'accordo. Purtroppo, anche se alcuni governi vogliono agire, devono fare i conti con economie globalizzate e sistemi finanziari che favoriscono lo status quo. E poi c'è la paura: nessun leader vuole essere quello che impone misure impopolari e poi perde le elezioni. La verità è che la politica, da sola, non può risolvere il problema. Serve una spinta dal basso, dalla società civile e dall'industria, affinché la sostenibilità diventi la scelta più logica e conveniente per tutti. Fino a che il cittadino scaricherà la totale responsabilità sulla politica, le cose faranno fatica a migliorare. Il cittadino deve prendere parte alla politica e schierarsi dalla parte di chi promuove politiche green.

ZARRIK

Come può un cittadino riconoscere quale politica sta davvero promuovendo politiche green?

POLITIC*

I valori alla base di ogni politica sostenibile non riguardano solo la protezione dell'ambiente, ma anche l'equità sociale, l'inclusività e il rispetto per le generazioni future. La nostra responsabilità, come politici e cittadini votanti, è quella di costruire un mondo dove il benessere collettivo venga prima dell'interesse individuale a breve termine. Ogni scelta, anche piccola, ha un impatto. E il cambiamento, quello vero, è alla nostra portata. Non si tratta di sperare in un miracolo, ma di essere abbastanza coraggiosi da prenderci la responsabilità di fare la nostra parte.

L'inquadratura si allontana.

INT. - GIORNO - STUDIO TELEVISIVO ALIENO

Siamo di nuovo nello studio tv.

ZARRIK

In sintesi: il pianeta Terra ha alcuni leader che vedono il problema e sanno cosa fare, ma sono bloccati da un sistema che premia l'inazione e punisce la lungimiranza.

Affascinante. Ricorda molto alcuni casi studiati in altre civiltà... che non esistono più. Però c'è speranza, che sta nella grande forza d'animo e nei forti valori che guidano chi sta agendo con speranza attiva verso il cambiamento.

La cosa interessante è che anche al di fuori dei palazzi del potere, ci sono individui della specie umana che cercano attivamente di cambiare il sistema dal basso, sfidando le logiche del profitto immediato per costruire un modello economico più sostenibile. Ma con quali difficoltà? E con quali speranze? Per capirlo, ho intervistato un piccolo imprenditore umano.

INT. - GIORNO - LABORATORIO ARTIGIANALE

Un piccolo laboratorio artigianale con scaffali pieni di prodotti biologici e sostenibili. Il titolare, ROSSI, indossa una maglietta con un logo ecologico, siede dietro un bancone. Ha un'aria stanca ma soddisfatta e determinata.

ZARRIK

Signor Rossi, lei è proprietari* di una piccola impresa di produzione alimentare che punta sulla sostenibilità. Quali sono le maggiori difficoltà che incontra nel cercare di coniugare etica e sostenibilità economica?

ROSSI

La sfida principale è competere con le grandi aziende che dichiarano di essere sostenibili ma, in realtà, applicano strategie di marketing ingannevoli. Il cosiddetto greenwashing. Il pubblico viene spesso attratto da prezzi più bassi, senza considerare le reali implicazioni ambientali e sociali di ciò che acquista. Inoltre, a volte le certificazioni e le normative, pur essendo fondamentali, rappresentano

un ostacolo burocratico ed economico per chi come me cerca di operare nel rispetto di certi valori. Il sistema premia chi produce in modo più economico, non chi lo fa nel modo più giusto. Ed io devo pensare anche al benessere mio e della mia famiglia, quindi non è semplice...

ZARRIK

Ritiene che il consumatore medio sia consapevole di queste dinamiche o sia vittima di un'illusione di sostenibilità?

ROSSI

Credo che ci sia una crescente sensibilità, ma non ancora sufficiente. L'educazione al consumo consapevole dovrebbe essere una priorità, altrimenti continueremo a vedere piccole realtà soccombere sotto il peso della concorrenza sleale... Tuttavia, non mi arrendo.

ZARRIK

Cosa le dà la forza per farlo?

ROSSI

Il pensiero dei miei figli e del loro futuro. Non mi perdonerei mai il non aver fatto tutto quello che era in mio potere fare per costruire un mondo migliore per loro.

L'inquadratura si allontana.

INT. - GIORNO - STUDIO TELEVISIVO ALIENO

Siamo di nuovo nello studio tv.

ZARRIK

Abbiamo visto che a quanto pare bilanciare sostenibilità ambientale ed economica non è facile, eppure alcuni imprenditori sfidano con convinzione il sistema economico con le loro scelte lavorative quotidiane. L'ultimo esponente della specie umana che intervistiamo rappresenta coloro che combattono su un altro fronte: la mobilitazione pubblica. I giovani, in particolare, sembrano aver compreso l'urgenza della crisi climatica e si sono organizzati per portare il tema all'attenzione globale. Ma quanto è efficace la loro azione? E cosa li spinge a non arrendersi? Per rispondere, ho parlato con un*

giovane attivista.

