

R.I.S.E. - Reflect, Inspire, Sustain, Engage: museum collections and educational activities to address eco-anxiety and promote sustainable behaviour

Chiara Parisi ^{1,2} & Lavinia Caffarelli ^{1,2}

¹ Museum of Paleontology and Prehistory "P. Leonardi";

² Department of Humanities, University of Ferrara, Italy;

chiara.parisi@unife.it; lavinia.caffarelli@unife.it

Abstract

This research project explores the potential of museum-based educational programmes to mitigate eco-anxiety and encourage sustainable behaviours through experiential learning and emotional engagement. Conducted at the 'Piero Leonardi' Museum of Palaeontology and Prehistory of the University of Ferrara in Italy, the programme was initially targeted at high school students who are particularly susceptible to eco-anxiety due to their developmental stage, exposure to climate narratives, and lack of engagement with Natural History and Palaeontological museums.

Grounded in the social cognitive psychology theory of self-efficacy, the study explores how palaeontological and archaeological collections, as well as climate narratives, can inspire reflective thinking and sustainable actions. Through a structured educational pathway balancing the presentation of the negative impacts of climate change with positive examples of pro-environmental actions, the project aims to mitigate eco-anxiety and foster sustainable behaviours. Data were collected through a series of assessment tools designed to explore participants' perceptions of the relationship between humans and nature, their confidence in taking sustainable actions, and their willingness to engage in pro-environmental behaviours. Preliminary results suggest that, although eco-anxiety is prevalent among adolescents, museum-based educational interventions can effectively mitigate feelings of powerlessness by promoting positive behavioural changes that can be taken into action. This educational approach also emphasises the significant role of using emotional narratives in museums to encourage critical thinking and strengthen a sense of agency in addressing environmental challenges.

Keywords: Eco-anxiety, Sustainability, Museum collection, Palaeontology, Archaeology, Educational activities

1. Justification

1.1 Aim

This project primarily aims to explore the potential of museum education as a tool for mitigating eco-anxiety and promoting sustainable behaviours among young people.

Building on its core goals, the initiative develops a structured framework to empower participants to critically engage with environmental issues, thereby fostering emotional resilience and encouraging proactive behaviour. It also aims to establish museums as pivotal educational spaces where climate-related narratives are internalised as well as conveyed, leading to behavioural changes that can also be measured in.

It investigates the impact of eco-anxiety on pro-environmental behaviour among young students, and evaluates the effectiveness of museum educational pathways in fostering sustainable attitudes through palaeontological collections and climate change narratives from the present day to 'deep time'¹.

Natural History Museum collections are not just displays of ancient specimens; they are living testimonies that recount the story and relationship of Earth, environment, and humanity across time. Climate change has occurred over vast time scales, spanning millions of years, and the appearance of humans is a relatively recent phenomenon. Throughout *Homo's* history, there has been a gradual increase in human impact on terrestrial and aquatic ecosystems. Archaeological investigations provide a chronological framework for analysing the interrelationships between humans and the natural world. Examining how past populations responded to climatic and environmental shifts, as well as the impact of human activities on these dynamics, provides valuable insights. Palaeontological and archaeological records provide a unique opportunity to observe, measure and understand how animals and humans have responded, adapted and evolved to a wide range of climatic events in the past. These records can inform us about how climate change might transform our lives in the future, offering a range of possible solutions (Monks, 2017; Burke et al., 2021). Museums could provide sensory and effective experiences that create narratives around climate change and encourage targeted action among audiences (Cameron et al., 2013). Reconstructing past environments can offer a balanced perspective that addresses ecological anxiety while providing reassurance and maintaining awareness of the serious nature of the problem. This approach ensures that the critical nature of the phenomenon remains at the forefront of attention. In this sense, the faunal record could serve as a valuable tool for establishing the timeline of interactions between humans and the environment. Rediscovering these issues through exhibits also helps to develop critical awareness of today's challenges. As spaces for social learning and transformation, museums must respond to contemporary challenges and contribute to the

¹ A geological concept referring to the vast expanse of geologic time, covering millions and billions of years, which is difficult for humans to comprehend due to the difference in scale between this timeframe and our lifespans.

formation of more democratic and progressive societies (Mouliou, 2014; Kondyli et al., 2024; Parisi, 2024).

1.2 Interest

Concerns about an uncertain and unstable future can significantly contribute to the development of anxiety, which often manifests as fear, anger, depression and stress (Clayton, 2021). Numerous international studies have documented the widespread prevalence of these emotions, particularly among younger generations. When these concerns are specifically directed towards environmental degradation and climate change, they fall under the category of eco-anxiety. While the term remains somewhat fluid, it is generally understood to refer to the psychological distress associated with environmental and climate-related threats. It is increasingly recognised as a factor affecting not only mental health, but also behavioural responses to environmental issues.

In recent years, eco-anxiety has emerged as a critical area of concern, particularly among young people. In Italy, although eco-anxiety is becoming a more visible psychological response to environmental crises, there is still a lack of empirical studies examining its prevalence and impact. Most existing data originate from international contexts, with few Italian studies examining how eco-anxiety influences sustainable behaviour or leads to eco-paralysis.

Pioneering research from the University of Florence's Department of Psychiatry (Innocenti et al., 2021; 2023) has provided initial evidence that climate change anxiety (CCA) is significantly associated with heightened general anxiety, reduced self-efficacy - defined as the belief in one's ability to perform actions that will achieve desired outcomes - (Bandura, 1997), and decreased pro-environmental behaviour. These results, obtained from 150 Italian participants aged 19 to 76 in 2021 and 394 Italian participants aged 18 to 80 in 2023, align with the international literature (Verplanken et al., 2020; Boluda-Verdú et al., 2022; Kennedy-Woodard & Kennedy-Williams, 2022).

This suggests that eco-anxiety can motivate individuals to take action for the environment or lead to feelings of helplessness and disengagement, depending on how anxiety is processed.

Verplanken et al. (2020) in fact demonstrated that constructive worry, characterised by a focus on problem-solving and proactive engagement, can foster sustainable behaviour. This is particularly true when the worry is triggered by specific situations and is accompanied by protective action and positive emotions such as hope and optimism. Conversely, unconstructive worry, characterised by repetitive and uncontrollable concern, often correlates with feelings of powerlessness and disengagement. Distinguishing between these two forms is crucial in order to understand the potential impact of educational interventions on sustainable behaviour.

