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„Exploring the Role of Interest in Nature as a Key Driver of
Pro-Environmental Behavior among Adolescents“

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Anna-Lena Neurohr, B.Ed. M.Ed.

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List of Abbreviations

DCN	<i>Disposition to Connect with Nature</i>
ESD	<i>Education for sustainable Development</i>
GEB	<i>General Ecological Behavior Scale</i>
INS	<i>Inclusion of Nature in Self Scale</i>
PEB	<i>Pro-environmental behavior</i>
SIN	<i>Scale of Interest in Nature</i>
2-MEV	<i>Two Major Environmental Values Model</i>

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Abstract

With the challenges of climate change and biodiversity crises, it is crucial to understand and identify the key influencing factors driving pro-environmental behavior (PEB). Research indicates that, in addition to environmental attitudes and involvement in nature-related activities, interest in nature plays a significant role in motivating individuals to engage in PEB. However, the relationship between interest in nature and PEB among adolescents is still not well-explored, even though the foundations for PEB are typically established during childhood. This dissertation aims to bridge this gap by (1) examining the level of interest in nature among lower secondary school students, (2) analyzing the interrelationships between interest in nature, nature-related activities, and environmental attitudes, and (3) understanding its collective impact on PEB. To assess adolescents' interest in nature, we developed the *Scale of Interest in Nature* (SIN), validated using item response theory and the known group approach (N = 351). This scales' construct validity was confirmed through bivariate Pearson correlations with existing measures like the Inclusion of Nature in Self scale (INS), and the Environmental Values model (2-MEV). A cross-sectional study revealed declining interest in nature, nature-related activities, and PEB (General Ecological Behavior Scale) during lower secondary school, with a significant positive correlation among these constructs. Integrating established PEB influencers – like connection to nature (Disposition to Connect with Nature Scale), and environmental attitudes (2-MEV) – allowed us to assess the additional value of interest in explaining PEB. Our analyses revealed not only a significant positive correlation among all determinants of PEB but also demonstrated that interest in nature directly influences PEB itself. Therefore, interest in nature is an essential factor to be considered in future studies exploring the development of PEB. The results of this thesis also suggest that in order to effectively foster PEB, it is essential to simultaneously enhance students' interest in, connection to, and attitudes towards nature. Incorporating nature-related activities into school curricula and leveraging Education for Sustainable Development (ESD) programs can enhance the above mentioned three components and hence encourage the development of resilient, sustainable, and intrinsically motivated PEB among adolescents. With the successful development and validation of the Interest in Nature scale (SIN), our research offers an effective tool to measure adolescents' interest in nature in future research contexts and ESD settings alike.

Zusammenfassung

Angesichts der Herausforderungen des Klimawandels und der Biodiversitätskrise ist es entscheidend, die Einflussfaktoren eines umweltfreundlichen Verhaltens zu identifizieren und zu verstehen. Studien zeigen, dass neben umweltbezogenen Einstellungen und Aktivitäten in der Natur, das Interesse an der Natur eine bedeutende Rolle dabei spielt, Menschen für umweltfreundliches Verhalten zu motivieren. Es wurde beobachtet, dass junge Menschen sich eher für die Umwelt einsetzen, wenn sie ein Interesse an der Natur haben und ihren Wert erkennen. Trotz dieser Erkenntnisse ist die Beziehung zwischen dem Naturinteresse und einem nachhaltigen Umweltverhalten unter Jugendlichen noch wenig erforscht, obwohl die Grundlagen für ein solches Verhalten in der Regel bereits in der Kindheit gelegt werden. Diese Dissertation zielte darauf ab, diese Lücke zu schließen, indem sie (1) die Ausprägung von Naturinteresse bei Schüler*innen der Mittelstufe untersucht, (2) die Zusammenhänge zwischen Naturinteresse, naturbezogenen Aktivitäten und umweltbezogenen Einstellungen analysiert und (3) die gemeinsame Wirkung dieser Faktoren auf das Umweltverhalten untersucht, um so die zugrundeliegenden Mechanismen aufzudecken. Um das Naturinteresse von Jugendlichen zu messen, entwickelten wir die Skala des Interesses an der Natur (SIN). Die Skala wurde basierend auf der Item-Response-Theorie konstruiert und mit Hilfe eines Extremgruppenvergleichs ($N = 351$) validiert. Bivariate Pearson-Korrelationen zwischen dem Naturinteresse, der Naturverbundenheit und den Umwelteinstellungen zeigten die Konstruktvalidität der Skala. In Rahmen einer Querschnittsstudie in der Mittelstufe fanden wir einen Rückgang des Naturinteresses, der naturbezogenen Aktivitäten und des Umweltverhaltens (*General Ecological Behavior Skala*), von Klassenstufe 5 bis 9, wobei eine signifikante positive Korrelation zwischen diesen Konstrukten festgestellt wurde. Durch die Integration etablierter Einflussfaktoren von Umweltverhalten, wie beispielsweise die Naturverbundenheit (*Disposition to connect with nature*), und umweltbezogene Einstellungen, konnten wir den zusätzlichen Wert des Naturinteresses zur Erklärung von Umweltverhalten bewerten. Unsere Analysen zeigten nicht nur eine signifikante Korrelation zwischen allen Einflussfaktoren von Umweltverhalten, sondern auch, dass das Naturinteresse das Umweltverhalten direkt beeinflusst. Daher ist das Interesse an der Natur ein wesentlicher Faktor, den es in zukünftigen Studien zur Entwicklung des Umweltverhaltens zu beachten gilt. Die Ergebnisse dieser Arbeit weisen auch darauf hin, dass es wichtig ist, gleichzeitig das

Interesse an, die Verbundenheit mit und eine positive Einstellung zur Natur bei Jugendlichen zu fördern, um das Umweltverhalten effektiv zu steigern. Die Integration von naturbezogenen Aktivitäten in den Schulunterricht und die Nutzung von Bildung für nachhaltige Entwicklung (BNE) - Programmen können die drei oben erwähnten Faktoren fördern und so zur Entwicklung eines nachhaltigen und intrinsisch motivierten Umweltverhaltens bei Jugendlichen beitragen. Mit der erfolgreichen Entwicklung und Validierung der Skala „Interesse an der Natur“ (SIN) bietet unsere Forschung ein effektives Instrument zur Messung des Naturinteresses von Jugendlichen in zukünftigen Forschungs- und BNE-Kontexten.

Synopsis

1 Introduction

In the face of escalating global challenges such as environmental degradation, climate change, and the loss of biodiversity, it has become increasingly clear that urgent action is needed to secure the future of our planet. These challenges are predominantly driven by anthropogenic factors, including habitat destruction, invasive species, pollution, overharvesting, and human overpopulation ([Wilson & Knopf, 2002](#)). As a result, natural resources are being depleted at an alarming rate, surpassing the Earth's capacity for regeneration ([Milfont & Duckitt, 2004](#)). Despite international efforts such as the Paris Agreement, which aims to limit global warming to a 1.5°C threshold, current projections indicate a worrisome trajectory towards a significant temperature increase of 2.7°C by the end of the century ([Steffen et al., 2015](#); [UNEP, 2021](#)). The recent IPCC report ([2023](#)) emphasized how drastic cuts in carbon emissions are crucial to prevent an environmental catastrophe. This rapidly advancing climate change not only exerts a detrimental influence on the economy, societies and public health but also casts a shadow over many of the world's species and ecosystems, precipitating a troubling decline in biodiversity. The climate crisis and biodiversity loss are undeniably interconnected, necessitating a joint approach to combatting these pressing issues ([Palmer, 2022](#)). Achieving success requires synchronized efforts on a global scale, encompassing both broad-scale measures and localized initiatives that holistically address these challenges. To confront these ecological issues effectively, we must not only secure political commitments and establish institutional frameworks but also cultivate individual responsibility and embrace sustainable lifestyles ([Pörtner et al., 2022](#)).

To effectively promote the development of pro-environmental actions and behaviors, it is imperative to gain insight into the driving forces behind pro-environmental behavior (PEB). Understanding the motivating factors that underpin individuals' willingness to engage in environmental and climate protection is essential for facilitating PEB and informing government policies that enjoy broad-based public support. Numerous factors influencing PEB have been thoroughly examined in previous research, including environmental attitudes, the sense of connectedness to nature, and experiences in natural environments ([Bamberg & Möser, 2007](#); [Gifford & Nilsson, 2014](#); [Kollmuss & Agyeman, 2002](#); [Li et al., 2019](#)).

Nevertheless, the scope of influencing factors on PEB and the obstacles that must be overcome during its development remain unclear ([Kollmuss & Agyeman, 2002](#)). As part of this clarification process, interest in nature has been explored as a promising factor that motivates individuals to engage in pro-environmental actions. Interest in nature refers to a unique and multifaceted relationship between an individual and nature as an object of interest ([Krapp, 2002](#); [Neurohr et al., 2023](#)). What distinguishes this construct is its inclusion of emotion-related, value-related, and intrinsically motivated aspects. The theory of interest states that individuals are more inclined to engage with objects of interest if they can personally identify with and integrate them into their sense of self ([Blankenburg & Scheersoi, 2018](#); [Krapp & Prenzel, 2011](#)). Interest in nature can thus act as an intrinsic motivator, propelling a person's involvement in the preservation of nature, rather than relying on external rewards or incentives ([Schiefele et al., 1993](#)). Consequently, we expect that a commitment to preserving nature can only develop when there is heightened appreciation for and greater interest in nature ([Kaiser et al., 2013](#); [Kals et al., 1999](#); [Neurohr et al., 2023](#); [Roczen et al., 2014](#)).

While interest in nature is considered a promising influencing factor, especially among young people ([Kals et al., 1999](#); [Leske & Bögeholz, 2008](#)), it has remained relatively understudied in previous research. Therefore, the present studies place a strong emphasis on interest in nature by enhancing its assessment and exploring its interactions with other influencing factors, with a particular focus on its impact on sustainable PEB in the crucial demographic of adolescents. Given the limited attention that interest in nature has received in the field of environmental psychology, the objective of this thesis is to highlight its significance and advocate for its promotion. To this end, we analyze its relationship with other constructs in environmental psychology and demonstrate its relevance in various models. As part of our efforts to accurately measure young people's interest in nature, a pivotal aspect of this endeavor involves the development and validation of an interest in nature scale. With this instrument, we want to lay the groundwork for subsequent studies providing evidence on the effectiveness of Environmental Education and Education for Sustainable Development programs in cultivating interest in nature among adolescents.

2 Interest in nature

Among the various factors that influence pro-environmental behavior (PEB), interest in nature appears to be an essential element, as it plays a crucial role in the development and sustenance of environmental knowledge, values, and attitudes ([Uitto et al., 2011](#)). Research suggests that young people's inclination to engage in pro-environmental actions is notably higher when they possess a genuine interest in nature and recognize the value of protecting it ([Cheng & Monroe, 2012](#); [Kals et al., 1999](#); [Leske & Bögeholz, 2008](#); [Uitto et al., 2011](#)). Guiney (2009) revealed that conservation volunteers actively engage in nature preservation primarily due to their early interest in nature, coupled with their exposure to nature-related activities and experiences during adolescence_ ([Chawla, 2020](#); [Kals et al., 1999](#)). This enthusiasm and experience foster a comprehensive understanding of the natural world and the intricate relationship between humans and nature, subsequently fostering environmental awareness and a willingness to take action ([Bogner, 2007](#); [Kals et al., 1999](#)).

2.1 Conceptualization and development of interest

According to Krapps' person-object theory ([2002](#)), interest involves an interactive relation between an individual and certain aspects of his or her environment (e.g., objects, events, ideas) and is therefore topic-specific. It includes both intellectual and affective components and is further conceptualized in two forms: situational interest and individual interest ([Krapp, 2002](#)). Situational interest represents a psychological state characterized by increased attention, effort, and positive affect experienced during a particular activity ([Harackiewicz et al., 2016](#)). It serves as a foundation for developing sustained individual interest and is usually triggered by external stimuli. In contrast, individual interest reflects individuals' dispositional motivational state and is seen as a relatively stable tendency to engage with a specific topic without external influence ([Krapp & Prenzel, 2011](#)). Individuals with well-developed individual interest not only act intrinsically but also display persistence in the face of setbacks or negative emotions ([Renninger & Hidi, 2002](#)).

Through psychological processes like internalization and identification, the object of interest becomes integrated into an individual's values and emotions, becoming a permanent part of their identity ([Blankenburg & Scheersoi, 2018](#); [Krapp, 2007](#)). This process is described by the four-phase model of interest development ([Hidi & Renninger, 2006](#); [Renninger & Hidi, 2016](#)). It begins with situational interest, where environmental features like novelty,

ambiguity, and surprise capture attention. Situational interest can extend into an emerging individual interest when tasks are perceived as meaningful and enjoyable, leading individuals to seek more engagement. Over time, this emerging individual interest can mature into a self-sustaining, well-developed individual interest in the specific topic (see Figure 1).

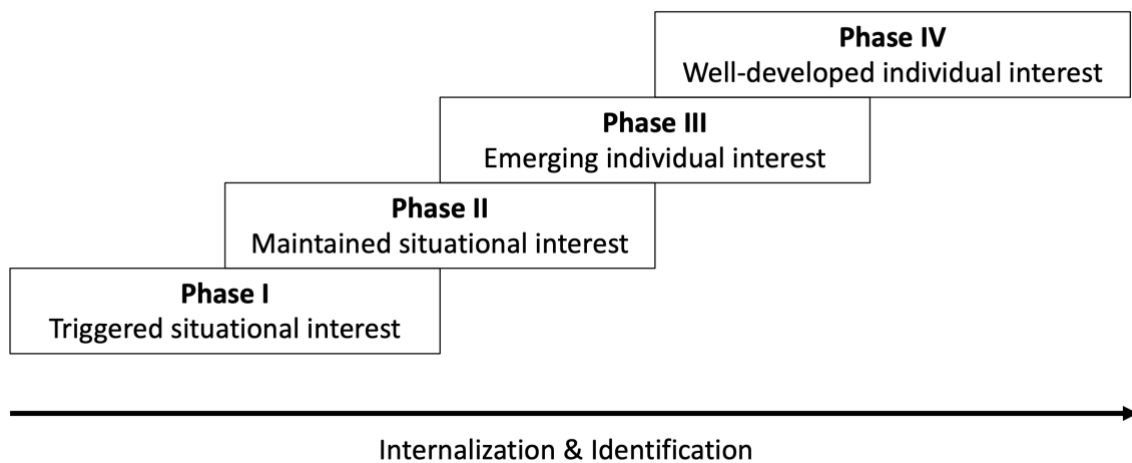


Figure 1. The Four Phases of Interest Development ([Hidi & Renninger, 2006](#))

Renninger & Hidi ([2016](#)) point out that the term “phase” is preferred over “stage”, because the duration and nature of each phase can vary between individuals and, even within individuals, be influenced by factors like experience. Advancing through these phases requires an environment that nurtures the individual pursuit of interests ([Harackiewicz et al., 2016](#)). Without self-generated or environmental support for sustained involvement, a person's interest in an object of interest may decline or disappear altogether. Only when interest deepens across the four developmental phases do individuals start to identify with the object, integrate it into their self-concept, make conscious choices, and autonomously pursue their interests ([Renninger & Hidi, 2016](#)).

A significant feature of well-developed individual interest is its motivational function. It directs activities and goals toward specific domains, undergirds efforts toward achieving goals, and provides a context that sustains persistence until objectives are accomplished ([Rounds & Su, 2014](#)). As interest affects the direction, intensity, and persistence of goal-oriented behaviors, research has begun to focus on interest in nature as an influence on nature-protective and pro-environmental behaviors.

2.2 Interest in Nature as a Specific Form of Interest

Interest in nature can be considered a facet of individual interest establishing a connection between a person and the natural world. This relationship aligns with Markl's (1989) concept of nature, promoting a "biocentric" approach where humans recognize their interconnectedness with the broader web of life, including animals, plants and landscapes. The "biophilia hypothesis", fundamental to the notion of a connection to nature, further supports this idea, proposing that humans possess an innate interest in life and life-like processes (Wilson, 1984). It emphasizes that our bond with nature goes beyond mere physical survival. Initial studies support these theories, revealing a positive correlation between intellectual interest in nature and the willingness to protect nature, suggesting that it could serve as a predictor of nature-protective behavior (Kals et al., 1999; Langeheine & Lehmann, 1986; Vining & Ebreo, 1992). Despite findings indicating that intellectual factors (such as environmental knowledge) seem to have little to no influence on PEB (Abrahamse et al., 2005; Frick et al., 2004; Otto & Pensini, 2017), previous studies have primarily focused on intellectual interest in nature (Kals et al., 1999; Kleespies et al., 2021), and neglected to explore its affective dimension. This oversight is significant, as some scholars propose a purely affective construct of interest, disregarding the cognitive dimension and identifying 3 affective subcategories: value-related, emotion-related, and intrinsic (Schiefele et al., 1993). While the value-related component of interest pertains to matters holding personal significance to an individual, the emotional component encompasses subjects that evoke positive feelings, such as pleasure. The intrinsic component involves direct emotional and value-based attributions to an object or action (Schiefele et al., 1993).

Instead of solely focusing on the intellectual component of interest, it is more likely that the motivation to act is influenced by affective or motivational factors, such as personal values, goals, and self-efficacy beliefs, which play a vital role in driving behavior. These factors can shape individuals' intentions, decision-making processes, and level of involvement in taking action (Ajzen, 1985; Deci & Ryan, 2000; Singh et al., 2006). Although the specific impact of affective interest in nature on PEB has not been extensively explored, it is reasonable to assume that an interest in nature primarily driven by emotions could serve as a strong motivation for individuals to actively participate in environmental protection.

However, the extent of affective interest in nature among adolescents and its correlation with other factors influencing pro-environmental behavior, such as environmental attitudes,

remains unclear. Additionally, its ultimate influence on pro-environmental behavior requires further exploration. Interest in nature may serve as an additional construct explaining how students develop enhanced pro-environmental competence through nature-based environmental education ([Otto & Pensini, 2017](#)).

3 Interest in nature as a possible underlying mechanism of pro-environmental behavior

Pro-environmental behavior (PEB) encompasses a range of actions aimed at reducing one's environmental impact, such as minimizing energy and water consumption, reducing waste, and making conscientious transportation choices. Understanding the drivers of PEB is crucial for designing effective programs and policies in ESD. Contrary to initial research assumptions, knowledge about environmental issues is not the primary driving force behind PEB. This gap between knowledge and behavior is referred to as the knowledge-behavior gap or action-knowledge gap ([Barth et al., 2012](#); [Knutti, 2019](#)). Various studies suggest that environmental knowledge has minimal to no influence on PEB ([Frick et al., 2004](#); [Kals et al., 1999](#); [Steg & Vlek, 2009](#)). Fostering narrow knowledge about a specific ecological behavior has the lowest effect ([Abrahamse et al., 2005](#); [Otto & Pensini, 2017](#)). In Otto & Pensini's (2017) model, environmental knowledge explained only 2% of the variance in ecological behavior, with 69% explained by connection to nature. Therefore, the studies in this thesis focus on affective and behavioral factors, thus analyzing the underlying mechanism of PEB.

A promising, yet under-studied factor is interest in nature, which appears to play an important role in developing and maintaining environmental values and attitudes ([Uitto et al., 2011](#)). Research suggests that young people are more likely to engage in PEB if they have an interest in nature and recognize the value of protecting it ([Cheng & Monroe, 2012](#); [Kals et al., 1999](#); [Leske & Bögeholz, 2008](#); [Uitto et al., 2011](#)). Interest in nature at a young age, as well as nature-related activities and experiences during adolescence, have been identified as primary reasons why conservation volunteers actively engage in nature protection ([Chawla, 2020](#); [Kals et al., 1999](#)). Such interest and experience contribute to a comprehensive understanding of the natural world and the complex relationship between humans and nature, which in turn enhances environmental awareness and willingness to act ([Bogner, 2007](#); [Kals et al., 1999](#)). Therefore, it is essential to understand how interest in nature develops over time, how it is

related to other factors that influence PEB, like environmental attitudes, and how it ultimately affects PEB.

Given that the foundations for environmentally protective behavior are typically established in childhood ([Chawla, 2020](#); [Evans et al., 2018](#); [Otto et al., 2019](#)), it can be assumed that the formation of affective interest in nature also takes place at an early age. Although most research on connection to nature, environmental attitudes, and values has been conducted with adults, there is a growing body of evidence indicating similar findings among adolescents ([Collado et al., 2015](#); [Otto & Pensini, 2017](#); [Roczen et al., 2014](#)). Understanding the development of these tendencies is essential, as the foundations for PEB are mostly laid in childhood and tend to stabilize in adulthood, making it more challenging to instill these behaviors later in life ([Kaiser et al., 2014](#)). Thus, it is essential to shed light on adolescents' interest in nature, gain further insights into possible correlations with specific activities or attitudes and better understand its role as a determinant of PEB. Only by comprehending how to stimulate the early development of individual interest in nature can we ensure its transformation into a robust personal trait, which in turn has the potential to foster environmentally responsible behavior.

In addition, previous research has emphasized the significance of social and psychological factors in influencing conservation actions ([Mascia et al., 2003](#); [Schultz, 2011](#)). However, despite a high level of concern about environmental problems and nature protection, a gap exists between environmental attitudes and actual behavior. This suggests the presence of barriers hindering individuals from engaging in PEB, such as personal cost (e.g., time and finances) or lack of structural support (e.g., efficient public transport that one could take) ([Kollmuss & Agyeman, 2002](#); [Whitburn et al., 2020](#)). Nevertheless, achieving a sustainable future necessitates a reduction in consumption and exploitation of natural resources as well as the adoption of more environmentally conscious behaviors ([Otto et al., 2019](#)). Given that behavior is socially motivated ([Schwartz, 1977](#); [Stern et al., 1999](#)), social norms and individual motives, including attitudes, problem awareness, and perceived behavioral control, are significant independent predictors of PEB ([Bamberg & Möser, 2007](#); [Kaiser & Wilson, 2004](#)). Recent research has underscored the importance of several concepts in promoting PEB, including environmental attitudes, connection to nature, and experiences in nature ([Brügger et al., 2011](#); [Chawla, 2020](#); [Nisbet et al., 2009](#); [Richardson et al., 2020](#); [Roczen et al., 2014](#); [Schultz, 2002](#); [Torkar & Krašovec, 2019](#)).

Over the past few decades, researchers have not only analyzed influencing factors but also developed various models and frameworks to explain the structure of PEB ([Kals et al., 1999](#); [Naess, 1973](#); [Roczen et al., 2014](#); [Schultz, 2002](#)). Attitude towards nature has been identified as particularly important in driving behavioral change ([Abrahamse & Steg, 2009](#)) and has been found to be a crucial force in determining the extent to which adolescents embrace ecological lifestyles ([Brügger et al., 2011](#)). Building on the theory of planned behavior ([Ajzen, 1985](#)), Kaiser et al. ([1999](#)) demonstrated that environmental attitudes influence PEB but are mediated by environmental behavior intention. [Kals et al. \(1999\)](#) expanded this research by including additional factors that influence ecologically relevant decisions. They examined perceived responsibility toward nature, willingness to protect nature, interest in nature, nature-related experiences and emotional ties with nature as important factors in explaining nature-protective decision-making. The pro-environmental competence model by Roczen et al. ([2014](#)) integrates these studies and establishes a relationship between intellectual, behavioral and affective factors: 1) environmental knowledge, 2) pro-environmental behavior, and 3) attitude toward nature. In this model, attitude towards nature is understood as the most significant motivational factor ($\beta = 0.54$) for PEB, reflecting the emotional connection humans have with nature. Whitburn et al. ([2019](#)) further explored the relevance of this emotional connection and revealed that connection to nature, exposure to nature, and the use of nature for psychological restoration explained 46% of the variance in PEB. Otto & Pensini ([2017](#)) explained an even higher percentage (69%) of the variance in PEB through connection to nature. The effects were significant and demonstrated a strong positive effect of connection to nature on PEB ($\beta = 0.83$; $p < 0.001$). In contrast, environmental knowledge had only a small effect ($\beta = 0.13$; $p = 0.035$). A recent study by Otto et al. ([2021](#)) identified a mediator model in which connection to nature mediated the positive relationship between prosocial propensity and pro-environmental behavior. Prosocial propensity indicates an individual's inclination to engage in actions benefiting others or society. Within the environmental domain, this inclination manifests in environmentally friendly behaviors like recycling, reducing energy consumption, and supporting conservation initiatives ([Neaman et al., 2021](#)). Cultivating a robust prosocial propensity increases the likelihood of environmentally positive actions, resulting in a reduced ecological footprint, heightened participation in environmental initiatives, and the formation of collective efforts to address environmental challenges. In the ecological realm, a strong prosocial propensity fosters responsibility,

empathy, and collective action, contributing to a more sustainable and harmonious relationship between humans and the natural world ([Otto et al., 2021](#)). Therefore, Otto et al. (2021) posits a recursive effect, in which thoughts and feelings associated with connection to nature or engaging in PEB impact one's prosocial propensity and connection to nature, thereby driving further PEB. These findings support the notion that individuals who develop a relationship with nature are more likely to protect it ([Whitburn et al., 2019](#)).

As both environmental attitudes and connection to nature have demonstrated significant influences on PEB, the question arises as to how interest in nature fits into these models. Given that interest in nature appears to be another promising factor influencing the development of an individual's PEB, understanding the detailed interrelationships among all influencing factors has become crucial. While only a few studies so far have focused on linking interest in nature to other factors impacting PEB, these studies, in particular, have provided initial indications that interest positively correlates with both environmental attitudes ([Leske & Bögeholz, 2008](#); [Uitto et al., 2011](#)) and connectedness to nature ([Cheng & Monroe, 2012](#); [Kals et al., 1999](#)). There, it is imperative to include interest in nature in future attempts to explain the development of PEB.

By examining the relationship between interest in nature, environmental attitudes, connection to nature, and PEB, we can gain insights into the interplay of these psychological constructs and, more importantly, into the underlying mechanism of the development of PEB. In accordance with theory and prior research, interest in nature can be considered a personal trait that is directly triggered through extended and repeated environmental education programs. This cultivation may enhance other influencing factors of PEB, such as environmental attitudes and connection to nature, ultimately resulting in a more pronounced and robust expression of PEB. This lays the foundation for future projects aimed at promoting sustainable lifestyles and fostering a sustainable future. It appears that human- and nature-related motivations, interests, and attitudes are interconnected, but with varying degrees of significance ([Uitto et al., 2011](#)). To enhance our understanding of the psychological constructs employed to assess the significance of interest in nature within this specific framework, I will now provide more comprehensive definitions of the psychological factors used in this thesis: environmental attitudes and connection to nature. Following this, there will be an overview of the different studies conducted as part of this dissertation, along with their specific aims and objectives.