INT. - GIORNO - AULA DI UN LICEO

Siamo nell'aula di un liceo. Un* STUDENTE/SSA di circa diciassette anni, con un cartellone scritto a mano a fianco a lei ("Il futuro è nelle nostre mani!").

ZARRIK

Lei è molto attiv* nei movimenti per la giustizia climatica. Quando ha deciso di dedicarsi a questa causa e perché?

STUDENTE/SSA

Ho iniziato a informarmi seriamente dopo un corso che abbiamo fatto a scuola su questo tema. Da lì ho capito che il cambiamento climatico non è solo una questione ambientale, ma un problema che riguarda direttamente la giustizia sociale. Mi sono reso conto che le persone più vulnerabili sono quelle che subiranno le conseguenze peggiori, pur avendo contribuito meno alla crisi. Questo mi ha spinto a voler fare qualcosa di concreto. Non basta essere indignati, bisogna agire.

ZARRIK

Molti giovani si sentono impotenti di fronte a un problema di tale portata. Lei come affronta questa sensazione di frustrazione?

STUDENTE/SSA

È normale sentirsi sopraffatti, ma ho capito che l'azione, sia individuale che collettiva, è fondamentale. Dal punto di vista individuale nella mia vita quotidiana ho deciso di agire mangiando molta meno carne, utilizzando quando possibile la bici e riducendo gli acquisti inutili. Dal punto di vista collettivo ho deciso di partecipare a manifestazioni, sensibilizzare i miei coetanei e pensare a come il mio futuro professionale possa contribuire al cambiamento. È bello impegnarmi in questo, mi dà un senso di scopo. La rassegnazione è un lusso che non possiamo permetterci, perché il tempo per agire si sta esaurendo.

L'inquadratura si allontana.

INT. - GIORNO - STUDIO TELEVISIVO ALIENO

Siamo di nuovo nello studio tv.

ZARRIK

Le interviste appena mostrate sono solo un piccolo estratto delle numerose analisi condotte dalla mia specie. Le informazioni raccolte sono state esaminate attentamente dal Consiglio Galattico, che ha valutato se la civiltà terrestre meriti di essere preservata o se debba essere considerata irrecuperabile. Oggi leggeremo insieme il comunicato ufficiale che contiene la decisione ufficiale presa dal consiglio.

Entra in scena un VALLETTA. Porge a Zarrik una busta. Zarrik la prende e ne estrae un foglietto.

ZARRIK

(con tono solenne)

Dopo lunghe discussioni, il Consiglio ha deciso di concedere un'ultima opportunità alla razza umana.

L'umanità dovrà dimostrare di essere in grado di reagire. Entro 7 giorni terrestri dovrete creare e presentare documentari che raccontino come avete intenzione di affrontare il cambiamento climatico nel futuro.

Ogni documentario dovrà affrontare un problema specifico a vostra scelta.

Non saranno accettate narrazioni di rassegnazione o inerzia: ci aspettiamo soluzioni, azioni concrete e testimonianze di individui chiave. Il materiale raccolto sarà valutato dal Consiglio e determinerà il vostro destino.

Zarrik ripone il foglietto.

ZARRIK

Razza umana, il coniglio ha parlato e il tempo stringe. Mostrate al cosmo che siete degni di questa opportunità. La storia del vostro pianeta non è ancora scritta... ma sta a voi decidere come finirà.

Schermo nero. Dissolvenza del logo della Confederazione Galattica. Musica finale.

FINE.

English translation

TITLE: PLANETARY RECYCLING

INT. – DAY – ALIEN TV STUDIO

A sleek, dimly lit television studio.

Superimposed text appears: Galactic Sustainability: Successes and Failures.

The lights brighten. Behind a news-style desk sits an alien: Dr. ZARRIK.

ZARRIK

Welcome to a new episode of Galactic Sustainability: Successes and Failures.

I am Dr. Zarrik, Head of the Environmental Assessment Division of the Galactic Confederation, and today I will guide you through one of the most emblematic cases in recent history: The Case of Planet Earth.

On the screen appears the episode title: The Case of Planet Earth – History and Fate of the Human Species.

ZARRIK

Earth is a singular planet: abundant in water, extraordinarily biodiverse, and endowed with an ecological balance that has enabled the rise of several intelligent life forms—among them a technologically advanced civilisation known as humankind.

However, in recent centuries, that very civilisation has tested the limits of its own habitat.

Collected data show that the planet is now in a critical phase: the accumulation of greenhouse gases has altered the global climate, biodiversity is sharply declining, and natural resources are being exploited at unsustainable rates.

A montage of images follows: deforestation, industrial pollution, smog-choked cities, oceans filled with plastic.

ZARRIK

As you know, the Galactic Confederation enforces a strict protocol for the management of endangered ecosystems.

Our radars collect vital data on all life-supporting planets within our galactic sector.

When those readings become alarming—when they indicate that a civilisation is no longer capable of maintaining ecological balance—

a final analysis is conducted to determine whether to proceed with the recycling of the invasive species, for the sake of the rest of the ecosystem.

What, then, is the verdict?