Within this framework, self-efficacy is a key factor in determining whether eco-anxiety inspires action or causes paralysis.

The study carried out by Innocenti et al. (2021, 2023), and Bandura's (1997) concept of self-efficacy provides the theoretical basis for this study.

In the context of climate change, self-efficacy encompasses the perception of one's ability to act sustainably and the belief that these actions will have a positive, tangible impact.

This research addresses a gap in the Italian literature on this topic by exploring how educational pathways that integrate palaeontological collections and climate change narratives can enhance self-efficacy and transform eco-anxiety into constructive, pro-environmental behaviour in the context of museum education.

In light of this, it is crucial to identify educational tools that can transform eco-anxiety into a positive driving force for promoting sustainable behaviours. Environmental education plays a pivotal role here, particularly when it is designed to enhance perceived self-efficacy and foster constructive worries. Natural history museums can be viewed as potential settings for psychoeducational interventions, offering a combination of scientific content and emotionally engaging experiences that help individuals to reframe climate anxiety as proactive engagement. When their collections are contextualised and interpreted appropriately, museums offer unique opportunities to understand the long-term evolution of ecological crises and perceive the continuity between the planet's past, present and future. Indeed, natural history museums are increasingly recognised as vital platforms for environmental education, offering unique opportunities to contextualise current ecological crises within broader historical and evolutionary frameworks. According to the literature, these institutions play a dual role as conservators of scientific knowledge and as facilitators of public engagement with environmental issues (Allmonn et al., 1994; Warren, 1994; Winkler, 2004; Cook, 2014; Parisi & Thun Hohenstein, 2024). Therefore, museum education can act as a catalyst, transforming eco-anxiety into environmental awareness and commitment.

1.3 Problem and questions guiding the research carried out

Natural History Museums continue to struggle with a disconnection between the value of their collections and how the public understands them, particularly concerning palaeontological species and their relevance today.

The limited communication strategies employed by museums in the past, which were more aimed at schoolchildren, may have contributed to reduced awareness of their value, leading to a loss of understanding of the wide-ranging impact that the study of natural history collections has on today's society: from the understanding of climate change, to the appropriate management of natural resources and related economic issues as well as significant contributions to a wide variety of scientific fields such as agriculture or medicine (identification of invasive species, threats to human health, etc.).

Despite the growing awareness of the climate crisis and the resulting feelings of eco anxiety, little

research has explored the role of museum education in mitigating feelings of distress through structured learning paths. While existing educational practices in museums often focus on transmitting scientific knowledge, there may be a lack of targeted strategies to address the emotional and psychological impact of climate change. This gap offers an opportunity to develop educational pathways that integrate emotional engagement, increase self-efficacy and push the adoption of pro-environmental behaviour in the museum context.

The role of Natural History Museums is also crucial in terms of educating new generations and equipping them with the necessary skills to deal with complex issues such as climate change, biodiversity loss and health emergencies. These issues are central not only to scientific advancement but also to the development of people and a society capable of facing growing global challenges.

In light of the identified gaps, the present research seeks to investigate how museum-based educational programmes can go beyond knowledge transmission to promote emotional resilience and behavioural change.

To guide this inquiry, the following research questions were formulated:

1. How can museum educational programmes increase pro-environmental behaviour and mitigate eco-anxiety by transforming it from unconstructive concern (eco-paralysis) to constructive concern (pro-environmental behaviour)?
2. What is the level of eco-anxiety among students that took part in the museum based educational experience?
3. How effective is the educational experience in increasing participants' self-efficacy and willingness to adopt pro-environmental behaviours?

1.4 Conceptual framework

Naturalistic collections provide a significant source of data for formulating original scientific questions, allowing students to develop hypotheses and test them through empirical analysis and reflection. Direct interaction with these collections fosters deeper, more meaningful learning experiences, especially when linked to contemporary issues in biodiversity and conservation. This pedagogical approach increases the practical and contextual relevance of science education in Natural History Museums, aligning it with contemporary ecological issues (Cook, 2014).

This study's conceptual framework also draws on theories from environmental psychology and emotional learning, which emphasise the role of emotional engagement in driving behavioural change. Despite the growing recognition of the emotional dimension in environmental education, the potential of museums as facilitators of emotional learning remains largely unexplored, especially with regard to eco-anxiety.

This research not only positions museum education as a means of disseminating scientific knowledge, but also as a platform for emotional engagement. It fosters pro-environmental behaviours by using carefully curated narratives and activities to link past extinction events to

contemporary environmental challenges. Emotions play a pivotal role in shaping how individuals respond to environmental information, as aforementioned, feelings such as fear, guilt, and sadness can act as catalysts for behavioural change, but they can also lead to psychological distress and eco-paralysis. In educational settings, the strategic use of emotional narratives has been shown to facilitate critical reflection and foster empathy (Gardner, 2021; Owen, 2021). Nevertheless, it is crucial to strike an equilibrium between negative and positive emotional content to prevent reinforcing feelings of helplessness or disengagement.

Unlike museums, which tend to avoid emphasising the negative aspects of climate change and human impact in order to minimise visitor anxiety and discomfort, this project aims to strike a balance between alleviating existing or potential anxiety and raising awareness of the harsh reality we are facing. The aim is to encourage young people to recognise the importance of their own ability to act, and to challenge the widespread perception that acting locally cannot achieve global results. The pathway aims to promote the belief that each individual can make a difference and contribute to climate mitigation.

At the end of the educational activity, participants were asked to complete a questionnaire investigating several aspects, including the possible presence of eco-anxiety in the participants, their perception of the relationship between humans and the natural environment, and the measure to which the activity, and its emotional component, has influenced their inclination to adopt more environmentally sustainable behaviour.

This research was carried out at the Museum of Palaeontology and Prehistory 'Piero Leonardi'-University of Ferrara, Italy. The museum has always played a significant role in the city of Ferrara and its community, but unfortunately a great earthquake struck the city in 2012, causing significant damage to the collections and the building itself. More than ten years later, the museum is still facing the problem of being closed to the public. The prolonged closure has prompted a rethink of the museum's mission and accessibility. In response, a variety of initiatives have been launched, ranging from educational innovations to digital transformations, with the aim of making it as accessible as possible and overcoming the perception of 'closed doors' (Parisi et al. *in press*). This specific project embodies that renewed mission in order to remain relevant to society and its local territory despite the closed doors.

