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Primary children's views about appreciating, supporting, and learning about nature

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ABSTRACT

Biology education aims to inspire interest, curiosity, and understanding about the natural world, foster children's interests and orientations towards supporting and protecting nature, and support children towards biology-related careers (including those involving nature and animals). However, it remains less clear how these views might associate with different aspects of education and life. In order to gain new insights, 679 children in England (between 7 and 10 years old) were surveyed. The questionnaire included established measures for views about nature and learning, alongside new areas. The analysis applied predictive modelling to reveal independent associations between the children's views. The children's appreciation of nature and affinities towards animals were two of the strongest positive predictors of their interest in learning about nature, which was the strongest positive predictor of their aspirations towards careers involving nature or animals. Other findings highlighted the importance of nature-related activities and also children's wider educational contexts and views. Watching nature-related media positively predicted children's interest in learning about nature, while reading books about nature or wildlife positively predicted children's aspirations towards careers involving nature or animals. Children's confidence and enjoyment in their schoolwork positively predicted their appreciation of nature and also their interest in learning about nature.

KEYWORDS

Environment; nature connection; empathy; attitudes; aspirations

Introduction

Contemporary biology education aims to inspire interest, curiosity, and understanding about the natural world, which is intended to help people throughout their lives (Osborne and Dillon 2008; Royal Society of Biology 2019). Children are also often encouraged to consider science-related studies and careers, so that rewarding and beneficial careers can become more accessible to them (Royal Society of Biology 2019; Royal Society 2014). Children's progressions towards science-related studies and careers often follow from their personal interests, alongside numerous other influences (Henriksen, Jensen, and Sjaastad 2015; Regan and DeWitt 2015). For example, people working within science-related fields have highlighted their childhood experiences and interests as important influences on their career trajectories (Maltese and Tai 2010; Maltese, Melki, and Wiebke 2014), and environmentalists and naturalists have specifically highlighted the importance of their childhood experiences outdoors in nature (Chawla 1998; Corcoran 1999; Palmer 1993; Tanner 1980).

Children often learn about aspects of nature and the natural environment as topics within biology and geography at school, which may involve and/or be supplemented by various outdoor activities (Department for Education 2014). Children also undertake various activities and follow their own interests outside of school. Although contemporary curricula in England do not explicitly involve teaching children to support and protect nature, the wider field of environmental education has historically aimed to foster life-long interests and orientations towards supporting and protecting nature, as well as inspiring practical actions and wider advocacy (Hungerford and Volk 1990; Hungerford, Peyton, and Wilke 1980; Knapp 2000; Stapp 1969). Supporting and protecting nature are increasing concerns in England and the wider United Kingdom (Department for Environment, Food and Rural Affairs 2018; State of Nature 2019), as well as the international community (Cardinale et al. 2012; Folke et al. 2011; United Nations 2015).

Within these contexts, policy makers, teachers, and the wider public could benefit from an awareness of which aspects of children's lives associate with their interests, affinities, and other orientations towards nature, including their views about nature-related careers. This could then inform where and how support could be focused. In order to gain new insights, the research presented here surveyed primary school children (aged between 7 and 10 years) in England. The research considered what might associate with their enjoyment and appreciation of nature, empathy and affinity for animals, sense of oneness with and responsibility towards nature (reflecting orientations towards supporting/protecting nature), interest in learning about nature, and aspirations towards careers involving nature or animals.

Appreciating, supporting, and protecting nature

Children and young people often value nature, recognise and appreciate the diverse experiences that can be possible in nature, and associate natural places with positive feelings and/or relaxation (Bonnett and Williams 1998; Gurholt 2014; Wiens, Kynğäs, and Pölkki 2016). Primary school children in England have particularly conveyed their appreciation of animals and plants (Harvey et al. 2020). Primary school children in England have also expressed concern with the welfare of animals (and sometimes plants), and proposed fairness and equality for their treatment; these children also emphasised that people need the environment to live, and were aware of environmental concerns (Bonnett and Williams 1998). Children in various other countries have frequently conveyed empathy and sympathy for nature, recognition of dependency between people and nature, and recognition of the impacts that people have on nature (e.g. Aaron and Witt 2011; Collado, Íñiguez-Rueda, and Corraliza 2016; Rios and Menezes 2017; Tanner 2010; see also: Chawla 2020).

Considered from a wider perspective, children across England typically express positive affinities and orientations towards nature (e.g. Hughes et al. 2019; Kerr 2015; RSPB 2013). These affinities/orientations are often referred to as 'nature connection' (or equivalent terms such as 'nature relatedness'), and have been considered as encompassing numerous views including: inherently valuing experiences of nature and enjoying being in nature (Cheng and Monroe 2012); feeling in harmony and connected with nature (Mayer and Frantz 2004); feeling affinities towards and appreciation of wildlife (Cheng and Monroe 2012; Nisbet, Zelenski, and Murphy 2009); feeling responsibility and sympathy for nature (Cheng and Monroe 2012; Mayer and Frantz 2004; Nisbet and Zelenski 2013); and recognising the importance or value of nature as an aspect of their personal identity (Nisbet, Zelenski, and Murphy 2009; Nisbet and Zelenski 2013). Measures of nature connection have been found to associate with positive attitudes towards the environment and with actions and behaviours that support/protect the environment (e.g. Barbaro and Pickett 2016; Hunt et al. 2017; Mackay and Schmitt 2019).

Children's nature connection has been found to associate with visiting and/or otherwise engaging with nature (Cheng and Monroe 2012; Szczytko et al. 2020). In children and adults, nature connection has also been found to link with other activities such as watching wildlife, reading books

about the natural world, and watching nature-related media (Eagles and Demare 1999; Hunt et al. 2017). It is plausible that nature connection can follow from people's engagement with nature (Richardson et al. 2016), and also that nature connection can be a motivation for people to engage with nature (Flowers, Freeman, and Gladwell 2016; Lin et al. 2014). Additionally, having and/or perceiving more local nature near their home, or otherwise living close to nature, has been found to positively associate with nature connection for children and adults (Cheng and Monroe 2012; Shanahan et al. 2017), which highlights the contextual importance of also having access and/or opportunity to engage with nature.

Girls often express higher nature connection than boys and younger children often express higher nature connection than older children (Hughes et al. 2019; Richardson et al. 2019). However, it remains unclear why different children hold different views. For example, it remains unclear whether differences in children's views about nature might be partially or completely explained by differences in their engagement with nature, and/or whether differences in views link with other aspects of children's lives such as their education. New insights might also be revealed through considering children's affinities/orientations in more detail, rather than encompassed within one single measure of nature connection, and considered alongside further views such as their interest in learning about nature.