Although the data are far from reassuring, the fate of humankind has not yet been sealed.

The camera zooms in on Zarrik approaching the screen, where faces of the interviewees appear: a sneering billionaire, a thoughtful scientist, a politician in a formal pose, a worried entrepreneur, and a determined student.

ZARRIK

To fully understand the situation, our team of experts visited Earth, taking on human appearance to interview several members of the species.

The selected specimens belong to different social groups—each with their own vision of the problem, their own reasoning and justification.

What do they really think?

What obstacles hold them back?

And above all—does their species still have a chance at redemption, or must we activate the recycling protocol?

Our research has identified several categories of individuals who influence Earth's ecological destiny. Among the most problematic is a small fraction of the population who, despite possessing immense resources, refuse to acknowledge their responsibility in environmental degradation.

Music rises. The screen fades into the first interview.

INT. – DAY – LUXURIOUS PENTHOUSE

A lavish penthouse overlooking a glowing metropolis.

The BILLIONAIRE lounges on a leather sofa, whiskey glass in hand, a golden watch on the wrist.

ZARRIK

Mr./Ms. Blackwood, you are among the leading investors in the fossil-fuel industry.

How do you respond to the criticism concerning the environmental impact of your activities?

BILLIONAIRE

(smiling confidently)

Ah, this climate-change story... You know, people talk about it endlessly, but no one can prove it's caused by humans.

It's just natural cycles! Look at Earth's history—there have always been warm and cold periods.

And even if it were true, we must think of economic wellbeing.

My job is to create jobs, offer opportunities, grow the economy.

Anyone who says otherwise is an enemy of progress.

ZARRIK

In truth, science provides overwhelming evidence of human influence on global warming and the flaws of the capitalist economic system...

BILLIONAIRE

That's what some scientists say. But you know what I say? There's always another opinion.

For every study claiming the planet is heating, there's another that says the opposite.

And who funds these studies, anyway?

I stand with ordinary people, not with some elite trying to impose new rules to control the economy.

We produce energy, keep industries running, and provide the lifestyle people want. That's what matters.

ZARRIK

So you don't believe the planet is at risk, nor that your industry should take responsibility?

BILLIONAIRE

My dear young lady, you're a bright and beautiful journalist—it doesn't suit you to be so pessimistic.

Be like me: I believe in human ingenuity and technology. I don't worry about the future.

Those who say we're in trouble, believe me... they just want to sell you something.

The camera slowly pulls back.

INT. – DAY – ALIEN TV STUDIO

We return to the studio.

ZARRIK

So, according to some representatives of this civilisation, global warming cannot be proven with certainty and scientists disagree.

But is that really the case?

Is Earth's scientific knowledge so uncertain and open to interpretation?

To answer, we interviewed one of the planet's leading climate experts. Let's hear what Earth's scientific community has to say.

INT. – DAY – SCIENTIST'S OFFICE

A room lined with books, charts, and climate models projected on a screen.

Dr. BIANCHI, calm and reflective, sits in an armchair.

ZARRIK

Dr. Bianchi, you are among the foremost experts on climate and climate change.

Is it true that the data on the planet's climate shifts are uncertain or contradictory?

BIANCHI

No. The data are very clear and confirm what science has stated for decades: climate change is real.

The scientific community is united—all major experts agree.

We can say with very high confidence that global warming is mainly caused by human activity.

ZARRIK

Does that mean science has removed all uncertainty?

BIANCHI

No, it doesn't. The climate system is well studied and understood, but being a complex system, some uncertainty is inevitable.

The goal of science is to help us manage that uncertainty and make the right choices toward a sustainable future.

ZARRIK

And how is that possible?

BIANCHI

We've built increasingly sophisticated climate models—mathematical and computational representations of Earth's climate system simulating interactions between atmosphere, oceans, land, and biosphere.

These models have confirmed that humans are driving climate change while also allowing us to project different possible futures.

ZARRIK

What are these "scenarios"?

BIANCHI

They're possible evolutions of the climate depending on greenhouse-gas emissions and other factors.

Through these scenarios, we can understand what actions we should take today to build a sustainable tomorrow.

ZARRIK

You are also an editor for the IPCC, the international body assessing scientific knowledge on climate change—a vast collaborative network.

Can you explain how this global effort translates scientific knowledge into information accessible to policymakers?

BIANCHI

The IPCC process is unique. Leading scientists from all over the world work together to collect, evaluate, and synthesise the most up-to-date scientific evidence on climate change.

Each report compiles the most reliable knowledge available and presents it in clear yet rigorous language, useful both for policymakers and ordinary citizens.

At that point, the responsibility shifts from science to political and individual decision-making.

ZARRIK

If such knowledge exists, why, in your view, is humanity failing to move effectively toward the Paris Agreement goals?

BIANCHI

In my opinion—not as a scientist, but as a citizen—public discourse portrays climate change as either too complicated to grasp or merely a matter of opinion.

But science doesn't work on opinions—it works on evidence. And the evidence is there, accessible to everyone.

The real challenge isn't ignorance but complexity.