2. Methodology

The study follows a practice-oriented methodological approach, combining qualitative educational design with quantitative tools for data collection and analysis.

The research focuses on implementing an experimental, museum-based educational programme aimed at reducing eco-anxiety, inspiring pro environmental behaviour and enhancing perceived self-efficacy based on Bandura's (1997) theoretical framework, focusing on its four key dimensions:

Mastery Experience, Vicarious Experience, Verbal/Social Persuasion and Psychological and Affective States. These components are embedded within the museum’s educational programmes through practical, collaborative and reflective activities designed to encourage sustainable thinking and behaviour.

The methodology was developed to address three main objectives:

- 1) To reinforce the self-efficacy of participant through the workshop activities and explore the emotional dimension of the educational experience and its influence on motivation for sustainable action;
- 2) To assess the presence and levels of eco-anxiety among students;
- 3) To evaluate the effectiveness of the intervention in increasing self-efficacy and the willingness to adopt pro-environmental behaviours.

The first aim was reached through the educational experience.

The educational model developed in this project is designed to activate all four dimensions of Bandura’s theory of self-efficacy through specific, carefully structured educational experiences (Table 1) .

Table 1: Goals of educational activities aligned with Self-efficacy dimension

Goals of the structured framework of educational storytelling 'Human evolution and Environmental Sustainability' (2024)	Self-efficacy dimension
Facilitates emotional resonance with environmental fragility and human vulnerability but also resilience, promoting empathy and reflective imagination	Affective and Psychological States; Verbal and Social Persuasion; Vicarious Experience
Builds confidence through peer discussion, affirmation, and the social modelling of pro-environmental reasoning and agency	Affective and Psychological states; Verbal and Social Persuasion; Vicarious Experience
Reinforces perceived capability by witnessing peers’ successful engagement in environmental problem- solving	Affective and Psychological states; Verbal and Social Persuasion; Vicarious Experience

Each stage of the activity was conceived with one or more of the self-efficacy components (Bandura, 1997) in mind, ensuring that students receive information, experience critical thinking and build emotional engagement in a psychologically safe context.

The **“mastery experience”** is promoted through the hands-on workshops, in which participants engage directly with palaeontological material (such as fossil replicas and species identification). This allows them to experience competence and success in a task related to scientific enquiry, and to experience 'being capable of'.

The **“vicarious experience”** involves observing other people succeed in a task, which has a positive influence on one’s own efficacy beliefs. This concept is incorporated into group-based practical sections, where collaboration and peer learning allow students to observe and learn from one

another's success. This reinforces their own beliefs in their capabilities through shared participation.

'Verbal/social persuasion' and 'psychological and affective states' play a crucial role in directly influencing confidence in one's abilities. Positive feedback and encouragement, as well as an environment that fosters positive and constructive emotions, are fundamental elements that the museum activities must take into account.

The **"verbal and social persuasion"** is provided by the constant presence and support of museum educators, who play a fundamental role in sustaining an encouraging environment. They help participants recognise their strengths and potential for change through constructive feedback, positive reinforcement and accessible language.

The **"psychological and affective states"** are addressed throughout the narrative arc of the activity, which is carefully designed to balance concern and inspiration. By presenting environmental challenges alongside real-world solutions, the programme prevents eco-paralysis, promoting emotional regulation, resilience and a renewed sense of agency instead.

In this way, the educational experience is transformative as well as informative, using emotional engagement to shift from eco-anxiety to motivation for change and from reflection to concrete behavioural intention.

The research project was articulated in consecutive phases: the development of educational narratives and activities (paragraph 2.1); a structured, multidimensional, short-term evaluation questionnaire (paragraph 2.2); and follow-up implementations and expansions (paragraph 4).

2.1 Human Evolution and Environmental Sustainability pathway

The educational pathway, related to Human Evolution, was developed in 2024 through an interdisciplinary approach based on the application of geographic thinking skills² (Parisi, & Thun Hohenstein, *in press*). The educational narrative focused on the evolution of hominins in relation to climate change and human impact, with the aim of addressing eco-anxiety and encouraging sustainable behaviours.

In the storytelling of the human evolution pathway, answering the first aim described in the previous paragraph, negative and positive emotions are carefully balanced, contrasting the negative impacts of humans on the environment with the positive actions they take to protect the planet (Table 2).

² Geographical concept developed for the analysis and understanding of a phenomenon through different scales and perspectives: spatial, historical, geological, economic, political, cultural, ecological; and human-environment interaction (Oberle et al. 2019).

Detailed overview in Table 2.

Table 2: Structured framework of educational storytelling ‘Human evolution and Environmental Sustainability’

Structured framework of educational storytelling ‘Human evolution and Environmental Sustainability’ (2024)					
Perspective	Guiding Question	Narrative Content and Museum Objects	Negative / positive narrative	Scale of Analysis	Educational goals
Spatial	<i>Where do we come from?</i>	Location of human origins in Africa; interactive mapping of migrations	NA	Global → Regional → Local	Understand human dispersion and challenge misconceptions about migration as recent or abnormal
Geological	<i>What are the physical and tectonic features that shaped our evolution?</i>	Formation of the Great Rift Valley; volcanic soils and preservation conditions; Laetoli footprints	<u>Positive narrative:</u> A notable example of sustainable energy (geothermal) use by an African country	//	Connect fossil preservation to tectonics; introduce geothermal energy in Kenya as link to present-day sustainability
Ecological	<i>How did ancient humans interact with their environments?</i>	<i>Homo ergaster</i> ’s adaptation and migration; extinction of Paranthropus	<u>Negative narrative:</u> concept of evolutionary trap - climate change due to human impact	Global → Regional → Local	Recognise environment- species interactions and vulnerabilities to environmental change
Biological (Added dimension)	<i>How did our bodies evolve under environmental pressures?</i>	Comparative morphology of hominin skulls (Sahelanthropus, Australopithecus, <i>Homo habilis</i> , etc.)	<u>Critical narrative:</u> In what ways might the biology of our species evolve now that we no longer inhabit an ecological niche?	NA	Foster critical reflection on anatomy, adaptation, and identity through direct observation
Cultural	<i>How did behaviour and culture evolve in Homo species?</i>	Tool production, fire use, burials, symbolic behaviour; Neanderthal art and <i>Homo sapiens</i> innovations	NA	Global → Regional → Local	Connect technological innovation to ecological impact; reflect on human agency and responsibility
Economic	<i>How did humans begin exploiting resources?</i>	From foraging to agriculture; domestication; metallurgy and its environmental impact	<u>Negative narrative:</u> Intensive farming and agriculture: impact and consequences (deforestation - destruction of natural barriers - increase in epidemics - increase in zoonoses)	Global → Regional → Local	Highlight early anthropogenic pressures; link to current unsustainable models of resource use