4 Additional factors impacting pro-environmental behavior related to interest in nature

4.1 Environmental attitudes

Environmental attitudes refer to predispositions that shape an individual's favorable or unfavorable responses towards various aspects of the environment, such as nature, energy, pollution, or technology ([Hollweg et al., 2011](#)). The construct of environmental attitude (EA) extends beyond mere environmental concern and encompasses multiple components ([Hadler et al., 2022](#)). According to Schultz et al. ([2004](#)), environmental attitudes are a “collective of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues” (p. 31). Various approaches distinguish among three dimensions: the affective dimension (related to emotional involvement, e.g., concern), the cognitive dimension (including facts, knowledge, or understanding), and the conative dimension (related to action and behavioral intention) ([Bogner & Wiseman, 2006](#); [Diekmann & Preisendörfer, 1998](#); [Fishbein & Ajzen, 1974](#); [Gray, 1985](#); [Hadler et al., 2022](#); [Maloney & Ward, 1973](#)).

There have been inconsistent empirical findings on the relationship between EA and pro-environmental behavior, with often only a moderate correlation ([Bamberg & Möser, 2007](#); [Maurer & Bogner, 2020](#); [Meinhold & Malkus, 2005](#)) and varying results ([Eagles & Demare, 1999](#); [Oerke & Bogner, 2013](#)). One potential reason for this moderate relationship is the incomplete understanding of the dimensionality of EA ([Costarelli & Colloca, 2004](#)). To capture the complexity of EA, measurement approaches have been proposed to assess attitudes, worldviews, and values at different levels of specificity ([Bogner & Wiseman, 2002](#)). For instance, Gagnon Thompson and Barton ([1994](#)) identified two roots of EA: concern for all living things (ecocentric) and concern for humans (anthropocentric). Schultz ([2000](#)) proposed three correlated factors: concern for the self (egoistic), concern for other people (altruistic), and concern for the biosphere (biospheric). Bogner & Wiseman ([1996](#)) conducted a higher-order factor analysis based on a large pool of items, revealing a model with two orthogonal dimensions: Utilization and Preservation (see Figure 2). This model of EA allows individuals to endorse both the protection of the environment on a biocentric dimension and the usage of nature on an anthropocentric dimension. A strong emphasis on preservation (biocentric) does

not necessarily imply a weak focus on utilization (anthropocentric). Instead, preservation and utilization are viewed as complementary and uncorrelated values, leading to the categorization of individuals into four quadrants rather than a continuum. The 2-MEV scale, translated into 33 different languages, has been validated independently by different research groups (Boeve-de Pauw & Van Petegem, 2011; [Drissner et al., 2010](#); [Johnson & Manoli, 2011](#); [Milfont & Duckitt, 2004](#); [Munoz et al., 2009](#)).

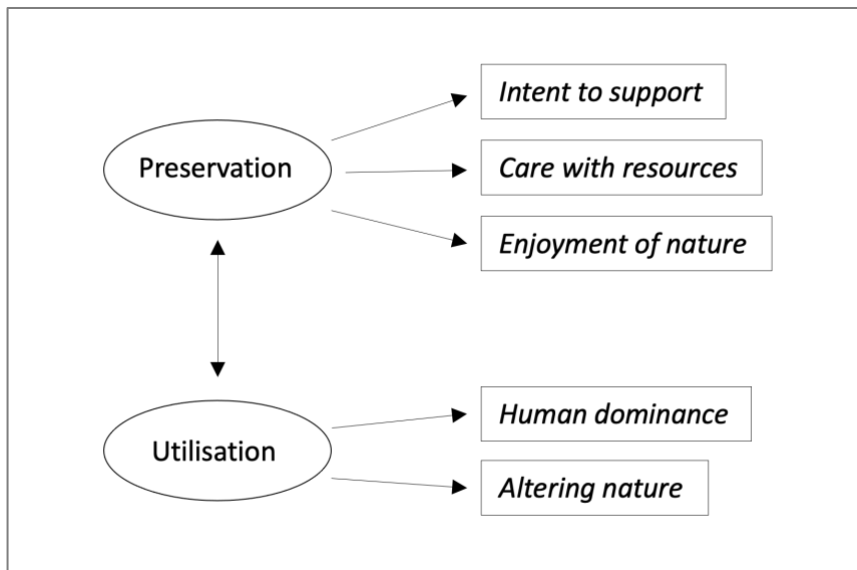


Figure 2. Dimensions of the 2-MEV model by Bogner & Wiseman ([Bogner & Wiseman](#)); adapted from Bogner & Wiseman ([Bogner & Wiseman](#))

Environmental attitudes are influenced by various factors, including age, gender, cultural background, experiences, rural/urban residence, and knowledge ([Gifford & Sussman, 2012](#)). For example, younger individuals and those with higher levels of education tend to exhibit greater environmental awareness ([Dunlap & Jones, 2002](#); [Grønhøj & Ölander, 2007](#)). Notably, studies have observed a decreasing trend in EA from lower secondary school to high school ([Bogner et al., 2015](#); [Bogner & Wilhelm, 1996](#); [Bogner & Wiseman, 2002](#); [Otto et al., 2019](#)). Studies of environmental attitudes among American high school seniors have indicated a significant decline in support for environmental issues, accompanied by diminishing beliefs in personal accountability for environmental problems ([Wray-Lake et al., 2010](#)). This decline is concerning, particularly considering that students who emphasize sustainable attitudes are more likely to express interest in studying environmental issues and engage in responsible behaviors ([Uitto et al., 2011](#)). Strengthening other associated psychological factors, such as

interest in nature, could potentially counteract this troubling trend. However, empirical evidence regarding the correlations between EA and interest in nature is still lacking, creating a need for further investigation into this relationship and its impact on PEB.

4.2 Connection to nature

The relationship between individuals and the natural world, often referred to as connection to nature, is a vital factor in preserving the biosphere ([Chawla, 2020](#); [Schultz et al., 2004](#); [Whitburn et al., 2020](#)). This concept is based on Wilson's "biophilia hypothesis" ([1984](#)), which states that humans possess an innate connection to and interest in life and life-like processes. According to Schultz ([2002](#)), connection to nature reflects to what extent individuals perceive nature as integral to their own identity. When people view themselves as interdependent with nature, they also recognize the inherent value of the natural world. Therefore, expanding one's self-identity to include the environment and fostering a sense of belonging with nature are key components of connection to nature ([Schultz, 2002](#)).

In the current field, various terms describe the concept of connection to nature, such as connectedness with nature, affinity, biophilia, environmental identity, and nature-relatedness, among others ([Beery, 2013](#)). One approach to assessing a person's relationship with nature is the Inclusion of Nature in Self Scale (INS) developed by Schultz et al. ([2004](#)). This scale uses a single item that presents a series of seven differentially overlapping circles labeled "self" and "nature", in which participants select the circle that best describes their feeling of being connected to nature. The INS is widely used to measure individual connectedness with nature and has been found to be highly accurate and well-correlated with other connection with nature instruments ([Brügger et al., 2011](#)). Additionally, Brügger et al. ([2011](#)) introduced the Disposition to Connect with Nature Scale, which includes affective and behavioral elements of connection to nature. This instrument has demonstrated unidimensionality and incremental validity compared to other similar measures ([Mayer & Frantz, 2004](#)).

Numerous studies explore the experiences that shape connection to nature and its associations with other aspects of life, such as happiness and support for environmental protection ([Restall & Conrad, 2015](#); [Tam, 2013](#); [Zylstra et al., 2014](#)). Prior research has shown that connection to nature correlates with pro-environmental behaviors (PEB) both directly and indirectly through environmental attitudes ([Nisbet et al., 2009](#); [Whitburn et al., 2019](#)).

Schultz (2011) suggests that promoting a stronger connection to nature can increase individuals' engagement in pro-environmental and conservation behaviors, including resource conservation, pro-environmental activism, and support for environmental organizations (Whitburn et al., 2020). Therefore, researchers argue that an important prerequisite for engaging in PEB is feeling connected to nature (Kossack & Bogner, 2012; Mayer & Frantz, 2004; Otto et al., 2014; Roczen et al., 2014). To enhance this connection, it is crucial to consider how individuals spend their time in nature and what aspects they focus on (Richardson et al., 2020). Positive experiences with nature and spending time in natural surroundings can intensify an individual's relationship with nature (Schultz, 2002). Simple activities such as gardening, wildlife observation, or listening to birdsong have been found to be closely linked to individuals' connectedness to nature (Richardson et al., 2020; Sanvichith, 2011). While brief environmental education programs can lead to positive changes in connection to nature, achieving a long-term connection requires repeated experiences (Kossack & Bogner, 2012; Möller, 2021; Sellmann & Bogner, 2013; Stern et al., 2008).

Studies have shown that young people who have more access to and experience with nature tend to express a stronger connectedness with the natural world, and are more likely to care for it even into adulthood (Barrable & Booth, 2020; Chawla, 2020; Cheng & Monroe, 2012; Collado et al., 2013; Evans et al., 2018). Childhood is a crucial period for developing a connection to nature, but it often declines during adolescence before gradually rising again in adulthood (Hughes et al., 2019; Liefländer et al., 2013; Richardson et al., 2019). This decline in connection to nature during adolescence is associated with spending more time indoors, watching television, playing digital games, and using social media (Michaelson et al., 2020). Increasing immersion in the digital world has led to a decline in humans' connection with the natural world (Kesebir & Kesebir, 2017; Kuss & Griffiths, 2017; Soga & Gaston, 2022), a phenomenon that is defined as "nature deficit disorder" (Louv, 2005). Studies suggest that this disconnection can lead to apathy towards environmental degradation and protection, as connection to nature has been recognized as a potential catalyst for profound societal change toward respecting and caring for nature (Ives et al., 2018; Pyle, 2003). As previous findings suggest a link between an individual's connection to nature and their interest in nature, it follows that this declining trend could extend to their level of interest. Simultaneously, triggering an individual's interest in nature may also contribute to them feeling more connected to nature and recognizing its value. However, to develop programs to effectively

foster either interest or connection and optimize their collective impact on promoting PEB, it is crucial to understand the interplay between the different psychological factors.

5 Research questions and aims of the dissertation

In order to address the gaps in environmental education research outlined in the previous section, the work presented in this thesis pursues three core aims:

- (1) development and validation of an age-appropriate instrument that effectively measures adolescents' affective interest in nature,
- (2) exploration of adolescents' interest in nature with a cross-sectional sample in lower secondary school, and
- (3) investigation of (a) the influence of adolescents' interest in nature on their pro-environmental behavior and (b) its correlation with other established drivers of pro-environmental behavior such as environmental attitudes and connection to nature.

This research aimed to offer valuable insights into the intricate dynamics of pro-environmental behavior by examining the relationships among interest in nature, environmental attitudes, and connection to nature within a comprehensive model. The work presented in this thesis addresses these three primary objectives in three manuscripts, using diverse methodological approaches and applying interdisciplinary concepts to provide multiple perspectives on the topic. In the next section, the aims of the dissertation are presented in greater detail, followed by the respective research questions.

Given my dissertation's focus on adolescents' interest in nature and its association with environmental attitudes and behavior, it was crucial to establish a reliable and valid measurement instrument for assessing this construct. Therefore, the first objective of my research was to develop an age-appropriate instrument specifically designed for adolescents to measure their interest in nature (see Manuscript 1). To achieve this, we adapted an existing and well-established interest measurement tool by Schiefele et al. ([1993](#)), tailoring it to the context of nature and the age group of adolescents. To ensure the accuracy and effectiveness of the self-reported instrument in assessing adolescents' interest in nature, we undertook a series of rigorous steps to evaluate its reliability and validity. Firstly, we aimed to demonstrate

the measure's validity through known-group comparisons, allowing for meaningful comparisons between different groups of adolescents. Additionally, we sought to establish the instrument's reliability by confirming its internal consistency and unidimensionality, ensuring that it effectively captures the intended construct. The development of this new scale, the Scale of Interest in Nature (SIN), aimed to provide a valuable assessment tool for measuring adolescents' interest in nature. Its potential applications extend beyond research settings, as it could also prove beneficial in formal and informal Education for Sustainable Development (ESD) contexts. By establishing a robust instrument, this dissertation sought to contribute to the field by enhancing our understanding of adolescents' interest in nature and its relevance for promoting sustainable attitudes and behaviors (see Manuscript 1).

Additional to the development of the SIN, the following research questions were posed in Manuscript 1:

- (1) Do adolescents who are more involved in nature-related activities in their free time exhibit a higher interest in nature and feel more connected to nature?*
- (2) How does interest in nature correlate with connection to nature and environmental attitudes?*

After gaining access to a reliable measurement tool, the next objective, pursued in Manuscript 2 was to delve into the level of interest in nature among adolescents. Interest in nature, as a possible driver of PEB, has received limited attention in previous research. Existing studies have predominantly focused only on interest in nature among adults, neglecting to explore adolescents' interest ([Kals et al., 1999](#); [Kleespies et al., 2021](#)). This knowledge gap is significant considering the growing body of evidence indicating that PEB primarily forms during childhood ([Chawla, 2020](#)). Therefore, the second aim of this dissertation was to address this gap by examining adolescent students' interest in nature across grade levels 5 to 9 within lower secondary school. The period of adolescence is of particular interest due to emerging research suggesting a decline in environmental attitudes and PEB during this phase. Notably, as adolescents undergo puberty, their focus on social interactions often supersedes their inclination to spend time in nature. Especially when puberty hits, adolescents seem to become more interested in social interactions than in spending time in nature. This shift may not only result in a disconnection from nature but also lead to a diminished interest in it. To contribute

to the ongoing discourse, this study aimed to provide insights by addressing the following questions:

- (1) How is interest in nature pronounced in school grades 5-9 within lower secondary school?*
- (2) How pronounced are nature activities among students in grades 5 to 9 and which of these activities are associated with a strong interest in nature?*
- (3) How does students' interest in nature correlate with their self-reported pro-environmental behavior?*

Given the objectives of Education for Sustainable Development to develop effective programs and policies to promote PEB ([UNESCO, 2020](#)), it is crucial to gain a comprehensive understanding of the primary drivers behind PEB ([Richardson et al., 2020](#); [Whitburn et al., 2020](#)). While previous research has examined various psychological factors influencing PEB ([Kollmuss & Agyeman, 2002](#)), the role of interest in nature as a potential driver has not been adequately explored. This represents a significant gap in current models explaining PEB, as interest is recognized as a fundamental factor in fostering internal motivation for learning and action ([Uitto et al., 2011](#)). To address this gap, our third aim, which is pursued in Manuscript 3, was to investigate the relationship between well-established drivers of PEB, such as connection to nature and environmental attitudes, and interest in nature. By integrating these factors into a unified model, we aimed to explore how they collectively influence PEB. This analysis sought to uncover the interconnections and prerequisites underlying environmental attitudes and behaviors, which can serve as the foundations for a sustainable future. By examining the relationships among connection to nature, environmental attitudes, and interest in nature within a comprehensive model, this research aimed to provide valuable insights into the complex dynamics of PEB. The findings contribute to a more holistic understanding of the drivers of PEB, shedding light on the unique role that interest in nature plays in fostering sustainable attitudes and behaviors. Ultimately, this knowledge could inform the development of more effective educational programs and policies that promote pro-environmental actions and pave the way for a sustainable future. Therefore, we aimed to answer the following research questions:

- (1) How is interest in nature related to other drivers of PEB, like connection to nature and environmental attitudes?*
- (2) What is the underlying structure of the relationships among students' interest in nature, connection to nature, and environmental attitudes, and their impact on self-reported behavior?*

By following these goals, this dissertation seeks to enhance our understanding of how interest in nature contributes to the development of PEB among students. The findings aim to shed light on the interconnectedness of different influencing factors – namely environmental attitudes, connection to nature, and nature-related activities – and provide insights into the role of interest in nature in promoting sustainable attitudes and actions. The overarching question is: Does interest really matter?

6 Outline of the thesis

This dissertation includes three first-authored publications: one published article, one article accepted with major revisions and one article under review, each addressing the above-mentioned goals. A summary and an explanation of the dissertation author's personal contribution is provided with each publication.

Paper N°1 (published open access in *Frontiers in Psychology*)

Neurohr, A-L., Pasch, N., Siegmar, O. & Möller, A. (2023). Measuring adolescents' interest in nature: a promising psychological factor facilitating nature protection. *Frontiers in Psychology*, Vol. 14. DOI: 10.3389/fpsyg.2023.1186557

Paper N°2 (accepted with major revisions in *The Journal of Environmental Education*)

Neurohr, A-L., Pasch, N., Bergmann-Gering, A. & Möller, A. Linking students' interest in nature to their self-reported pro-environmental behavior and nature activities – a cross-sectional study in grade 5 to 9.

Paper N°3 (under review in the *Journal of Environmental Psychology*)

Neurohr, A-L., Möller, A., Bergmann-Gering, A. & Johnson, B. Does Interest Really Matter? Interest in Nature as A Possible Determinant of Pro-Environmental Behavior.

6.1 Manuscript 1

Neurohr, A-L., Pasch, N., Siegmar, O. & Möller, A. (2023). Measuring adolescents' interest in nature: a promising psychological factor facilitating nature protection. *Frontiers in Psychology*, Vol. 14. DOI: 10.3389/fpsyg.2023.1186557

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Own contribution¹: Conceptualization of the paper, Methodology, Formal analysis, Fieldwork, Data curation, Writing – Original draft preparation, Writing – Review & editing, Visualization, Project administration

Summary

Research suggests that a genuine interest in nature and perceiving it as deserving protection can motivate individuals, particularly young people, to engage in pro-environmental behavior (PEB). While previous studies have focused mainly on the intellectual aspects of interest, it is proposed that affective or emotional factors may play a more influential role. This study aimed to develop and validate the Scale of Interest in Nature (SIN) to measure adolescents' affective interest in nature and investigate its importance as a possible driver of pro-environmental behavior. The scale was developed based on existing interest items, adapted for adolescents and nature-related topics, and validated using the known-group approach. The hypothesis was that adolescents who frequently engage in nature protection activities would exhibit stronger affective interest in nature.

A total of 351 adolescents aged 10 to 15 years old participated in the study and were divided into three interest groups: members of sports clubs, members of socially engaged organizations, and members of environmental organizations. Alongside interest in nature, participants answered questions about their environmental attitudes using the 2-MEV scale and their connection to nature using the INS scale. These established instruments were used

¹ To describe my contributions to each paper, the Contributor Roles Taxonomy Framework is used. It was introduced with the intention of recognizing individual author contributions, reducing authorship disputes, and facilitating collaboration. It was developed by researchers, the International Committee of Medical Journal Editors (ICMJE) and publishers (Allen et al., 2019).

to evaluate the discriminant and convergent construct validity of the newly developed SIN scale. Measurement data were analyzed using the Rasch model to obtain objective test results.

The empirical findings of the study indicate that the SIN is a reliable and valid instrument for measuring adolescents' interest in nature. It can be considered a specific and meaningful aspect of their attitude towards and connectedness to nature. The results demonstrate a significant difference in the level of interest between members and non-members of environmental organizations, suggesting that increased engagement with nature can promote interest. The study also reveals correlations between interest in nature and other environmental attitudes, providing insights into the underlying mechanisms of pro-environmental behavior.

The SIN scale provides researchers and educators with a tool to empirically assess interest in nature, which is crucial for promoting a more sustainable future. It contributes to understanding the interconnections between and prerequisites for environmental attitudes and can complement existing outcome measures of Education for Sustainable Development (ESD). By further investigating the relationship between interest in nature and other variables, including its influence on pro-environmental behavior, the scale can inform effective ESD and environmental education programs. Practitioners in formal and non-formal ESD settings can use the SIN to evaluate the effectiveness of their programs in increasing adolescents' interest in nature and fostering pro-environmental behavior.



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EDITED BY

Maria Limniou,
University of Liverpool, United Kingdom

REVIEWED BY

Michael Franzen,
Allegheny Health Network, United States
Melissa Hatty,
Monash University, Australia

*CORRESPONDENCE

Anna-Lena Neurohr
✉ anna-lena.neurohr@univie.ac.at
Andrea Möller
✉ andrea.moeller@univie.ac.at

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Measuring adolescents' level of interest in nature: a promising psychological factor facilitating nature protection

Anna-Lena Neurohr^{1*}, Nadine Pasch², Siegmund Otto³ and
Andrea Möller^{1,4*}

¹Austrian Educational Competence Centre for Biology, University of Vienna, Vienna, Austria, ²Biology Education, University of Trier, Trier, Germany, ³Department of Sustainable Development and Change, University of Hohenheim, Hohenheim, Germany, ⁴Department of Life Sciences, University of Vienna, Vienna, Austria

Studies indicate that young people are more prepared to engage in pro-environmental behavior if they are interested in nature and recognize it as worthy of protection. However, a reliable instrument to measure adolescents' interest in nature is still lacking. Therefore, we developed a new metric, the *Scale of Interest in Nature* (SIN). It consists of 18 items, is based on Item-Response-Theory and was validated using the known group approach ($N=351$ adolescents). Results indicate that adolescents' interest in nature correlates positively with their connection with nature, their intention to preserve nature and engagement in pro-environmental activities in their free time. Bivariate Pearson correlations between the SIN and the Connectedness to Nature Scale (INS), as well as the Environmental Values model (2-MEV) demonstrated the scale's construct validity. Hence, the SIN scale provides an economical way to measure adolescents' interest in nature in research contexts or environmental and sustainability education settings.

KEYWORDS

interest in nature, attitude measurements, environmental attitudes, adolescent attitudes, connection with nature, item response theory

1. Introduction

With the climate change and biodiversity crises, humanity is facing perhaps the most difficult challenges in its history. Reports about global warming (Al-Ghussain, 2019), sea-level rise (Nerem et al., 2018), permafrost gradation (Colucci and Guglielmin, 2019), glacier melting and retreat (Brighenti et al., 2019) as well as the dramatic loss of biodiversity (Eichenberg et al., 2021) are ubiquitous. Both, the IPBES (2019) as well as the (IPCC, 2021) reports confirm that human behavior and decisions are the main cause of these global effects. Changes are needed in political commitment, institutional frameworks, policies and instruments in order to set clear adaptation goals and define responsibilities and commitments (Pörtner et al., 2022). In addition, individual actions must also change. In regard to this important agenda, researchers worldwide highlight the great potential of the education sector to play an active role in fostering a just climate transition (Anderson, 2012; Lutz et al., 2014; Reimers, 2021; Winter et al., 2022). Otto I. M. et al. (2020) even identified the education system as a "social tipping element" within the "climate tipping elements," indicating the prominent role of education in helping to activate social dynamics that can stabilize the earth's climate by 2050 (Otto I. M. et al., 2020; Winter et al.,

2022). Here, Education for Sustainable Development (ESD) can respond to the urgent and dramatic challenges the planet faces and offers learners of all ages the knowledge, skills, values and attitudes needed to promote sustainable development and pro-environmental action. ESD is considered a lifelong learning process empowering people to make informed decisions and take individual and collective actions to address national and global challenges—such as climate change or biodiversity loss (UNESCO, 2020). Within this framework, research indicates that different influencing factors, such as environmental knowledge, interests, values, and attitudes, work to form a person's pro-environmental behavior (Kals et al., 1999; Roczen et al., 2014; Evans et al., 2018; Maurer and Bogner, 2020). These factors include affective, intellectual and behavioral components (Schwartz, 1992; Eagly and Chaiken, 1993; Fishbein, 2010; Kahneman, 2011). Interest, for example can be triggered either by intellectual or affective aspects (Hidi and Renninger, 2006).

Among the various factors influencing environmental behavior, interest in nature seems to play an important role in developing and maintaining environmental knowledge, values and attitudes (Uitto et al., 2011). Studies indicate that young people are more prepared to engage in pro-environmental behavior if they are interested in nature and recognize it as worthy of protection (Kals et al., 1999; Leske and Bögeholz, 2008; Uitto et al., 2011; Cheng and Monroe, 2012). Guiney (2009) demonstrated that the main reasons conservation volunteers actively engage in nature protection were interest in nature at a young age as well as nature-related activities and experiences in adolescence (Kals et al., 1999; Chawla, 2020). Such interest and experience leads to a comprehensive understanding of the natural world and humans' complex relationship with it, which in turn contributes to environmental awareness and willingness to act (Kals et al., 1999; Bogner, 2007).

Most research on interest in nature concentrates on its intellectual aspects (Kals et al., 1999; Kleespies et al., 2021). However, these intellectual factors (such as environmental knowledge) seem to have little to no influence on environmental behavior (Frick et al., 2004; Abrahamse et al., 2005; Otto and Pensini, 2017). Instead, it is more likely that the motivation to act is triggered by affective or motivational factors, such as personal values, goals, and self-efficacy beliefs, which play a crucial role in driving behavior. These factors can influence individuals' intentions, decision-making processes, and level of engagement in taking action (e.g., Ajzen, 1985; Deci and Ryan, 2000; Singh et al., 2006). Although interest's affective factors have not been thoroughly examined regarding their influence on pro-environmental behavior, it seems reasonable to assume that an interest in nature primarily driven by emotions could motivate individuals to actively engage in environmental protection. Therefore, the question arises as to how interest in nature develops over time and how it is related to other factors that influence pro-environmental behavior, such as environmental attitudes, and how it ultimately affects behavior. Since we already know that most of the foundations for environmentally protective behavior is laid in childhood (Evans et al., 2018; Otto et al., 2019; Chawla, 2020), it can be assumed that formation of an affective interest in nature should also take place at an early age.

This study aims to validate a scale for measuring adolescents' interest in nature (*Scale of Interest in Nature*, SIN) in terms of its affective aspects—intrinsic, value and emotion-related—in order to provide an age-appropriate assessment instrument. We specifically

chose adolescents as the target population because studies show that interest in nature drops with increasing age, especially when puberty hits (e.g., Leske and Bögeholz, 2008). Therefore, we believe it is of great importance to have an instrument at hand that reliably assesses interest in nature in this specific age group in research contexts as well as in environmental and sustainability education settings. Moreover, the newly introduced variable (SIN) could unveil additional attitude traits that affect pro-environmental behavior and enhance comprehension of the interrelations among these attitudes. Furthermore, by looking into existing measures of connectedness to and interest in nature (e.g., Kals et al., 1999; Schultz, 2002; Mayer and Frantz, 2004; Brügger et al., 2011), but also by their conceptualization, we expect interest in nature will most likely establish “only” as a specific but practically meaningful facet of attitude toward or connectedness to nature.

The scale developed for this purpose is based on the interest items by Schiefele et al. (1993) and was adapted to adolescents and to the topic of nature. In developing the items, we included (Markl's 1989) concept of nature and the biophilic values by Kellert (1993). For validation, we use the known groups approach and compare groups with different frequencies of experiences in nature. Based on former studies (e.g., Guiney, 2009) we hypothesize that adolescents who are more involved in nature-related activities in their free time feel more connected with nature and show a higher affective interest in it.