This complexity makes single, linear solutions impossible. Humans love simple stories, but facing complexity requires effort.

For many, reducing everything to "it's too late" or "someone else will handle it" feels more comforting.

Yet confronting a complex problem doesn't mean there are no solutions—it means we need more tools and more people working together, taking responsibility and doing their part.

The camera pulls back.

INT. – DAY – ALIEN TV STUDIO

Back to the studio.

ZARRIK

To recap: humankind has developed a science advanced enough to identify the problem and propose multiple approaches to address it.

Efforts are being made to share these results with policymakers and citizens.

Yet, it seems a defining feature of their psychology is a certain resistance to systemic thinking when dealing with complex issues.

Fascinating, isn't it? Our species mastered that skill long ago...

At this point, one wonders: how does this human limitation manifest in their political organisation?

To find out, we interviewed a representative of the human political class.

INT. – DAY – POLITICIAN'S OFFICE

A refined office with a large window overlooking a modern skyline.

The POLITICIAN, confident and composed, sits behind a tidy desk.

ZARRIK

Honourable Verdi, you are known for your commitment to ambitious climate policies. Yet global progress appears slow and fragmented.

From your perspective, what are the main political obstacles to ecological transition?

POLITICIAN

There are several.

First, the electoral cycle: governments must show short-term results to be re-elected, while ecological transition requires long-term planning and initial sacrifices.

Second, the pressure of lobbies: vast economic interests slow change because the current system still benefits those who profit from it.

Third, public perception: many people understand the problem, but few are willing to accept radical changes in their daily lives.

Finally, global interconnection: climate knows no borders, but policies do. Coordinating effective action among nations with vastly different priorities and resources is a monumental challenge.

ZARRIK

Some might argue that humanity already possesses both scientific knowledge and political solutions.

By signing the Paris Agreement, most countries committed to reducing emissions—yet progress is too slow. Why?

POLITICIAN

Political will exists, but it's constantly tested by conflicting interests and geopolitical instability.

As you know, for instance, Trump once again withdrew the U.S. from the agreement.

Even governments willing to act must contend with globalised economies and financial systems that favour the status quo.

And then there's fear: no leader wants to impose unpopular measures and lose elections.

The truth is, politics alone cannot solve the problem.

Change must also come from below—from civil society and industry—so that sustainability becomes the most logical and convenient choice for everyone.

As long as citizens place full responsibility on politics, improvement will be slow.

Citizens must engage in politics and support those who promote green policies.

ZARRIK

How can citizens recognise which policies are truly sustainable?

POLITICIAN

The values behind every genuine sustainable policy go beyond environmental protection—they include social equity, inclusiveness, and respect for future generations.

Our duty, as politicians and voters, is to build a world where collective wellbeing comes before short-term individual interest.

Every choice, even a small one, has an impact.

Real change is within our reach. It's not about hoping for a miracle—it's about having the courage to take responsibility and do our part.

The camera slowly retreats.

INT. – DAY – ALIEN TV STUDIO

Back in the studio.

ZARRIK

In summary: Planet Earth has leaders who see the problem and know what to do, but they are trapped in a system that rewards inaction and punishes foresight.

Intriguing. It resembles several civilisations we once studied... that no longer exist.

Yet there is hope—in the strong spirit and values of those acting with active hope toward change.

Interestingly, even outside the halls of power, there are humans striving to change the system from below, challenging the logic of immediate profit to build a more sustainable economic model.

But with what difficulties—and what hopes?

To find out, I interviewed a small human entrepreneur.

INT. – DAY – ARTISAN WORKSHOP

A small workshop lined with shelves of organic, sustainable products.

ROSSI, wearing a shirt with an eco-friendly logo, sits behind the counter—tired but resolute.

ZARRIK

Mr./Ms. Rossi, you own a small food-production business focused on sustainability. What are the main challenges you face in combining ethics and economic viability?

ROSSI

The main challenge is competing with big companies that claim to be sustainable but actually use deceptive marketing—so-called greenwashing.

Consumers are often drawn to lower prices, ignoring the true environmental and social costs of what they buy.

Moreover, certifications and regulations, though essential, can become bureaucratic and financial obstacles for those of us who try to work ethically.

The system rewards those who produce cheaply, not those who produce responsibly.

And I must also think of my own wellbeing and that of my family—so it's not easy.

ZARRIK

Do you think the average consumer is aware of these dynamics, or are they victims of a sustainability illusion?

ROSSI

Awareness is growing, but it's still not enough.

Education for conscious consumption should be a priority; otherwise, small businesses like mine will keep struggling against unfair competition.

Still—I refuse to give up.

ZARRIK

What keeps you going?

ROSSI

Thinking of my children and their future.

I could never forgive myself for not doing everything within my power to build a better world for them.

The camera fades out.

INT. – DAY – ALIEN TV STUDIO

Back once again to the studio.

ZARRIK

We have seen how difficult it is to balance environmental and economic sustainability—yet some entrepreneurs courageously challenge the system with their everyday choices.

Our final human interviewee represents those fighting on another front: public

mobilisation.