			<u>Positive narrative:</u> Sustainable action and project (reforestation - recovery of endangered species - organic and biological products - local economy)		
Political/Social	<i>How are migrations and resource exploitation interconnected across time?</i>	Modern vs ancient migrations; mineral extraction, social injustice, colonialism	<u>Negative narrative:</u> Extraction of rare earth elements (essential for producing smartphones, computers, and game consoles) often occurs in areas marked by human rights violations, environmental degradation, and toxic waste mismanagement. <u>Positive narrative:</u> Actions and projects related to minimizing consumption, properly recycling electronic devices, and preferring refurbished products.	Local ↔ Global	Promote reflection on equity, global justice, and postcolonial perspectives in environmental discourse

In order to meet the set goals, the work was divided into several stages: a theoretical part, in which the history of human evolution in relation to climate change was explained through the aforementioned interdisciplinary approach, also highlighting the importance of prehistory in understanding and addressing contemporary environmental challenges (Parisi & Thun Hohenstein, 2023; 2024; *in press*).

The educational program took place in the second half of 2024 and was addressed to high school students. The storytelling component was followed by hands-on activities involving tactile interaction and species recognition exercises related to the hominins covered in the session.

The hands-on activity consists of a sensory-inquiry experience (developed by the founding members of the Student Association PreHistorica, which has historically supported the “Piero Leonardi” Museum’s educational initiatives) and it is based on the recognition of different human species from their anthropological and morphological characteristics.

Some of the calcs presented and described from a morphological point of view during the theory phase are placed inside special boxes equipped with a slit, through which the participants, divided into groups, can introduce their hands to explore the calcs without being able to see them. Using only their sense of touch, and collaborating with members of their group, the participants have to fill in a worksheet noting the morphological characteristics essential for identifying the species. Once the worksheet has been completed in all its sections and the necessary information has been

gathered, each group should formulate a hypothesis by writing down the name of the identified species, based on the recognised features.

This sensory-inquiry activity is complementary to the aim of facilitating the experience of ‘mastery’, i.e. the direct perception of being capable and competent. Indeed, although previously developed, it has been kept for this project due to its very appropriate achievement of the pathway’s objectives by allowing participants to actively experience the knowledge acquired, consolidating it through a direct experiential approach. Similarly, the vicarious experience is fostered by group activities, where participants learn through confrontation with peers and collaboration, sharing successful experiences and enhancing learning through social interaction.

In this project, this structure and tools were identified as suitable for achieving the proposed goals, especially for identifying educational tools that can transform eco-anxiety into a positive driving force for sustainable behaviour (Table 3).

Table 3: Framework of educational tools addressing eco-anxiety through self-efficacy and geographical thinking.

Self-efficacy dimension (Bandura, 1997)	Activate self-efficacy concepts to strengthen personal belief in one’s ability to act and encourage pro-environmental behavior.
Emotional component	Balance negative and positive emotional components appropriately in the narrative.
Application of Geographical Thinking	Use multi-perspectives and scale (local–regional–global) to foster critical reflection, empathy and interdisciplinary understanding.
Sensory-inquiry activities	Engage learners through sensory, creative and reflective activities to build knowledge, critical thinking, self-efficacy and sustainable behaviours.
Short term and long-term evaluation assessment	Apply pre-, post- and follow-up assessments to measure the short- and long-term impact of these tools on behaviour change. The application of the psycho-educational tools listed above requires pre-activity, post-activity and long-term post-activity monitoring³.

³The current phase of the project only included short-term post-activity evaluation. Pre- and long-term monitoring will be included in future implementations (see paragraph 4).

2.2 Development of the questionnaire on the educational workshop ‘Human Evolution and Environmental Sustainability’ (2024)

To examine the influence of the educational narrative on learners’ emotional responses, self-perception and environmental attitudes, a multidimensional questionnaire was developed using Google Forms and designed to be completed in approximately three minutes. The tool (aiming to reach the second and third aim of our methodology) explores several interrelated constructs, such as perceptions of the human–nature relationship, self-efficacy in sustainable behaviour, emotional responses to the educational content, actual and intended pro-environmental actions.

The questionnaire was structured into six sections, each targeting a specific area of investigation:

Section 1 (three questions): collected basic demographic information (*e.g. age, gender, nationality*). **Section 2 (two questions):** included a general question about students’ perceived awareness of environmental challenges following the workshop and a question about how much they are concerned about the future of the environment. **Section 3 (one question):** focused on the perception of the natural environment and the human–nature relationship. Based on the study of Kunchambo et al. (2017), students were asked: *‘How do you perceive the natural environment?’* Here, four main categories of nature can be identified as ‘an extension of the self’, which are defined as follows:

- The ‘self separate from nature’ represents anthropocentric views. It is expressed through the statements “humans are superior to nature” and “humans and nature are two distinct entities”.
- The ‘extended relational self’ is associated with a utilitarian conception of nature and is represented by the expressions “which belongs to me” and “which I need”. The latter, however, takes on differentiated value depending on the context: when connected to the ‘assimilated self’, it has an ecocentric meaning; if it refers exclusively to the extended relational self or self separate from nature, it implies an exploitative view of nature.
- The ‘assimilated self’ represents an ecocentric orientation and, according to environmental literature, is the category in which educational interventions are most effective. This is manifested in the expressions “to which I belong” and “human is one with nature”.
- The ‘encapsulated self’, so the perception of nature as a superior entity is often influenced by spiritual and religious beliefs and is expressed by the statement “nature is superior to human”.

In order to be able to measure the construction and development of self-efficacy within the educational experience, the study draws on the psychological theory developed by Bandura (1997) and further implementation by Van der Bijl and Shortridge-Baggett (2002). These authors clearly

highlight the importance of evaluating three main dimensions to gain a comprehensive understanding of self-efficacy: magnitude, strength, and generality.