2. Theoretical framework

2.1. Environmental attitudes

Researchers emphasize the multidimensional nature of environmental attitudes and assume a framework of intellectual (facts, knowledge or understanding), affective (emotion and feeling) and conative (action and behavior) components (e.g., Fishbein and Ajzen, 1974; Gray, 1985). Educational programs have long provided the foundations of environmental awareness and concern about human impact, which shape the development of environmental behavior (Gigliotti, 1990; Hungerford and Volk, 1990; Bogner, 2004). Researchers have suggested that the most important determinant of behavior is attitude (Eagles and Demare, 1999). The construct of environmental attitudes commonly encompasses multiple components and can be defined as a “collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues” (Schultz et al., 2004, p. 31). However, values might be at the broadest level and are conceptualized as important principles in life (Olson and Zanna, 1993; Schultz et al., 2004). Values function as an organizing system for attitudes and beliefs, and they are viewed as determinants of attitudes. Studies have further emphasized the importance of values in situational and personal interest (Hidi and Renninger, 2006). The term environmental values refers to values that are specifically related to nature or that have been found to correlate with specific environmental attitudes or concerns (Schultz et al., 2004).

Numerous approaches to operationalizing empirical scales have been proposed within the domain of environmental attitudes (Bogner and Wiseman, 2002), which captures attitudes at various levels of specificity, such as attitudes, worldviews, and values. In order to measure adolescents' environmental attitudes, Bogner and Wiseman (1999, 2002) developed the Environmental Scale (2-MEV). Their first

study revealed several subscales of environmental concern, including attitudes, verbal commitment, and actual behavior. Using higher-order factor analysis based on a large pool of items, they developed a model of ecological values (MEV) based upon one's position on two orthogonal dimensions: Utilization and Preservation. These two values allow a person both to endorse the protection of the environment on a biocentric dimension and to support the utilization of nature on an anthropocentric dimension. The theory of ecological attitudes (EA) posits that people who have strong Preservation (biocentric) attitudes do not necessarily have weak Utilization (anthropocentric) attitudes. This allows individuals to be placed in one of four quadrants rather than on either end of a continuum. The theory explicitly states that Preservation and Utilization are complementary and uncorrelated, not opposing values. Hence, a respondent's position on one dimension provides no information about his position on the other. At present, the 2-MEV scale's validity has been independently and repeatedly confirmed by different research groups and has been translated into 33 different languages. Additionally, several researchers have confirmed the bi-dimensional structure of EA, suggesting that Preservation and Utilization are two distinct constructs (Milfont and Duckitt, 2004; Johnson and Manoli, 2010). Therefore, Bogner and Wiseman (2006) offer an age-adjusted item battery for adolescents employing more rigorous psychometric techniques. By measuring environmental attitudes, they expect to obtain a valuable predictor of ecological behavior (Oerke and Bogner, 2013; Maurer and Bogner, 2020; Bogner and Suarez, 2022).

2.2. Connectedness with nature

Adolescents are increasingly disconnected from nature, a trend that has significant implications for the preservation of the biosphere (Louv, 2005; Charles et al., 2018; Chawla, 2020). Connectedness with nature is linked to ecological concern and is seen as a lever for societal change toward respect and care for nature (Ives et al., 2017; Otto and Pensini, 2017). This connectedness describes how people form a relationship with elements in the environment (Beery, 2013; Salazar et al., 2021). Numerous studies have identified experiences that create a sense of connection to nature and how this connection is linked to other aspects of life, such as happiness and support for environmental preservation (Tam, 2013; Zylstra et al., 2014; Restall and Conrad, 2015). Spending time in nature and focusing attention on it can enhance this connection (Richardson et al., 2020; Bezeljak et al., 2023).

Furthermore, studies have found that connection to nature is positively associated with pro-environmental behavior and can thus be seen as a significant predictor of it (Mayer and Frantz, 2004; Nisbet et al., 2009; Otto et al., 2014; Roczen et al., 2014; Zelenski et al., 2015; Whitburn et al., 2019, 2020). However, environmental values, attitudes, emotional involvement, social and cultural factors also play roles in explaining environmental behavior (Kollmuss and Agyeman, 2002; Eames et al., 2018). Young people with more access to and experience in nature express a stronger connectedness with it and are more likely to take action to care for nature, even into adulthood (Cheng and Monroe, 2012; Collado et al., 2013; Evans et al., 2018; Barrable and Booth, 2020; Chawla, 2020). Childhood is a crucial period for connecting with nature, but the level of connection tends to decrease to its lowest level in adolescence before slowly rising again in adulthood (Liefänder et al., 2013; Hughes et al., 2019; Richardson et al., 2019).

Regarding the terminology, various terms are employed to describe the concept of connectedness with nature, including affinity, biophilia, ecological self, and nature-relatedness, among others (Beery, 2013). One approach is presented by Schultz et al. (2004), who argue that an individual's beliefs about the extent to which they are part of the natural environment provides the foundation for the types of concerns they develop, and the types of situations that will motivate them to act. To analyze connectedness with nature, they used the Inclusion of Nature in Self Scale (INS; Schultz, 2002) which examines a person's relationship with nature. They found that connectedness correlates with biospheric concerns and with self-reported environmental behavior. Therefore, individuals who feel a link between themselves and the natural environment tend to have broader sets of concerns for environmental issues. In contrast, those who feel separate from nature only value nature when it benefits them individually.

2.3. Interest in nature

While connection with nature has been interpreted as an environmental attitude (Brügger et al., 2011), personal interest in nature can be seen as the basic factor underlying the development and maintenance of an internal motivation to study nature or act in a pro-environmental way (Uitto and Saloranta, 2010). According to the person-object theory by Krapp (2002), interest represents a specific relationship between a person and an object and encompasses intellectual and affective components (Hidi et al., 2004). Furthermore, he distinguishes between two levels of interest: a situational interest and individual interest (Krapp, 2002). Situational interest describes a motivational state of being interested during an actual activity and is necessary for the development of a sustained, individual interest (Krapp and Prenzel, 2011). Individual interest refers to a person's dispositional motivational state and is interpreted as a relatively stable tendency to engage with an object of interest without external pressure (Krapp and Prenzel, 2011). Through psychological processes like internalization and identification, the object of interest will be integrated into an individual's values and feelings and becomes a permanent part of their own identity (Krapp, 2007; Blankenburg and Scheersoi, 2018). Individuals with a well-developed individual interest not only act primarily out of their own motivation but have also developed a persistence to carry on despite failures or negative feelings (Renninger and Hidi, 2002). Therefore, in order to foster a successful development of interest and engagement in an object, individuals need to first identify with the object of interest and to integrate it into their self-concept (Blankenburg and Scheersoi, 2018).

Interest in nature can be considered a type of individual interest, describing the relationship between a person and the object of nature. This relationship is also described in Markl's (1989) understanding of nature: he advocates for a "biocentric" perspective in which humans recognize that they are part of a larger web of life rather than separate from it. This includes all aspects of the natural world, such as animals, plants and landscapes. In line with this, the biophilia hypothesis argues that humans have an innate interest in life and life-like processes (Wilson, 1984) and need nature for more than just physical survival. Studies support these theories and have shown that an (intellectual) interest in nature has a direct effect on the development of willingness to protect nature and could be therefore a predictor of

nature-protective behavior (Langeheine and Lehmann, 1986; Vining and Ebreo, 1992; Kals, 1996; Kals et al., 1999). However, existing studies have concentrated only on intellectual interest in nature, not on its affective character. Even though some researchers suggest that interest is a purely affective construct (Schiefele et al., 1993), it remains unclear what influence an affective interest in nature might have on pro-environmental behavior.

Schiefele et al. (1993) go further in describing affective interest and identify three different components: a value-related, an emotion-related, and an intrinsic component. Whereas the value-related component refers to matters that are personally meaningful to an individual, the emotional component of interest consists of matters that are associated with positive feelings such as pleasure. The intrinsic component involves direct emotional and value attributions to an object or action (Schiefele et al., 1993). Although these components are theoretically well-grounded, they do not separate well analytically in various studies and often load onto a common factor. Taking Schiefele et al.'s (1993) theoretical approach into account, Leske and Bögeholz (2008) examined the influence of interest in nature on the willingness to preserve biodiversity among student in grades 7–12. Their analysis identified the value-related and emotional components as influential predictors. However, they extended the concept of nature used by Kals et al. (1999) to include the terms “biodiversity” and “ecosystems.” Both terms do not merely describe the natural environment, but also emphasize the importance of its conservation and preservation. Thus, the inclusion of these terms in the measurement of interest in nature implies not only a fascination or attraction to nature but also a recognition of the need to protect it for future generations (Miller, 2005). By including these terms, interest in nature does not describe an individual preference anymore, but also carries a sense of responsibility and concern for the well-being of the environment.

However, it remains unclear what influence interest in nature has on pro-environmental behavior and how it is related to other environmental attitudinal variables. Interest in nature could be an additional or rather more direct construct than environmental attitudes and behavior, possibly explaining why students develop greater pro-environmental competence through nature-based environmental education (Otto and Pensini, 2017). Moreover, interest in nature could be a motivation to develop environmental competency similar to a fascination with science, which is an important motivator for engaging in science and supports deeper learning (Otto S. et al., 2020).

Therefore, in this study we aim to develop and validate a comprehensive self-report instrument that accurately assesses adolescents' interest in nature: the Scale of Interest in Nature (SIN). We want to demonstrate the measure's reliability by confirming the internal consistency of the construct and by confirming unidimensionality. Assuming that attitudes toward nature and attitudes toward environmental protection represent different dimensions (Kaiser et al., 2013), we predict interest in nature to be on the same dimension as the inclusion of nature in self (Schultz, 2002), while preservation (Bogner and Wiseman, 2006) should be on a separate dimension. To ensure the construct validity of SIN, a known-group comparison was used. Using SIN, we hope to provide an assessment tool for adolescents' interest in nature, which can be helpful in research settings as well as in formal or informal education for sustainable development.

3. Methods

3.1. Participants and procedures

In 2017 and 2018, a sample of 351 adolescents (average age = 12.58 years, SD: 1.58, range: 10–15; 41.9% girls) were selected from different interest groups in Germany (Rhineland-Palatinate, North Rhine-Westphalia, and Saarland) and Austria (Vienna and Lower Austria). We employed the method of comparing of known groups as a validation criterion for the scale, as this approach has been previously utilized to assess pro-environmental and pro-social behavior (e.g., Neaman et al., 2021; Otto et al., 2021). Known-groups validity is demonstrated when a questionnaire can discriminate between two groups known to differ on the variable of interest. Based on previous research, we chose environmental organizations, humanitarian organizations, and sport clubs (i.e., Scarborough, 2013; Otto et al., 2021). This prior research has shown that connectedness to nature is higher in students enrolled in environmental studies compared to students enrolled in other courses, in park management students compared to sports management students, and in members of environmentalist groups compared to humanitarian groups. As interest in nature is theoretically related to attitudes and general ecological behavior, we expect that members of environmental groups spend more time outside, feel more responsible for nature and show a higher interest in nature and the environment than members of other interest groups. To test this hypothesis, we linked participants' interest in nature with their free time activities. Therefore, we divided the sample into three different interest groups:

1. Members of Sports Clubs ($N=133$, e.g., football, handball or track and field), who were expected to express no specific interest in nature or nature protection. This group has chosen its hobby because of the physical activity involved. In personal conversations, the adolescents claimed that they chose football, for example, because of the sport itself and not as a way to spend more time outside;
2. Members of Socially Engaged Associations ($N=112$, e.g., the Red Cross or other welfare organizations), who are engaged in voluntary work, but not with regard to nature or the environment; and
3. Active Members in Various Groups or Organizations for Nature Protection ($N=106$, such as participants in Junior Ranger Programs or the youth associations of national nature conservation groups), who engage with protecting nature in their free time and also conduct nature protection activities as private individuals. To ensure that all participating groups are really focused on nature and its protection, we accompanied and observed them as they conducted weekly nature conservation activities. These activities include hanging birdhouses, building bat shelters, and planting trees.

We identified sport clubs, humanitarian and environmental organizations in the respective regions via the internet and then made individual appointments with the different groups to collect the data. The selected organizations were the same in Germany and Austria (e.g., the German and the Austrian Red Cross) in order to ensure that the organizations had equivalent aims. Participants completed the

questionnaire at their regular group meetings during their free time. To prevent overlap in interest groups, the questionnaires asked about participation in other organizations. Only 4.08% of participants demonstrated double engagement. Of the 360 participants who were provided with the paper-and pencil questionnaire, 351 completed it (response rate: 97.5%).

3.2. Measures

The 2 Major Environmental Values model scale (2-MEV, Wiseman and Bogner, 2003) comprises 18 statements addressing the constructs of Preservation and Utilization (see [Supplementary material 1](#)). The Preservation measure was derived from students' responses to 9 items, such as "I take care to save water and electricity." Utilization was also measured with 9 items, such as "Humans are more important than other living beings (e.g., animals and plants)." Participants gave their responses on a 5-point Likert scale from 0 (strongly disagree) to 4 (strongly agree). Conventional principal factors' extraction with varimax rotation confirmed the proposed two-factor solution. In total, the two-factor model accounted for 40.42% of the common variance in the data. Scores on the individual levels were calculated in accordance with convention as mean values for the 18 items using a Rasch-scale calibration. Although the 2-MEV was originally subject to a factor analysis, we believe a Rasch-based analysis provides numerous advantages. Even if participants do not respond to the exact same set of items, they can still be quantitatively compared as long as the scales have some core overlapping items (Kaiser et al., 2018). Because the estimation procedure is based on a maximum likelihood approach, attitude estimates can be attained even with incomplete data sets that contain missing values (Baierl et al., 2022). Further, Kaiser et al. (2018) propose that the Rasch model can assure a specific objectivity by ordering indicators transitively with respect to their difficulty. The type of indicator is not a defining feature of environmental attitudes, but the "numerical relations of magnitudes of psychological attributes incorporated in people" is (Kaiser et al., 2018, p. 141). The results of the analyses are in line with previous studies (Bogner and Wiseman, 2006) and revealed acceptable internal consistencies for both Preservation ($\alpha = 0.79$) and Utilization ($\alpha = 0.74$).

Inclusion of nature in self (INS) is the second scale used in this study. The INS is widely used as an assessment of nature connectedness and is based on only one item (Schultz, 2002). By means of a series of seven differentially overlapping circles (labeled "self" and "nature"), participants could choose the one that best described how connected they felt with nature. Compared to other multiple-item scales, the INS has been found to be very accurate for measuring individual connectedness with nature and correlates well with other connection with nature instruments (Brügger et al., 2011). Scores range from 0 to 6, with the circle with the least overlap receiving a score of 0 (complete separation from nature) and the most overlapping circle receiving a score of 6 (complete connection to nature) (see Schultz, 2002). Since this measure is a single-item measure, its reliability could not be estimated with our data. Nevertheless, its 4-week test-retest reliability is reported to be $r_{tt} = 0.84$ (Schultz et al., 2004).

3.3. Development of the scale of interest in nature

Our newly developed scale of interest in nature (SIN) is a composite of 18 interest items (see [Table 1](#)), which were adapted from Schiefele et al. (1993). The item set was reduced statistically from initial 43 items via item response theory (see [Supplementary material 2](#) for the initial set of 43 items). In contrast to other research groups (Prenzel et al., 1986; Kleespies et al., 2021), Schiefele et al. (1993) present a distinct perspective on the nature of interest. They conceptualize interest as a purely affective construct, separated from any intellectual or knowledge-related components. They propose indeed three components of affective interest: an emotion-related component, a value-related component, and an intrinsic component.

The emotion-related component involves positive emotional experiences and thoughts associated with the object of interest. The value-related component pertains to the personal significance or attributions linked to the object. Finally, the intrinsic component, which Schiefele et al. (1993) consider the most crucial, refers to self-intentionality. It represents a person's engagement with the object for its own sake, driven by internal motivation rather than external rewards or incentives. By emphasizing the intrinsic component, interest is distinguished from other forms of motivation that are externally driven. It describes then a self-determined and autonomous interest that arises from the inherent qualities of the object itself. This approach is consistent with former studies, which have suggested that intellectual variables have little or no effect on environmental behavior (Frick et al., 2004; Abrahamse et al., 2005; Barth et al., 2012; Otto and Pensini, 2017; Knutti, 2019).

To incorporate the idea of nature into our items, we utilized both Markl's (1989) concept of nature and Kellert's (1993) biophilic values. Both researchers emphasize the importance of understanding and valuing nature for the sake of environmental protection. Markl (1989) focuses more on the emotional aspects of human-nature relationships, underlining the importance of experiencing wonder in nature as part of one's spirituality. He suggests that humans should strive for a harmonious relationship with nature based on respect and humility. Similarly, Kellert's concept of biophilia emphasizes the innate human connection to nature and the importance of maintaining the connection for our well-being and the preservation of the natural world. However, unlike other studies (Kals et al., 1999; Leske and Bögeholz, 2008), we did not take into account resources, biodiversity and ecosystem in our items. These aspects encompass the idea of environmental preservation and thus express motivation rather than interest. We found support in this decision in Kaiser et al. (2013), who found that attitude toward nature and attitude toward nature protection represent two separate constructs. The items were formulated using age-appropriate language and considering the reality of adolescents' lives.

We measured interest in nature with 18 self-reported items on a 5-point Likert scale (0 = strongly disagree to 4 = strongly agree). To control for response style bias, the scale included 5 inverse items, which we recoded afterwards. In line with Kaiser and Wilson (2004), the answers to the polytomous items were recoded into a dichotomous format by collapsing strongly disagree, disagree and partially agree as indicators for a lack of interest in nature. The responses agree and strongly agree were combined to indicate an interest in nature. This dichotomization practice is an established precaution to guard against

TABLE 1 Item fit values of all the 18 items for the Scale of Interest in Nature (SIN) of the pilot and of the final study, adapted from Schiefele et al. (1993).

POI dimension	Original item (Schiefele et al.), translated	Items in the final questionnaire		MNSQ pilot study (N=256)	MNSQ final study (N=351)
		#	Item		
Emotion-related valences	Working with the subject matter and problems of my major is not really among my favorite activities	IN 27	I enjoy discovering nature with my friends more than playing computer games or video games with them	1.16	0.94
	I do not like to talk much about the subject matter related to my studies	IN 5i	Plants are boring	1.15	0.98
		IN 37	It is exciting to examine bees or other insects with a magnifying glass	0.88	0.93
	I prefer to talk about my hobbies rather than about my major	IN 13i	I prefer talking about new movies and music, rather than animals	0.83	1.11
	When I am in a library or bookstore, I like to browse through magazines or books with topics related to my major	IN 15	In libraries, I like reading nature books (for example on animals or plants)	0.64	0.91
	A reference book as a birthday present would not give me any particular pleasure	IN 3	In my opinion, documentaries and movies on nature are interesting	0.83	1.00
		IN 16	I would be happy to receive a calendar with nature pictures (for example animals or landscapes) for my birthday	0.92	0.95
	Many areas within my major do not mean anything to me	IN 17i	I do not really mind the fact that humans destroy nature	0.70	1.10
Value-related valences	It was of great personal importance to be to be able to study this particular subject	IN 24	It is important to me to know the names of local animals and plants	0.67	0.92
		IN 26	Personally, I find it important to know the role of humans in nature	0.68	1.06
	To be absolutely honest, I feel sometimes rather indifferent toward my major	IN 22i	If I am being completely honest, I do not care about animals and plants at all	1.05	0.99
	Compared to other things that are of great importance to me (e.g., hobbies, social life), my studies are of markedly less significance to me	IN 7i	I have no personal interest in what happens in nature	0.60	1.12
	I cannot imagine pursuing the content of my studies as a hobby*	IN 28	I could imagine collecting feathers, leaves or other things as a hobby	1.10	0.86
Intrinsic orientation	If I had enough time, I would work more intensively with certain aspects of my studies, even if they had nothing to do with any course requirements	IN 21	In my spare time I take pictures of flowers, animals and landscapes	1.08	1.12
	In my free time, I am unwilling to deal with problems in my field of study*	IN 34	In my spare time I examine plants and conduct small experiments with them (e.g., poking them gently, blowing at them)	1.11	0.96
		IN 30	In my spare time I participate in projects on preserving nature	0.86	1.06
	Even before coming to college I voluntarily spent time thinking about the subject matter of my major (e.g., read books, went to lectures, had conversation with others)	IN 36	Outside of school, I seek out information about animals and plants (for example on the internet or in books)	0.81	0.70
	I chose my major primarily because of the interesting subject matter involved	IN 42	I purposely chose hobbies that allow me to spend a lot of time in nature (e.g., riding, fishing, geocaching)	1.25	1.16

*own translation due to missing translation by the author, "i" indicates an inverted item.

excessive measurement error, particularly in attitude research (DeCoster et al., 2009; for supporting evidence, see, e.g., Kaiser and Wilson, 2004; Byrka et al., 2016). For all items, “Not applicable” was an alternative response when an answer was not possible: such responses were treated as missing values. Rasch model calibrations and therefore person score estimations can be gained even with incomplete data records, as this estimation is based on a maximum probability procedure (Embretson and Reise, 2000; Linacre, 2002; Kaiser et al., 2007; Boone et al., 2014). In addition, we collected socioeconomic data from the adolescents such as age, gender, grade, type of school and the native language.

Using the methodology of parceling (Little et al., 2002), the items of the SIN scale were reduced statistically from 43 to 18 items via item response theory (see [Supplementary material 2](#) for the 43 initial items). This method involves grouping multiple observed variables together into smaller parcels, which are then used as indicators of latent variables. It is mostly used in structural equation modeling (SEM) to create composite variables or parcels from observed indicators. Parceling aims to improve the efficiency and stability of the analysis by reducing the number of observed variables and increasing the reliability of the parcels. We reviewed Item Infits (MS Infit <1.3; Wright et al., 1994) and the difficulty distribution on a Wright map (person-item map). A Wright map is a graphical representation of a Rasch model that visually displays the performance of items and persons on a single scale, demonstrating the fit between items and persons and providing information about any patterns or anomalies in the data (Linacre, 2021). It is a useful tool for evaluating the performance of a questionnaire and can be used to identify problematic items. Items that are on the same level on the Wright Map cover the same degree of interest in nature. In order to reduce the number of items and ensure that all levels of interest were covered, we removed items that were located on the same level in the Wright Map. As a result of this reduction, we lessened disturbance variants, minimized scattering and errors, and enabled a normal distribution (Bandalos and Finney, 2001). This adaptation was justified by two pilot studies (first pilot: $N = 79$; second pilot: $N = 177$) in grades 5–8 (10–15 years old) in German schools (Rhineland-Palatinate) using the original scale (item rel.: 0.96, person-rel.: 0.92 and MNSQ Infit: 0.62–1.45). The indices for item reliability, person reliability, construct validity, normal distribution and model fit were checked, which attested to the test quality (e.g., Linacre, 2009; Boone et al., 2014). Mean-Infit MS-Values (MNSQ) up to 1.3 suggest a reasonable fit of the data to the model (Wright et al., 1994).

3.4. Statistical analysis

The Rasch model was used to analyze the measurement data (Linacre, 2002). This model can obtain specifically objective (i.e., item and person-independent) test results. Specific objectivity in this context means that two persons can be quantitatively compared with each other regarding a latent attribute (e.g., environmental attitudes) even if different measurement instruments have been used to assess the attribute (for more details, see Kaiser et al., 2018). Therefore, the specific objectivity can be seen as a formal validation criterion. To test if the developed test items fit the Rasch model, we analyzed the model fit indices. To further evaluate the test quality, reliability indices such

as person reliability, person separation and item reliability were also checked (Bond et al., 2020). Person separation was used to classify individuals and ensure that the instrument can effectively differentiate between high and low performers. Item separation was employed to validate the item difficulty hierarchy, which demonstrated the construct validity of the instrument (Boone et al., 2014; Boone and Staver, 2020). Malec et al. (2007) suggests the following critical values: item reliability of 0.90, person reliability of 0.80, person separation of 2.0, and item separation of 4.0. Due to the relatively large sample size, we relied on the mean square values (MS Infits) in the assessment of item fit, where values lower than 1.3 indicate an acceptable fit (O'Connor et al., 2016; Linacre, 2021).

The discriminant and convergent construct validity of the newly developed scale were evaluated with two well-established environmental attitude instruments (INS: Schultz, 2002; 2-MEV: Bogner and Wiseman, 1999). To demonstrate that the instrument is unidimensional and internally consistent, we conducted a principal-axis factor (PAF) analysis based on the theoretical factors established in the instrument design process. Analyses were done with a varimax rotation. The inclusion of nature in self scale (INS) is designed to measure the degree to which people include nature in their self-concept (Schultz, 2001). Since both the INS scale and interest in nature measure individuals' psychological connection and affinity with the natural world, comparing the scores on these two measures can provide evidence of convergent validity. To show discriminant validity, the Preservation items by Bogner and Wiseman (1999) were used. Kaiser et al. (2013) postulates a two-dimensional attitude model, which distinguishes between appreciation for nature (which we measure with SIN) and appreciation for environmental protection (which can be called preservation).

To ensure construct validity, we compared groups with different frequencies of experiences in nature (known-groups) using an analysis of variance (ANOVA). Following the known groups approach, we assume that members of an environmental organization, respectively, show a higher-than-average pro-environmental motivation (Otto et al., 2021). Data analysis was conducted with the Rasch software Winsteps (Linacre, 2015) and SPSS 26 for further calculations.

4. Results

The present findings are reported in two parts. First, we describe the calibration of the proposed SIN scale using the partial-credit Rasch model in order to evaluate the construct validity with the 2-MEV (Wiseman and Bogner, 2003) and INS (Schultz, 2002). Here, we present the test quality indices. Second, we also present the comparison of the known groups to demonstrate the construct validation of the newly developed scale.

4.1. Psychometric quality of the scale of interest in nature

To assess the construct validity of the three instruments used, we performed a principal-axis factor analysis (PAF) with a varimax rotation, extracting three factors. The objective was to confirm that the

items representing the constructs of Interest in Nature, Preservation, and Utilization loaded significantly on their respective factors. The PAF was employed to establish the unidimensionality and internal consistency of each of the three above mentioned constructs, based on the underlying theoretical framework. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.81, above the commonly recommended value of 0.5, and Bartlett's test of sphericity was significant ($p < 0.001$), indicating that correlations between items were sufficiently large to perform a PAF. Examination of Kaiser's criteria and the scree plot yielded empirical justification for retaining three factors with eigenvalues exceeding 1, which accounted for 31.94% of the total variance.

Based on the theoretical framework, we assumed three factors to be examined: Interest in Nature, Preservation and Utilization. The analyses indicated that most of the items' factor loadings resembled the theoretical structure (see Table 2). Some unexpected cross-loadings were found between the value-related interest in nature items and the preservation items. However, this can be explained with reference to the theoretical derivation of the two constructs. Only if a person considers nature to be valuable will he or she also commit themselves to it and protect it. For this reason, the Preservation construct already contains value-related tendencies. If the SIN is used together with the 2-MEV, the 5 value-related items could be cut (Table 1), since these are already reflected in the preservation items (in the following "SIN re" refers to the reduced version of the scale consisting of 13 items). The internal consistency of the reduced SIN scale and bivariate correlations can be found in Table 3 (see variable SIN re). However, since the aim was to create a stand-alone instrument, these items remain included in the further analyses, and the results presented below pertain to the entire SIN scale (with 18 items).