Young people, in particular, seem to have grasped the urgency of the climate crisis and organised to bring it to global attention.

But how effective is their action? And what keeps them from giving up?

To find out, I spoke with a young activist.

INT. – DAY – HIGH-SCHOOL CLASSROOM

A classroom.

A STUDENT, about seventeen, sits beside a handmade sign reading “The Future Is in Our Hands!”

ZARRIK

You’re very active in climate-justice movements.

When did you decide to dedicate yourself to this cause, and why?

STUDENT

I started learning seriously after a course we had at school.

That’s when I realised climate change isn’t just an environmental issue—it’s a matter of social justice.

The most vulnerable people will suffer the worst consequences, even though they contributed the least to the crisis.

That pushed me to act. It’s not enough to be outraged—you have to do something.

ZARRIK

Many young people feel powerless when faced with a problem of this magnitude.

How do you cope with that sense of frustration?

STUDENT

It’s normal to feel overwhelmed, but I’ve learned that action—both individual and collective—is essential.

Personally, I eat much less meat, bike whenever possible, and avoid unnecessary purchases.

Collectively, I join demonstrations, raise awareness among my peers, and think about how my future career can contribute to change.

Being active gives me a sense of purpose.

Resignation is a luxury we can’t afford—the time to act is running out.

The camera pulls back.

INT. – DAY – ALIEN TV STUDIO

We return for the final time.

ZARRIK

The interviews you've just seen are only a small portion of the many analyses conducted by my species.

The information collected has been carefully reviewed by the Galactic Council, which has deliberated on whether Earth's civilisation deserves preservation—or should be deemed irredeemable.

Today, we shall read the official communiqué containing the Council's verdict.

An AIDE enters, handing Zarrik an envelope. She opens it and unfolds a small note.

ZARRIK

(solemnly)

After lengthy deliberation, the Council has decided to grant humankind one last opportunity.

Humanity must now prove its ability to react.

Within seven Earth days, you must create and present documentaries showing how you intend to confront climate change in the future.

Each documentary must address a specific problem of your choice.

Narratives of resignation or inertia will not be accepted: we expect solutions, concrete actions, and testimonies from key individuals.

The collected material will be evaluated by the Council and will determine your fate.

Zarrik sets the note aside.

ZARRIK

Humankind, the Council has spoken—and time is running out.

Show the cosmos that you are worthy of this chance.

The story of your planet is not yet written... but it is up to you to decide how it ends.

Black screen.

Fade-in: Logo of the Galactic Confederation.

Final music.

END.

A.2 Data collection tools

A.2.1 Pre/Post questionnaires extracts (*FyouTURES*' narrative layer)

Original version

Estratto dal pre-questionario:

1) Racconta una storia che parla di cambiamento climatico. Scegli dei personaggi, un'ambientazione e degli eventi chiave. La storia può essere ambientata nel passato, nel presente o nel futuro. (Limite massimo 1000 caratteri.) [Risposta aperta]

2) Hai mai visto/letto/ascoltato storie sul cambiamento climatico? Se sì, quali? [Risposta aperta]

Estratto dal post-questionario:

1) Alla luce di quello che hai imparato durante il corso, racconta una storia che parla di cambiamento climatico. Puoi modificare la storia che hai raccontato nel questionario della prima lezione o crearne una nuova. (Limite massimo 1000 caratteri.) [Risposta aperta]

English translation

Pre-questionnaire extract:

1) Tell a story about climate change. Choose some characters, a setting, and key events. The story can take place in the past, present, or future. (Maximum 1000 characters.)
[Open-ended response]

2) Have you ever seen/read/listened to stories about climate change? If yes, which ones?
[Open-ended response]

Post-questionnaire extract:

1) In light of what you have learned during the course, tell a story about climate change. You may modify the story you wrote in the first questionnaire or create a new one. (Maximum 1000 characters.) [Open-ended response]

A.2.2 Pre-questionnaire (School-based course)

Original version

— Sezione 1: Interesse e aspetti emotivi —

1) Quanto sei interessat* al tema del cambiamento climatico? [Risposta chiusa da 1 (per niente) a 5 (Moltissimo)]

2) Il cambiamento climatico suscita in te qualcuna delle seguenti sensazioni/emozioni? [Risposta in griglia a scelta multipla tra “sì”, “no” e “non saprei” per le seguenti emozioni: Afflizione, Ansia, Confusione, Curiosità, Determinazione, Disperazione, Dolore, Esitazione, Incertezza, Indifferenza, Interesse, Meraviglia, Motivazione, Senso di impotenza, Ottimismo, Pessimismo, Perplexità, Rabbia, Sconforto, Senso di colpa, Tormento/Inquietudine, Tristezza, Vergogna]

3) Le tue emozioni riguardo al cambiamento climatico influenzano qualcuno di questi aspetti della tua vita? [Risposta in griglia a scelta multipla tra “sì”, “no” e “non saprei” per i seguenti aspetti: Abitudini alimentari, Gestione degli spostamenti, Gestione del tempo libero, Relazioni sociali, Lo studio/lo stare a scuola]