Magnitude dimension refers to the perceived difficulty that a person attributes to a specific behaviour—how challenging it seems to adopt a given action. *Strength* dimension indicates the degree of certainty a person has in their own ability to succeed in a specific task. *Generality* dimension, meanwhile, concerns the extent to which these beliefs are transferable across different behavioural domains, contexts, or over time.

Based on this theoretical model, the study's questionnaire was designed to evaluate these dimensions. The **section 4** of the questionnaire used during this study was structured to evaluate the different dimensions of self-efficacy. The 'Self-Efficacy Assessment' scale—adapted from Bandura's original work and informed by the conceptual distinctions offered by Van der Bijl and Shortridge-Baggett—was designed to measure perceived competence in sustainable behaviours. Specific questions were used to assess: generality (the extent of general self-efficacy - e.g. *"In general, how capable do you feel you are of achieving the desired result with your actions?"*), strength (confidence in one's ability to act sustainably - e.g. *"How confident do you feel that you can adopt a more sustainable behaviour?"*) and magnitude (the perceived difficulty of pro-environmental behaviours - e.g. *"Do you find it difficult to adopt sustainable behaviour in your daily life?"*).

The generality and strength dimension are measured using the Likert scale⁴, the magnitude dimension with 'yes' or 'no' answer.

The **section 5** of the questionnaire also incorporated a modified version of the Pro-Environmental Behaviour Scale (PEB; Larson et al., 2015), which assesses participants' current sustainable habits and level of engagement with environmental practices, ranging from everyday behaviours to community-level involvement and activism. Students were asked *"How often do you engage in the following activities to improve the quality of the environment in which you live?"* and they responded using a 5-point Likert scale for each of the five listed categories: recycling, reducing consumption of water or energy, purchasing eco-friendly products, participating in citizen science initiatives, and engaging in individual or collective community actions related to environmental issues.

In the end, **section 6** of the questionnaire aimed to evaluate the emotional impact of the educational narrative by examining how positive and negative emotions experienced during the intervention influenced participants' motivation to engage in pro-environmental behaviour. Two questions addressed the emotional impact of the narrative structure, differentiating between the effects of negative content and positive content. For each, multiple emotional and behavioural reactions were listed (e.g. *"It made me think"*, *"It increased my concern"*, *"It made me feel powerless or optimistic"*, *"It motivated me to adopt sustainable behaviour"*, *"it has no effect"*), allowing for a nuanced analysis of emotional engagement. Additional two questions assessed post-workshop motivation to act sustainably (e.g. *"After this workshop, do you feel motivated to adopt more*

⁴ The Likert scale is a psychometric technique for measuring attitudes, developed by the psychologist Rensis Likert. It mainly involves formulating a series of statements, known as 'items', that express positive and negative attitudes towards a specific object.

sustainable behaviour?” - Yes/No answer) and whether the museum activity helped reduce feelings of eco-anxiety (e.g. *“Did the narrative and the route collections help reduce your eco-anxiety?”* - Yes/Partially/No/I don’t have eco-anxiety answer).

The results of the questionnaire submitted after the Human evolution educational experience (2024) are discussed in paragraph 3.1.

3. Results and discussion : presentation and interpretation

3.1 Results: ‘Human Evolution and Environmental Sustainability’ pathway Questionnaire (2024)

Here are presented the results collected from the structured questionnaire described in paragraph 2.2.

Data were collected on a sample of 50 students (three classes) from the Humanities and languages high school of the city of Ferrara (Table 4). Of these, 96% were Italian, 2% were Chilean, and 2% were Polish. The participants’ ages ranged from 14 to 17 (six were 14, 23 were 15, 18 were 16 and three were 17).

The majority of the sample (78%, n=39) identified as female, while 22% (n=11) identified as male.

Table 4: Demographic information of the student sample

Nationality	Number of Students	Percentage
Italian	48	96%
Chilean	1	2%
Polish	1	2%
Age		
14 years old	6	12%
15 years old	23	46%
16 years old	18	36%
17 years old	3	6%
Gender		
Female	39	78%
Male	11	22%
Total	50	100%

The question - based on the study of Kunchambo et al. (2017) and explained in paragraph 2.2 - “How do you perceive the natural environment?” explores participants’ perceptions of nature and allows them to select more than one option. Analysing the groups of answers in detail (Table 5), it is possible to observe that n= 7 (14%) students fall into the category of the ‘extended relational self’ highlighting a more transitional perception between an anthropocentric and a more ecocentric position, in this category nature is seen in a utilitaristic way. N=17 (34%) students fall into the

category of the 'assimilated self'; n= 9 (18%) students fall into the category of the 'encapsulated self'; and n= 5 (10 %) students fall between the two categories highlighting an ecocentric view.

Here too there are answers that fall into different perspectives: n= 9 (18%) students place themselves between 'extended relational self' and 'assimilated self' reflecting a view that although perceiving nature as utilitarian prevails a tendency more towards eco than anthropocentrism; the same applies to the n= 3 (6%) students who place themselves in the categories 'extended relational self' - 'assimilated self' - 'encapsulated self'. In this sample of 50 students there is no one with an anthropocentric perception.

Table 5: Perceptions of the natural environment.

Category / Combination of Categories	Number of Students	Description
Extended relational self	7 (14%)	Transitional perception between anthropocentric and ecocentric; nature seen in a utilitarian way
Assimilated self	17 (34%)	Distinct perception category
Encapsulated self	9 (18%)	Ecocentric view
Between assimilated self and encapsulated self	5 (10%)	Highlighting an ecocentric view
Between extended relational self and assimilated self	9 (18%)	Utilitarian view but tendency towards ecocentrism
Between extended relational self, assimilated self, and encapsulated self	3 (6%)	Mixed perspectives
Anthropocentric	0 (0%)	No students in this category
Total	50 (100%)	

In order to measure the degree of concern about the future of the environment due to human impact, the following question was defined: 'On a scale from 1 (not at all concerned) to 5 (very concerned), how concerned are you about the future of the environment and natural resources in relation to anthropic impacts and climate change?' Fifty participants took part in the vote. 5 of them (10%) voted for option 2, 18 (36%) voted for option 3, 20 (40%) voted for option 4 and 7 (14%) voted for option 5 (Table 6).

Table 6: Level of concern about the future of the environment.