Using a Rasch analysis, we found that all item statistics lay within a valid range and indicated a good test quality for the developed SIN scale (Item-Rel.: 0.99, MNSQ Infit mean: 0.99). All 18 items fitted the model prediction with reasonable MS-values between 0.70 and 1.16. None of the items fell outside the tolerable range of fit (i.e., $MS < 1.3$; cf. Wright et al., 1994; Linacre, 2009; Boone et al., 2014). The Rasch-model based person reliability of our developed scale was thus also found to be good with person rel. = 0.81 ($N = 351$).

The convergent validity of interest in nature was derived from the pattern of correlations between interest in nature and inclusion of nature in self. In addition to its intellectual dimension, inclusion of nature in self contains an affective dimension which describes the feeling of a connection to and desire to care for nature (Schultz, 2002). Thus, an emotional affinity can arise between a person and nature (Kals et al., 1999). These emotion-and value-related aspects can also be found in the construct of interest in nature. As expected, the measurement-error-attenuation-corrected Pearson correlation between the two instruments showed that they substantially overlap (i.e., $r_{corr} = 0.61$; see Table 3).

Discriminant validity was inferred by the correlations between the interest in nature and the two environmental attitudes - Preservation and Utilization. Kaiser et al. (2013) present a two-dimensional attitude model, distinguishing between appreciation for environmental protection and appreciation for nature. We therefore assume that interest in nature reflects a different dimension than Preservation and Utilization. This idea is also supported by the preceding PAF, where items from these scales loaded on different factors. Both measures

TABLE 2 Standardized loadings on the dimensions emotion-related, value-related and intrinsic interest in nature (SIN) as well as Preservation (PRE) and Utilization (UTL) for the sample of adolescents (10–15years old) ($N = 351$).

Item		SIN	PRE	UTL
Emotion-related				
IN3 ^a		0.52		
IN5i ^a		0.38		
IN13i ^a		0.47		
IN15 ^a		0.55		
IN16 ^a		0.43		
IN17i ^a			0.43	
IN27 ^a		0.38	0.39	
IN37 ^a		0.55		
Value-related				
IN7i ^a			0.34	
IN22i ^a			0.42	−0.31
IN24 ^a		0.49		
IN26 ^a		0.35	0.39	
IN28 ^a		0.68		
Intrinsic				
IN21 ^a		0.46		
IN30 ^a		0.47		
IN34 ^a		0.53		
IN36 ^a		0.74		
IN42 ^a		0.39		
UTL1 ^b				0.49
UTL2 ^b				0.49
UTL3 ^b				0.41
UTL4 ^b			−0.33	0.50
UTL5 ^b				0.48
UTL6 ^b				0.42
UTL7 ^b			−0.34	0.63
UTL9 ^b			−0.44	0.46
UTL10 ^b				0.55
PRE1 ^b			0.55	
PRE2 ^b		0.36	0.62	
PRE3 ^b			0.49	
PRE4 ^b				−0.50
PRE5 ^b		0.31	0.51	
PRE7 ^b			0.65	
PRE8 ^b		0.58	0.46	
PRE9 ^b			0.48	
PRE10 ^b				−0.56

Inverse items are marked with an *i* (for inverted); loadings under 0.3 were suppressed.

Item (s) source:

^aModified from Schiefele et al. (1993).

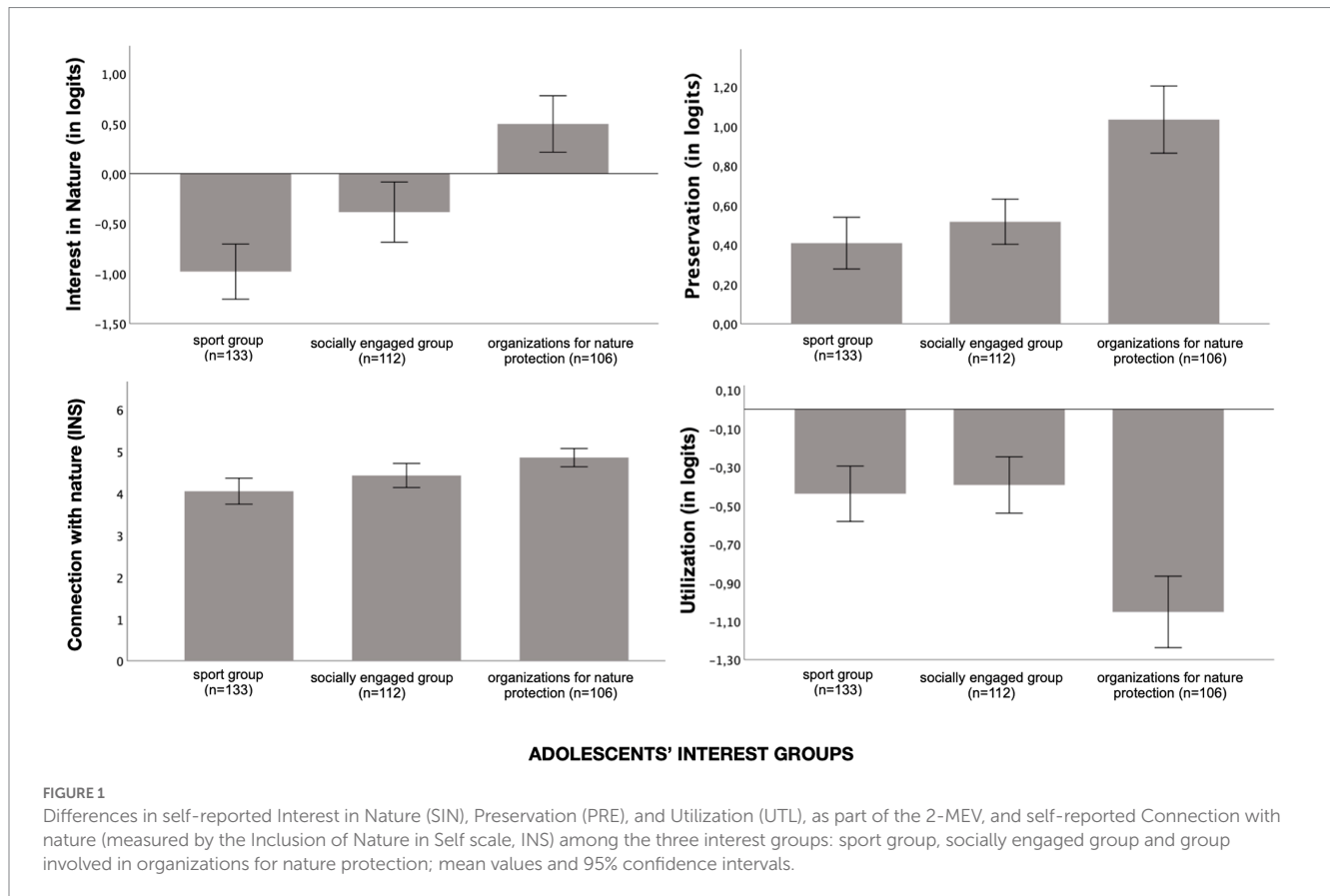
^bModified from Bogner and Wiseman (2006).

exhibit only a small to moderate correlation with interest in nature ($0.16 < r_{corr} < -0.29$), which shows the measured constructs to be unrelated or only slightly related.

TABLE 3 Descriptive statistics and bivariate correlations of attitudes toward nature (Preservation and Utilization), Inclusion of nature in self (INS) and interest in nature (total and reduced).

	<i>M</i>	<i>SD</i>	<i>N</i>	SIN	SIN re	PRE	UTL	INS
Interest in nature (SIN)	−0.34	1.68	351	0.99	0.98	0.16	−0.29	0.61
Interest in nature (SIN, reduced)	−0.66	1.76	351	0.96**	0.99	0.15	−0.20	0.61
Preservation (PRE)	0.63	0.80	351	0.16**	0.15**	0.96	−0.14	0.18
Utilization (UTL)	−0.61	0.91	351	−0.28**	−0.20**	−0.14*	0.98	−0.23
Inclusion of nature in self (INS)	4.41	1.53	335	0.56**	0.56**	0.16**	−0.21**	0.84

The reduced version of the SIN does not include the 5 value-related items and thus comprises only 13 items.



4.2. Known groups comparison

The known-group comparison is based on the assumption that participants who are less involved with nature or its protection in their free time will also show little interest in nature. To test this hypothesis, we linked participants' interest in nature with their free time activities. Our results indicated that this was the case. Specifically, we defined three different interest groups: a sports group, a socially engaged group and a group demonstrating an active commitment to nature and environmental protection.

A first analysis of variance (ANOVA) indicated a significant difference between groups in interest in nature: $F(2, 348) = 26.28$, $p < 0.001$, $d = 0.94$ (see Figure 1). For theoretical reasons, we expected that the assumed stronger attitudes in favor of environmental protection among members of a nature conservation organization would be linked to a higher interest in nature. Accordingly, we discovered that participants in nature conservation groups held a

more pronounced interest in nature ($M = 0.50$, $SD = 1.47$) than participants in socially engaged groups ($M = -0.38$, $SD = 1.61$) or sports groups ($M = -0.98$, $SD = 1.61$). To examine the construct validity of the interest in nature scale, we compared the three different interest groups. *Post hoc* comparisons using t-tests with Bonferroni correction indicated highly significant differences (sports group and socially engaged group, $t(243) = -2.89$, $p = 0.01$, $d = -0.37$; sports group and nature protection organization, $t(237) = -7.33$, $p < 0.001$, $d = -0.96$; socially engaged group and nature protection organization, $t(216) = -4.22$, $p < 0.001$, $d = -0.58$). Overall, we discovered a continuum of interest from the sports group to the social group to the nature group.

Additionally, we were able to show that the three interest groups have different preferences for environmental preservation (Figure 1). Nature group participants' preservation level ($M = 1.03$, $SD = 0.88$) significantly surpassed that of both the socially engaged group ($M = 0.52$, $SD = 0.61$, $t(216) = -5.06$, $p < 0.001$, $d = -0.67$) and the

sports group ($M=0.41$, $SD=0.76$, $t(237)=-5.87$, $p<0.001$, $d=-0.76$). By contrast, there was no evidence for a significant difference between sports group participants and participants in socially engaged groups ($t(243)=-1.21$, $p=0.23$).

In terms of Connection to Nature and Utilization, no significant difference emerged between participants in sport groups (INS: $M=4.05$, $SD=1.74$; UTL: $M=-0.44$, $SD=0.84$) and socially engaged groups (INS: $M=4.42$, $SD=1.52$; UTL: $M=-0.39$, $SD=0.78$). However, if we compare participants in both the sport group and the socially engaged group with environmental organization members (INS: $M=4.85$, $SD=1.10$; UTL: $M=-1.05$, $SD=0.96$), significant differences can be seen ($p<0.001$, see Figure 1). Cohen's d values show small effects ($0.158<d<0.353$).

5. Discussion

Interest in nature seems to have an influence on willingness to preserve nature (Kals et al., 1999), but it remains unclear how it is related to environmental attitudes and behavior. Interest in nature might be a construct and motive explaining why adolescents develop greater pro-environmental behavior (Otto and Pensini, 2017; Otto S. et al., 2020). To analyze these relationships better, a comprehensive instrument to measure interest in nature is needed. To this end, the aim of this study was to develop a valid instrument to assess adolescents' interest in nature.

We therefore developed an age-appropriate scale for measuring adolescents' interest in nature, the SIN. Using Wright Maps and already established scales for measuring environmental attitudes we were able to establish construct validity (convergent and divergent). In addition, the results from known group comparisons support the construct validity of our instrument. Unless stated otherwise, the results presented for the SIN scale pertain to the overall scale consisting of 18 items.

Both the principal-axis factor analysis, and the Rasch-model analysis support the assertion that the SIN has a one-factor structure. The different items seem to measure different parts of one latent construct. As in the underlying scale (Schiefele et al., 1993), this study confirmed that the theoretically postulated interest components—namely emotion-related and value-related valences as well as the intrinsic character of interest—cannot be conceived as independent (orthogonal) factors. Even though the interest components represent covarying aspects of the interest construct, we nevertheless consider their analytic distinction useful and necessary (Kropp, 2002, 2007).

The factor analysis confirms that the constructs Preservation and Utilization do not load onto the same factor as the SIN scale. These data align with Kaiser et al. (2013), who find that attitude toward nature and attitude toward environmental protection are two separate but correlated constructs. However, the factor analysis of the SIN and 2-MEV items together showed that some value-related items not only loaded onto the respective factor of SIN, but also cross-loaded on the Preservation factor of the 2-MEV. The 2-MEV measures environmental values and includes various subscales of environmental concern. Thus, it is to be expected that the items also contain a value-related tendency, which is thus related to some of the SIN items. In any case, SIN provides more detailed information on the emotion-related and intrinsic components of interest in nature.

Furthermore, the analysis confirmed that the newly developed measure is an instrument with reasonable psychometric quality, namely good item fit, reliability, and internal consistency. In terms of convergent validity, the SIN correlated strongly with the INS scale (inclusion of nature in self, Schultz, 2002) and thus should be seen as a more specific dimension within the construct of nature connectedness, but with high practical usefulness. While connection to nature encompasses a broader concept that includes emotional, cognitive, and behavioral components, interest in nature specifically focuses on the level of attraction, curiosity, and engagement individuals have toward the natural world. Regarding discriminant validity, we found low correlations between the SIN scale and the environmental attitude scales Preservation and Utilization (MEV-2 model, Bogner and Wiseman, 2006). By excluding items related to interest in nature preservation from our instrument, our scale will be fully distinct from these aspects and the 2-MEV. Unlike previous studies (e.g., Kals et al., 1999; Leske and Bögeholz, 2008), we did not include measures referencing resources, ecosystem and biodiversity in our item set.

The results show that connection to nature is not only related to interest in nature, but also slightly related to environmental attitudes, in this case Preservation and Utilization. Thus, even though the two scales (INS and 2-MEV) represent two different constructs, the data shows a relationship between them. This suggests that the degree to which a person associates themselves with nature is related to their attitude toward nature protection. Therefore, a person with a stronger connection to nature is more concerned about environmental issues. This is consistent with previous studies showing that nature connectedness and environmental attitudes are substantially related (Schultz et al., 2004; Sellmann and Bogner, 2013; Otto and Pensini, 2017). Moreover, Roczen et al. (2014) integrated nature connectedness into their environmental competence model and considered it an important factor influencing individual environmental behavior. In our study, the strongest level of connection to nature was found among members of environmental organizations. We assume that frequent (positive) experiences with nature increased their individual connection to nature. Even though positive changes in connection are already apparent after one-day environmental education programs, a long-term connection to nature can only be achieved after longer, repeated nature experiences (Stern et al., 2008; Kossack and Bogner, 2012; Sellmann and Bogner, 2013; Möller, 2021). We also identify a trend across the various interest groups in interest in nature. We find the strongest connection to nature in the nature groups, which often spend longer periods of time in nature and deal with topics related to nature conservation (i.e., planting trees, installing nest boxes for birds etc.).

The SIN measure discriminates well between the three interest groups. In the present sample, the higher the SIN, the more likely that one is a member of an environmental organization, that aims to motivate and guide adolescents toward more environmentally friendly behavior. Within the study samples, drawn in Germany and Austria, we also found that adolescents' self-reported interest in nature was significantly related to the kind of activities they engage in in their free time. We found that members of environmental organizations reported a stronger interest in nature than did members of sports groups or socially engaged groups. We also found the same effect for the connection to nature (INS) and the

environmental attitude scales Preservation and Utilization of nature (2-MEV). Our hypothesis suggests that frequent interactions with nature enhance the level of personal engagement among adolescents actively involved in environmental organizations, ultimately leading to a greater interest in nature. Only those who identify with the object of interest will develop an individual interest (Krapp, 2002). The result of individual interest is an experience of positive emotions, increased appreciation, and a consolidation of knowledge about the subject matter (Renninger and Hidi, 2002). We assume that adolescents involved in environmental organizations have developed an individual interest in environmental issues due to their positive experiences in nature and that they have integrated nature as an important aspect of their identity. They have rather low values regarding utilization of nature in this study, which indicates that they do not place humans above nature and therefore do not believe that people should exploit nature for their own needs, which also fits well with their high values on the Preservation-scale.

The results of the known-group comparison align with previous studies highlighting the significance of prosocial propensity in the ecological domain (e.g., Otto et al., 2021). Prosocial propensity refers to an individual's inclination to engage in actions that benefit others or society as a whole. Within the ecological domain, this propensity is reflected in a willingness to participate in behaviors that protect and conserve the environment, such as recycling, reducing energy consumption, and supporting conservation initiatives (Neaman et al., 2021). By cultivating a strong prosocial propensity, individuals are more likely to take actions that benefit the environment, promote sustainability, and yield positive outcomes such as a reduced ecological footprint, increased involvement in environmental initiatives, and the formation of collective efforts to address environmental challenges. Prosocial propensity in the ecological domain plays a crucial role in fostering a sense of responsibility, empathy, and collective action toward environmental protection, ultimately contributing to a more sustainable and harmonious relationship between humans and the natural world (Otto et al., 2021). In our study, adolescents engaged in social activities also demonstrate a stronger connection to nature and a higher level of interest in the natural world. While their environmental attitudes may not be as pronounced as those of adolescents involved in environmental organizations, they still fall within a higher range compared to members of sports groups.

A limitation of our study is that pro-environmental behaviors and time spent in nature were not directly assessed, but rather assumed based on membership in environmental organizations. However, the examined groups were carefully selected according to strict criteria. It was crucial for us that the meetings of the environmental groups took place outdoors in natural settings and involved activities related to nature and environmental conservation, such as hanging bird houses or planting trees. This approach aimed to ensure that the adolescents not only regularly spent time in nature but also actively participated in nature conservation activities. To ensure the groups' suitability and adherence to these criteria, we accompanied them on-site. However, in order to make statistically robust statements about the causal relationship between engagement in various leisure activities, time spent in nature, and pro-environmental behavior, future studies should measure these constructs using self-reported variables, such as the General Ecological Behavior scale (Kaiser and Wilson, 2004).

Based on the present study, we cannot make any causal statement. This could be addressed in future studies.

Another limitation is the composition of the three interest groups. Not only do they differ in sample size, but they were also collected at different locations. This was due to the challenge of finding enough adolescents in the respective groups willing to participate in the study. In addition, in this age group, it was particularly difficult to find young people who are institutionally involved in nature conservation in their free time. Because of this, we expanded the sample acquisition geographically (in the authors' home countries of Germany and Austria). This condition may limit the generalizability of the conclusions. The latter would require a representative sample. Another limitation of the present study involves the possibility of participants engaging in multiple groups. We tried to avoid overlaps by also asking all participants about their participation in all three types of organizations (e.g., nature conservation organizations or welfare associations). Only 4.08% of participants demonstrated double engagement, mainly between the socially engaged group and members of nature protection organizations. For participants with double engagement, we can assume a higher tendency toward pro-environmental behavior, as this is driven by prosocial propensity (Otto et al., 2021). Note, however, that such double engagement would have deflated rather than increased the differences between groups in terms of interest in nature, connection with nature and preservation and utilization of it.

6. Conclusion

The empirical findings presented in this study suggest that the SIN is a reliable and valid instrument that can be used to measure adolescents' level of interest in nature as a specific and practically meaningful facet of attitude toward or connectedness to nature. Furthermore, the results of the comparison between members and non-members of environmental organizations indicate a significant difference in the level of interest. Therefore, to promote interest in nature, a stronger engagement with nature should be encouraged (Otto and Pensini, 2017). Additionally, our data suggests a correlation between interest in nature and other environmental attitudes, which may contribute to a deeper understanding of the underlying mechanisms underlying pro-environmental behavior. For example, our scale could help model the interconnections between as well as the prerequisites for environmental attitudes. With the SIN, we provide researchers and educators with an instrument to empirically assess interest in nature as an important component of a more sustainable future. This is of great importance, as the ecological domain seems to be related to the prosocial domain of sustainable development, at least on the individual level (Otto et al., 2021). Prosocial propensity stems from a feeling of connection to a relevant domain. In our case, it is connectedness to nature which serves as a motive for acting on one's prosocial propensity within the ecological domain and generating further pro-environmental behavior (Otto et al., 2021). Knowing that environmental education interventions foster connectedness to nature as well as pro-environmental behavior, it is important to investigate any recursive effect on prosocial propensity. Only by understanding the interrelatedness of these constructs can we make recommendations on the most effective ESD or environmental education programs (Otto

et al., 2021). Here, our scale could supplement even broad existing outcome measures of ESD (e.g., Günther et al., 2022) by contributing a measure of a potential driver of individual sustainable behavior. With the SIN, we can not only investigate the relationship between interest in nature and other environmental variables in more detail, but also find out more about its influence on pro-environmental behavior. It can also be used by practitioners in formal or non-formal ESD settings alike to evaluate their programs, exploring whether they are able to increase adolescents' interest in nature and thus pave the way for more pro-environmental behavior.

Data availability statement

The original contributions presented in the study are publicly available. This data can be found at: <https://osf.io/w2epc/>.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

A-LN contributed to the conceptualization, methodology, data collection, validation, formal analysis, writing the original draft, visualization, and project administration. NP contributed to the conceptualization and methodology. SO contributed to the validation, formal analysis, reviewing, and editing the manuscript. AM contributed to the conceptualization, methodology, validation, formal analysis, reviewing, and editing the manuscript, resources, project administration, funding acquisition and supervision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1186557/full#supplementary-material>

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Supplemental material 1

Supplemental material for Neurohr, A.-L., Pasch, N., Otto, S. & Möller, A. (2023). Measuring adolescents' level of interest in nature: A promising psychological factor facilitating nature protection. Frontiers in Psychology. Vol., 24. doi: [10.3389/fpsyg.2023.1186557](https://doi.org/10.3389/fpsyg.2023.1186557)

Questionnaire of the validation study

1. 18 items of the Scale of Interest in Nature (SIN)

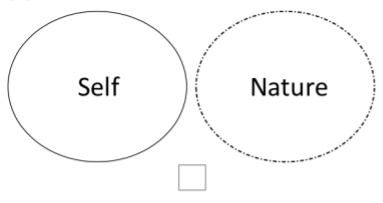
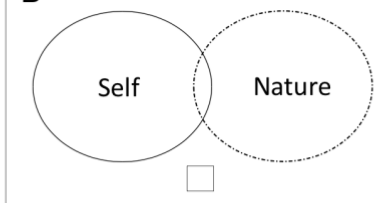
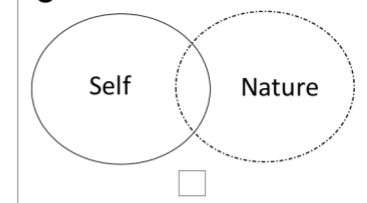
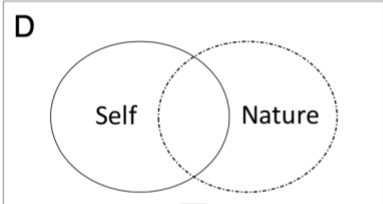
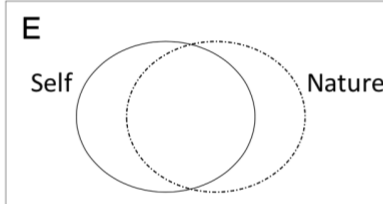
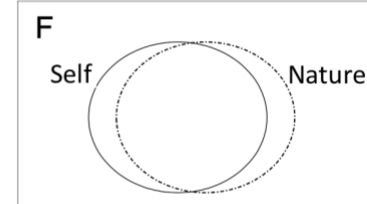
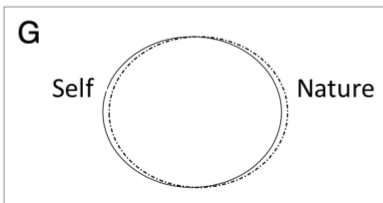
[illegible]

UTL 6i	Only plants and animals of ecological importance need to be protected.	☐	☐	☐	☐	☐	☐
PRE 1	It upsets me to see countryside taken over by building sites.	☐	☐	☐	☐	☐	☐
UTL 5i	We must build more roads so people can travel to the countryside.	☐	☐	☐	☐	☐	☐
PRE 3	Humankind will die out if we don't live in tune with nature.	☐	☐	☐	☐	☐	☐
PRE 2	I enjoy trips to the countryside.	☐	☐	☐	☐	☐	☐
PRE 4i	Society will continue to solve even the biggest environmental problems.	☐	☐	☐	☐	☐	☐
PRE 8	It is interesting to know what kind of creatures live in ponds or rivers.	☐	☐	☐	☐	☐	☐
PRE 9	Dirty industrial smoke from chimneys makes me angry.	☐	☐	☐	☐	☐	☐
PRE 10i	Our planet has unlimited resources (e.g., oil, wood, coal).	☐	☐	☐	☐	☐	☐
UTL 3i	Nature is always able to restore itself.	☐	☐	☐	☐	☐	☐
UTL 4i	People worry too much about pollution.	☐	☐	☐	☐	☐	☐

Note. Inverse items are marked with an i (for inverted)

3. Inclusion of nature in self (INS)

How interconnected are you with nature? Choose the picture which best describes your relationship to nature.

A  ☐	B  ☐	C  ☐
D  ☐	E  ☐	F  ☐
G  ☐		

(Adapted from Schultz, 2002)

Supplemental material 2

Supplemental material for Neurohr, A.-L., Pasch, N., Otto, S. & Möller, A. (2023). Measuring adolescents' level of interest in nature: A promising psychological factor facilitating nature protection. *Frontiers in Psychology*. Vol., 24. doi: 10.3389/fpsyg.2023.1186557

Table 1. Original 43 items of the SIN scale (18 final items used in the validation study are in bold)

Item ID	Item wording
1 IN	When I see a bird, I know what its species is called.
2 IN	When I look at leaves on trees, I know what species they belong to.
3 IN	In my opinion, documentaries and movies on nature are interesting.
4 IN	When I go swimming in a lake or the sea, I'm interested in what other species are swimming in the water.
5 IN	Plants are boring.
6 IN	When I observe insects on flowers, I recognize their species.
7 IN	I have no personal interest in what happens in nature.
8 IN	Walking through forests or meadows has a positive effect on my mood.
9 IN	When I hear animal voices in the forest, I know which animal they belong to.
10 IN	I enjoy observing animals.
11 IN	I maintain some kind of friendship with an animal (e.g. dog, cat, horse).
12 IN	Playing with animals or petting them gives me joy.
13 IN	I prefer talking about new movies and music, rather than animals.
14 IN	I do not enjoy taking care of pets.
15 IN	In libraries, I like reading nature books (for example on animals or plants).
16 IN	I would be happy to receive a calendar with nature pictures (for example animals or landscapes) for my birthday.
17 IN	I don't really mind about the fact that humans destroy nature.
18 IN	When I paint animals or plants, it's important to me to draw them as real as possible.
19 IN	In my spare time I like to draw animals, plants or landscapes.
20 IN	I like to collect chestnuts, acorns or leaves (e.g. for crafting, decorating).
21 IN	In my spare time I take pictures of flowers, animals and landscapes.
22 IN	If I am being completely honest, I don't care about animals and plants at all.