Learning and studying about nature

Children often learn about nature, animals, and plants within biology (rather than physics or chemistry) within science at school (Department for Education 2014). Students have often reported higher interest in biology than in physics or chemistry at school, and with girls often reporting higher interest in biology than boys (Hamlyn et al. 2020). Girls have also tended to express more interest, compared to boys, in the environmental, health, and human areas of biology (Uitto 2014; Uitto et al. 2006).

Engaging in informal and/or extra-curricular activities such as reading books and watching media about science has been found to link with children's general interest in science (Bonnette, Crowley, and Schunn 2019), and children's interest in biology has been found to link with their experiences in nature and engagement with nature-related media (Uitto et al. 2006). Children's interests and views about nature also seem to link in various ways. For example, children's connections to nature (encompassing their enjoyment in experiencing nature), previous experiences in nature, and family values towards nature have all been found to associate with their interest in participating in nature-based activities and their interest in environmentally-friendly practices (Cheng and Monroe 2012). Children's interests in environmental topics and issues have been found to associate with their positive attitudes and responsibility towards the environment (agreement with statements such as 'I can personally influence what happens with the environment' and 'People should care more about protection of the environment'), and also have been found to associate (though to a lesser extent) with their bio-centric values (agreement with statements such as 'The natural world is sacred and should be left in peace' and 'Nearly all human activity is damaging for the environment') (Uitto et al. 2011).

Children's interest in learning about nature has often been examined within applied contexts, such as through considering the implications of outdoor learning. Specifically, children's interest in learning about aspects of nature has often been found to have been fostered by outdoor learning experiences (e.g. Hinds 2011) and by environmental education programmes (e.g. Ballantyne, Fien, and Packer 2001). Experiences of outdoor learning have also helped foster children's interests and motivations towards specific areas of their studies, such as natural history (Stern, Powell, and Ardoin 2008) and science (Dettweiler et al. 2017). Outdoor learning can also provide memorable experiences (Dierking and Falk 1997; Knapp and Benton 2006; Liddicoat and Krasny 2014), which have sometimes been found to foster children's interest in engaging with nature and to increase their environmental awareness and behaviours to protect or support nature (Liddicoat and Krasny 2014). Nevertheless, such findings do not necessarily mean that children's interest in learning about

nature can only be fostered by outdoor learning or by spending time outdoors, and more knowledge may benefit policy makers, educators, and researchers.

In England, more students tend to study biological sciences at upper-secondary school (A-Level) and at university than other areas of science, although relatively few biology graduates continue into science-related employment (Royal Society 2006, 2008). It remains unclear why. Students of biology at university have been found to consider that careers in biology and conservation would be rewarding and satisfying but may be poorly paid (Henderson, Stanisstreet, and Boyes 2007). Students' aspirations towards science-related studies and careers link with their interests, confidence, and numerous other factors (Regan and DeWitt 2015). For example, students' progressions towards biology link with their inherent interest and enjoyment in the area, and (for some students) this includes their outdoor experiences and activities in nature (Henriksen, Jensen, and Sjaastad 2015). Adult environmentalists have reported that their positive experiences in nature during childhood fostered their affinities towards nature, together with support from their family members, teachers, and other people, and alongside influences from various other aspects of life such as their educational experiences (Chawla 1998; Corcoran 1999; Palmer 1993; Tanner 1980). Naturalists have similarly recounted the relevance of their own outdoor experiences (undertaken by themselves and also with support from their families) and their educational experiences (including classroom activities and support from their teachers) in helping facilitate their developing interests and identities around nature (Hecht, Knutson, and Crowley 2019). However, such accounts cannot explain why other people with similar experiences in childhood may not enter nature-related careers. Nevertheless, these prior studies highlight the importance of childhood and the benefit of considering children's views in more detail, especially their interests in learning about nature and their aspirations towards careers involving nature.

Research aims

The field of science education aims to facilitate children's interests towards learning about the natural world (Osborne and Dillon 2008; Royal Society of Biology 2019; Royal Society 2014). The field of environmental education, and policies across England, also aim to facilitate children to support and protect nature (e.g. Department for Environment, Food and Rural Affairs 2018; Knapp 2000). Nevertheless, it remains less clear what might help foster these various views.

In order to gain new insights, the research presented here surveyed primary school children in England. The research considered the children's self-reported characteristics, engagement with various activities in daily life, and views about nature and learning. The research ultimately aimed to reveal which of the aspects covered by the questionnaire independently associated (while accounting for the other aspects covered by the questionnaire) with the children's reported enjoyment/appreciation of nature, empathy/affinity for animals, sense of oneness/responsibility for nature, interest in learning about nature, and aspirations towards careers involving nature or animals.

These research aims can be expressed as research questions: 'From the array of areas considered by the questionnaire, which of these independently associate with the children's reported enjoyment/appreciation of nature and at what magnitude(s)?', 'From the array of areas considered by the questionnaire, which of these independently associate with the children's reported empathy/affinity for animals and at what magnitude(s)?', and through equivalent questions for the other outcomes. Essentially, it was assumed that any/all of the areas considered by the questionnaire might potentially associate with the various outcomes; the research was focused on revealing what actually did associate with the outcomes and at what magnitude(s).

Methods

The research was reviewed and approved by the ethics committee of the host institution. Children due to attend outdoor learning activities at nature reserves and wildlife centres were invited to

participate; parental information sheets and consent materials were disseminated and collected via the children's schools and/or by reserve/centre staff. Questionnaires were completed before any activities were undertaken, in order to gain insights into children's general views and hence generate wider knowledge for educators and researchers.

Participants

The research considered the questionnaire responses of 679 children: 356 (52.6%) identified as girls and 321 (47.4%) identified as boys (while the remainder did not answer that particular question). The children were aged between 7 and 10 years old (on average, 8 years old), and were based within various regions of England: the East; London; the North West; the South East; the South West; the West Midlands; and Yorkshire and the Humber.

Questionnaires

A questionnaire was designed to cover a range of areas, encompassing validated items taken from the literature and also new items in order to explore under-researched issues. The use of existing questionnaire items aimed to maximise the validity/reliability of measurement and reduce the need for extensive piloting, which could otherwise burden children within the relatively limited opportunities for surveying. Initial responses to the questionnaire were considered (the first 111 children) within a piloting process, which affirmed that the questionnaire was understood by the children, could be completed within a reasonable time, and without issues/problems being highlighted. The surveying then continued to ultimately cover 679 children.