Level of Concern (1–5)	Number of Students	Percentage
1 – Not at all concerned	0	0.0%
2	5	10.0%
3	18	36.0%
4	20	40.0%
5 – Very concerned	7	14.0%
Total	50	100%

The Pro-Environmental Behaviour Scale (PEB), used to assess students' commitment to pro-environmental behaviour, show that the most frequently adopted sustainable behaviours are: 'recycling paper, plastic, metal and electronic waste'; followed by 'responsible management of water or energy consumption'; and lastly by 'buying environmentally friendly and/or energy-efficient products'. 'Citizen science' and 'Collective or individual activities to address environmental issues in your community, collaborate with others, participate in local groups, sign petitions, write letters, donate money or discuss environmental issues with other people' are the least performed with more than half of the participants giving a value of 1 and/or 2 on the Likert scale (Table 7).

Table 7: Assessment of Pro-Environmental Behaviour Scale (PEB)

Pro-Environmental Behaviour Scale (N=50 respondents)	Likert Scales's value	Percentage
<i>Recycling paper, plastic, metal and electronic waste</i>	5	26%
	4	40%
	3	26%
	2	6%
	1	2%
<i>Managing water or energy consumption responsibly</i>	Likert Scales's value	Percentage
	5	12%
	4	28%
	3	44%
	2	10%
	1	6%
<i>Buying eco-friendly and/or energy-efficient products</i>	Likert Scales's value	Percentage
	5	0%
	4	10%
	3	48%
	2	38%
	1	4%
<i>Participating in wildlife monitoring (Citizen Science)</i>	Likert Scales's value	Percentage
	5	0%
	4	0%
	3	22%
	2	22%
	1	56%
<i>Collective/individual actions on environmental issues (e.g., petitions, local groups, discussions)</i>	Likert Scales's value	Percentage
	5	0%
	4	2%
	3	28%
	2	34%
	1	36%

To measure the construction and development of self-efficacy within the educational experience, as well as the relationship between self-efficacy and the increase in pro-environmental behaviours, are now introduced the answers relating to the assessment of self-efficacy dimensions (Table 8).

The first question that measured the ‘generality’ dimension of the self efficacy: show the highest percentage (72%) of students indicating 3 on a likert scale (1 to 5) and only the 18% of students indicate 4 and 4% indicate 5.

Similarly, the question that measures the ‘strength’ dimension of the self efficacy: show a majority of students (50%) give a value of 3 accompanied by 32% of students that indicate a value of 4.

The last dimension of self efficacy - ‘magnitude’ - requires only a yes or no answer: 60% of students said ‘no’ against the 40% that said ‘yes’.

Table 8: Assessment of self-efficacy dimensions.

Self-efficacy dimension	Likert Scales's value	Percentage
<i>Generality</i>	5	4%
	4	18%
	3	72%
	2	3%
	1	3%
<i>Strength</i>	Likert Scales's value	Percentage
	5	4%
	4	32%
	3	50%
	2	14%
	1	0%
<i>Magnitude</i>	Yes/no answer	Percentage
	Yes	40%
	No	60%
Total	50	100%

Correlating these results, it shows that most students do not feel particularly confident or very capable of achieving concrete results through their actions (generality dimension) although most students also indicate a moderate to fairly high perception of their ability to adopt more sustainable behaviour (strength dimension). And finally, the magnitude dimension suggests that a significant proportion of students perceive sustainability as attainable and not particularly difficult to integrate into their daily lives. However, the 40% who consider it difficult to adopt sustainable behaviours may indicate perceived obstacles or practical barriers to large-scale adoption.

These results are linked to the question in section 6, relating to participation and impact of educational activities.

The answers to these questions showed that all of the people who took part in the workshop reported feeling more informed and aware of environmental challenges afterwards. Just over half (60%) of respondents say ‘it’s easy for them to incorporate more sustainable behaviours into their day-to-day activities’, while the remaining 40% say ‘it’s more of a challenge for them’. 80% of participants agreed that the pathway had deepened their knowledge of climate change and helped them to understand the impact of environmental changes on human life, while 20% partially agreed and none disagreed. Following the workshop, 18% of people do not feel motivated to adopt sustainable behaviour, while 82% of people feel more motivated to do so (Table 9). The museum’s storytelling and workshop helped to ‘reduce eco-anxiety’ by 8%, while ‘partly reducing it’ for 52% of people. They ‘did not help’ 14% of people, and 26% of people ‘did not suffer from eco-anxiety’ (Table 9).

Table 9: Motivation and impact on eco-anxiety after the workshop.

Following the workshop	Response	Number of Students	Percentage
Motivation to adopt sustainable behaviour	Feel more motivated	41	82%
	Do not feel motivated	9	18%
	Total	50	100%
Impact on eco-anxiety	Helped to reduce eco-anxiety	4	8%
	Partly helped to reduce eco-anxiety	26	52%
	Did not help	7	14%
	Did not suffer from eco-anxiety	13	26%
	Total	50	100%

The evaluation questionnaire showed that the educational experience had a positive impact on environmental awareness and the propensity to adopt sustainable behaviour. As well as the narrative approach, which balances the presentation of negative human impacts with concrete solutions, proved effective in reducing eco-anxiety and encouraging active reflection on environmental issues.

The results of this approach, indeed, were particularly encouraging. According to the answers provided by the participants in section 6⁵, around 86% of them reported feeling more confident in their ability to adopt sustainable behaviour after the activity.

Analysis of the responses of section 6, revealed that negative emotions, such as concern, sadness or a sense of urgency, tended to have a stronger motivational effect than positive emotions. In several cases, these emotions were accompanied by an increased sense of responsibility and awareness. This suggests that discomfort or worry can be a catalyst for reflection and action. Only one participant expressed a sense of helplessness, which was reflected in her self-efficacy score of 2 out of 5 regarding her ability to achieve personal goals.

⁵ “After this workshop, do you feel motivated to adopt more sustainable behaviour?” - Yes/No answer

In contrast, positive emotions, such as hope, inspiration or a sense of connection, were associated with slightly fewer behavioural intention responses. However, when present, these emotions were often linked to constructive reflections, such as 'it has strengthened my determination' or 'it made me understand the value of small actions that we can all take'. This suggests that, although negative emotions may provoke a stronger behavioural response, positive emotional experiences also contribute to a more resilient and empowering engagement by reinforcing self-efficacy through hope and perceived agency.