23 IN	When I travel to a foreign country, it is important for me to get to know animals living there as well.
24 IN	It is important to me to know the names of local animals and plants.
25 IN	If I could, I would touch exotic animals like snakes or sharks to know how they feel.
26 IN	Personally, I find it important to know the role of humans in nature.
27 IN	I enjoy discovering nature with my friends more than playing computer games or video games with them.
28 IN	I could imagine collecting feathers, leaves or other things as a hobby.
29 IN	When I find mushrooms or berries in the forest, I recognize which ones are edible.
30 IN	In my spare time I participate in projects on preserving nature.
31 IN	It is important for me to decorate my room with plants or natural materials (e.g. shells, feathers).
32 IN	If possible, I explore what animals live in the water or soil.
33 IN	When I see plants in fields, I recognize what the farmer is growing there.
34 IN	In my spare time I examine plants and conduct small experiments with them (e.g., poking them gently, blowing at them)
35 IN	I only deal with nature when I have to (e.g. at school).
36 IN	Outside of school I inform myself about animals and plants (for example on the internet or in books).
37 IN	It is exciting to examine bees or other insects with a magnifying glass.
38 IN	I enjoy biology classes.
39 IN	If I don't know a leaf or animal I've found, I ask for help at home or from my teachers.
40 IN	In my spare time I catch animals (tadpoles, grasshoppers, frogs) and keep them in a bucket or terrarium.
41 IN	I know a lot about feeding relationships in the forest.
42 IN	I purposely chose hobbies that allow me to spend a lot of time in nature (e.g., riding, fishing, geocaching).
43 IN	I enjoy looking for animal tracks in the woods with friends or family.

6.2 Manuscript 2

Neurohr, A-L., Pasch, N., Bergmann-Gering, A. & Möller, A. Linking students' interest in nature to their self-reported pro-environmental behavior and nature activities – a cross-sectional study in grade 5 to 9.

Status: Manuscript accepted with major revisions in *The Journal of Environmental Education*

Own contribution: Conceptualization, Methodology, Formal analysis, Data curation, Writing – Original draft preparation, Writing – Review & editing, Visualization

Summary

The consequences of humanity exceeding the planet's ecological limits are severe. Education for Sustainable Development (ESD) can play a crucial role in addressing this challenge. Pro-environmental behavior (PEB) is a key aspect of ESD, and understanding the factors that influence PEB, including interest in nature, is essential for effective educational programs. Interest in nature, which involves a specific relationship between individuals and nature, has received less attention compared to other factors influencing PEB. Interest is characterized by affective components such as emotions, personal values, and intrinsic motivation. Previous studies, including Manuscript 1, suggest that spending time in nature and engaging in nature-related activities can cultivate interest in nature and promote pro-environmental attitudes and behaviors. However, most studies have focused on adults, while research on adolescents, whose environmental attitudes and behaviors are mainly shaped during childhood, remains limited. Moreover, adolescents are currently spending less time in nature, which may contribute to a decline in their interest in the natural world.

Therefore, the aim of this study was to assess the extent of interest in nature among lower secondary school students in Germany (grades 5-9, $n = 1092$) and examine its relationship with their self-reported PEB and nature activities. The study seeks to deepen our understanding of interest in nature among adolescents and its connection to PEB. Interest in nature was measured using the Scale of Interest in Nature (SIN) and pro-environmental

behavior was assessed using the General Ecological Behavior scale (GEB). Additionally, students indicated their involvement in nature activities by reporting their time spent in nature, pursuit of nature-related hobbies, and membership in environmental organizations.

Our results contribute to understanding the link between adolescents' interest in nature and PEB. Comparing cross-sectional data, we observed a decline in interest in nature with increasing grade levels. Significant differences emerged between nearly all grades, particularly when they were more distantly spaced, as reflected in the stronger effect sizes. Consequently, students in the early years of secondary school demonstrated greater interest in nature compared to their counterparts in later years. This pattern aligns with the students' diminishing involvement in nature activities, as both time spent in nature and engagement in nature-related hobbies decreased significantly as grade level increased. The findings highlight a robust positive correlation among engaging in nature activities, interest in nature, and PEB across all grades. In essence, students who dedicated more time to nature exhibited a heightened interest and were more likely to participate in pro-environmental actions. Subsequent regression analysis validated the relationship between interest in nature and PEB, revealing that 36.4% of the variance in PEB could be attributed to interest. Thus, interest in nature not only correlates positively with PEB but appears to exert a direct impact on it. However, to assert a causal relationship in this context, further studies are required.

To address this, we propose adopting a holistic approach involving social policies to encourage increased time in the outdoors for children. This strategy should extend beyond formal ESD programs and encompass free, place-based education initiatives. Given the anticipated rise in the global urban population by 2050, especially in areas with limited access to nature, it is crucial to create educational opportunities that offer direct experiences with nature within schools and in the community. Integrating nature and environmental protection into the curriculum in interdisciplinary ways can facilitate the development of individual interest in nature. Recognizing interest in nature as a motivating factor for PEB, future studies should consider it when exploring the underlying mechanisms of PEB. By fostering an interest in nature through ESD programs, we can lay the groundwork for sustainable PEB among adolescents.

Linking students' interest in nature to their self-reported pro-environmental behavior and nature activities - a cross sectional study in grade 5 to 9

Anna-Lena Neurohr^{a*}, Nadine Pasch^b, Alexander Bergmann-Gering^c, Andrea Möller^{a,d*}

^a *Austrian Educational Competence Centre for Biology, University of Vienna, Vienna, Austria*

^b *Biology Education, University of Trier, Trier, Germany*

^c *Biology Education, University of Leipzig, Leipzig, Germany*

^d *Faculty of Life Sciences, Department of Evolutionary Biology, University of Vienna, Vienna, Austria*

ORCID

Anna-Lena Neurohr - <https://orcid.org/0000-0003-4706-6763>

Alexander Bergmann-Gering - <https://orcid.org/0000-0002-5492-8512>

Andrea Möller - <https://orcid.org/0000-0002-2345-1299>

*Corresponding Authors:

Anna-Lena Neurohr

anna-lena.neurohr@univie.ac.at

Andrea Möller

andrea.moeller@univie.ac.at

Linking students' interest in nature to their self-reported pro-environmental behavior and nature activities - a cross sectional study in grade 5-9

Abstract

To promote pro-environmental behavior (PEB), it is crucial to understand the drivers behind it. Studies indicate that, in addition to environmental attitudes and nature activities, interest in nature drives people to engage in PEB. However, the relationship between interest in nature and PEB is still greatly understudied among adolescents even though the foundations for PEB seem to be laid during childhood. Therefore, our study focuses specifically on the link between adolescents' interest in nature, their nature activities, and PEB. We collected self-reported cross-sectional data from 954 German school students using the Scale of Interest in Nature (SIN) and the General Ecological Behavior Scale (GEB). Findings indicate a decline in interest in nature, PEB, and nature activities from grade 5 to 9, while also revealing a significant positive correlation between all these constructs. Results highlight the importance of fostering interest in nature in environmental education programs and suggest including it in further research.

Keywords: interest in nature, pro-environmental behavior, adolescents, nature activities, cross-sectional study

Introduction

For several decades, humanity has exceeded the planet's ecological limits (Steffen et al., 2015). The consequences are severe on a global scale, ranging from record-low sea ice levels in the Arctic and bush fires in Australia to heat waves in Europe and a massive decline of biodiversity on all continents (Eichenberg et al., 2020; Goldrick, 2019; IPCC, 2021). Both the IPBES (2019) and IPCC reports (2021) confirm that human behavior and decisions are the main cause of these global effects. In order to overcome or at least mitigate these crises and achieve a more sustainable future, the United Nations (2015) presented a global action plan, the "Agenda 2030", encompassing 17 Sustainable Development Goals (SDGs). Researchers worldwide highlight education as one of the cornerstones in the effort to achieve these goals (Otto et al., 2020; Reimers, 2021; Winter et al., 2021). Especially, Education for Sustainable Development (ESD) responds to these challenges by fostering a lifelong learning process that

empowers individuals to make informed decisions and take national and global actions (UNESCO, 2020). Underlying ESD is the certainty that a sustainable future is only possible if people start engaging more in nature-protective and pro-environmental behaviors (Gifford & Nilsson, 2014; Liefänder et al., 2013; Otto et al., 2019; Otto & Kaiser, 2014; Richardson et al., 2020).

In order to foster pro-environmental behavior (PEB) and develop appropriate ESD programs, it is important to understand and determine key influencing factors of PEB (Richardson et al., 2020; Whitburn et al., 2020). Some influencing factors have already been examined in empirical studies, such as environmental attitudes, connection to nature and experiences in nature (Bamberg & Möser, 2007; Gifford & Nilsson, 2014; Kollmuss & Agyeman, 2002; Li et al., 2019). However, a recurring yet under-studied factor seems to be interest in nature. Interest in nature describes the specific relationship between a person and nature as an object of interest (Krapp, 2002; Neurohr et al., 2023). If a person has a relatively stable tendency to deal with an object of interest without external cause, it is considered an individual interest (Krapp & Prenzel, 2011): it describes the dispositional motivational state of a person. A sustained individual interest can develop only if a person has previously experienced a situational interest, which corresponds to a motivational state of being interested during an actual interest-based activity (Hidi & Renninger, 2006). It is typically triggered by external stimulation and may develop through repeated engagement with the object. Successful triggers for situational interest can be instructional conditions or specific learning environments, such as group work (e.g., Hidi et al., 1998; Randler & Bogner, 2007). Individuals who possess a strong individual interest are primarily driven by their personal initiative and demonstrate persistence in their actions, even in the face of failures or negative emotions (Renninger & Hidi, 2002). If a person can identify with the object of nature and integrates it into the self, they will be more likely to engage with it (Blankenburg & Scheersoi, 2018; Krapp & Prenzel, 2011). Therefore, we assume that an ambition to protect nature can only develop with a growing appreciation for and a higher interest in nature (Kaiser et al., 2013; Kals et al., 1999; Neurohr et al., 2023; Roczen et al., 2014).

Individual interest can be further characterized by intellectual and affective components (Hidi et al., 2004). However, Schiefele et al. (1993) postulate that interest is a purely affective variable and distinguish three affective components: an emotional, a value-related and an intrinsic component. Whereas the emotional component refers to matters associated with

positive feelings such as joy, the value-related component refers to matters that are personally significant. The intrinsic component, on the other hand, represents a person's engagement with the object of interest driven by internal motivation rather than external rewards or incentives (Schiefele et al., 1993). In this study, we will focus on the affective components of interest, as studies have shown that intellectual variables have little to no effect on environmental behavior (Knutti, 2019; Otto & Pensini, 2017; Steg & Vlek, 2009).

Even though influencing factors on interest in nature have not yet been studied in greater detail so far, one central factor is already emerging: time spent in nature (Chawla, 2020; Cheng & Monroe, 2012; Kals et al. 1999; Torkar & Krašovec, 2019). Studies show that spending time in nature can help to build up not only emotional bonds but also interest in nature (Bezeliak et al., 2023; Neurohr et al., 2023). Hobbies in nature, such as hiking, picking flowers or fruits, planting trees, or caring for plants as well as being an active member of an environmental organization have a positive relationship with pro-environmental attitudes and behaviors (Arnold & Kaiser, 2016; Kals et al., 1999; Neurohr et al., 2023; Otto et al., 2021; Richardson, et al., 2020; Tam, 2013; Zylstra et al., 2014; Wells & Lekies, 2006). However, most of these studies focus only on adults, whereas adolescents remain greatly understudied. This might be a significant gap, since research shows that most of the foundations for environmentally protective behavior are laid in childhood (for an overview, see Chawla, 2020). Adult conservation volunteers, for example, develop their interest in nature at a young age (Guiney, 2009). Studies reveal a concerning trend where children are spending a decreasing amount of time in nature and become increasingly alienated from it (Louv, 2005). Since children's experiences in nature are declining, it is highly likely that their interest in nature is also falling (Chawla, 2020; Soga & Gaston, 2016). A cross-sectional study observed a downward trend in students' interest in nature from upper secondary school (grades 9 and 10) to the end of high school (Leske & Bögeholz, 2008). As possible reasons, researchers identified not only a decline in nature experiences (Pyle, 1993; Soga & Gaston, 2016), but a growing level of digitalization as well (Kuss & Griffith, 2017; Michaelson et al., 2020).

ESD programs could be an opportunity to offer children direct contact with nature through experiences in nature and thus foster their interest in nature. To appropriately develop such programs, it is essential to know more about adolescents' interest in nature and gain further insights into its role as a determinant of PEB: How is interest in nature demonstrated in different age groups? Which kind of nature experiences correlate with interest in nature? How

does interest correlate with PEB? So far, there are only a few studies focusing on interest in nature, and to our knowledge, none focuses on preadolescents and adolescents or investigates possible correlations with PEB (Kals et al., 1999; Kleespies et al., 2021; Leske & Bögeholz, 2008). In our study, we therefore explicitly chose to focus on lower secondary school students (grades 5 to 9), using an age-appropriate scale to measure students' self-reported interest in nature (*Scale of interest in nature* – "SIN") and analyzing its relationship with PEB. We aim to address four objectives: (1) to observe the extent of interest in nature among a large sample of German lower secondary school students (grades 5 – 9), (2) to examine the relationship between interest in nature and PEB, (3) to analyze nature activities such as time spent outside, membership in an environmental organization or a hobby in nature among students in different lower secondary school grades, and (4) to identify which of these nature activities are associated with a strong interest in nature.

Methods

Participants and recruitment

Our study encompassed a convenience sample of 1092 students from North Rhine-Westphalia, Germany, covering grades 5 to 9 (ages 10 to 15, M_{age} : 12.48, SD: 1.54; 54% female). The sample was evenly distributed across all five grades. All schools were public schools, supported financially by the government and providing free education. None of the participating schools had a focus on specific subjects or offered special education programs. Students were informed in advance about the aims of the research, duration, procedure, and anonymity of the data. Informed consent was obtained from all participants included in the data analysis. In accordance with the law in North Rhine-Westphalia, the study was approved by each head of school. This study did not involve clinical patients, was non-invasive, and participation was voluntarily and anonymous.

Procedures

Students completed an anonymous paper-and-pencil questionnaire during class time. The questionnaire was administered by the classes' teachers. In addition to the written instructions on the questionnaire, the teachers received standardized instructions for an oral introduction and explanations. It took the students between 30 and 40 minutes to complete the questionnaire. The students' questionnaires were returned to the research team after the

lessons. The questionnaire included seven scales measuring different aspects of affective attitudes and awareness related to nature and the environment. These were either directly adopted from established literature or adapted for our own study. In this study, however, we focus exclusively on two of the scales since we aim to examine the role of interest in nature as determinant of PEB.

Measures

Interest in nature was measured by the Scale of interest in nature (SIN: Neurohr et al., 2023). The scale comprises 18 items, each consisting of a statement regarding the individuals' interest in nature (e.g., "In my opinion, documentaries and movies on nature are interesting."). The participants had to rate their agreement with each statement on a 5-point Likert scale (0 = strongly disagree, 1 = disagree, 2 = partially agree, 3 = agree, and 4 = strongly agree). To control for response style bias, the scale includes reversed items, which we recoded afterwards. The results of the analysis show that all items fit the model, and the Rasch-model-based item reliability of the measure was discovered to be 1.00 (N = 954).

Pro-environmental behavior was assessed based on the Campbell paradigm (Kaiser et al., 2010), which addresses the extent to which individuals generally embrace an environmentally friendly lifestyle, instead of focusing on specific behavioral domains. This approach recognizes that individuals perform a broad multitude of behaviors, which all have some environmental impact (Otto & Pensini, 2017). To capture an individual's broader environmental impact, a broad assessment of ecological behaviors is necessary. Therefore, we used the behavior-based environmental attitude scale (GEB: Kaiser et al., 2007) as a comprehensively tested and validated self-report instrument. There is currently no other general performance measure that is similarly well developed and specifically designed to be used with adolescents. Respecting the limited behavioral alternatives available to adolescents (Evans et al., 2007), we reduced the scale to the most suitable 18 behavioral items, while still addressing all 6 domains of the original scale: recycling, waste avoidance, consumerism, mobility and transportation, energy conservation, and vicarious conservation behaviors. The reduction of items was justified by two pilot studies in which we examined person reliability, item difficulty, normal distribution, and the basic model fit of the items. Example items are „I separate my trash“ or „I take a tote bag or backpack with me when I go shopping“. We used a five-point scale ranging from 0 (never) to 4 (always) for the behavioral self-report items. 3 of

18 items were reverse coded and described unecological behaviors. Item reliability was found to be $rel. = 1.00$ ($N = 954$).

Nature activities were assessed in terms of three different aspects: time spent in nature, pursuing a hobby in nature, and membership in an environmental protection organization. Students answered how many days per week (0-7) they spend time in nature on average. In line with Bezeljak et al. (2023), for the analyses, we split the reported time spent in nature into two groups: those spending less time in nature (0-3 days) and those spending more time in nature (4-7 days). In addition, participants indicated if they have a hobby that involves spending a lot of time in nature, such as hiking, rock climbing, birdwatching, or gardening and if they are an active member of an environmental protection organization (e.g., Greenpeace, Friends of the Earth Germany (BUND), or the Nature and Biodiversity Conservation Union (NABU)). Both items were answered in a dichotomous format („yes“ or „no“). Furthermore, we collected demographic information such as grade, age, and gender.

Data analysis

We employed the Rasch rating scale model using the Winsteps software program (Linacre, 2021) to calibrate our measures of interest in nature (SIN) and general ecological behavior (GEB). Initially, a missing value analysis was conducted to exclude cases with significant missing data on the main scales, resulting in the exclusion of 138 participants (12.64%) and a reduced sample size of 954 participants. To ensure the quality of our measures, various steps were taken in line with standard practices for Rasch rating scale analysis (Boone & Staver, 2020; Boone et al., 2014; Davis & Boone, 2021; Otto et al., 2021). These steps included examining the dimensionality of the scales, assessing the functioning of the rating scales, evaluating reliability indices, and generating Wright maps from the data.

The reliability of the measurement instruments was assessed by evaluating person and item reliability as well as person and item separation (Boone & Staver, 2020; Boone et al., 2014). Critical values suggested by Malec et al. (2007) were considered, such as an item reliability value of .90, person reliability of .80, person separation of 2.0, and item separation of 4.0. The data were controlled for unidimensionality using infit mean squares (MNSQ), within an acceptable range of 0.5 to 1.5 (Linacre, 2021; O'Connor et al., 2016). A principal component analysis of residuals (PCAR) was employed to assess unexplained variance, with an eigenvalue below 2.0 indicating evidence of unidimensionality (Bradley et al., 2016). Point measure

correlations were examined to ensure that items were measuring the same construct, with correlations larger than 0.3 considered indicative of this (Lie et al., 2018).

Furthermore, we evaluated the rating scale functioning and checked that all rating scale categories contribute to providing measurement information regarding respondents. Following other researchers, we used five guidelines by Linacre (1999, 2002) for investigating the rating scale functioning: 1) 10 observations in each rating scale category, 2) normal distribution of observations, 3) outfit MNSQ is less than 2.0, 4) monotonic increase of average measures within each category and 5) orderly series of step calibrations that advance in a monotonic way. Targeting, floor and ceiling effects were evaluated as a final step of the Rasch analysis (Khadka et al., 2016; Wong et al., 2018). Good targeting was indicated by a difference between the average person measure and average item measure below 1.00 logits (Finger et al., 2012). Floor and ceiling effects, representing the presence of respondents at the extreme ends of the scale, were categorized as “excellent” when below 0.5% and as “poor” when greater than 5% (Fisher, 2007).

Additional analyses, including group comparisons, Pearson correlations, and regression analysis, were conducted using IBM SPSS 26. Prior to applying the statistical tests, statistical outliers were identified and assumptions for parametric statistics and regression analysis were examined. While the SIN data were found to be normally distributed, as confirmed by the Shapiro-Wilk test ($p > .05$), this assumption was violated for the GEB. Homogeneity of variance using Levene’s Test was satisfied for the GEB ($p > .05$), but not for the SIN. Given the relative robustness of single-factor ANOVA to violations of the normal distribution assumption, ANOVA was used for further analyses (Blanca et al., 2017).

After controlling for assumptions in the regression analysis, we found a total missing data rate of 6.71% for variables related to activities in nature (time spent in nature: 4.4%; membership in environmental organization: 0.7%; hobby in nature: 3.1%). The missing data was primarily due to item nonresponse. To handle this, we used multiple imputation (MI) with all analysis variables, assuming the missing values were random (Little test: $p = .772$). MI has been shown to be superior to listwise deletion and other traditional methods (Allison, 2002; Buhi et al., 2008; Cox et al., 2014). During the regression analysis, we identified and removed five outliers. These cases not only exceeded the ± 3 standard deviation threshold but also violated the guidelines for leverage values and Cook distances (Huber, 1981). Ultimately, all assumptions for linear regression were met, including multicollinearity, independent error,

heteroscedasticity, and normality of residuals (Durbin-Watson = 1.910, VIF: 1.053-1.466, tolerance: 0.682-0.950, highest $r = .693$; Breusch-Pagan: $p = .148$; see Table 5).

Results

The results are presented in two parts. First, we report scale calibration details for the employed measurement instruments, including fit statistics and reliability information. Second, we present details of the cross-sectional study, focusing on interest in nature: its prevalence across grades 5 to 9, its role as a determinant of PEB, and its association with different kinds of nature activities.

Calibration of Measurement Instruments

Item reliability and item separation for both scales were high, with values above 0.90 and 4.0 (SIN: rel. = 1.00, sep. = 21.26; GEB: rel. = 1.00, sep. = 21.61). Person reliability and person separation for the SIN scale were satisfactory (person rel. = 0.89, person sep. = 2.84), while the GEB scale fell slightly below the suggested values (person rel. = 0.78, person sep. = 1.87). The analysis supported the unidimensionality assumption for both scales. Item fit measures (MNSQ) demonstrated a good overall fit within the suggested range of 0.7 and 1.5. Principal component analysis of residuals (PCAR) showed eigenvalues of the unexplained variance in the first contrast, indicating unidimensionality for both scales (SIN: eigenvalue = 1.8; GEB: eigenvalue = 1.7). Point measure correlations for the SIN scale were positive and above 0.3, supporting the coherence of the items. Although one GEB item had a point measure slightly below 0.3 (0.28), its good item fit (MNSQ Infit = 1.41) justifies its inclusion in the analysis.

The rating scales performed as expected. They met the criteria of having at least 10 observations in each category and a uniform distribution of responses within the categories. MNSQ values for all categories were below 2.0, satisfying the criteria. Average measures and Andrich thresholds increase monotonically from the lowest to the highest rating scale category. Lastly, targeting, floor and ceiling effects were evaluated. The differences between the average person measure and average item measure were below 1.00 logits (Δ SIN = 0.17 logits; Δ GEB = 0.15 logits), indicating good targeting. Floor effects were minimal, with 0.2% (SIN) and 0% (GEB), while the ceiling effect for both scales was 0.1%. Overall, the Scale of

interest in nature (SIN) and the General ecological behavior (GEB) scale can both be considered excellent instruments.

Interest in nature in relation to grade in school and nature activities

The study shows that lower secondary school students' interest in nature decreases from grade 5 ($M = 0.44$, $SD = 0.90$) to 9 ($M = -0.71$, $SD = 0.83$), see Figure 1. The ANOVA indicated a significant difference between grades ($F_{(4, 945)} = 43,87$, $p < .001$, $\eta^2 = .16$). Post hoc comparisons using t-tests with Bonferroni correction indicated highly significant differences between almost all grades ($p < .003$), with small to large effect sizes ($0.36 < d < 1.33$). The further apart the compared grades, the higher the effect size. Only between grades 7 and 8 ($t_{(381)} = 2,337$, $p = .19$) and grades 7 and 9 ($t_{(365)} = 2,343$, $p = .38$) were no significant differences found.

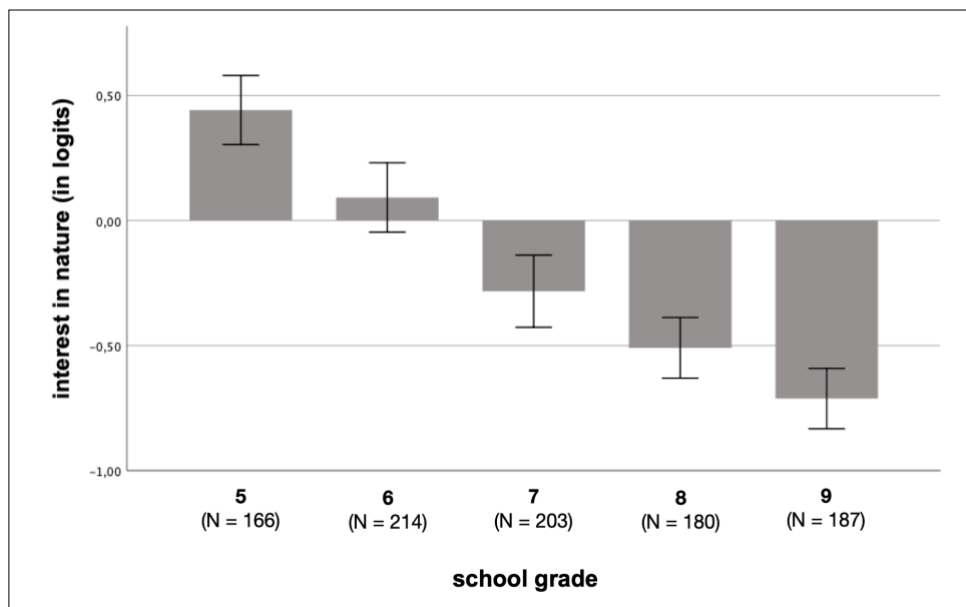


Figure 1. Level of self-reported interest in nature (SIN) across grades 5 to 9; mean values and 95% confidence intervals.

In addition to school grades, we also aimed to investigate whether nature activities change over the course of lower secondary school and what kinds of activities are associated with a strong interest in nature. To do so, we focused on three variables in detail: time spent in nature, active membership in environmental organizations and pursuing a hobby in nature. The results show that both time spent in nature ($F_{(4,892)} = 6,740$, $p < .001$, $\eta^2 = .03$) and pursuing a hobby in nature ($F_{(4,940)} = 3,495$, $p = .008$, $\eta^2 = .01$) differed significantly by grade level. This

means that older students tend to spend less time in nature and are less likely to pursue a hobby in nature. For example, 48% of 5th graders spend time in nature 4-7 days per week, compared to only 29.4% of 9th graders. 73.5% of 5th graders, but only 58.6% of 9th graders, report having a hobby in nature. In terms of active membership in an environmental organization, there is a decreasing trend from grade 5 to 9, but we could not identify significant differences between the different school grades ($F_{(4,940)} = 0.806$, $p = .522$). In general, we found that only 2.8 - 6% of all students were members of an environmental organization (highest percentage in grade 5 and lowest in grade 8).