For most items on the questionnaire, children expressed their agreement or disagreement against various statements, with response categories of 'Strongly disagree' (scored as 1), 'Disagree' (2), 'Neither agree nor disagree' (3), 'Agree' (4), and 'Strongly agree' (5). Some items on the questionnaire were aggregated to provide single indicators; these aggregated indicators can be referred to as 'factors', 'scales', 'dimensions', 'constructs', and/or 'indices'. These indicators were calculated as the arithmetic mean of the relevant items so that their magnitudes can be interpreted against the same disagreement/agreement scale as the underlying items. Factor analysis (not reported for brevity) affirmed that the relevant items could be aggregated into their respective indicators, and acceptable reliability (internal consistency across the items) was observed via Cronbach's alpha coefficients (as reported below).

Children's characteristics and contexts

The questionnaire allowed children to convey their personal characteristics and context:

- **Gender;**
- **Age;**
- **Whether either of their parents (or guardians) went to university.**

Differences in views about nature have often been revealed across children of different genders and ages (Hughes et al. 2019; Richardson et al. 2019), although it remains unclear whether such differences follow from other aspects of life such as generalised advantage in society. Higher levels of family education reflect one aspect of generalised advantage in society (OECD 2015). While some children may not know whether their parents or guardians went to university, it is less feasible to ask children of these ages complex and detailed questions about their family income and/or their parents' occupations in order to measure advantaged/disadvantaged circumstances. 136 of the 679 children (20.0%) did not answer the question about whether their parents/guardians attended university, suggesting that they may not have known these details. Accordingly, 'yes', 'no', and 'unknown' categories were used within predictive modelling in order to ensure that all children were included.

The questionnaire also considered the children's views about their education and school context through indicators of:

- **Enjoying and being confident in learning** ('I usually do well in school work', 'I enjoy learning at school', and 'I can do most things at school if I try'; 3 items, Cronbach's alpha = 0.705);
- **Sense of belonging at school** ('I feel like I belong at my school', 'I get on well with my classmates', and 'I get on well with my teachers'; 3 items, Cronbach's alpha = 0.697);
- **Life/learning aspirations** ('Doing well in school will help me in the future', 'I have goals and plans for the future', and 'I think I will be successful when I grow up'; 3 items, Cronbach's alpha = 0.636).

These areas have been similarly measured in other research with children (e.g. Eccles 2009; Kendall and Rodger 2015; Lereya et al. 2016). Children's interests and motivations towards their studies have often been found to associate with numerous aspects of their education including their confidence and their sense of school belonging (e.g. Allen et al. 2018; Green et al. 2012). Accordingly, new insights could emerge when considering these indicators together with children's views about nature; for example, more positive views about enjoyment/confidence in learning might link with enjoyment/appreciation and/or interest in nature.

Children's activities and engagement with nature

The questionnaire measured children's engagement with various nature-related activities and aspects of life through specific items considering:

- **'I watch nature and wildlife programmes or videos';**
- **'I read books about nature and wildlife';**
- **'My parents encourage me to spend time outdoors in nature';**
- **'I spend time outdoors in nature'.**

These were measured as engagement frequencies from 'Never or almost never' (scored as 1), 'A few times a year' (2), 'A few times a month' (3), 'A few times a week' (4), to 'Every day or almost every day' (5). Additionally, levels of agreement from 'Strongly disagree' (scored as 1), 'Disagree' (2), 'Neither agree nor disagree' (3), 'Agree' (4), to 'Strongly agree' (5) were used to measure:

- **'I live near nature, such as a park, some woods, or the countryside'.**

Previous research with children and adults has highlighted the potential relevance of some of these activities/engagement (Eagles and Demare 1999; Hunt et al. 2017; Uitto et al. 2006).

Children's views about nature

The questionnaire considered the children's views about nature through indicators of:

- **Enjoyment/appreciation of nature** (e.g. 'Being outdoors makes me happy', 'Being in the natural environment makes me feel peaceful'; 7 items, Cronbach's alpha = 0.814);
- **Empathy/affinity for animals and wildlife** (e.g. 'I feel sad when wild animals are hurt', 'I enjoy touching animals and plants'; 4 items, Cronbach's alpha = 0.756);
- **Sense of oneness/responsibility for nature** (e.g. 'Humans are part of the natural world', 'People cannot live without plants and animals', 'My actions will make the natural world different', 'Picking up litter on the ground can help the environment'; 5 items, Cronbach's alpha = 0.708).

- **Interest in learning about nature** ('I like learning about nature', 'I like learning about plants and animals', and 'I would like to learn more about nature in school'; 3 items, Cronbach's alpha = 0.866);
- **Career intentions/aspirations** ('I would like a career involving nature or animals').

The enjoyment/appreciation of nature, empathy/affinity for animals and wildlife, and sense of oneness/responsibility items/indicators were sourced from the 'Connection to Nature Index', which was designed for use with children (Cheng and Monroe 2012) and has been previously applied in England and across the wider United Kingdom (e.g. Kerr 2015). A personal sense of oneness/responsibility towards nature has historically been considered through various perspectives, such as focusing on the preservation of nature and the dependence of people and nature (Dunlap and Van Liere 1978; Restall and Conrad 2015; Zylstra et al. 2014). The oneness/responsibility items from the 'Connection to Nature Index' have conceptual similarities with other measures of positive attitudes and responsibility towards the environment (which have involved statements such as 'I can personally influence what happens with the environment'; e.g. Uitto et al. 2011).

Interest in learning about nature has sometimes been considered to reflect an aspect of children's contextualised ecological/environmental orientation (Larson, Green, and Castleberry 2011), but has not been conceptualised as an aspect of personal affinities/connections towards nature considered as 'nature connection' (Restall and Conrad 2015; Tam 2013).

Career intentions/aspirations were considered through a single item, given that this represents a clear and distinct idea that does not necessarily and/or easily involve multiple facets.

Analytical approaches

Across the analysis, 'statistically significant' results were indicated through p-values less than 0.05. Differences in responses across children with different characteristics (such as gender) were explored in order to provide initial insights and a description of the sample. Magnitudes of difference between averages were quantified through Cohen's D-values, which are commonly interpreted through values below 0.20 reflecting a minimal difference, values from 0.20 to 0.50 reflecting a small difference, values from 0.50 to 0.80 reflecting a moderate difference, and values above 0.80 reflecting a large difference (Cohen 1988).

Observed associations between the children's responses were explored through Pearson correlation coefficients (R-values). These are commonly interpreted through values below 0.10 reflecting minimal associations, values from 0.10 to 0.30 reflecting small associations, values from 0.30 to 0.50 reflecting moderate associations, and values above 0.50 reflecting strong associations (Cohen 1988).