Together, these results emphasise the importance of balancing the emotional content of educational narratives to create space for both constructive concern and empowerment, and to activate reflection without triggering disengagement or discouragement.

Reasoning on these results, in agreement with those related to self efficacy, we can probably expect a concrete implementation of sustainable behaviour by a lower percentage than the 82% declared in response to the question in Section 6 of the questionnaire⁶, at the end of the activities in the museum. Further confirmation of this may be provided by future implementations.

3.2 Discussion

Preliminary results from the study suggest that museum-based interventions, to a certain extent, mitigate eco-anxiety and inspire environmentally friendly behaviour by fostering emotional and experiential engagement. The data indicate a growing environmental awareness and a predominantly ecocentric perception of nature among students. Most respondents recognise that they belong to, or are intrinsically connected with, nature, reflecting a shift away from traditional anthropocentric views.

These results suggest an extended environmental identity aligned with values of care, and responsibility toward nature but they also show that the ecological identity (even if predominantly ecocentric) is not well defined in the majority of students and may suggest that students are balancing different perceptions of the world. The fact that many students selected answers that fall into more than one category indicates that perceptions of nature are highly variable: students may recognise nature either as part of their self (ecocentric) or as something they need (utilitarian tending towards anthropocentric). This reflects the complexity of environmental perceptions and the possibility that students are still developing an integrated view of their relationship with nature. In contrast, students who responded within a single category show more defined and less nuanced perceptions of their relationship with nature.

The absence of strictly anthropocentric responses reinforces the idea that young people are increasingly distancing themselves from exploitative views of the environment. This shift in perspective represents fertile ground for activating behavioural change, particularly when

⁶ "After this workshop, do you feel motivated to adopt more sustainable behaviour?" - Yes/No answer

supported by emotionally engaging and contextually relevant educational experiences such as those provided in the museum space.

This is also mirrored in widespread concern about climate change and the future of natural resources, as discussed in paragraph 3.1 table 6⁷, which can be interpreted as a sign of emotional engagement with climate and sustainability issues. While high levels of concern may at times be associated with eco-anxiety or feelings of helplessness, in this context they appear to coexist with a readiness for reflection and action. The data suggest that students are not only aware of the urgency of environmental challenges, but are also emotionally affected by them. This dynamic, if supported by appropriate educational tools, can foster constructive forms of behaviour. When students perceive both the seriousness of the issue and their ability to contribute meaningfully, concern may act as a motivational driver rather than a paralyzing emotion. This interpretation highlights the importance of emotional literacy in environmental education and confirms the relevance of self-efficacy as a mediating factor in the transition from eco-anxiety to sustainable behaviour.

Behavioural data show that students tend to adopt individual, low-effort sustainable practices, whereas collective and community-oriented actions are less frequent. Self-efficacy results suggest that, while most students feel capable of adopting sustainable behaviours, they are less confident that their actions can generate a broader impact. In other words, although they believe they can take small personal steps, they doubt that these steps will make a real difference. This perception of limited impact can discourage participation in more ambitious, community-based initiatives. Moreover, 40% of students reported that integrating sustainable behaviour into their daily lives is difficult (*magnitude* dimension), suggesting that perceived barriers further constrain their willingness to act.

Nevertheless, the museum-based educational intervention appears to have potential in fostering environmental awareness and reducing eco-anxiety by engaging participants emotionally and experientially. Participants reported increased motivation and a deeper understanding of environmental issues after the activity. Similarly, the narrative and experiential approach of the museum activities helped to reduce eco-anxiety among the majority of students by offering concrete solutions and opportunities for action, rather than denying the challenges. This was also reflected in the students' emotional responses: concern and urgency acted as catalysts for reflection and behavioural intention, while positive emotions such as inspiration and hope reinforced resilience and a willingness to act.

These results highlight the complexity of fostering sustainable behaviours. While attitudes and values are shifting towards ecological consciousness, the practical implementation of these behaviours remains uneven. This underlines the need for targeted strategies that enhance self-efficacy, remove structural barriers, and utilise cultural and educational institutions as catalysts for environmental engagement. Furthermore, it emphasises the importance of long-term strategies

⁷ 'On a scale from 1 (not at all concerned) to 5 (very concerned), how concerned are you about the future of the environment and natural resources in relation to anthropic impacts and climate change?'

and follow-up actions to determine whether the motivational boost observed immediately after the intervention can lead to sustained behavioural change over time.

4. Future directions

The R.I.S.E. project has shown the effectiveness of educational storytelling in fostering critical thinking, emotional engagement, and awareness of environmental challenges, while minimising distress and eco-anxiety. A limitation of the current phase is the absence of long-term evaluation of actual pro-environmental behaviours after participation.

To overcome the current limitations of the project, future implementations have been developed: from autumn 2025 onwards, a series of new educational tools and activities will be introduced in the museum setting to encourage long-term engagement with environmental issues. One of the key innovations is the launch of the 'Sustainability Diary', a long-term evaluation tool designed to assess the lasting impact of educational experiences beyond immediate feedback. Participants can use the diary individually, with their parents at home or as a class to track their sustainable behaviours over time across four thematic areas: reducing consumption, mindful eating, supporting biodiversity and responsible travel. Alongside this, a new educational pathway focusing on extinction will be introduced. This new pathway will explore mass extinction events, from the 'Big Five'⁸ to the current biodiversity crisis caused by human activity and it will be gradually integrated into the museum's educational programmes from September 2025 onwards.

⁸ The term "Big Five" refers to those mass extinction events that occurred at five different times in Earth's history: 1) Ordovician mass extinction (approximately 445 million years ago); 2) Devonian mass extinction (approx. 375 mya); 3) Permian-Triassic extinction event (approx. 252 mya); Triassic-Jurassic extinction (approx. 201 mya); 4) End Cretaceous extinction (approx. 66 mya).

Acknowledgements:

We would like to express our sincere gratitude to everyone who contributed to the development and implementation of this project.

Firstly, our deepest thanks go to Prof. Ursula Thun Hohenstein, Director of the Museum of Palaeontology and Prehistory "Piero Leonardi" (MPPPL), for her ongoing support and for providing an institutional framework that encourages experimentation and educational innovation.

We would also like to thank Lucilla Angeletti, PhD student, for her valuable collaboration in delivering the initial phase of the human evolution programme and developing its subsequent extension.