Next, we analyzed which of these nature activities are associated with a strong interest in nature. Regarding time spent in nature, the results show that students who spend more time in nature (4-7 days a week) have a significantly higher SIN score than students who spend less time in nature (0-3 days a week) ($t_{(896)} = -10.518$, $p < .001$, $d = .70$). The same applies to the other two variables describing nature activities: students show a higher interest in nature if they are members of environmental organizations ($t_{(947)} = -6.903$, $p < .001$, $d = .45$) or pursue a hobby in nature ($t_{(722,327)} = -8.244$, $p < .001$, $d = .61$).

To further assess the relationships between reported SIN scores, grade level, time spent in nature, membership in environmental organizations, and pursuing a hobby in nature, we examined Spearman correlations. The results are presented in Table 1. The SIN is significantly positively correlated with the frequency of time spent in nature (Spearman's $\rho = .38$, $p < .001$), membership in an environmental organization (Spearman's $\rho (949) = .22$, pursuing a hobby in nature (Spearman's $\rho = .25$, $p < .001$), and significantly negatively correlated with students' grade in school (Spearman's $\rho = -.40$, $p < .001$). Furthermore, grade level is significantly negatively correlated with frequency of time spent in nature (Spearman's $\rho = -.17$, $p < .001$) and pursuing a hobby in nature (Spearman's $\rho = -.11$, $p = .001$). Hence, the older students get, the less time they spend in nature and the less likely they are to pursue a hobby in nature.

Table 1. Correlation between self-reported interest in nature (SIN), grade in school, time spent in nature, membership in environmental organizations, and hobbies in nature (N = 945), levels of significance: ** for $p < .01$, * for $p < .05$.

	1.	2.	3.	4.	5.
1. Interest in nature (SIN)		-.40**	.38**	.22**	.25**
2. Grade level		-	-.17**	-.06	-.11**
3. Time spent in nature			-	.08*	.35**
4. Environmental organization				-	.09**
5. Hobby in nature					-

Interest in nature and pro-environmental behavior

Finally, we analyzed the relationship between interest in nature and PEB. Since studies have already shown that experiences in nature have an influence on one's PEB (Otto et al., 2021; Richardson et al., 2020), we also included the three variables regarding nature activities in our analysis to control for possible effects. We found strong correlations between students' interest in nature and PEB in grades 5 to 9 (see Table 2). The strongest correlation between the two constructs is in grade 6 ($r = .701$, $p < .001$, $N = 214$) and 7 ($r = .722$, $p < .001$, $N = 203$). Time spent in nature showed a moderate correlation with general ecological behavior ($r = .35$, $p < .001$, $N = 949$), whereas membership in an environmental association ($r = .20$, $p < .001$, $N = 949$) and pursuing a hobby in nature ($r = .19$, $p < .001$, $N = 949$) showed only low correlations with GEB.

Table 2. Bivariate correlations between interest in nature (SIN) and general ecological behavior (GEB) in grades 5 to 9.

Grade	N	r	p
Overall	949	.693	<.001*
5	166	.664	<.001*
6	212	.720	<.001*
7	201	.671	<.001*
8	180	.612	<.001*
9	186	.541	<.001*

*Note. * $p < 0.01$*

Using a stepwise regression analysis, we followed recommendations from the literature (Petrocelli, 2003) and first entered general socio-demographics as more static variables in the regression analysis. Interest in nature was entered in a second and nature activities in a third step (see Table 3). We first regressed students' general ecological behavior levels ($M = 0.14$, $SD = 0.56$) on age ($M = 12.48$, $SD = 1.55$) and gender ($M = 0.48$, $SD = 0.50$). We found students' GEB to be systematically related to both variables, $F_{(2, 946)} = 64,054$, $p < .001$, $R^2 = .119$, explaining 12% of the variance in PEB (Table 3). After including interest in nature ($M = -0.21$, $SD = 1.01$) in the second step, the model explained 48.3% ($F_{(3, 945)} = 294,219$), $p < .001$, $R^2 = .483$, $\text{Adj. } R^2 = .481$) of the variance in PEB. Interest in nature accounted for an additional 36.4% of variance above demographics. The gender variable, however, no longer explained significant variance in the model ($\beta = .003$, $p = .840$). In a third step, we included the variables for time spent in nature ($M = 3.25$, $SD = 1.86$), membership in environmental organizations ($M = 0.04$, $SD = 0.20$), and hobby in nature ($M = 0.65$, $SD = 0.48$). Including these three variables led to a slightly higher proportion of explained variance ($F_{(6, 942)} = 153, 524$, $p < .001$, $R^2 = .494$, $\text{Adj. } R^2 = .411$). Gender ($\beta = .003$) and hobby in nature ($\beta = -.01$) did not emerge as significant predictors of general ecological behavior ($p > .05$). Even when all other variables were included in the model, interest in nature turned out to be the comparatively strongest determinant of PEB ($\beta = .62$).

Table 3. Pro-environmental behavior regressed stepwise on interest in nature and activities in nature (time spent in nature, membership in an environmental organization, and hobby in nature), controlling for demographic variables, in grades 5 to 9.

Variables	Step 1				Step 2				Step 3			
	<i>B</i>	<i>SE B</i>	β	<i>p</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>
Age	-.114	.011	-.312	< .001	-.022	.009	-.060	.018	-.021	.009	-.059	.020
Gender	-.169	.034	-.150	< .001	-.005	.027	-.005	.840	.003	.027	.003	.916
Interest in nature					.374	.015	.669	< .001	.348	.016	.622	< .001
Days spent in nature									.031	.008	.103	< .001
Environm. organization									.154	.067	.055	.021
Hobby in nature									-.010	.030	-.008	.749
ΔR^2	.119				.364				.011			
R^2 (R^2_{adj})	.119	(.117)			.483	(.481)			.494	(.491)		

Note. The table displays the results of a three-step regression analysis. Age and gender were entered in the first step, interest in nature in the second. Last, time spent in nature, membership in an environmental organization and hobby in nature were entered in a third step. For the full model (Step 3): Durbin-Watson = 1.91; average FIV = 1.21; VIF = 1.05-1.47; average tolerance = 0.84; tolerance range = 0.68-0.95, highest zero-order correlation: $r = 0.69$; Breusch-Pagan: $\chi^2 = 2.09$, $p = .148$. $N = 949$.

In summary, the sociodemographic variables combined accounted for 12% of the variance in students' PEB, interest in nature alone accounted for 36.4%, and activities in nature – time spent in nature and membership in an environmental organization – for another 1%. In other words, interest in nature determined whether a student would act in a pro-environmental

way. In the full model (Step 3), gender no longer explains any variance in GEB ($p = .916$), nor does pursuing a hobby in nature seem to add any value to the model in this case ($p = .749$).

Discussion

Many studies have pointed to the increasingly severe conditions on our planet (IPCC, 2023). Extreme natural phenomena such as global warming, sea-level rise, glacier melting or biodiversity loss are clearly the result of human behavior over decades (Al-Ghussain, 2018; Brighenti et al., 2019; IPCC, 2021; Nerem et al., 2018). To counteract this trend, we must encourage a wider engagement in PEB, such as reducing individuals' environmental impact and supporting the restoration of biodiversity (Richardson et al., 2020). To do so, it is of great importance to better understand determinants of PEB. Although studies have indicated that interest in nature has a direct effect on the development of willingness to engage in nature protection (Kals et al., 1999; Leske & Bögeholz, 2008; Vining 1992), there have been no studies focusing on interest in nature and its relationship to PEB among adolescents. In our study, we aim to examine the previously under-studied construct of affective interest in nature in more detail and analyze its relationship to age (represented by grade level in school), nature activities, and PEB.

Comparing the cross-sectional data, we found that interest in nature decreases with increasing grade level (see Figure 1). We identified significant differences between almost all grades, especially when they were further apart. This is also reflected in the effect sizes: the greater the distance between two grades, the stronger the effect. Thus, students in the early years of secondary school exhibited greater interest in nature compared to those in later years. This aligns with previous studies showing a decreasing trend in environmental attitudes and behavior from primary school to high school (Bogner & Wiseman, 2002; Bogner et al., 2015; Collado et al., 2015; Otto et al., 2019; Torkar et al., 2021). As interest in nature can be considered an important aspect of environmental attitudes (Neurohr et al., 2023), we expected a similar pattern. Our findings support this hypothesis by demonstrating a significant decline in interest in nature during lower secondary school (from grade 5 to 9), expanding on previous research (Leske & Bögeholz, 2008). This trend is consistent with students' level of involvement in nature activities. Both time spent in nature and engagement in nature-related hobbies decrease significantly as grade level increases. Although participation in environmental organizations remains relatively stable across grade levels, the overall

percentage of students who are active members is notably low. These results are especially troubling when looking more closely at the relationship between activities in nature and interest in nature. All three nature activities studied exhibit a significant positive correlation with interest in nature. This suggests that students with more exposure to nature, involvement in environmental organizations, or engagement in nature-related hobbies also display higher levels of interest in nature. Older students may prioritize forming social connections and become more immersed in the digital world, leading to a disconnection from nature (Flammer et al., 1999; Kuss & Griffith, 2017; Michaelson et al., 2020). As adolescents spend less time outdoors, their bond with nature weakens, resulting in a decline in interest in nature (Louv, 2005).

In addition, we shed some light on the possible link between students' interest in nature and their PEB. The analysis showed strong relations between interest in nature and PEB across all grade levels ($.541 < r < .720$). Subsequent regression analysis also confirmed the relationship, showing that 36.4% of the variance in environmental behavior can be explained by the SIN. Interest in nature is thus not only positively related to connection to nature (Neurohr et al., 2023), but also has a direct impact on environmental behavior. This makes interest in nature a valuable variable for understanding the underlying mechanism of environmental behavior that should be included in future studies. In addition, it also demonstrates a path to target PEB more specifically. A situational interest in nature, which can be generated in formal and non-formal ESD programs alike, can develop into individual interest through repeated occurrence over time.

Previous studies indicate that PEB can develop through experiences in nature (Otto et al., 2021; Richardson et al., 2020). The regression analysis in our study showed that time spent in nature and participation in an environmental organization together explain only 1.1% of the variance in environmental behavior. A hobby in nature does not explain any significant variance in PEB. This goes in line with prior research showing that time spent in nature can influence an individual's affinity with and connection to nature (Chawla, 2020; Kals et al., 1999). However, the low amount of explained variance is consistent with Richardson et al. (2020), suggesting that it is not time spent outside per se that influences environmental behavior, but how that time is spent. Nature activities like birdwatching or gardening have been found to be linked to PEB as well as connectedness with nature (Richardson et al., 2020). In general, meaningful, and experiential activities related to students' lives encourage positive

PEB (Johnson & Cincera, 2023). Interestingly, PEB has been found to be especially high when children spent a lot of time in nature during their early years, especially in the form of unstructured play in nature (Guiney, 2009; Mackay & Schmitt, 2019; Whitburn et al., 2019).

Even one-day interventions can enhance environmental attitudes and connection to nature when they are filled with experiential activities (Kossack & Bogner, 2012; Sellmann & Bogner, 2013). However, lasting bonds with nature require longer and repeated experiences (Sellmann & Bogner, 2013; Stern et al., 2008). The same might be true for interest in nature. When students are regularly exposed to nature, they can develop an individual interest in nature over time (Krapp, 2002) and will act in a pro-environmental way out of their own motivation (Krapp, 2002; Krapp & Prenzel, 2011; Renninger & Hidi, 2002). We thus suggest that educational programs in ESD should systematically incorporate exploratory and ecological nature experiences to strengthen students' interest in nature. Active involvement in environmental organizations during one's free time also correlates with a higher interest in nature, a stronger connection to nature and greater environmental values in adolescents (Neurohr et al., 2023). Therefore, motivating adolescents to participate in environmental protection during their free time can foster sustainable PEB. This is meaningful, since studies suggest that early engagement in nature predicts adults' PEB (Evans et al., 2018; Otto & Pensini, 2017; Wells & Leskies, 2006). Since pronounced PEB in adulthood reflects the acquisition of more environmental knowledge, interventions during adolescence can alter the developmental trajectory of such behavior (Otto et al., 2014). Thus, ESD programs should be integrated into students' education from an early age.

Self-reported behavior as in the GEB might not provide the same substantial information about an individual's behavior as measures of actual engagement in PEB. However, the GEB is a well-established measure of general ecological behavior that has been repeatedly validated as relevant for behaviors including energy use, transportation and mobility, and acceptance of nature conservation measures (e.g., Arnold, et al., 2017; Byrka et al., 2016; Otto et al., 2018). Since we used self-reports to measure interest in nature and environmental behavior, social desirability could have affected our findings. However, the GEB has been shown to be resistant to social desirability (e.g., Kaiser, 1998; Oerke & Bogner, 2013). Also, studies have found that social desirability can have a small impact on certain aspects of environmental attitudes but has no impact on environmental behavior (Oerke & Bogner, 2013). In our study, the questionnaire was answered anonymously, and teachers did not look

at the students' responses before putting them in envelopes. However, in future environmental attitude and behavior studies, it would be advisable to include a social desirability index as a potential statistical covariate.

Conclusion

Our research contributes to a deeper understanding of adolescents' interest in nature and its influential role in shaping PEB. Our results reveal a positive relationship between nature activities, interest in nature, and PEB among students from grades 5 - 9. Specifically, students who spend more time in nature demonstrate a greater interest in it, and they also exhibit a more pronounced engagement in PEB. However, it is concerning that lower secondary school students progressively reduce their time spent in nature and become less likely to pursue nature-related hobbies. Our data suggest the need for a comprehensive approach in which social policies facilitate children and adolescents spending more time in nature. This approach should encompass not only formal ESD, but also free ESD programs rooted in place-based education. This is becoming increasingly critical as projections indicate that by 2050, two-thirds of the global population will reside in cities or urban areas, where access to nature will be even more limited (World Health Organization, 2019). To address this issue, it is crucial to create educational opportunities that provide direct experiences with nature at both the school and community levels. By integrating nature and environmental protection into the curriculum in interdisciplinary ways, schools can foster the development of individual interest. If we succeed in generating and nurturing an interest in nature through ESD programs, it can pave the way for sustainable PEB. Interest appears to be another important trait of environmental attitudes, which may explain students' development of PEB through nature-based environmental education (Otto & Pensini, 2017). Just as fascination for science is a crucial factor that promotes deeper learning (Otto et al., 2020), interest in nature could serve as a motivating factor for students' engagement in PEB. Therefore, it is an important factor to be considered in future studies exploring PEB.

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6.3 Manuscript 3

Neurohr, A-L., Möller, A., Bergmann-Gering, A. & Johnson, B. Does Interest Really Matter? Interest in Nature as a Possible Determinant of Pro-Environmental Behavior.

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Summary

To achieve a sustainable future, active engagement in pro-environmental behavior (PEB) is crucial. Thus, understanding the key drivers behind PEB is vital for successful promotion and enhancement efforts (Milfont & Duckitt, 2004; Richardson et al., 2020; Whitburn et al., 2020). Previous research, including Manuscripts 1 and 2, suggests that interest in nature is a significant motivational factor, especially among young people, influencing PEB and strengthening connection with the natural environment (Blankenburg & Scheersoi, 2018; Guiney, 2009; Neurohr et al., 2023). Despite this, interest in nature has often been overlooked in models explaining PEB, which is a crucial oversight, as interest is recognized as a key factor in developing and sustaining internal motivation, both in general and in specific areas like PEB (Hidi & Renninger, 2006; Krapp, 2002; Uitto et al., 2011).

Therefore, the aim of this study is to fill this gap by incorporating interest in nature into a model explaining PEB. In this study, we examined the interrelationships between interest in nature, individuals' connection to nature, and their environmental attitudes towards preservation or utilization of nature. We also investigated how these factors collectively influence PEB, providing insights into the underlying mechanisms of PEB development.

For modelling, we used data from a cross-sectional study with 1092 students from grades 5 to 9 in German lower secondary schools. A paper-and-pencil questionnaire was employed, consisting of four established self-reported measures: 1) interest in nature, 2) connection to nature, 3) environmental attitudes, and 4) pro-environmental behavior. We first

conducted CFA measurement models for each latent construct with very good model fit. Subsequently, we successfully built structural equation models to examine the influence of each construct on GEB. However, the full structural equation model, aimed at exploring the interrelationships among the constructs and their influence on GEB, was not successful due to the multicollinearity of items from the different constructs. Nevertheless, given the successful measurement models, we proceeded to examine differences in these constructs between students with high GEB (Quartile 4) and low GEB (Quartile 1) scores.

Our study's findings demonstrate that interest in nature not only positively correlates with other determinants of PEB ($.62 < r < .85$, $p < .001$) but also significantly influences PEB itself. The interest and behavior model exhibited good fit. Furthermore, when comparing students with high GEB and low GEB, the analysis revealed significant differences in terms of interest in nature, connection to nature, and environmental attitudes ($p < .001$). Students with high GEB exhibited higher interest in nature, a stronger connection to nature, and more pronounced preservation of nature compared to students with low GEB. This research contributes to a deeper understanding of adolescents' interest in nature and its influential role in shaping PEB. By comprehending the interplay of all influencing factors, we can develop targeted Education for Sustainable Development programs. Our results suggest that generating and nurturing interest in nature in young people, for example in formal or informal Education for Sustainable Education settings, can pave the way for sustainable PEB in adulthood. Therefore, interest in nature is an essential factor to be considered in future research studies exploring PEB.

Does Interest Really Matter? Interest in Nature as a Possible Determinant of Pro-Environmental Behaviour

Anna-Lena Neurohr^{a*}, Andrea Möller^{a,b*}, Alexander Bergmann-Gering^c, Bruce Johnson^d

^a Austrian Educational Competence Centre for Biology, University of Vienna, Vienna, Austria

^b Faculty of Life Sciences, University of Vienna, Vienna, Austria

^c Biology Education, University of Leipzig, Leipzig, Germany

^d College of Education, University of Arizona, Tucson, AZ, USA

*Corresponding Authors:

Anna-Lena Neurohr

Mail: anna-lena.neurohr@univie.ac.at

Andrea Möller

Mail: andrea.moeller@univie.ac.at

University of Vienna

Austrian Educational Competence Centre Biology (AECC)

Porzellangasse 4/2

1090 Vienna, Austria

Does Interest Really Matter? Interest in Nature as a Possible Determinant of Pro-Environmental Behaviour

Abstract

Understanding the drivers of pro-environmental behaviour (PEB) is essential, as environmental degradation stemming from human actions is a profound challenge for humanity. Research suggests that in addition to connection to nature and environmental attitudes, interest in nature, especially when aroused in youth, can be a significant motivational factor driving people's engagement in PEB. However, the relationship between interest in nature and other determinants of PEB, as well as their collective influence on PEB on adolescents, is still greatly understudied. We aim to bridge this gap by incorporating interest in nature into a model explaining PEB. We used data from a cross-sectional study with German lower secondary school students ($n = 1092$, age 10-15 years), applying four self-report scales: 1) interest in nature (SIN), 2) connection to nature (DCN), 3) environmental attitudes (2-MEV), and 4) general ecological behaviour (GEB). Our findings demonstrate that interest in nature not only positively correlates with other determinants of PEB but also significantly influences PEB itself. This suggests that cultivating interest in nature among adolescents can potentially lay the groundwork for their development of PEB. Therefore, interest in nature should be considered in future research studies both exploring PEB and evaluating the effectiveness of ESD programs.

Keywords

Interest in nature, environmental attitudes, pro-environmental behaviour, environmental education

1 Introduction

Environmental degradation driven by anthropogenic factors such as climate change, habitat destruction, pollution, and over-harvesting represents one of humanity's greatest challenges (IPBES, 2019; IPCC, 2023, Wilson & Knopf, 2002). To create a sustainable future, it is crucial that people change their behaviours and lifestyles in order to reduce consumption (Ehrlich & Kennedy, 2005; Schultz, 2011). To achieve this goal, the United Nations introduced the "Agenda 2030", a comprehensive global action plan comprising 17 interlinked and

interdependent Sustainable Development Goals (SDGs). Among these, SDG 4 (education) holds a unique role within the Education for Sustainable Development (ESD) framework, as it contributes to the accomplishment of most other SDGs (United Nations, 2015, Otto et al., 2020, Winter et al., 2022). ESD is a response to humanity's current ecological and societal challenges, providing individuals of all age groups with the essential knowledge, skills, values, and perspectives required to advance sustainable development. ESD aims to empower individuals to make informed decisions and to start engaging in pro-environmental behaviour (PEB), which encompasses actions that seek to minimize one's negative impact on the natural environment (UNESCO, 2020).

Developing effective ESD programs to foster PEB and shaping impactful public policies require a holistic understanding of the drivers behind PEB across both the general population and particularly among children and adolescents (Milfont & Duckitt, 2004; Richardson et al., 2020; Whitburn et al., 2020). Prioritizing young individuals is essential, as research underlines that the foundation for sustainable PEB is often laid during childhood and solidifies in adulthood (Chawla, 2020; Kaiser et al., 2014; Otto et al., 2019). While most PEB studies have concentrated on adults, a growing body of evidence indicates similar trends among children (Collado et al., 2015; Otto & Pensini, 2017; Roczen et al., 2014). These investigations pinpoint several pivotal determinants influencing PEB. Connection to nature emerges as a key driver, boosting engagement in PEB (Brügger et al., 2011; Kollmuss & Agyeman, 2002; Mayer & Frantz, 2004; Bezeljak et al., 2023) and nurturing empathy and altruism towards the natural world (Schultz, 2001). Furthermore, growing nature appreciation fuels the inclination to protect endangered elements (Kaiser et al., 2013; Tam, 2022). Concern for the environment and commitment to its preservation are reflected in one's environmental attitudes, which seem to be a crucial factor for embracing PEB (Brügger et al., 2011; Kaiser et al., 2013; Roczen et al., 2014). Recent findings suggest that interest in nature is another significant predictor that is positively linked with nature connection and PEB (Kals et al., 1999; Leske & Bögeholz, 2008; Neurohr et al., 2023) and further enhances engagement in outdoor activities and hobbies (Guiney, 2009).

While previous models have examined relationships between connection to nature, environmental attitudes, and PEB (e.g., Maurer & Bogner, 2020; Naess, 1973; Otto et al., 2021; Otto & Pensini, 2017; Roczen et al., 2014; Schultz, 2002, Whitburn et al., 2019), interest in nature has not been included in any model explaining PEB. This omission might be an

oversight, since interest is recognized as a key factor in developing and sustaining internal motivation to study and take action (Hidi & Renninger, 2006; Krapp, 2002; Uitto et al., 2011). In this study, we aim to address this gap by including interest in nature in a model explaining PEB. Our goal is to analyse the interrelationships between students' connection to nature, environmental attitudes, and interest in nature and explore how they collectively influence PEB. Through this analysis, we seek to model the interconnections between and prerequisites for environmental attitudes and behaviour, which serve as the foundations for building a sustainable future. Recognizing that the roots of PEB are mostly established during childhood, our study deliberately concentrated on adolescents. This focus aimed to provide deeper insights into the underlying mechanisms of PEB development within this age group and the interplay of various factors essential for nurturing PEB. Gaining a comprehensive understanding of PEB's developmental trajectory is of great importance in order to more effectively promote it. Fostering interest in nature among young people through formal or informal ESD settings could pave the way for the development of sustainable PEB.

2 Theoretical Background

2.1 Pro-Environmental Behaviour

Pro-Environmental behaviour (PEB) encompasses actions like reducing energy use, conserving water, minimizing waste, and choosing eco-friendly transportation. Understanding the social and psychological factors that influence these actions is crucial (Oinonen & Paloniemi, 2023). Despite a high level of environmental concern, there is a gap between attitudes and sustainable living (Fox et al., 2006). This "knowledge-behaviour gap" reveals that knowing about environmental problems does not always drive behavioural change (Boyes & Stanisstree, 2012; Wibeck, 2014). Barriers like personal costs or lack of support explain this gap (Whitburn et al., 2020). However, a sustainable future is only possible if people reduce their consumption and behave in a more environmentally conscious way (Otto et al., 2019).

PEB is explained by internal and external factors (Hadler et al., 2022). External factors include politics, economics and culture, while internal ones encompass personal motives and social norms. Internal factors are significant due to the pro-social motivation behind behaviours (Schwartz, 1977; Stern et al., 1999). Therefore, social norms and individual

motives (e.g., attitudes, problem awareness, and perceived behavioural control) are essential predictors of PEB (Bamberg & Möser, 2007; Kaiser & Wilson, 2004). Previous findings suggest that attitudes play a crucial role in behaviour change (Abrahamse & Steg, 2009). To effectively promote behaviour changes, recent research considers influential factors such as emotional bonds with nature, environmental values and attitudes, connection to nature, and interest in nature (Brügger et al., 2011; Neurohr et al., 2023; Nisbet et al., 2009; Roczen et al., 2014; Schultz, 2002). Brügger et al. (2011) emphasize that attitudes toward nature greatly impact the adoption of ecological lifestyles, highlighting the need to address attitude changes in order to shift PEB.

2.2 Environmental attitudes

Environmental attitudes (EA) are learned predispositions to react favourably or unfavourably to aspects of the environment, encompassing energy, pollution, or technology (Hollweg et al., 2011). EA comprises multiple components, including emotions, knowledge, and behavioural intentions (Hadler et al., 2022, Schultz et al., 2004). Commonly, EA is divided into affective (emotional, e.g., concern), cognitive (knowledge-based), and conative (action-related) dimensions (Bogner, 2006; Diekmann & Preisendürfer, 1998; Gray, 1985; Hadler et al., 2022;). While some researchers propose EA as key drivers of PEB, empirical findings on the relationship between EA and behaviour are inconsistent (Eagles & Demare, 1999; Oerke & Bogner, 2013). EA's correlation with PEB tends to be moderate (e.g., Bamberg & Möser, 2007; Maurer & Bogner, 2020; Meinhold & Malkus, 2005), possibly due to unclear dimensions of EA (Costarelli & Colloca, 2004). Various dimensions have been proposed, like ecocentric and anthropocentric concerns (Thompson & Barton, 1994), or egoistic, altruistic, and biospheric concerns (Schultz, 2001). Using higher-order factor analysis based on a large pool of items, Bogner & Wiseman (2006) revealed two orthogonal dimensions: utilization and preservation. Their "2-MEV" model allows a person to both endorse protecting the environment on a biocentric dimension and support the usage of nature on an anthropocentric dimension. However, strong preservation (biocentric) is not necessarily linked with weak utilization (anthropocentric). The theory explicitly states that preservation and utilization are complementary and uncorrelated, not opposing values. Hence, individuals can be placed in one of four quadrants rather than on either end of a continuum.