Independent associations between the children's responses were then explored through predictive modelling, which reveals the independent association between a predictor and the outcome while accounting for all of the other predictors. Predictive modelling was undertaken via linear ordinary-least-squares (OLS) estimation (linear regression). The models showed acceptable fit and the various residual histograms and plots highlighted that the underlying assumptions were met (such as normally-distributed residual errors; linear regression assumes normally-distributed residual errors but does not require the predictors or outcome to be normally-distributed).

Predictive (independent) associations were quantified as standardised coefficients (β -values); these reflect the number of standard deviations of increase/decrease in the outcome, given one standard deviation increase in the predictor (accordingly, β -values can be directly compared regardless of any different measurement scales/units used across the different predictors). There are no established standards for interpreting magnitudes of standardised predictive coefficients.

Table 1. Sample summary and gender differences.

Indicator (1–5 scales unless otherwise shown)	All		Gender: Girls		Gender: Boys		Gender difference	
	M	SD	M	SD	M	SD	Cohen's D	Sig. (p)
Gender (0 = girls, 1 = boys)	.47	.50	-	-	-	-	-	-
Parents/guardians went to university (0 = no, 1 = yes)	.65	.48	.64	.48	.66	.47	.037	.664
Age (years)	8.36	.86	8.44	.88	8.27	.81	.207	.007
Confidence/enjoyment in learning	4.30	.75	4.39	.68	4.19	.81	.279	<.001
Aspirations in life/learning	4.51	.66	4.54	.62	4.48	.70	.093	.242
Belonging in school	4.37	.76	4.45	.75	4.28	.76	.232	.004
'I spend time outdoors in nature'	3.66	1.32	3.72	1.29	3.58	1.34	.104	.191
'I watch nature and wildlife programmes or videos'	2.99	1.49	3.05	1.45	2.91	1.53	.095	.240
'I read books about nature and wildlife'	2.84	1.44	2.95	1.45	2.71	1.42	.166	.041
'My parents encourage me to spend time outdoors in nature'	3.38	1.52	3.42	1.52	3.33	1.52	.060	.442
'I live near nature, such as a park, some woods, or the countryside'	4.13	1.21	4.13	1.22	4.13	1.20	.004	.964
Enjoyment/appreciation of nature	3.97	.83	4.14	.72	3.79	.91	.431	<.001
Empathy/affinity for animals	4.45	.72	4.52	.67	4.38	.77	.192	.016
Oneness/responsibility for nature	4.33	.72	4.39	.67	4.26	.76	.185	.020
Interest in learning about nature	4.24	.95	4.37	.88	4.10	1.00	.294	<.001
'I would like a career involving nature or animals'	3.81	1.29	3.96	1.24	3.63	1.34	.260	.001

Means ('M'), standard deviations ('SD'), and the magnitude ('D'; Cohen's D) and statistical significance ('Sig. (p)'; p-value) of the differences between girls and boys are reported. Significant p-values ($p < .05$) and the associated magnitudes are highlighted in bold for clarity.

Results

On average (Table 1), the children expressed positive views concerning nature and their learning: all averages were above the neutral mid-point of 3 on the 1–5 scale from strong disagreement to strong agreement, typically being around or above the value of 4 that reflected 'Agree'. The children also expressed somewhat frequent engagement with the various nature-related activities: most averages were around 'A few times a month' (values of 3 on the 1–5 frequency scale).

On average, compared to boys, girls reported more frequent reading of books about nature/wildlife and more positive views for confidence/enjoyment in learning, sense of belonging in school, enjoyment/appreciation of nature, empathy/affinity for animals, oneness/responsibility for nature, and interest in learning about nature (Table 1).

On average, compared to children who said that their parents/guardians had not gone to university, children who said that either of their parents/guardians had gone to university reported more frequent reading of books about nature/wildlife, parental encouragement to spend time outdoors in nature, and that they lived closer to nature (Table 2). Children who said that either of their parents/guardians had gone to university also reported more positive views for confidence/enjoyment in learning, aspirations in life/learning, belonging in school, and empathy/affinity for animals (Table 2). These differences were small in magnitude but highlight concerning inequality, given the young age of the children.

Many of the children's reported views and experiences positively correlated with small to moderate magnitudes (Table 3). Some strong magnitudes were also observed (where correlation coefficients were above 0.50). Specifically, the children's reported confidence/enjoyment in learning, aspirations in life/learning, and belonging in school all strongly and positively correlated. Similarly, the children's reported enjoyment/appreciation, empathy/affinity for animals, sense of oneness/responsibility for nature, and interest in learning about nature all strongly and positively correlated. Additionally, the children's reports of spending time outdoors in nature strongly and positively correlated with their reported enjoyment/appreciation of nature. The children's reported enjoyment/appreciation, empathy/affinity for animals, sense of oneness/responsibility for nature, interest in learning about nature, and reports of more frequently reading books about nature and wildlife, all

Table 2. Sample summary and family differences.

Indicator (1–5 scales unless otherwise shown)	All		Parents/ guardians went to university: No		Parents/ guardians went to university: Yes		Difference	
	M	SD	M	SD	M	SD	Cohen's D	Sig. (p)
Gender (0 = girls, 1 = boys)	.47	.50	.46	.50	.47	.50	.039	.664
Parents/guardians went to university (0 = no, 1 = yes)	.65	.48	-	-	-	-	-	-
Age (years)	8.36	.86	8.38	.86	8.30	.86	.092	.310
Confidence/enjoyment in learning	4.30	.75	4.18	.86	4.39	.67	.287	.004
Aspirations in life/learning	4.51	.66	4.39	.81	4.61	.54	.344	.001
Belonging in school	4.37	.76	4.24	.87	4.45	.71	.269	.007
'I spend time outdoors in nature'	3.66	1.32	3.52	1.37	3.70	1.30	.135	.153
'I watch nature and wildlife programmes or videos'	2.99	1.49	2.85	1.49	3.11	1.46	.177	.069
'I read books about nature and wildlife'	2.84	1.44	2.65	1.45	3.01	1.42	.251	.010
'My parents encourage me to spend time outdoors in nature'	3.38	1.52	3.18	1.54	3.56	1.50	.252	.007
'I live near nature, such as a park, some woods, or the countryside'	4.13	1.21	3.91	1.31	4.31	1.09	.341	.001
Enjoyment/appreciation of nature	3.97	.83	3.90	.86	4.04	.83	.159	.086
Empathy/affinity for animals	4.45	.72	4.36	.83	4.54	.65	.248	.013
Oneness/responsibility for nature	4.33	.72	4.25	.86	4.38	.65	.182	.071
Interest in learning about nature	4.24	.95	4.16	1.06	4.28	.92	.122	.204
'I would like a career involving nature or animals'	3.81	1.29	3.77	1.33	3.85	1.27	.055	.559

Means ('M'), standard deviations ('SD'), and the magnitude ('D'; Cohen's D) and statistical significance ('Sig. (p)'; p-value) of the differences between parent/guardian university status are reported. Significant p-values ($p < .05$) and the associated magnitudes are highlighted in bold for clarity.

had moderate positive correlations (coefficients above 0.30 but below 0.50) with their reported aspirations towards careers involving nature or animals.