Our heartfelt thanks also go to Dr. Andrea Perez and Dr. Giovanni Serafini, in charge of the PNRR CHANGES project at the MPPPL, for their scientific oversight and meticulous supervision of the educational storytelling content, ensuring both accuracy and coherence.

We would also like to thank Maria Letizia Selmi, student of the University of Modena and intern at the MPPPL, for her contribution to the drafting of educational content on Mesozoic reptiles, which enriched the narrative framework of the activities.

Our thanks also go to Giuseppe Maria Franco and Miriam Spalletta, educational interns at the MPPPL, for their active support in delivering the workshops; and to Daniela Olaru, a graphic design intern at MPPPL, for her creative work in developing the visual materials that accompany the educational experience.

References

- Bandura, A. (1997) *Self-efficacy: The exercise of control*. W.H. Freeman.
- Bertolini, M., Thun Hohenstein, U., Pasini, A., & Poletti, G. (2019). Il Museo Universitario di Paleontologia e Preistoria “P. Leonardi”: divulgazione e nuove tecnologie per un museo aperto a porte chiuse. *Museologia Scientifica. Memorie*, 20, 217-220.
ISBN 978-88-908819-3-0
- Burke, A., Peros, M. C., Wren, C. D., Pausata, F. S. R., Riel-Salvatore, J., Moine, O., de Vernal, A., Kageyama, M., & Boisard, S. (2021). The archaeology of climate change: The case for cultural diversity. *Proceedings of the National Academy of Sciences*, 118(30), 1–10.
<https://doi.org/10.1073/pnas.2108537118>
- Cameron, F., Hodge, B., Salazar, J.F., (2013). Representing climate change in museum space and places. *Wiley Interdisciplinary Reviews: Climate Change*.
<http://dx.doi.org/10.1002/wcc.200>
- Falk, J. H., & Dierking, L. D. (2016). *The museum experience revisited*. Routledge.
- Falk, J. H. (2021) *The value of museums: Enhancing societal wellbeing*. Rowman & Littlefield.
- Innocenti, M., Santarelli, G., Faggi, V., Castellini, G., Manelli, I., Magrini, G., Ricca, V. (2021). Psychometric properties of the Italian version of the Climate Change Anxiety Scale. *The Journal of Climate Change and Health*, 3, 100080.
<https://doi.org/10.1016/j.joclim.2021.100080>
- Innocenti, M., Santarelli, G., Lombardi, G. S., Ciabini, L., Zjalic, D., Di Russo, M., & Cadeddu, C. (2023). How can climate change anxiety induce both pro-environmental behaviours and eco-paralysis? The mediating role of general self-efficacy. *International Journal of Environmental Research and Public Health*, 20(4), 3085.
<https://doi.org/10.3390/ijerph20043085>

- Kondyli, C., Psychogiou, M., & Drinia, H. (2024). The museums of geology and paleontology as geoeeducational learning environments for raising climate change awareness. *Sustainability*, 16, 4481.
<https://doi.org/10.3390/su16114481>
- Kunchambo, V., Lee, C., Brace-Govan, J. (2017) Nature as extended-self: Sacred nature relationship and implications for responsible consumption behaviour. *Journal of Business Research*, 74, 126-132.
<https://psycnet.apa.org/doi/10.1016/j.jbusres.2016.10.023>
- Monks, G. G. (2017). Introduction: Why this volume? In G. G. Monks (Ed.), *Climate change and human responses* (pp. 1–4). Springer.
http://dx.doi.org/10.1007/978-94-024-1106-5_1
- Mouliou, M. (2014). Museums in the 21st century: Challenges, values, roles, and practices. In G. Bikos & A. Kaniari (Eds.), *Museology: Cultural management and education* (Vol. 77, p. 111). Gregory Publications.
- Oberle, A., Bess, J., Ehmke, K., Rath, S., & Robbins, A. (2019). Geo-inquiry: Informed action to make our world a better place. *The Geography Teacher*, 16 (4), 170-178.
<http://dx.doi.org/10.1080/19338341.2019.1662467>
- Owen, T. (2021). Planning for emotions in museums. *NEMO - Emotion and Learning in Museum*.
ISBN: 978-3-9822232-1-6
- Parisi, C., De Curtis, O., Caffarelli, L., & Thun Hohenstein, U. (*in press*). Paradata as a strategy for a systematic digitisation of museum objects: The case of the Museum of Palaeontology and Prehistory “Piero Leonardi”. *Lecture Notes in Computer Science*. Springer.
- Parisi, C., Thun Hohenstein, U. (2023). L'uso delle StoryMaps per la divulgazione nei musei. *In Atti della conferenza ESRI* (pp. 1-8).
https://resources.esriitalia.it/media/sync/Chiara_Parisi_UniFerrara.pdf

Parisi, C., & Thun Hohenstein, U. (2024). Educate about environmental and cultural sustainability through prehistoric collections: The case of the Museum of Paleontology and Prehistory “Piero Leonardi” of the University of Ferrara, Italy. *Bulletin du Musée d'Anthropologie Préhistorique de Monaco*, 63.
ISSN 0544-763

Parisi, C. (2024) Musei e democrazia culturale: tra parità ed inclusione verso l'abbattimento delle barriere sociali. *Messina University Press*. ISBN 979-12-80899-13-2.
<https://doi.org/10.13129/979-12-80899-13-2>

Parisi, C., & Thun Hohenstein, U. (*in press*). ArcGIS StoryMaps for human evolution: Use impactful digital storytelling to enhance the prehistoric collection of the ‘P. Leonardi’ Museum and learn about the present environmental change and social issues from our ancient past. In *The future of heritage science and technologies II. Lecture Notes in Mechanical Engineering*, Springer Nature.
ISBN 978-3-031-98378-8

Van der Bijl, J. J., & Shortridge-Baggett, L. M. (2002). The theory and measurement of the self-efficacy construct. In *Self-efficacy in nursing: Research and measurement perspectives* (15(3), pp. 189–209).
<http://dx.doi.org/10.1891/0889-7182.15.3.189>

Verplanken, B., Marks, E., & Dobromir, A.I. (2020). On the nature of eco-anxiety: How constructive or unconstructive is habitual worry about global warming?. *Journal of Environmental Psychology*, 72, 101528.
<https://doi.org/10.1016/j.jenvp.2020.101528>