2.3 Connection to nature

Connection to nature, a subjective assessment of one's relationship with the natural world, is vital for biosphere preservation (Chawla, 2020; Whitburn et al., 2020). Rooted in the biophilia hypothesis, this connection stems from humans' innate affinity for life (Wilson, 1984). Viewing the self and nature as interdependent leads to recognizing nature's inherent value (Schultz, 2001). Expanding self-identity to encompass nature and fostering a sense of belonging shape this connection. To enhance connection to nature, it is of great importance how one spends one's time in nature and what one's attention is focused on (Richardson et al., 2020). Simple activities such as gardening or birdwatching already seem to play an important role in predicting PEB (Sanvichith, 2011). Previous findings show that connection to nature has a strong direct association with PEB and an indirect association via environmental attitudes (Nisbet et al., 2009; Whitburn et al., 2019). Promoting a stronger connection to nature could increase individuals' engagement in PEB, including conservation of resources, pro-environmental activism, and support for environmental organizations (Schultz, 2011; Whitburn et al., 2020). Therefore, PEB necessarily requires the motivational pre-requisite of feeling connected to nature (van den Bosch & Bird, 2018). However, studies show an increasing alienation from nature, especially among young people, which can be attributed to spending less time in nature and feeling less connected with it (Bezelsjak et al., 2023; Hinds & Sparks, 2008; Pyle, 2003; Soga & Gaston, 2016). Children's bond with nature is breaking through indoor-centric lifestyles (Chawla, 2020; Louv, 2005). Recognized as a catalyst for societal change, particularly in childhood, this connection fosters respect and care for nature, while its absence can lead to environmental apathy (Ives et al, 2018; Pyle 2003).

2.4 Interest in nature

Appreciation and interest in nature positively drive the motivation to protect valued objects (Kaiser et al., 2013; Neurohr et al., 2023; Roczen et al., 2014; Tam, 2022). According to Krapp's person-object theory (2002), interest signifies a specific relationship between an individual and an object. Individual interest, as a dispositional motivational state, refers to a person's stable tendency to engage with an object of interest without external cause (Krapp & Prenzel, 2011). Well-developed individual interests lead to self-motivation and perseverance (Renniger & Hidi, 2002). Over time, through internalization and identification, an interest can become integrated into a person's values and identity (Krapp, 2002). Interest in nature,

specifically, deepens identification with the natural environment and increases the likelihood of engaging with it (Blankenburg & Scheersoi, 2018; Whitmarsh & O'Neill, 2010). This perspective aligns with the biophilia hypothesis, which suggests that humans have an innate interest in life and life-like processes, going beyond mere physical survival (Wilson, 1984). Recent research indicates that interest in nature not only positively correlates with connection to nature and experiences in nature but also explains a substantial portion of the variance in PEB. This suggests a link between greater nature interest and higher pro-environmental engagement.

However, the precise relationship between interest in nature, other environmental attitudes, and PEB remains unclear. To address this gap and gain a deeper understanding of the underlying mechanisms of PEB, we aim to model the interconnections between environmental attitudes and behaviour, including interest in nature. Our study focuses on correlating students' interest in nature with their environmental attitudes and behaviours. To achieve this, we explore the following questions:

- (1) What are the relationships between secondary school students' interest in nature and their connection to nature, environmental attitudes, and self-reported pro-environmental behaviour?
- (2) To what extent is secondary school students' interest in nature correlated with their connection to nature, environmental attitudes, and self-reported pro-environmental behaviour?
- (3) What is the underlying structure of the relationships among secondary school students' interest in nature, connection to nature, and environmental attitudes, and their impact on self-reported behaviour?

4 Methods

4.1 Participants and procedures

We conducted a cross-sectional study involving 1092 students (ages 10 to 15, $M_{\text{Age}} = 13.4$, $SD = 1.54$) from grades 5 to 9 in German secondary schools in North Rhine-Westphalia, Germany. The sample is balanced in terms of grades and gender (54% female). The participating schools are public academic-track schools ("Gymnasium"). Prior to the study, students and parents were informed about the research's purpose, process, anonymity, and data usage, and all

participants gave informed consent to participate in the study. The study received approval from the school principals and adhered to North Rhine-Westphalia's regulations. To participate in this study, written informed consent was provided by the participants' legal guardian or next of kin. The paper-and-pencil questionnaire, including scales measuring environmental attitudes and behaviours, was administered during class time (30-45 minutes). Teachers administered the questionnaire, providing both written and standardized oral instructions. Upon completion, teachers returned the survey to the research team. The study was non-invasive, voluntary, and anonymous.

4.2 Measures

In our study, we aimed to analyse the structure of influencing factors explaining students' PEB. To achieve this, we used measures of students' interest in nature, connection to nature, environmental attitudes, and PEB. As some of these measurements were originally based on the Rasch model, we evaluated their model fit using item reliability (> 0.90 , following Malec et al., 2007) and infit mean squares (MNSQ) within an acceptable range of 0.5 to 1.5 (following Linacre, 2021). In the following section, we will provide a detailed description of the instruments used in the study.

For measuring **interest in nature**, the Scale for Interest in Nature (SIN) was used, which consists of 18 items (Neurohr et al., 2023). We measured interest in nature with various self-report items on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). An example item is "In my opinion, documentaries and movies on nature are interesting". Positively and negatively formulated items were presented to control for response style bias. The five negatively formulated items were recoded afterwards. All interest items were found to fully fit the model, with an item reliability of 1.00 ($N = 954$) and a mean MNSQ of 1.01 ($SD = 0.20$).

A person's **connection to nature** was assessed by 18 of the original 40-item measure "Disposition to Connect with Nature" (DCN) established by Brügger et al. (2011). The instrument has been corroborated to overlap with other instruments that measure similar concepts: for example, the Connectedness to Nature Scale (Mayer & Frantz, 2004) and Environmental Identity (Clayton & Opatow, 2003). At the same time, the instrument has been shown to be technically superior in terms of conceptual purity (i.e., unidimensionality) and incremental validity (for details, see Brügger et al., 2011). Example items are "I cross meadows barefoot" or "I hike or run in nearby parks or forests". A five-point frequency scale ranging

from 1 (never) to 5 (always) was used. An item reliability of 1.00 (N = 954) and MNSQ values between 0.73 and 1.3 show a good fit to the Rasch model.

Environmental attitude was assessed using 18 items from Bogner and Wiseman's (2006) "Two Major Environmental Values model" (2-MEV), comprised of the two subscales preservation (PRE) and utilization (UTL). The self-reported item sets cover a biocentric dimension that reflects conservation and protection of the environment (preservation) and an anthropocentric dimension reflecting the utilization of natural resources (Bogner & Wiseman, 2003). An example item for preservation is "I make sure to save water and electricity" and for utilization "Humans are more important than other creatures (e.g., animals and plants)". One's personal point of view could be expressed with a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Of the 18 items, 10 were negatively formulated. All negatively formulated items, which represent a lack of commitment to environmental preservation, were reverse coded before calibration of the Rasch scale. The results are in line with previous studies (Bogner & Wiseman, 2006) and revealed very good internal consistencies (preservation: Cronbach's $\alpha = 0.78$, utilization: Cronbach's $\alpha = 0.70$).

Finally, **pro-environmental behaviour (PEB)** was measured by a comprehensively tested and validated self-report instrument "General Ecological Behavior" scale (GEB) (Kaiser & Wilson, 2004). To our knowledge, there is no currently available general performance measure that is similarly well developed and specifically designed to be used with adolescents. The behavioural self-reports can be grouped into six domains: recycling, waste avoidance, consumerism, mobility and transportation, energy conservation, and vicarious conservation behaviours. Example items are "I recycle waste" or "I take a tote bag or backpack with me when I go shopping". For the behavioural self-report items, we used a five-point scale ranging from 1 (never) to 5 (always). In line with previous research, the scale calibration was based on the classical Rasch model (see e.g., Kaiser & Wilson, 2004). All behaviour items were found to acceptably fit the model ($0.76 < \text{MNSQ} < 1.41$), and the Rasch-model-based reliability estimate of the measure was $rel = 1.00$ (N = 954).

All instruments were originally developed in German, so no translation was necessary. "Not applicable" was a response option when participants were - for whatever reason - not able to answer an item. The "not applicable" responses were treated as missing values. In addition, we collected socioeconomic data such as age, gender, and grade from the adolescents.

We reduced the DCN and GEB scales to 18 items each using item response theory. The adaptation was supported by two pilot studies (first pilot: N = 79; second pilot: N = 177) with students aged 10-15 using the original items. In order to confirm test quality and construct validity we assessed item reliability, person reliability, distribution adherence, and model fit (Linacre, 2009; Boone et al., 2014). Mean-Infit MS-Values below 1.3 indicated data-model alignment (Wright et al., 1994).

4.3 Data analysis

We conducted a missing value analysis initially to identify cases with substantial missing data on the main scales. As a result, 138 participants (12.64%) were excluded, leading to a reduced sample size of 954 participants. We then conducted confirmatory factor analyses for each of the instruments (SIN, DCN, 2-MEV with PRE, UTL, and GEB) with AMOS version 28 using maximum likelihood estimates. The purpose was to assess the contribution of each item to its respective factor in order to identify items with low contributions that could potentially be eliminated to improve the model fit. We then examined the relationship between interest, connection, and attitudes, and their contributions to behaviour, with a series of structural equation models, also using maximum likelihood estimates with AMOS version 28. To evaluate the fit of the models, we employed multiple measures of model fit, including both absolute and incremental fit indices, with more than one index of each type. The acceptability of the models was evaluated by considering widely used fit indices such as the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI). We used the following criteria: an RMSEA value of ≤ 0.06 (Hooper et al., 2008; Hu & Bentler, 1999), and CFI and TLI $\rho^2 \geq 0.90$ (Hu & Bentler, 1999) or ≥ 0.95 (Hooper et al., 2008). Regarding the CFI and TLI ρ^2 indices, values can range from 0.0 to 1.0, with values closer to 1.0 indicating a better fit. Initially, a cut-off criterion of 0.90 was established. However, further studies have revealed that a higher threshold is necessary to ensure that misspecified models are not accepted (Hu & Bentler, 1999). Therefore, a value greater than 0.95 is currently recognized as an indication of good model fit. Due to suboptimal model fit for our initial model, despite theoretical support for its structural assumptions, we opted to calculate correlations between the mean scores of each instrument (SIN, DCN, PRE, UTL, and GEB) and conducted group comparisons using SPSS version 26. By considering the highest and lowest

25% (Quartiles 1 and 4) of GEB scores, we compared these two extreme groups in terms of interest in nature, connection to nature, preservation, and utilization of nature.

5 Results

5.1 Measurement Models

Before examining the relationship between the variables of interest, confirmatory factor analyses (CFA) were conducted separately for all five instruments to confirm the expected structure of the constructs in the study (see Appendix 1). Several items were eliminated from each instrument due to low item loadings, resulting in improved model fit.

For the SIN model, three items (#7, #17, #42) were removed, resulting in a latent variable for interest in nature with 15 items. The model fit indices were within acceptable limits: CFI = .96, TLI = .94, RMSEA = .05.

Similarly, the DCN model demonstrated good model fit after eliminating three items (#3, #6, #15) with low item loadings, resulting in a latent variable for connection to nature (CFI = .96, TLI = .95, RMSEA = .05). However, the 2-MEV model did not support combining preservation (PRE) and utilization (UTL) items in a single model. The RMSEA value of .09 exceeded the commonly used maximum cut-off, and both CFI (.89) and TLI (.80) were below the recommended threshold of .95. To address this, separate models for PRE and UTL were established. The PRE model exhibited good model fit after removing three items (#3, #4, #5) with low item loadings, resulting in a latent variable with 5 items (CFI = .99, TLI = .99, RMSEA = .01). Similarly, the UTL model was confirmed after eliminating 5 items (#1, #2, #3, #10, #11) with very low or low loadings, resulting in a latent variable with 5 items. The model fit indices for UTL were strong: CFI = .99, TLI = .97, RMSEA = .04.

In the behaviour model, five items (#2, #5, #10, #20, #21) were removed due to low item loadings, resulting in a latent variable for behaviour with 13 items. The model fit was deemed good: CFI = .95, TLI = .93, RMSEA = .04. Taking into account the overall fit of the five measurement models, we proceeded with an analysis of the structural relationships between the latent variables interest in nature, connection to nature, environmental attitudes (preservation and utilization), and PEB.

5.3 Models explaining pro-environmental behaviour

In the next step, individual structural equation models (SEM) were conducted to assess each of the variables (1) interest, 2) connection, and 3) environmental attitudes (consisting of preservation and utilization) and relationships between each of the variables and pro-environmental behaviour (PEB) (see Appendix 1). All three models fit the data well. The fit indices for the interest and behaviour model were as follows: CFI = .92, TLI = .90, RMSEA = .045. Similarly, the connection and behaviour model demonstrated a good fit, with CFI = .94, TLI = .92, and RMSEA = .04. Additionally, the model including utilization, preservation, and behaviour exhibited a good fit with CFI = .94, TLI = .92, and RMSEA = .04. In order to gain a better understanding of the relationships between the key variables influencing PEB, we conducted a SEM with all five variables (interest, connection, preservation, utilization and behaviour). The fit indices of this model did not reach satisfactory levels (CFI = .88, TLI = .87). Only the root mean square error of approximation (RMSEA) (0.44) fell within an acceptable range. In addition, each of the four independent variables (interest, connection, preservation, and utilization) had loadings onto behaviour that were above 1.0, indicating multicollinearity between at least two latent variables. Too many of the items loaded similarly onto more than one variable in the model.

To further examine the relationships between the respective variables, we decided against model re-specification and instead computed Pearson correlations between interest in nature (SIN), connection to nature (DCN), environmental attitudes (PRE and UTL), and pro-environmental behaviour (GEB). The results, presented in Table 1, reveal significant positive correlations between almost all variables – interest, connection, preservation, and behaviour ($.62 < r < .85$, $p < .001$). The strongest correlation was observed between interest in nature and connection to nature ($r = .85$, $p < .001$). Utilization exhibited a significant negative correlation with all other variables at a moderate level ($-.32 < r < -.46$, $p < .001$), as has been found in many other studies (e.g., Bogner & Suarez, 2022; Schneller et al., 2015; Torkar & Bogner, 2019). Thus, it is evident that the variables influencing PEB not only demonstrate correlations with PEB but also exhibit significant and strong correlations with each other. These close relationships between the different constructs can lead to multicollinearity, which in turn compromises model fit.

Table 1. Descriptive statistics and bivariate correlations of interest in nature, connection to nature, environmental attitudes (preservation and utilization), and pro-environmental behaviour

	<i>M</i>	<i>SD</i>	<i>N</i>	SIN	DCN	PRE	UTL	GEB
Interest in nature (SIN)	2.76	0.82	801	-	.85*	.73*	-.39*	.72*
Disposition to connection with nature (DCN)	2.92	0.85	771		-	.76*	-.37*	.74*
Preservation (PRE)	3.71	0.88	892			-	-.46*	.62*
Utilization (UTL)	1.82	0.69	856				-	-.32*
General ecological behaviour (GEB)	2.95	0.67	577					-

Note. * stands for $p < .001$; **bold correlations** represent large effect sizes (i.e., $r > .50$)

5.2 Comparisons of interest, connection, attitude, and behaviour for students of high and low GEB scores

To contribute to our understanding of modelling challenges and future theory development, we examined the variables for different subsamples of students. We identified students at the two ends of GEB scores, representing large and small self-reported pro-environmental behaviour, and compared their mean scores on the other variables. To create two extreme groups, we utilized the first quartile (Q1: lowest 25%) and the fourth quartile (Q4: highest 25%) of the GEB scores. The results of our analysis revealed significant differences between these two groups in terms of interest in nature ($t(258) = -21.077$, $p < .001$, $d = 2.62$), connection to nature ($t(258) = -21.592$, $p < .001$, $d = 2.68$), and environmental attitudes (preservation: $t(257.392) = -16.663$, $p < .001$, $d = 2.01$; utilization: $t(256) = 6.388$, $p < .001$, $d = 0.80$) (see Figure 1). All t -tests yielded large effect sizes ($d > .80$).

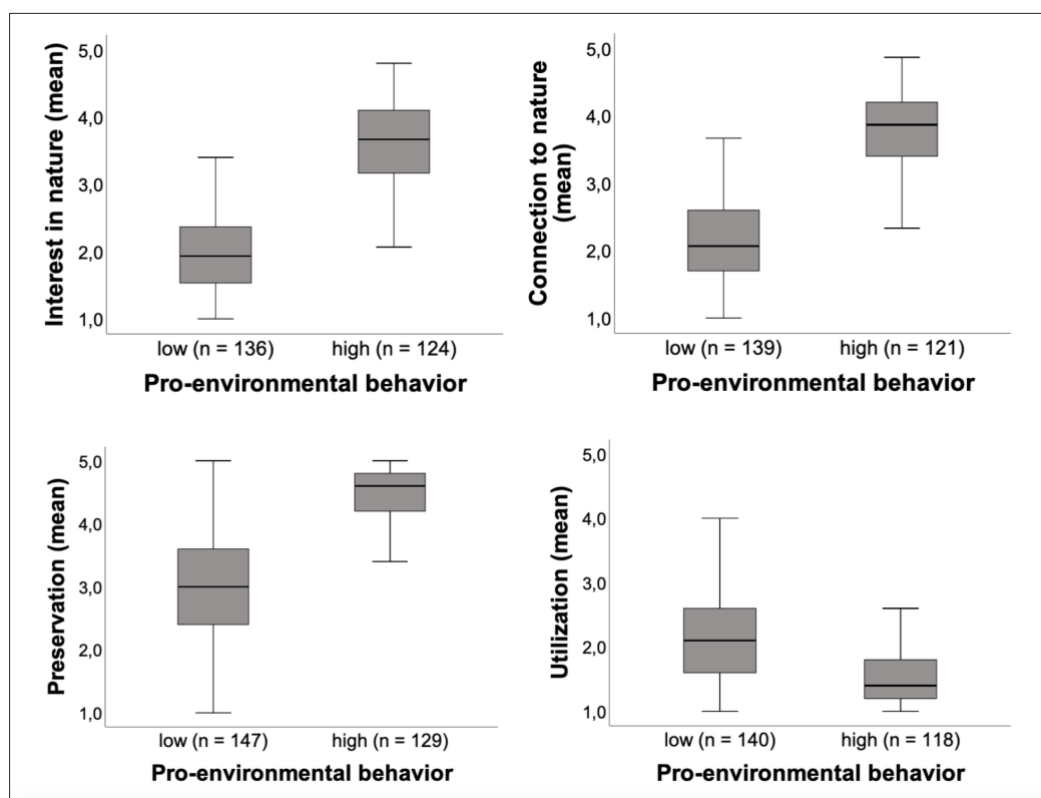


Figure 1. Differences in self-reported interest in nature (SIN), connection to nature (DCN), preservation (PRE) and utilization (UTL) as part of the 2-MEV between two extreme groups of PEB (measured by GEB scores), $n = 954$. Extreme groups were defined as low (lowest 25% of scores, quartile 1) and high (highest 25% of scores, quartile 4). Mean values and 95% confidence intervals are shown.

6 Discussion

This study aims to explore factors influencing sustainable pro-environmental behaviour (PEB) in adolescents, acknowledging human behaviour's pivotal role in ecological crises like climate change and biodiversity loss (IPBES, 2019; IPCC, 2023). Understanding PEB's development is vital for a sustainable future, which is why this research delves into key drivers of PEB, emphasizing its importance not only for reducing consumption but also promoting engagement in nature conservation actions (Richardson et al., 2020).

Given PEB's childhood origins, this study employs cross-sectional data from lower secondary school to uncover correlations among influencing factors in this age group. Grasping early PEB development can help in the development of targeted educational programs enhancing nature engagement. Interestingly, adult PEB isn't solely linked to maturation but also information exposure regarding environmental concerns via sources like

news or government directives (Otto & Kaiser, 2014; Otto et al., 2019). This suggests that altering the PEB trajectory before adulthood is feasible. Understanding the growth and consolidation of adolescents' PEB can significantly foster sustainable behaviour, benefitting future generations.

The inclusion of interest in nature as a potential determinant of PEB in this study provides new insights into the discussion of students' PEB and its underlying mechanisms. Our findings demonstrate a strong relationship between students' interest in nature, their connection to nature, environmental attitudes, and behaviour. This suggests that the development of PEB is influenced by the interplay between these factors. The strong link between connection to nature, environmental attitudes and behaviour is not surprising and confirms previous studies (e.g., Brügger et al., 2011; Johnson & Cincera, 2023; Maurer & Bogner, 2020; Otto & Pensini, 2017; Otto et al., 2019, 2021; Roczen et al., 2014; Whitburn et al., 2019, 2020). However, interest in nature emerges as another potential psychological factor influencing PEB. While only a few studies have analysed the importance of this relatively new construct (Kals et al., 1999; Kleespies et al., 2022; Neurohr et al., 2023), these findings resonate with studies looking at general interest as a motivational factor for a person's behaviour (Hidi & Renninger, 2006; Krapp, 2002; Rounds & Su, 2014). Thus, students' interest in nature can be seen as a relevant determinant of PEB, helping to strengthen the motivation to act in a pro-environmental way.

When comparing students with high and low PEB, we found that a higher PEB is associated with higher interest in nature, a stronger connection to nature and more pronounced pro-environmental attitudes. This means that students who are interested in topics and activities regarding nature, who have an emotional connection with nature and favour preserving it, are more likely to engage in pro-environmental actions. Therefore, to foster PEB, we could strengthen students' interest in, connection with, and attitudes towards nature at the same time. The models in this study support that each of the variables has a significant influence on PEB and counts as important determinant of it. While fostering PEB through educational programs, it is thus important to concentrate not only on one of these constructs but to try to strengthen all influencing factors simultaneously in order to promote strong, sustainable, and self-motivated PEB. Even though we were not able to include all these variables in one model, the individual models show that each of these variables has a significant influence on PEB and should therefore be further analysed.

Upon closer examination of the studied constructs, certain aspects that might have contributed to multicollinearity issues in the model emerge. For instance, the interest in nature scale (SIN) encompasses emotion-related, value-related, and intrinsic factors. Simultaneously, the preservation construct includes value-related tendencies, leading to item loading on multiple variables in the model (Neurohr et al., 2023). Moreover, some SIN items ask not only about interest in nature but also its protection (e.g., “In my spare time, I participate in projects on preserving nature”). A similar overlap is evident between interest and connection. Connection to nature signifies an emotional affiliation with nature (e.g., Mayer & Frantz, 2004) expressed as compassion for or concern about nature (e.g., “A cleared forest makes me miserable”). In addition to the interest-connection overlap, cross-loadings between preservation items and connection items related to concern for nature and its resources might have contributed to the high correlations between constructs, thus resulting in multicollinearity.

The findings of this cross-sectional study have implications for both, theory and practice. The results support the significance of considering students' interest in nature when analysing the underlying mechanisms of PEB, given its substantial variance-explaining power (Neurohr et al., 2023). Interest in nature may play a vital role in identifying with, fostering connections to, and motivating engagement with the environment. However, it would be important to examine the instruments used in this study in more detail in future studies in order to improve the discriminatory power of the constructs. Filtering out items that load onto more than one variable and cover different constructs simultaneously is essential. Understanding the interrelationships between these constructs is crucial to foster PEB appropriately and create a sustainable future for coming generations.

The findings underscore the importance of integrating interest-focused Education for Sustainable Development (ESD) programs. Nurturing interest in nature within educational contexts can notably impact PEB. Programs that evoke and sustain situational interest through structured activities, like challenges, problem-based learning or group work, have the potential to cultivate lasting individual interest over time (Harackiewicz et al., 2016; Hidi & Renninger, 2006). Another effective strategy to sustain students' interest in nature involves helping them discover meaning and value in the topic (Harackiewicz & Hulleman, 2010). Value-related beliefs, encompassing perceived usefulness and relevance to students' identity and goals, play a significant role (Eccles, 2009; Harackiewicz and Hulleman, 2010). When students

recognize nature's value, their interest, engagement, positive attitudes, and domain identification increase (Smith et al., 2015). This theory aligns with prior research regarding the object of nature (Kaiser et al., 2013; Neurohr et al., 2023; Sellmann & Bogner, 2013) and our findings, which indicate that high nature interest correlates with increased engagement, greater recognition of nature's value, and more positive attitudes.

Promoting interest in nature via nature activities is vital. Research shows that students exposed to nature or engaged in environmental organizations exhibit higher interest and nature connection (Kals et al., 1999; Neurohr et al., 2023). However, it's not just outdoor time that matters, but how it's spent (Richardson et al., 2020). Purposeful programs facilitating positive nature interactions lead to better PEB and connection (Johnson & Cinčera, 2023). Regular exposure to nature can cultivate individual interest over time, potentially driving autonomous PEB (Krapp & Prenzel, 2011; Renninger & Hidi, 2002). We propose that ESD programs integrate exploratory and ecological nature experiences to boost students' interest in nature. However, understanding students' pre-existing interest and competence levels is key for developing such interventions. What sparks interest can differ between students with strong interests and those in early interest stages (Harackiewicz et al., 2016). Hence, educators should tailor interventions to specific goals, instructional contexts, and students' needs (Harackiewicz et al., 2016). Early interest in nature is crucial, as interests impact preferences for specific activities and influence individuals' orientation towards the environment (Rounds & Su, 2014). Nurturing early interest in nature can lead to a lasting trait, encouraging an entire generation to become invested in PEB.

As with all studies, it is important to consider the limitations of the current research. The results obtained in this study are based on a specific target group, that is, lower secondary school students from academic track schools in Germany. Given potential variations across different school grades or types, further studies are necessary to investigate whether the model's outcomes exhibit similarities or differences. This exploration will aid in generating group-specific recommendations. Additionally, since all participants were from one country, conducting a cross-cultural validation of our results using samples from other countries and different age groups would be beneficial to enhance the generalizability of the findings.

Furthermore, this research paves the way for future investigations in several directions: Subsequent studies may consider incorporating the interest in nature survey into intervention and longitudinal studies to assess the effectiveness of ESD programs that target

the determinants of PEB. This would enable a more comprehensive understanding of the causal correlation between these factors and their impact on PEB. Qualitative analyses, such as interviews, could also be utilized to gain deeper insights into the development of interest in nature over time, providing valuable information about the underlying mechanisms driving PEB development. By addressing these limitations and exploring new avenues for research, we can advance our understanding of the factors influencing sustainable PEB and contribute to the development of effective educational programs and interventions that foster a more environmentally conscious and sustainable future.

7 Conclusion

In order to counteract this disconnection of humankind with the natural environment and make a sustainable future possible, we must actively engage in nature protection and PEB (Gifford & Nilsson, 2014; Otto et al., 2019; Richardson et al., 2020). Through our research, we have demonstrated that sustainable PEB is influenced by various psychological factors, all of which are closely interrelated. To successfully promote PEB and develop effective Education for Sustainable Development programs, we must focus on fostering individuals' interest in nature, their connection to nature, and their dedication to preserving it. While interest in nature was not extensively examined in previous studies, our findings strongly suggest that it not only correlates highly with other determinants of PEB but also directly influences PEB. Thus, generating and nurturing interest in nature among young people, whether through formal or informal ESD settings, can serve as a powerful motivational factor and pave the way for sustainable and self-motivated PEB in adulthood. Since theoretical work on interest has already demonstrated multiple ways to trigger and sustain situational interest, we can leverage this knowledge to develop interest-targeted ESD programs that ignite and sustain situational interest in nature, with the ultimate aim of transforming it into a deep-rooted individual interest over time. If more children and adolescents develop a genuine interest in nature, connect emotionally with it, and feel a strong sense of belonging to the natural world, we can raise a generation that prioritizes the needs of the environment over human interests and lives harmoniously with nature. By nurturing this profound bond between individuals and nature, we can foster a collective commitment to preserving our planet and ensuring a sustainable and thriving future for generations to come.