Predictive associations

Predictive modelling considered the various indicators in stages in order to help gain greater understanding.

Enjoyment/appreciation of nature

In the first stage of modelling (Table 4), the children's enjoyment/appreciation of nature was positively predicted by their educational views (confidence/enjoyment in learning, aspirations in life/learning, and belonging in school) but was negatively predicted by being a boy (compared to being a girl). In the second stage of modelling, many nature-related activities were also positively predictive, whereas belonging in school was no longer predictive. In the third stage of modelling, the children's empathy/affinity for animals and oneness/responsibility for nature were also both positively predictive, over and above the nature-related activities, while the children's aspirations in life/learning were no longer predictive. In the fourth and final stage of modelling, the children's enjoyment/appreciation of nature was positively predicted by their interest in learning about nature, empathy/affinity for animals, spending time outdoors in nature, parental encouragement to spend time outdoors (as reported by the children), reading books about nature/wildlife, oneness/responsibility for nature, and confidence/enjoyment in learning, but was negatively predicted by being a boy (compared to being a girl).

The changing pattern of predictors from stage to stage suggested that children with more positive overall aspirations in life/learning and sense of belonging in school would be more likely to express higher enjoyment/appreciation of nature, but that may reflect that these children were more likely to report more frequent engagement with nature-related activities and/or other positive views about nature (shown through aspirations in life/learning and sense of belonging in school).



Table 3. Summary of correlations.

Indicator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16
1. Gender (0 = girls, 1 = boys)	1.000														
2. Parents/guardians went to university (0 = no, 1 = yes)	.019	1.000													
3. Age (years)	-.103	-.044	1.000												
4. Confidence/enjoyment in learning	-.138	.135	.009	1.000											
5. Aspirations in life/learning	-.047	.162	.060	.590	1.000										
6. Belonging in school	-.115	.127	.012	.639	.529	1.000									
7. 'I spend time outdoors in nature'	-.052	.064	.048	.231	.220	.275	1.000								
8. 'I watch nature and wildlife programmes or videos'	-.048	.082	-.023	.184	.160	.190	.343	1.000							
9. 'I read books about nature and wildlife'	-.083	.117	-.038	.236	.191	.199	.386	.446	1.000						
10. 'My parents encourage me [...]'	-.030	.119	.099	.195	.240	.238	.404	.313	.322	1.000					
11. 'I live near nature [...]'	.002	.160	.096	.195	.204	.208	.336	.211	.223	.292	1.000				
12. Enjoyment/appreciation of nature	-.211	.076	.015	.407	.390	.415	.504	.405	.483	.420	.268	1.000			
13. Empathy/affinity for animals	-.095	.117	.011	.249	.331	.363	.374	.324	.335	.281	.297	.586	1.000		
14. Openness/responsibility for nature	-.092	.086	.099	.355	.390	.448	.380	.353	.353	.366	.358	.551	.610	1.000	
16. Interest in learning about nature	-.146	.058	-.006	.454	.470	.489	.432	.381	.409	.316	.237	.672	.615	.563	1.000
17. 'I would like a career involving nature or animals'	-.129	.026	-.092	.259	.270	.249	.220	.253	.325	.230	.072	.408	.382	.309	.499

Pearson correlation coefficients (R-values) are reported. Significant coefficients ($p < .05$) are highlighted in bold for clarity.

Table 4. Predicting enjoyment/appreciation of nature.

Predictor	Step 1		Step 2		Step 3		Step 4	
	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)
Intercept/constant	NA	<.001	NA	<.001	NA	.210	NA	.107
Age (years)	-.032	.389	-.044	.160	-.036	.207	-.022	.417
Gender (0 = girls, 1 = boys)	-.170	<.001	-.142	<.001	-.111	<.001	-.089	.001
Parents/guardians went to university (1 = yes, compared to no)	-.001	.973	-.062	.091	-.065	.055	-.043	.178
Parents/guardians went to university (1 = missing, compared to no)	-.027	.543	-.033	.371	-.029	.388	-.036	.254
Confidence/enjoyment in learning	.186	<.001	.127	.004	.146	<.001	.096	.013
Aspirations in life/learning	.162	.001	.106	.007	.045	.215	.007	.829
Belonging in school	.162	.001	.068	.095	-.011	.773	-.032	.374
'I spend time outdoors in nature'			.220	<.001	.171	<.001	.139	<.001
'I watch nature and wildlife programmes or videos'			.138	<.001	.074	.023	.042	.181
'I read books about nature and wildlife'			.198	<.001	.152	<.001	.115	<.001
'My parents encourage me to spend time outdoors in nature'			.178	<.001	.146	<.001	.136	<.001
'I live near nature, such as a park, some woods, or the countryside'			.015	.668	-.046	.150	-.025	.417
Empathy/affinity for animals					.284	<.001	.186	<.001
Oneness/responsibility for nature					.141	<.001	.111	.003
Interest in learning about nature							.289	<.001
'I would like a career involving nature or animals'							.024	.451
Explained variance (via adjusted R-squared)	22.6%		47.8%		56.8%		60.8%	

Standardised predictive coefficients (' β ') and their statistical significance ('Sig. (p)'; p-value) are reported. Significant p-values (p < .05) and the associated coefficients are highlighted in bold for clarity.

losing significance once these other predictors were included within the models). The final model nevertheless highlighted the relevance of children's confidence/enjoyment in their learning at school.

Empathy/affinity for animals

In the final stage of modelling (Table 5), the children's empathy/affinity for animals was positively predicted by their oneness/responsibility for nature, interest in learning about nature, enjoyment/appreciation of nature, and by living near nature, but was negatively predicted by their confidence/enjoyment in their learning.

The changing pattern of predictors from stage to stage suggested that girls and also children with more positive overall aspirations in life/learning, sense of belonging in school, and more frequent engagement in nature-related activities would be more likely to express empathy/affinity for animals, because these children hold other positive views about nature, which then associate with empathy/affinity for animals. However, it remains unclear why higher confidence/enjoyment in learning negatively predicted empathy/affinity for animals when accounting for children's enjoyment/appreciation of nature and oneness/responsibility for nature. Given that confidence/enjoyment in learning positively predicted enjoyment/appreciation of nature (Table 4), further exploration of structural patterns of association may be beneficial in future research. Structural modelling could potentially reveal indirect associations (while the research presented here can only reveal direct associations), and therefore help to quantify overall associations, considered as the sum of direct and indirect associations.