4) Puoi precisare il modo in cui il cambiamento climatico influenza i precedenti aspetti? [Risposta aperta]

----- **Sezione 2: Rapporto con la narrazione** -----

5) Ti piace creare o ascoltare/leggere storie (in qualunque formato: libri, film, podcast, social media)? [Risposta chiusa a scelta fra: Mi piace crearle, Mi piace ascoltarle/leggerle, Le storie non mi interessano]

6) Racconta una breve storia sul cambiamento climatico. Puoi scegliere fra una che conosci già o inventarne una (specificalo nella risposta) [Risposta aperta]

----- **Sezione 3: Conoscenze sul CC** -----

7) Quale pensi sia il tuo livello di conoscenza sul cambiamento climatico? [Risposta chiusa da 1(Non ne so nulla) a 5 (So tutto quello che c'è da sapere)]

8) Prova a dare una definizione di cambiamento climatico, secondo le tue conoscenze di base. [Risposta aperta]

9) Quanto pensi di essere consapevole delle cause cambiamento climatico? [Risposta chiusa da 1(Non ne so nulla) a 5 (So tutto quello che c'è da sapere)]

10) Fai un esempio di cause a te note. [Risposta aperta]

11) Quanto pensi di essere consapevole delle conseguenze del cambiamento climatico? [Risposta chiusa da 1(Non ne so nulla) a 5 (So tutto quello che c'è da sapere)]

12) Fai un esempio di conseguenze a te note. [Risposta aperta]

----- **Sezione 4: Azione e agency** -----

13) Quanto pensi che i seguenti attori possano essere una risorsa nell'agire nei confronti del cambiamento climatico? [[Risposta in griglia a scelta multipla tra "Per nulla", "Poco", "Molto" e "Sono fondamentali", "Non saprei" per i seguenti attori sociali: Decisori politici, Imprese e mercato economico, Cittadini, Io, Altri]

14) Attualmente stai intraprendendo delle azioni per contribuire alla mitigazione del cambiamento climatico? [Risposta chiusa a scelta fra: Non sto intraprendendo nessuna azione, Sto intraprendendo alcune azioni, Sto intraprendendo diverse azioni, Sto radicalmente cambiando il mio stile di vita]

----- **Sezione 5: Bisogni epistemici autopercipiti** -----

15) Quale aspetto del cambiamento climatico senti di aver bisogno di approfondire per poter avere gli strumenti che ti servono per capire e agire nei confronti del cambiamento climatico? [Risposta chiusa a scelta fra: La scienza del clima, Gli aspetti sociali, Gli aspetti economici/politici, La letteratura e l'arte che sono state

prodotte su questo tema, Esempi tratti da storie vere, Nessun aspetto, Altro (specifica)]

16) Puoi specificare le motivazioni della tua risposta precedente? [Risposta aperta]

English version

--- Section 1: Interest and emotional aspects ---

1. How interested are you in the topic of climate change?
[Closed question from 1 (Not at all) to 5 (Very much)]
2. Does climate change trigger any of the following feelings/emotions in you?
[Grid with multiple choice: "Yes", "No", "I don't know" for the following emotions: Affliction, Anxiety, Confusion, Curiosity, Determination, Despair, Pain, Hesitation, Uncertainty, Indifference, Interest, Wonder, Motivation, Sense of helplessness, Optimism, Pessimism, Perplexity, Anger, Discouragement, Guilt, Unease/Torment, Sadness, Shame]
3. Do your emotions about climate change influence any of the following aspects of your life?
[Grid with multiple choice: "Yes", "No", "I don't know" for the following aspects: Eating habits, Mobility choices, Leisure time management, Social relationships, Studying/school life]
4. Can you specify how climate change influences the aspects you mentioned above?
[Open question]

--- Section 2: Relationship with storytelling ---

5. Do you enjoy creating or listening to/reading stories (in any format: books, films, podcasts, social media)?
[Closed choice: I enjoy creating them / I enjoy listening to or reading them / I am not interested in stories]
6. Tell a short story about climate change. You may choose one you already know or invent one (please specify which in your answer).
[Open question]

--- Section 3: Knowledge about climate change ---

7. What do you think your level of knowledge about climate change is?
[Closed question from 1 (I know nothing) to 5 (I know everything there is to know)]
8. Try to give a definition of climate change, according to your current knowledge.
[Open question]

9. How aware do you think you are of the causes of climate change?
[Closed question from 1 (I know nothing) to 5 (I know everything there is to know)]
10. Give an example of causes you are aware of.
[Open question]
11. How aware do you think you are of the consequences of climate change?
[Closed question from 1 (I know nothing) to 5 (I know everything there is to know)]
12. Give an example of consequences you are aware of.
[Open question]

— **Section 4: Action and agency** —

13. To what extent do you think the following actors can be a resource in addressing climate change?
[Grid with multiple choice: “Not at all”, “A little”, “A lot”, “They are essential”, “I don’t know” for the following actors: Policy makers, Companies and the economic market, Citizens, Myself, Others]
14. Are you currently taking any actions to contribute to climate change mitigation?
[Closed choice: I am not taking any action / I am taking some actions / I am taking several actions / I am radically changing my lifestyle]