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Institutional Review Board Statement: In accordance with the local legislation and institutional requirements, ethical review and approval were not required for this study on human participants as it did not involve patients, was non-invasive, and participation was voluntary and anonymous. To participate in this study, written informed consent was provided by the participants' legal guardian or next of kin. The participants were also informed in advance that participation is voluntarily, and that data collection takes place anonymously.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data availability statement: The data that support the findings of this study are openly available in the Open Science Framework (OSF) at <https://osf.io/db5jr/>.

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7 Discussion

In the face of current global challenges, it is essential to recognize our pivotal role as a key species on Earth and take responsibility for all other organisms ([Richardson et al., 2020](#)). Therefore, the development of well-established pro-environmental behaviors among all human beings is crucial. The primary aim of this dissertation was to shed more light on the role of interest in nature when explaining the underlying mechanisms of pro-environmental behavior and its possible links with other factors influencing PEB. Understanding the various determinants of pro-environmental behavior and their interrelationships is essential for promoting them effectively through educational programs. Drawing on the theory of interest, which posits that interest predicts achievement, goals, and important life outcomes, we postulate that the same holds true for interest in nature. Several researchers have already suggested that interest in nature can be a significant motivational factor influencing pro-environmental behavior and strengthening individuals' connection to the natural environment ([Guiney, 2009](#)). Hence, this research contributes to a deeper understanding of adolescents' interest in nature and its influential role in shaping pro-environmental behavior. Considering that the foundations of pro-environmental behavior are often laid in childhood ([Kaiser et al., 2014](#)), and interests tend to stabilize early in life ([Rounds & Su, 2014](#)), this study focused on understanding their development among younger individuals.

By successfully developing and validating the Scale of Interest in Nature (SIN), this thesis offers an effective tool to measure adolescents' interest in nature in future research contexts and ESD settings alike (Manuscript1). Using the SIN in a known-group comparison and a large cross-sectional study among lower secondary school students, we examined the relationships between interest in nature and grade levels, activities in nature, connection to nature, and environmental attitudes and behaviors. The results demonstrate a decline in interest in nature, nature-related activities, and PEB during lower secondary school, while finding a significant positive correlation between these constructs (Manuscript 2). It appears that the period of lower secondary school may be crucial for the development of students' interest in nature and their pro-environmental behaviors (PEB), as previous studies have also shown a declining trend in environmental attitudes and behaviors from primary school to high school ([Bogner et al., 2015](#); [Bogner & Wiseman, 2002](#); [Collado et al., 2015](#); [Otto et al., 2019](#); [Torkar et al., 2021](#)). Since interest in nature can be considered “as a specific and practically

meaningful facet of attitude toward or connection to nature attitudes” (Manuscript 1), these findings contribute to a more comprehensive understanding of environmental attitudes among adolescents. Additionally, we showed that interest in nature correlates positively with dedication to preserve nature but negatively with utilization of nature, which aligns with prior research reporting a negative relationship between utilization of nature and other environmental values and behavior ([Johnson & Činčera, 2023](#); [Torkar & Bogner, 2019](#)). However, the analyses revealed that interest in nature not only correlates with other determinants of PEB, but also influences PEB itself (Manuscript 2 and 3). By comparing students with high and low levels of PEB, our study revealed that higher pro-environmental behavior (PEB) is correlated with increased interest in nature, a stronger connection to nature, and more pronounced pro-environmental attitudes. This suggests that students who show genuine interest in nature-related topics and activities form emotional bonds with nature, prioritize its preservation, and are more likely to engage in pro-environmental actions. Consequently, to effectively foster PEB, it is essential to simultaneously enhance students' interest in, connection to, and attitudes towards nature. The models used in this study support the significant influence of each variable on PEB, identifying them as crucial determinants. When implementing educational programs to promote PEB, it is important to not solely concentrate on one specific construct but to strengthen all influencing factors. By doing so, we can encourage the development of robust, sustainable, and self-motivated pro-environmental behavior among adolescents. In turn, only we can secure collective effort and engagement in nature-protective action will we be able to effectively address today's ecological challenges and strive for a sustainable future.

Therefore, the research conducted in this dissertation enhances our understanding of adolescents' interest in nature and its significant influence on shaping pro-environmental behavior (PEB). In the following sections, I will further explain the potential implications of our findings for theoretical frameworks and future research, teaching practice, and education policies.

7.1 Implications for theory and future research

The significance of interest in nature, connection to nature, environmental attitudes, behaviors in teaching environmental issues, and their relationship to Environmental Education and Education for Sustainable Development represent crucial areas for future research and the development of new approaches in science education. Our research not only revealed the correlation between interest in nature and nature activities, connection to nature, and environmental attitudes and behaviors, but also demonstrated that interest in nature serves as a further essential determinant of PEB. Therefore, interest in nature is a vital factor that should be included in future research exploring PEB and analyzing the underlying mechanisms of PEB development. The successful development and validation of the Scale of Interest in Nature (SIN) provides an effective instrument to measure adolescents' interest in nature, enabling future investigations in various research contexts and ESD settings alike.

To further advance our understanding, the SIN can be employed in different countries and environments around the world to ensure its adaptability to diverse cultural contexts. Exploring variations in interest in nature across countries and their possible connections to differences in curricula or educational programs would be intriguing. Longitudinal studies incorporating the scale can assess the effectiveness of ESD programs that target the determinants of PEB. This approach would lead to a more comprehensive understanding of the causal relationship between these factors and their collective impact on PEB. Considering that interests tend to stabilize early in life ([Rounds & Su, 2014](#)), research should focus on understanding their development among younger individuals. Longitudinal studies beginning in early childhood would be highly beneficial for understanding the antecedents, development, and outcomes of interest in nature and its influence on students' interaction with nature and the environment ([Low & Rounds, 2006](#)). Investigating potential links between interest in nature and demographic factors, such as rural/urban living or different school types, could provide valuable insights into the conditions for effectively fostering interest in nature.

As our findings regarding the modeling of PEB are based on a specific target group (lower secondary school students from academic-track schools in Germany), future studies could explore similarities or differences in other school grades or school types. A comprehensive understanding of the interplay among all factors influencing students' PEB is essential for promoting PEB through both formal and informal environmental educational settings.

7.2 Implications for teaching

The aim of this research was to identify the attitudes and behaviors necessary for today's students to contribute to a more sustainable future. As the educational system is constantly evolving to meet students' current needs, the findings of this thesis can offer valuable insights for educational institutions on how to better promote environmental skills and establish evidence-based innovations.

Given the significant decline in interest in nature, nature activities, and PEB during lower secondary school, it is even more critical to counteract this trend through interventions specifically designed to trigger and sustain students' interest in nature and motivate them to engage in more activities in nature. Developing students' interest is vital in all educational settings, particularly in domains initially unappealing to many students or areas where interest tends to diminish over time ([Harackiewicz et al., 2016](#)). As students' interest in nature and environmental issues seems to decline over the course of schooling ([Chawla, 2020](#); [Leske & Bögeholz, 2008](#); [Sjøberg & Schreiner, 2019](#)), focusing on this domain becomes increasingly important. However, there is no one-size-fits-all motivational intervention guaranteeing success, and what works for one type of student or classroom setting may not apply universally.

To effectively impact critical educational outcomes and develop targeted interventions focused on motivational processes, it is essential to consider the learner's phase of interest development. Harackiewicz et al. ([2016](#)) propose two intervention approaches based on the theory of interest: (1) trigger and maintain situational interest, and (2) build on emerging and well-developed individual interest. The first approach involves offering activities with structural features such as problems, challenges, and surprises to capture the attention and engagement of all students. The second approach entails delivering content and tasks that allow students to effectively connect academic topics with their existing interests. In the context of interest in nature, implications for structural features could include hands-on activities such as experimenting or dissecting ([Holstermann et al., 2010](#)), group work ([Palmer, 2009](#)), and physical activities in nature like working in a school garden or bird-watching in a park ([Richardson et al., 2020](#)). Our findings provide additional support for the significance of engaging in regular activities in nature, as they demonstrate a significant correlation with high interest in nature and strong PEB. It is essential that educational activities arouse students' immediate needs and excitement ([Dewey, 1913](#)).

Furthermore, personalized contexts can provide a coherent structure of meaning for students and connect new content to their pre-existing individual interests ([Elster, 2007](#); [Harackiewicz et al., 2016](#)). Interventions should include contextualized tasks related to students' interest in nature or activities in nature, rather than merely inserting surface-level information about their interests (e.g., favorite book or movie). Striking a balance between tailoring tasks to individual students or smaller subgroups of students, such as those who pursue the same nature activities, especially in heterogeneous school classes, could be beneficial. Additionally, leveraging advanced learning technologies to adapt content based on individual student preferences offers practical and scalable solutions for customized instruction ([Collins & Halverson, 2009](#)). Walkington & Bernacki ([2014](#)) emphasize the importance of students' autonomy in creating personalized contexts, as involving students in personalizing their own learning can lead to deeper connections. For instance, empowering students to develop proposals for environmentally protective activities in the community exemplifies strong student ownership of context personalization. This approach aligns with research suggesting that successful interventions are achieved as a result of factors such as perceived meaningfulness, teacher encouragement of responsible PEB, and providing students some level of autonomy to support their empowerment ([Johnson & Činčera, 2023](#)).

Our findings also highlight the effectiveness of utility-value interventions in promoting both situational and individual interest processes. By helping students recognize the meaning and value of the subject of nature, we can enhance their interest in it. According to the theory of interest, students who acknowledge the importance of the natural world are more likely to develop higher interest, increased engagement, positive attitudes, and a stronger sense of identification with nature ([Brown et al., 2015](#); [Smith et al., 2015](#)).

When considering different approaches to trigger and maintain interest in nature through interventions, we must consider students' pre-existing interest and their level of competence in the topic of nature and the environment. One intervention may not fit all students equally, as different interest triggers may distract those with well-developed interests, while igniting situational interest among students in the early stages of interest development ([Harackiewicz et al., 2016](#)). Therefore, educators should carefully tailor interventions based on their specific goals, instructional context, and students' needs ([Harackiewicz et al., 2016](#)). Adopting diverse and multiple approaches can be advantageous, as attempting to find a single nature-related activity that universally fosters nature-related

views in all children can be challenging ([Sheldrake & Reiss, 2022](#)). Despite the challenges, cultivating an early interest in nature is imperative given the profound impact of interests on educational choices and performance ([Rounds & Su, 2014](#)). By promoting individual interest in nature from a young age, we can foster a strong personal trait that persists into adulthood, nurturing a generation deeply committed to PEB.

7.3 Implications for education policy

Having discussed implications for future research and teaching, I will now provide a brief overview of the policy recommendations for Biology and STEM programs arising from our findings. Our research underscores a strong correlation between interest in nature, connection to nature, attitudes towards nature, and their significant impact on PEB. For an effective promotion of PEB, it is imperative for teachers to amplify these values and attitudes among students. To facilitate this, we need to equip teachers not only with this knowledge but also with the relevant methods to foster these qualities.

Given the pivotal role of interest in nature for the development of sustainable PEB it becomes crucial to embed this concept in both new and existing K-12 and higher education policies, including pre-service and in-service teacher requirements. Policies guiding the preparation of our future teachers must emphasize the importance of nurturing interest in nature to cultivate an environmentally conscious student body.

A potential policy action involves the proactive design of biology teacher preparation programs rooted in interest theory principles. These programs should incorporate strategies that sustain students' situational interest in nature, building on their emerging and well-developed individual interest in it. These teacher education courses could focus on evaluating and adopting both curricular and extracurricular interventions centered on students' interest in nature and its development process ([Diekman et al., 2015](#)), emphasizing techniques such as interest-triggering structural features ([Durik & Harackiewicz, 2007](#)) and context personalization ([Walkington & Bernacki, 2014](#)). Moreover, these courses should highlight how nurturing interest in nature deepens students' connection to it ([Walkington & Bernacki, 2014](#)) and demonstrates how students can benefit from different types of nature interest interventions ([Harackiewicz et al., 2014](#)). To ensure effective transfer into classroom practices, teacher preparation policies must promote the integration of these interest-driven interventions. In formal education, school gardens, ponds or apiaries can serve as valuable

drivers of interest in nature (Williams & Dixon, 2013; Möller, 2021). Also, non-formal ESD settings like public or national parks could possibly serve as invaluable starting points for developing interest in nature.

A further step involves revising existing policies that already hold administrators and instructors accountable for student learning about nature and environmental issues and expanding them to include fostering interest in nature. Accountability policies can establish a new norm for the central role of student interest in nature in environmental education. At the same time, teacher education programs should prioritize providing future teachers with the professional knowledge to promote and sustain students' evolving interest in nature and environmental concerns. By incorporating interest theory into educational policy and practice, we can take a step toward creating a future generation of students prepared to shape their world in a sustainable manner ([Hidi & Harackiewicz, 2000](#); [Renninger et al., 2004](#)).

8 Conclusion

In conclusion, our research offers valuable contributions to the field of environmental education and the promotion of PEB. By recognizing the significance of interest in nature and its impact on PEB, we pave the way for future investigations and interventions aimed at nurturing a generation deeply committed to environmental conservation and sustainability. Furthermore, our data suggests that schools can play a crucial role in fostering the development of individual interest in nature by integrating nature-related activities into their curricula. By incorporating Education for Sustainable Development (ESD) programs into formal and non-formal educational settings, we have the potential to generate and nurture interest in nature among adolescents, leading to the cultivation of sustainable PEB in adulthood. Should a greater number of children and adolescents cultivate a genuine interest in nature, establish an emotional connection with it, and experience a deep-rooted sense of belonging to nature, we can raise a generation that prioritizes the needs of the environment over human interests and coexists harmoniously with the natural world. Through fostering this bond between individuals and nature, we have the ability to promote a collective commitment to preserving our planet and ensure a sustainable and thriving future for generations to come.

9 References

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Appendix

Questionnaire of the cross-sectional study (English and German)

Questionnaire of the cross-sectional study (Manuscript 2 and 3)

1. Interest in Nature / Naturinteresse

English items from Neurohr et al., 2023; Translation to German by Anna-Lena Neurohr and Andrea Möller

Likert scale (0-4): strongly disagree, disagree, partially agree, agree, strongly agree

Likert Skala (0-4): Stimmt gar nicht, stimmt eher weniger, stimmt teilweise, stimmt größtenteils, stimmt völlig

#	English	German
SIN 3	In my opinion, documentaries and movies on nature are interesting.	Ich finde Naturdokumentationen und Naturfilme interessant.
SINi 5	Plants are boring.	Pflanzen sind langweilig.
SINi 13	I prefer talking about new movies and music, rather than animals.	Ich unterhalte mich lieber über die neusten Filme und Musik als über Tiere.
SIN 15	In libraries, I like reading nature books (for example on animals or plants).	In einer Bibliothek oder einem Buchladen lese ich gerne in Naturbüchern (z. B. über Tiere oder Pflanzen).
SIN 16	I would be happy to receive a calendar with nature pictures (for example animals or landscapes) for my birthday.	Über einen Kalender mit Naturfotos (z. B. Tiere, Landschaften) würde ich mich zum Geburtstag freuen.
SINi 17	I don't really mind the fact that humans destroy nature.	Dass der Mensch die Natur zerstört, ist mir ehrlich gesagt egal.
SIN 27	I enjoy discovering nature with my friends more than playing computer games or video games with them.	Es macht mir mehr Spaß mit meinen Freunden die Natur zu erkunden, als mit ihnen Computer- oder Videospiele zu spielen.
SIN 37	It is exciting to examine bees or other insects with a magnifying glass.	Mit einer Lupe Bienen, Käfer oder andere Insekten zu untersuchen, ist spannend.
SINi 7	I have no personal interest in what happens in nature.	Was in der Natur vor sich geht, hat für mich keine persönliche Bedeutung.
SINi 22	If I am being completely honest, I don't care about animals and plants at all.	Wenn ich ehrlich sein soll, sind mir bedrohte Tiere und Pflanzen egal.
SIN 24	It is important to me to know the names of local animals and plants.	Es ist mir wichtig, die Namen heimischer Tiere und Pflanzen zu kennen.

SIN 26	Personally, I find it important to know the role of humans in nature.	Es ist mir persönlich wichtig zu wissen, welche Rolle der Mensch in der Natur spielt.
SIN 28	I could imagine collecting feathers, leaves or other things as a hobby.	Ich kann mir vorstellen, das Sammeln von Federn, Blättern oder anderen Dingen aus der Natur als Hobbys zu betreiben.
SIN 21	In my spare time I take pictures of flowers, animals and landscapes.	In meiner Freizeit fotografiere ich Blumen, Tiere oder Landschaften.
SIN 30	In my spare time I participate in projects on preserving nature.	In meiner Freizeit mache ich bei Aktionen und Projekten zum Naturschutz mit.
SIN 34	In my spare time I examine plants and conduct small experiments with them (e.g., poking them gently, blowing at them)	In meiner Freizeit untersuche ich Tiere und Pflanzen oder führe kleine Versuche mit ihnen durch (z. B. Anstupsen, Anpusten).
SIN 36	Outside of school I seek out information about animals and plants (for example on the internet or in books).	Auch außerhalb der Schule informiere ich mich gerne über Tiere oder Pflanzen (z. B. Internet, Bücher).
SIN 42	I purposely chose hobbies that allow me to spend a lot of time in nature (e.g., riding, fishing, geocaching).	Ich habe bewusst Hobbys gewählt, bei denen ich viel in der Natur sein kann (z. B. Reiten, Skaten, Angeln, Geocaching).

Note. Inverse items are marked with an i (for inverted)

2. Environmental attitudes (2-MEV) / Umwelteinstellungen

English items adapted from Bogner & Wiseman (2006); Translation to German by Nadine Pasch und Andrea Möller

Likert scale (0-4): strongly disagree, disagree, partially agree, agree, strongly agree

Likert Skala (0-4): Stimmt gar nicht, stimmt eher weniger, stimmt teilweise, stimmt größtenteils, stimmt völlig

#	English	German
P1	It upsets me to see countryside taken over by building sites.	Es stört mich, wenn Wald- und Wiesenflächen von neuen Straßen oder Wohnsiedlungen bebaut werden.
P2	I enjoy trips to the countryside.	Es macht mir großen Spaß, selbst ins Grüne (Wald, Wiese) hinausgehen zu können.
P3	Humankind will die out if we don't live in tune with nature.	Die Menschheit muss mit der Natur in Einklang leben, um zu überleben.
P4i	Society will continue to solve even the biggest environmental problems.	Man ist bis jetzt immer mit Umweltproblemen fertig geworden und wird es auch in Zukunft schaffen.
P5	I make sure to save water and electricity.	Ich achte darauf, Wasser und Strom zu sparen.
P7	The state must set aside areas to protect endangered species.	Der Staat muss mehr Schutzgebiete einrichten, um vom Aussterben bedrohten Tieren und Pflanzen helfen zu können.
P8	It is interesting to know what kind of creatures live in ponds or rivers.	Es ist spannend herauszufinden, welche Lebewesen in einem Tümpel oder Fluss leben.
P9	Dirty industrial smoke from chimneys makes me angry.	Wenn ich dunklen Qualm aus Industrieschornsteinen sehe, denke ich sofort an Luftverschmutzung und werde ärgerlich.
U1i	For the technical progress some endangerments of the nature must be accepted.	Damit die Technik weiterentwickelt wird, müssen einige Gefährdungen der Natur hingenommen werden.
U2i	We need to clear forests in order to grow crops.	Um uns alle ernähren zu können, müssen Wälder oder Moore in Felder umgewandelt werden, um z. B. Getreide anzubauen.

U3i	Nature is always able to restore itself.	Die Natur ist immer in der Lage, sich zu erholen und selbst zu erneuern.
U4i	People worry too much about pollution.	Ich finde, dass Menschen sich zu viele Gedanken über Umweltverschmutzung machen.
U5i	We must build more roads so people can travel to the countryside.	Es sollten mehr Straßen gebaut werden, damit mehr Menschen raus aufs Land fahren können.
U6i	Only plants and animals of ecological importance need to be protected.	Nur nützliche Tiere und Pflanzen sollten unter Schutz gestellt werden.
U7i	Humans have the right to change nature as they see fit.	Der Mensch hat das Recht, die Natur nach seinen Wünschen zu verändern.
U9i	Human beings are more important than other creatures (e.g., animals and plants).	Menschen sind wichtiger als andere Lebewesen (z. B. Tiere und Pflanzen).
U10i	We should remove garden weeds to help beautiful flowers grow.	Unkraut muss entfernt werden, damit nützliche und schöne Pflanzen wachsen können.
U11i	Our planet has unlimited resources (e.g., oil, wood, coal).	Unser Planet hat unbegrenzt viele Rohstoffe (z. B. Öl, Holz, Kohle).

Note. Inverse items are marked with an i (for inverted); P stands for Preservation items and U for Utilization items.

3. Disposition to connect with nature / Naturverbundenheit

English items adapted from Brügger et al., 2011; Translation to German by Nadine Pasch und Andrea Möller

Likert scale (0-4): never, seldom, occasionally, often, always

Likert Skala (0-4): nie, selten, gelegentlich, oft, immer

#	English	German
DCN 1	I get up early to watch the sunrise.	Ich stehe morgens früh auf, um den Sonnenaufgang zu sehen.
DCN 3	I cross meadows barefoot.	Ich gehe barfuß über Wiesen.
DCN 4	I help snails and toads cross the street.	Ich helfe Tieren wie z. B. Schnecken und Kröten über die Straße.
DCN5	I watch TV shows that have animals as the main characters.	Ich sehe mir Fernsehsendungen an, deren Hauptdarsteller Tiere sind.
DCN 6	I have a CD or tape with recorded sounds of the sea or the rain.	Ich höre CDs oder Musik mit Meeresrauschen oder dem Geräusch von Regen.
DCN 8	I take time to consciously smell flowers.	Ich rieche gerne an Blumen.
DCN 11	I collect objects from nature such as stones, flowers, or seashells.	Ich sammle Dinge aus der Natur, wie z. B. Steine, Blumen oder Muscheln.
DCN 12	I deliberately take time to watch stars at night.	Ich nehme mir bewusst Zeit, die Sterne zu beobachten.
DCN 14	Even when it is very cold or rainy I go out for a walk.	Auch wenn es sehr kalt ist oder wenn es regnet, gehe ich gerne raus in die freie Natur.
DCN 15	I hike or run in nearby nature reserves or forests.	Ich wandere oder jogge in nahe gelegenen Parks oder Wäldern.
DCN 23	I feel the need to be out in nature.	Ich verspüre das Bedürfnis, nach draußen in die Natur zu gehen.
DCN 25	Walking through a forest makes me forget about my daily worries.	Im Wald vergesse ich meine Sorgen und Probleme.

DCN 26	I personally take care of plants.	Ich versorge gerne Pflanzen.
DCN 29	Listening to the sounds of nature makes me relax (e.g., bird voices).	Es entspannt mich, Naturgeräuschen zuzuhören (z. B. Vogelstimmen).
DCN 21	I enjoy gardening (e.g., at home or in the school garden).	Wenn ich kann, kümmere ich mich um Arbeit im Garten (z.B. Zuhause, Schulgarten).
DCN 33	A cleared forest makes me miserable.	Ich fühle mich schlecht, wenn ich abgeholzte Wälder sehe.
DCN 35	It makes me miserable to see a hedgehog or a fox that was hit by a car.	Überfahrene Tiere wie Igel und Füchse machen mich traurig.
DCN 36	Watching animals is exciting.	Ich finde es spannend, Tiere zu beobachten.

4. General ecological behavior / Umweltverhalten

English items adapted from Kaiser & Wilson, 2004; Translation to German by Nadine Pasch und Andrea Möller

Likert scale (0-4): never, seldom, occasionally, often, always

Likert Skala (0-4): nie, selten, gelegentlich, oft, immer

#	English	German
GEB 2	When I am the last one to leave the room, I turn of the lights.	Wenn ich den Raum als Letzte(r) verlasse, mache ich das Licht aus.
GEB4	In winter, I turn down the heat when I leave my room for several hours.	Im Winter drehe ich die Heizung runter, wenn ich das Zimmer für mehrere Stunden verlasse.
GEB5i	In the winter, I keep the heat on so that I do not have to wear a sweater.	Im Winter ist mein Zimmer warm genug, um nur im T-Shirt herumzulaufen.
GEB 10	I take refillable packaging to school or sports (e.g., lunch box, water bottle).	Ich nehme wieder auffüllbare Verpackungen mit in die Schule oder zum Sport (z. B. Butterbrotdose, Trinkflasche).
GEB 11i	If I am offered a plastic bag in a store, I take it.	Wenn ich in einem Geschäft eine Plastiktüte angeboten bekomme, nehme ich sie.
GEB13	I take a tote bag or backpack with me when I go shopping.	Zum Einkaufen nehme ich eine Tragetasche oder einen Rucksack mit.
GEB16	I separate my trash.	Ich trenne meinen Müll.
GEB17	I save used wrapping paper to use again.	Ich hebe benutztes Geschenkpapier auf, um es wieder zu verwenden.
GEB18	To take notes, I use the back of already written or printed sheets.	Um mir Notizen zu machen, benutze ich die Rückseite von bereits beschriebenen oder bedruckten Blättern.
GEB15	I use notebooks and writing pads made of recycled paper.	Ich benutze Hefte und Schreibblöcke aus Recyclingpapier.
GEB20	I buy organic food.	Ich kaufe Bio-Lebensmittel.

GEB21i	I kill insects with a chemical insecticide.	Ich töte Insekten mit Insektengift oder Spray.
GEB25	I ask my parents to buy a fuel-efficient automobile.	Ich bitte meine Eltern, ein energiesparsames Auto zu kaufen.
GEB26	I have pointed out unecological behavior to someone.	Ich weise andere Leute auf ihr umweltschädigendes Verhalten hin (z. B. Müll in die Natur werfen).
GEB27	I contribute financially to environmental organizations.	Ich spende Geld für den Naturschutz.
GEB28	I ask my parents to buy regional products.	Ich bitte meine Eltern, Produkte aus unserer Region zu kaufen.
GEB29	I inform myself about environmental issues (e.g., through TV, books, internet).	Ich informiere mich über Umweltprobleme (z. B. über Fernsehen, Bücher, Internet).
GEB31	After a picnic, I leave the place as clean as it was originally.	Ich stehe morgens früh auf, um den Sonnenaufgang zu sehen.

Note. Inverse items are marked with an i (for inverted)