Oneness/responsibility for nature

In the final stage of modelling (Table 6), the children's sense of oneness/responsibility for nature was positively predicted by their empathy/affinity for animals, belonging in school, enjoyment/appreciation of nature, living near to nature, parental encouragement to spend time outdoors, watching nature/wildlife programmes/videos, and their age.

Table 5. Predicting empathy/affinity for animals.

Predictor	Step 1		Step 2		Step 3		Step 4	
	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)
Intercept/constant	NA	<.001	NA	<.001	NA	<.001	NA	<.001
Age (years)	-.037	.349	-.050	.179	-.047	.154	-.029	.360
Gender (0 = girls, 1 = boys)	-.106	.008	-.092	.013	-.029	.376	-.014	.659
Parents/guardians went to university (1 = yes, compared to no)	.070	.134	.019	.658	.049	.199	.061	.101
Parents/guardians went to university (1 = missing, compared to no)	-.015	.749	-.015	.734	-.003	.936	-.013	.724
Confidence/enjoyment in learning	-.041	.462	-.089	.086	-.148	.001	-.173	<.001
Aspirations in life/learning	.206	<.001	.168	<.001	.100	.015	.058	.147
Belonging in school	.239	<.001	.168	.001	.074	.088	.049	.247
'I spend time outdoors in nature'			.145	.001	.046	.245	.031	.421
'I watch nature and wildlife programmes or videos'			.150	<.001	.054	.148	.025	.500
'I read books about nature and wildlife'			.106	.013	-.003	.934	-.029	.433
'My parents encourage me to spend time outdoors in nature'			.041	.337	-.067	.078	-.063	.089
'I live near nature, such as a park, some woods, or the countryside'			.128	.002	.071	.049	.084	.016
Enjoyment/appreciation of nature					.370	<.001	.250	<.001
Oneness/responsibility for nature					.303	<.001	.267	<.001
Interest in learning about nature							.263	<.001
'I would like a career involving nature or animals'							.066	.070
Explained variance (via adjusted R-squared)	14.8%		27.4%		43.7%		47.5%	

Standardised predictive coefficients (' β ') and their statistical significance ('Sig. (p)'; p-value) are reported. Significant p-values ($p < .05$) and the associated coefficients are highlighted in bold for clarity.

Table 6. Predicting oneness/responsibility for nature.

Predictor	Step 1		Step 2		Step 3		Step 4	
	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)
Intercept/constant	NA	<.001	NA	<.001	NA	.185	NA	.133
Age (years)	.068	.073	.044	.202	.066	.038	.065	.043
Gender (0 = girls, 1 = boys)	-.047	.222	-.034	.316	.017	.606	.017	.590
Parents/guardians went to university (1 = yes, compared to no)	.039	.384	-.024	.562	-.018	.627	-.015	.691
Parents/guardians went to university (1 = missing, compared to no)	-.006	.899	.002	.967	.011	.755	.009	.804
Confidence/enjoyment in learning	.086	.105	.041	.394	.044	.324	.036	.424
Aspirations in life/learning	.147	.002	.096	.025	.030	.457	.024	.560
Belonging in school	.301	<.001	.225	<.001	.165	<.001	.157	<.001
'I spend time outdoors in nature'			.059	.145	-.021	.578	-.027	.473
'I watch nature and wildlife programmes or videos'			.147	<.001	.080	.027	.075	.041
'I read books about nature and wildlife'			.117	.003	.052	.162	.051	.181
'My parents encourage me to spend time outdoors in nature'			.139	<.001	.097	.009	.101	.007
'I live near nature, such as a park, some woods, or the countryside'			.169	<.001	.130	<.001	.131	<.001
Enjoyment/appreciation of nature					.174	<.001	.150	.003
Empathy/affinity for animals					.286	<.001	.269	<.001
Interest in learning about nature							.086	.084
'I would like a career involving nature or animals'							-.029	.421
Explained variance (via adjusted R-squared)	22.1%		37.1%		46.8%		47.0%	

Standardised predictive coefficients (' β ') and their statistical significance ('Sig. (p)'; p-value) are reported. Significant p-values ($p < .05$) and the associated coefficients are highlighted in bold for clarity.

The changing pattern of predictors from stage to stage suggested similar insights as before, and (together with the other findings) broadly convey that some educational views and nature-related activities associate with views about nature (such as enjoyment/appreciation of nature, empathy/affinity for animals, and oneness/responsibility for nature), which then generally associate with one

another. Nevertheless, interest in learning about nature did not predict oneness/responsibility for nature when accounting for the children's other views about nature.

Interest in learning about nature

In the final stage of modelling (Table 7), the children's interest in learning about nature was positively predicted by their enjoyment/appreciation of nature, empathy/affinity for animals, aspirations towards careers involving nature/animals, confidence/enjoyment in learning, aspirations in life/learning, belonging in school, watching nature/wildlife programmes/videos, and spending time outdoors in nature.

The changing pattern of predictors from stage to stage suggested that girls would be more likely to express interest in learning about nature, but that this reflected differences in enjoyment/appreciation of nature and/or empathy/affinity for animals (girls were indeed predicted to express higher enjoyment/appreciation of nature; Table 4).

Aspirations towards careers involving nature or animals

In the final stage of modelling (Table 8), the children's aspirations towards careers involving nature/animals were positively predicted by their interest in learning about nature, reading books about nature/wildlife, and parental encouragement to spend time outdoors in nature, but were negatively predicted by their age.

The changing pattern of predictors from stage to stage (together with the other findings) suggested that children with higher enjoyment/appreciation of nature and/or empathy/affinity for animals would be more likely to express aspirations towards careers involving nature/animals, because enjoyment/appreciation of nature and empathy/affinity for animals associate with interest in learning about nature, which then associates with aspirations towards careers involving nature/animals.

Table 7. Predicting interest in learning about nature.