— **Section 5: Self-perceived epistemic needs** —

15. Which aspect of climate change do you feel you need to explore more deeply in order to have the tools you need to understand and act on it?
[Closed choice: Climate science / Social aspects / Economic and political aspects / Literature and art produced on this topic / Examples from real-life stories / None / Other (please specify)]
16. Can you specify the reasons for your previous answer?
[Open question]

A.2.3 Post-questionnaire (School-based course)

Original version

— **Sezione 1: conoscenza ed emozioni** —

- 1) Quanto sei interessat* al tema del cambiamento climatico? [Risposta chiusa da 1(per niente) a 5 (Moltissimo)]

2) Il cambiamento climatico suscita in te qualcuna delle seguenti sensazioni/emozioni?[Risposta in griglia a scelta multipla tra “sì”, “no” e “non saprei” per le seguenti emozioni: Afflizione, Ansia, Confusione, Curiosità, Determinazione, Disperazione, Dolore, Esitazione, Incertezza, Indifferenza, Interesse, Meraviglia, Motivazione, Senso di impotenza, Ottimismo, Pessimismo, Perplessità, Rabbia, Sconforto, Senso di colpa, Tormento/Inquietudine, Tristezza, Vergogna]

3) Quanto pensi che i seguenti attori possano essere una risorsa nell'agire nei confronti del cambiamento climatico? [[Risposta in griglia a scelta multipla tra “Per nulla”, “Poco”, “Molto”, “Sono fondamentali” e “Non saprei” per i seguenti attori sociali: Decisori politici, Imprese e mercato economico, Cittadini, Io, Altri]

4) Quale pensi sia il tuo livello di conoscenza sul cambiamento climatico adesso, dopo aver concluso il corso? [Risposta chiusa da 1(Non ne so nulla) a 5 (So tutto quello che c'è da sapere)]

5) Prova a dare una definizione di cambiamento climatico, secondo le tue conoscenze di oggi. [Risposta aperta]

---Sezione 2: agency---

6) Quale delle seguenti affermazioni descrive meglio il tuo modo di pensare al cambiamento climatico dopo questo corso? (Seleziona una risposta) [Risposta chiusa a scelta fra: È un problema con una soluzione chiara e definitiva, Si possono individuare strategie efficaci per affrontarlo, È così complicato e incerto che è impossibile agire con sicurezza, La mia percezione non è cambiata molto rispetto a prima]

7) Alcune persone dicono che l'incertezza scientifica sul cambiamento climatico significa che non possiamo prendere decisioni concrete. Qual è la tua opinione su questa affermazione? [Risposta aperta]

8) Ti è mai capitato, durante il corso, di cambiare idea su qualcosa legato al cambiamento climatico? Se sì, cosa ti ha fatto cambiare idea? [Risposta aperta]

9) Quale delle seguenti situazioni trovi più realistica per spiegare come affrontare il cambiamento climatico? (Seleziona una risposta) [Risposta multipla a scelta fra: Un gruppo di esperti trova una soluzione e la applica su larga scala, Diverse persone e comunità sperimentano soluzioni diverse e imparano dagli errori, È impossibile trovare soluzioni, quindi non resta che adattarsi, Nessuna delle precedenti]

10) Se un amico ti dicesse che le azioni individuali sono inutili perché solo i governi e le grandi aziende possono fare la differenza, cosa risponderesti? [Risposta aperta]

--- Sezione 3: Narrazioni e pensiero narrativo ---

11) Creare un personaggio con un punto di vista diverso dal tuo ti ha aiutato a vedere il cambiamento climatico sotto una nuova luce? Se sì, come? [Risposta aperta]

12) Ascoltare storie o scrivere la vostra storia ti ha fatto riflettere su come le persone prendano decisioni in situazioni di incertezza? Se sì, in che modo? [Risposta aperta]

13) Durante la scrittura, vi è capitato di creare alcuni personaggi più motivati da emozioni, altri da dati scientifici, altri ancora da interessi personali? Se sì, quale dinamica ti è sembrata più interessante? [Risposta aperta]

14) Ascoltare storie o scritto la tua ti ha fatto capire meglio perché alcune persone trovano difficile agire contro il cambiamento climatico? Se sì, che cosa hai scoperto? [Risposta aperta]

15) Creare la tua storia ti ha aiutato a pensare al cambiamento climatico in termini di azioni e conseguenze? Se sì, cosa hai notato? [Risposta aperta]

— Sezione 4: Sense-making —

16) Se dovessi spiegare il cambiamento climatico a un amico che non ha seguito questo corso, quale approccio useresti di più? (Seleziona una risposta) [Risposta multipla a scelta fra: Dati scientifici e fatti per mostrare il problema in modo oggettivo, Una storia o un esempio concreto per comprendere meglio le implicazioni umane, Una combinazione di entrambi per bilanciare comprensione ed emozione, Eviterei di parlarne perché è troppo complicato o divisivo]