Predictor	Step 1		Step 2		Step 3		Step 4	
	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)
Intercept/constant	NA	.002	NA	.009	NA	.098	NA	.030
Age (years)	-.055	.126	-.050	.124	-.027	.337	-.008	.767
Gender (0 = girls, 1 = boys)	-.122	.001	-.102	.002	-.033	.249	-.021	.445
Parents/guardians went to university (1 = yes, compared to no)	-.026	.535	-.066	.086	-.049	.142	-.043	.186
Parents/guardians went to university (1 = missing, compared to no)	.024	.570	.020	.599	.034	.306	.030	.346
Confidence/enjoyment in learning	.191	<.001	.140	.002	.117	.004	.104	.008
Aspirations in life/learning	.219	<.001	.183	<.001	.105	.003	.087	.012
Belonging in school	.216	<.001	.152	<.001	.078	.038	.080	.030
'I spend time outdoors in nature'			.165	<.001	.057	.093	.066	.046
'I watch nature and wildlife programmes or videos'			.169	<.001	.082	.012	.071	.025
'I read books about nature and wildlife'			.161	<.001	.066	.049	.041	.210
'My parents encourage me to spend time outdoors in nature'			.054	.148	-.021	.529	-.037	.252
'I live near nature, such as a park, some woods, or the countryside'			-.007	.837	-.052	.101	-.039	.204
Enjoyment/appreciation of nature					.321	<.001	.294	<.001
Empathy/affinity for animals					.229	<.001	.200	<.001
Oneness/responsibility for nature					.061	.113	.064	.084
'I would like a career involving nature or animals'							.178	<.001
Explained variance (via adjusted R-squared)	29.6%		43.7%		57.8%		60.1%	

Standardised predictive coefficients (' β ') and their statistical significance ('Sig. (p)'; p-value) are reported. Significant p-values ($p < .05$) and the associated coefficients are highlighted in bold for clarity.

Table 8. Predicting 'I would like a career involving nature or animals'.

Predictor	Step 1		Step 2		Step 3		Step 4	
	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)	β	Sig. (p)
Intercept/constant	NA	<.001	NA	<.001	NA	.054	NA	.017
Age (years)	-.131	.001	-.123	.002	-.107	.006	-.098	.009
Gender (0 = girls, 1 = boys)	-.118	.004	-.102	.009	-.066	.089	-.055	.144
Parents/guardians went to university (1 = yes, compared to no)	-.012	.805	-.040	.388	-.034	.450	-.018	.681
Parents/guardians went to university (1 = missing, compared to no)	.010	.837	.013	.784	.020	.656	.009	.838
Confidence/enjoyment in learning	.110	.054	.076	.164	.073	.180	.034	.518
Aspirations in life/learning	.175	.001	.144	.003	.102	.036	.067	.155
Belonging in school	.058	.269	.025	.623	-.008	.870	-.034	.495
'I spend time outdoors in nature'			.005	.908	-.051	.273	-.069	.123
'I watch nature and wildlife programmes or videos'			.105	.017	.063	.154	.036	.403
'I read books about nature and wildlife'			.184	<.001	.140	.002	.118	.008
'My parents encourage me to spend time outdoors in nature'			.121	.007	.091	.044	.098	.026
'I live near nature, such as a park, some woods, or the countryside'			-.052	.226	-.072	.093	-.055	.187
Enjoyment/appreciation of nature					.149	.010	.044	.451
Empathy/affinity for animals					.167	.001	.092	.070
Oneness/responsibility for nature					-.021	.688	-.041	.421
Interest in learning about nature							.328	<.001
Explained variance (via adjusted R-squared)	10.6%		18.4%		22.1%		26.5%	

Standardised predictive coefficients (' β ') and their statistical significance ('Sig. (p)'; p-value) are reported. Significant p-values ($p < .05$) and the associated coefficients are highlighted in bold for clarity.

Discussion

Biology education has many aims, including inspiring children's interest, curiosity, and understanding about the natural world (Kampourakis and Reiss 2018). Science education and wider policies also continue to support children towards science-related careers, including those involving nature and animals, and to foster children's interests and orientations towards supporting and protecting nature (Department for Environment, Food and Rural Affairs 2018; Royal Society of Biology 2019; Royal Society 2014; State of Nature 2019). Within these wider contexts, the presented results offer new insights. The findings reveal numerous associations between children's views, which suggest how children's interests and enjoyment may link and develop. The findings also highlight the importance of particular nature-related activities, which may be tangible avenues for support and encouragement, and also highlight the importance of children's wider views about their education.

The children's enjoyment/appreciation of experiencing nature and empathy/affinities towards animals were two of the strongest positive predictors of the children's interest in learning about nature, which was the strongest positive predictor of the children's aspirations towards careers involving nature or animals. Many other insights were revealed, including that: children's reports of spending time outdoors positively predicted their enjoyment/appreciation of nature and their interest in learning about nature; watching nature-related media positively predicted sense of oneness/responsibility for nature and interest in learning about nature; and reading books about nature/wildlife positively predicted enjoyment/appreciation of nature and aspirations towards careers involving nature or animals. These results emerged while accounting for the children's other views about nature; for example, the children's reports of spending time outdoors positively predicted their interest in learning about nature, over and above their enjoyment/appreciation of nature and empathy/affinity for animals, which were also both positively and independently predictive.

These results affirm and also extend earlier research, which has linked children's generalised affinities/orientations towards nature ('nature connection') with visiting and/or otherwise engaging

with nature (Cheng and Monroe 2012; Szczytko et al. 2020), and with other activities such as watching wildlife, reading books about the natural world, and watching nature-related media (Eagles and Demare 1999; Hunt et al. 2017). The results also affirm and extend earlier research that has revealed associations between children's nature connection and actions and behaviours that support/protect the environment (e.g. Cheng and Monroe 2012; Hughes, Richardson, and Lumber 2018). Previous research has often considered nature connection through aggregating enjoyment/appreciation of nature, empathy/affinity for animals, oneness/responsibility for nature, and/or other views. The results presented here highlighted that new insights are possible through considering these views separately, given that different arrays of predictors were relevant for each outcome. The importance of empathy/affinities towards animals also links with research that has highlighted that children often appreciate and feel empathy and concern towards animals and plants (Bonnett and Williams 1998; Harvey et al. 2020).

These results also reveal new and wider insights. Children's views about nature may not necessarily only link with nature-related activities and aspects of life. Specifically, higher confidence/enjoyment in learning, aspirations in life/learning, and sense of school belonging independently and positively predicted the children's interest in learning about nature, even when accounting for their other views about nature. Children's confidence/enjoyment in learning and sense of belonging in school have been found to link to various beneficial outcomes within education such as attainment, which further highlights their importance (e.g. Allen et al. 2018; Green et al. 2012). Ensuring that children can feel supported and confident at school may help facilitate their freedom to develop more specific learning interests such as towards nature.