17) All'inizio del corso, quanto ti è sembrato difficile capire cosa significhi che il cambiamento climatico è un fenomeno "complesso"? [Risposta chiusa da 1(per niente) a 5 (Moltissimo)]

18) Dopo aver ascoltato storie e scritto la tua, hai una visione più chiara? Se sì, cosa ti ha aiutato di più? [Risposta aperta]

19) Dopo aver scritto la tua storia, senti di aver compreso meglio il fatto che il cambiamento climatico coinvolge molte cause e conseguenze intrecciate? [Risposta aperta]

20) All'inizio del corso, quanto ti è sembrato difficile capire i diversi tipi di incertezza relativi al cambiamento climatico? [Risposta chiusa da 1(per niente) a 5 (Moltissimo)]

21) Ti è capitato, mentre scrivevi la tua storia, di dover gestire situazioni incerte o di dover immaginare come potrebbero evolversi nel tempo? Se sì, come hai affrontato questa difficoltà? [Risposta aperta]

22) Se avessi solo studiato il cambiamento climatico attraverso dati e concetti scientifici, senza scrivere storie o ascoltarne, pensi che la tua comprensione sarebbe stata diversa? In che modo? [Risposta aperta]

English translation

--- Section 1: Knowledge and emotions ---

1. How interested are you in the topic of climate change?
[Closed question from 1 (Not at all) to 5 (Very much)]
2. Does climate change trigger any of the following feelings/emotions in you?
[Grid with multiple choice: "Yes", "No", "I don't know" for the following emotions: Affliction, Anxiety, Confusion, Curiosity, Determination, Despair, Pain, Hesitation, Uncertainty, Indifference, Interest, Wonder, Motivation, Sense of helplessness, Optimism, Pessimism, Perplexity, Anger, Discouragement, Guilt, Unease/Torment, Sadness, Shame]
3. To what extent do you think the following actors can be a resource in addressing climate change?
[Grid with multiple choice: "Not at all", "A little", "A lot", "They are essential", "I don't know" for the following actors: Policy makers, Companies and the economic market, Citizens, Myself, Others]
4. What do you think your level of knowledge about climate change is now, after completing the course?
[Closed question from 1 (I know nothing) to 5 (I know everything there is to know)]
5. Try to give a definition of climate change, according to your knowledge today.
[Open question]

--- Section 2: Agency ---

6. Which of the following statements best describes your way of thinking about climate change after this course? (Select one answer)
[Closed choice: It is a problem with a clear and definitive solution / Effective strategies can be identified to address it / It is so complex and uncertain that it is impossible to act with confidence / My perception has not changed much compared to before]
7. Some people say that scientific uncertainty about climate change means we cannot make concrete decisions. What is your opinion about this statement?
[Open question]

8. During the course, did you ever change your mind about something related to climate change? If yes, what made you change your mind?
[Open question]
9. Which of the following situations do you find most realistic to explain how to address climate change? (Select one answer)
[Multiple choice: A group of experts finds a solution and applies it on a large scale / Different people and communities try out different solutions and learn from mistakes / It is impossible to find solutions, so we must adapt / None of the above]
10. If a friend told you that individual actions are useless because only governments and big companies can make a difference, what would you reply?
[Open question]

--- Section 3: Narratives and narrative thinking ---

11. Did creating a character with a different point of view from your own help you see climate change in a new light? If yes, how?
[Open question]
12. Did listening to stories or writing your own story make you reflect on how people make decisions in situations of uncertainty? If yes, in what way?
[Open question]
13. While writing, did you create some characters driven more by emotions, others by scientific data, and others by personal interests? If yes, which dynamic did you find most interesting?
[Open question]
14. Did listening to stories or writing your own help you better understand why some people find it difficult to act against climate change? If yes, what did you discover?
[Open question]
15. Did creating your story help you think about climate change in terms of actions and consequences? If yes, what did you notice?
[Open question]

--- Section 4: Sense-making ---

16. If you had to explain climate change to a friend who did not attend this course, which approach would you use most? (Select one answer)
[Multiple choice: Scientific data and facts to show the problem objectively / A story or concrete example to better understand the human implications / A combination of both to balance understanding and emotion / I would avoid talking about it because it is too complicated or divisive]

17. At the beginning of the course, how difficult did it seem to you to understand what it means that climate change is a “complex” phenomenon?
[Closed question from 1 (Not at all) to 5 (Very much)]
18. After listening to stories and writing your own, do you now have a clearer view? If yes, what helped you most?
[Open question]
19. After writing your story, do you feel you have better understood that climate change involves many intertwined causes and consequences?
[Open question]
20. At the beginning of the course, how difficult did it seem to you to understand the different kinds of uncertainty related to climate change?
[Closed question from 1 (Not at all) to 5 (Very much)]
21. While writing your story, did you have to deal with uncertain situations or imagine how they might evolve over time? If yes, how did you handle this difficulty?
[Open question]
22. If you had only studied climate change through scientific data and concepts, without writing or listening to stories, do you think your understanding would have been different? In what way?
[Open question]