The children's aspirations towards careers involving nature or animals were positively predicted by their interest in learning about nature, reading books about nature, and parental encouragement to spend time outdoors in nature, but were negatively predicted by age (i.e. older children were predicted to express lower aspirations). These results provide new evidence on children's views, and complement previous research that has focused on adult environmentalists and their retrospective accounts of influences on their career trajectories (Chawla 1998; Corcoran 1999; Palmer 1993; Tanner 1980). The results affirm the importance of children's interest, which has been frequently highlighted within research exploring studying and career progressions towards (or away from) biology and science (Henriksen, Jensen, and Sjaastad 2015; Regan and DeWitt 2015). These results also highlight the importance of parental encouragement, which may perhaps reflect wider home support towards nature-related affinities. Parental encouragement and support during childhood has been highlighted as an important influence within recollections by environmentalists and naturalists (Chawla 1998; Corcoran 1999; Hecht, Knutson, and Crowley 2019; Palmer 1993; Tanner 1980). Nevertheless, further research remains necessary in order to understand why older children express lower aspirations. Children's career aspirations may also develop, change, and/or be influenced in various ways over time, which suggests that more detailed and extensive research may be beneficial.

Educational and wider implications

The results presented here offer implications for educators and other stakeholders, and also for educational researchers and foci for future research.

Various nature-related activities could be encouraged, facilitated, and/or integrated within education. The results presented here revealed that children's reports of more frequently watching nature/wildlife programmes/videos positively predicted their interest in learning about nature and sense of oneness/responsibility for nature. The children's reports of more frequently spending time outdoors also positively predicted their enjoyment/appreciation of nature and their interest in learning about nature. This suggests that outdoor learning activities and excursions facilitated by schools may be beneficial, particularly given that some children may not otherwise have these opportunities. Outdoor learning activities have indeed been found to link with

children's interest in learning about nature (e.g. Hinds 2011; Stern, Powell, and Ardoin 2008) and children's interests and appreciation of wildlife (e.g. Lindemann-Matthies 2005). Nevertheless, the associations between children's reports of spending time outdoors in nature, their enjoyment/appreciation of nature, and their interest in learning about nature and other views, suggest that some benefits from spending time outdoors in nature may depend on children enjoying the experience. Children may benefit from support and/or encouragement to help overcome barriers to engaging with nature. Children may also benefit from support and encouragement to find their own personally enjoyable ways to experience nature, which might involve different activities and/or avenues for different children.

From a wider educational perspective, biology education and environmental education have multiple aims, including fostering interests in learning about nature and also orientations towards supporting/protecting nature (considered as oneness/responsibility for nature within the research presented here). The presented results highlight an important implication: there may be many ways to promote and foster children's views, but different aspects of life may be more or less relevant for different outcomes. Additionally, while accounting for their other views, the children's sense of oneness/responsibility for nature did not independently predict their interest in learning about nature, and the children's interest in learning about nature did not independently predict their sense of oneness/responsibility for nature. This broadly suggests that applying diverse and multiple approaches may be beneficial.

Finally, the results presented here showed that the children, on average, conveyed positive enjoyment/appreciation of nature, empathy/affinity for animals, oneness/responsibility for nature, and interest in learning about nature. In earlier research, children across England have often been found to express positive affinities and orientations towards nature (e.g. Hughes et al. 2019; Kerr 2015). Children are not necessarily 'disconnected' from nature. Nevertheless, the results presented here showed that girls tended to have more positive views about nature than boys, especially for their enjoyment/appreciation of nature, which affirms previous research (e.g. Hughes et al. 2019; Richardson et al. 2019). The results presented here also highlight that children who said that either of their parents/guardians had gone to university reported more frequent reading of books about nature/wildlife, parental encouragement to spend time outdoors in nature, and that they lived closer to nature. Essentially, education and research may need to focus on addressing inequality and inequity in order to ensure that all children can be supported to access and enjoy nature.

Limitations

The analysis considered children's questionnaire responses at only one time point, and so cannot definitively establish whether some views or aspects of life (as reported on a questionnaire) influence or entail other views or aspects of life. Additionally, findings from the children considered within this research may not necessarily be generalisable to children of different ages and/or children in different contexts (such as in different areas of England and/or in different countries). The children were also due to engage in outdoor learning activities, and so might differ from children in other schools without these opportunities. From a wider perspective, qualitative research using interviews would also help affirm and/or gain new insights to complement and/or extend quantitative research using surveys.

The questionnaire aimed to maximise validity/reliability through applying existing items (e.g. from Cheng and Monroe 2012), which also enhanced contextualisation and comparability with prior studies. Nevertheless, future research could extend and/or refine questionnaire items. Acceptable measurement reliability is often considered as Cronbach's alpha coefficients being 0.70 or higher, and the indicator of life/learning aspirations showed lower reliability ('Doing well in school will help me in the future', 'I have goals and plans for the future', and 'I think I will be successful when I grow up'; 3 items, Cronbach's alpha = 0.636). It is possible that younger children might find these areas to be harder or more complex to consider. For example, having or not having

aspirations towards particular careers might be relatively simple to consider, while having 'goals and plans' and/or 'being successful' are more generalised and abstracted ideas and so might be open to more interpretation. Other questionnaire areas could also be developed further, such as considering enjoyment and confidence for learning biology and/or about nature rather than for schoolwork in general.

Many aspects of life may influence children's views, and the questionnaire could only consider a limited number of aspects within a reasonable length. Social-cognitive perspectives onto learning and motivation highlight the relevance of someone's context and circumstances (including social contexts and norms) and someone's emerging identity, which link with their various attitudes and self-beliefs (including self-confidence and interest/enjoyment in various activities), which then link with their intentions/aspirations and actions (Eccles 2009). These perspectives are somewhat similar to the theory of planned behaviour (Ajzen 1991), which highlights the importance of attitudes, social norms, self-confidence, and other aspects of life, and which has frequently been applied in order to model and predict behaviours that support and protect nature (Bamberg and Möser 2007). These different theories and perspectives usually involve slightly different conceptualisation and contextualisation of particular components (such as 'attitudes' and 'intentions'), but similarly highlight the general importance of someone's socio-cultural context and localised circumstances as well as their personal characteristics, experiences, and their own diverse views. These theories and perspectives suggest further areas to explore when considering children's interest in learning about nature and children's aspirations towards nature-related careers.

Affinities/orientations towards nature are often generalised into the idea of 'nature connection'. Different conceptualisations of nature connection place different emphases on people inherently valuing experiences of nature and enjoying being in nature, feeling in harmony and connected with nature, and other related notions. Despite varying foci and conceptualisations, different measures of nature connection have been found to closely associate (Tam 2013). The results presented here reveal insights that became possible through separately considering enjoyment/appreciation of nature, empathy/affinity for animals, oneness/responsibility for nature, and interest in learning about nature. This suggests the benefit of further reflection regarding how affinities/orientations towards nature could or should be conceptualised and considered within research.

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Research participants and ethics review

The research was reviewed and approved by the ethics committee of the UCL Institute of Education (reference REC 872) before any data were collected.

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