Article

What Environmental and Personal Factors Determine the Implementation Intensity of Nature-Based Education in Elementary and Lower-Secondary Schools?

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Abstract: As society becomes increasingly urbanized, children are becoming much less likely to experience nature. This progressive disengagement from the natural world, often termed the ‘extinction of experience’, has been viewed both as a key public health issue and one of the most fundamental obstacles to halting global environmental degradation. School education has an important role in mitigating and reversing the ongoing extinction of experience. Here, we examine the role of several factors that determine the implementation intensities of nature-based education by science teachers in the classrooms of both primary and secondary schools. We performed a large-scale questionnaire survey comprising 363 elementary and 259 lower-secondary schoolteachers. Several factors predicted the implementation intensity of nature-based education in schools. The most important predictor was teachers’ levels of nature-relatedness, with nature-orientated teachers being more likely to provide nature-based education in their classes. Levels of teachers’ ecological knowledge, frequency of childhood nature experiences, and greenness within the school were also positively associated with the implementation intensity of education. Our results suggest that, to promote nature-based education in schools, it is important to increase schoolteachers’ nature-relatedness and ecological knowledge, as well as to provide more green spaces within schools.

Keywords: biodiversity conservation; environmental education; extinction of experience; nature relatedness

1. Introduction

Much academic and popular concern has been raised over the ‘extinction of experience’—the ongoing loss of direct interactions that people have with nature [1–4]. The ongoing extinction of experience is a profound cause for concern for two overarching and interrelated reasons. First, people with few direct interactions with nature do not gain the substantial health benefits that human–nature interactions provide [5–7]. Second, fewer natural experiences during childhood can result in a reduced willingness to support pro-conservation policies and actions [4,8,9]. As a result, this creates a feedback loop towards a progressive loss of the human-nature relationship that is detrimental to both
humans and the environment. This loop is viewed as a major public-health issue and is one of the fundamental obstacles to reversing global environmental degradation [4].

There has been growing attention given to the consequences of the extinction of experience, leading to an increasing recognition of the importance of reducing, and ultimately reversing, this phenomenon [4]. School education has an important role to play in this pursuit. Through nature-oriented educational activities, schoolteachers can affect children’s opportunities to experience nature, potentially increasing their inclinations towards nature (e.g., environmental education) [4,10–14]. It remains unclear, however, which factors influence the intensity (i.e., frequency and duration) of such activities, although it has been often argued that teachers’ environmental knowledge and attitudes (i.e., environmental literacy) can be the key driver [15–17].

The implementation intensity of nature-based activities in science classes is likely to be determined by multiple opportunity- and orientation-related factors. For example, the amount of natural environments within and around a school (i.e., opportunity) can affect the frequency and duration of outdoor nature-based activities given in class because schoolteachers generally conduct activities within the confines of the school [18]. Likewise, teachers’ levels of nature orientation (e.g., nature-relatedness, ecological knowledge, and education level about nature-related education) are likely to increase the intensity of nature-based activities given in class [19,20]. Along with these opportunity- and orientation-related factors, other personal factors of teachers can also affect the frequency and duration of nature-based activities, such as frequency of childhood nature experiences, gender, and length of teaching career [20]. However, the relative role of these different factors in determining the implementation intensity of nature-based education in school is still poorly understood. Knowledge about the relative importance of these factors is crucial, and has the potential to inform the development of education strategies that mitigate the extinction of experience and its negative consequences.

In this study, we conducted a large-scale questionnaire survey of 698 elementary and lower-secondary schoolteachers in Japan. Our aim was to understand the relative importance of multiple opportunity- and orientation-related factors, as well as other personal factors, on the frequency and duration of nature-based activities (e.g., providing outdoor nature observation, showing wildlife specimens and wildlife video) in science classes.

2. Materials and Methods

2.1. Study Area

We conducted the study in Tochigi Prefecture, central Japan (Figure 1). The prefecture administrative area covers 6408 km², with an estimated population of 1,952,926 residents in 2019 [21]. Tochigi Prefecture consists of 25 municipalities and encompasses a broad gradient of urban land-use intensity (Figure 1). The capital city of the prefecture is Utsunomiya City, with a population density of approximately 1200 per km² [22].

2.2. Participants and Procedure

We chose 51 elementary and 122 lower-secondary schools as the study sample (Figure 1). These schools were chosen to encompass a diverse range of geographic and socioeconomic communities. In late September 2017, we mailed questionnaires to each school and asked the School Principal to administer the survey and send the completed questionnaires back by mail within a one-month deadline. Every science teacher within participating schools received a five-page questionnaire written in Japanese. The questionnaire took approximately 10 min to complete. In Japan, elementary schoolteachers teach all subjects, and lower-secondary schoolteachers teach a specialist subject. We therefore asked all elementary schoolteachers and only specialist (science) secondary schoolteachers to participate in the survey. The questionnaire comprised one topic to determine the implementation intensity of nature-based education and three topics to determine the factors that influence this. In total the four topics were:

i. Intensity of nature-based activities in science classes;
ii. Orientation-related factors;
iii. Opportunity-related factors; and
iv. Other personal factors.

Two months after we sent the questionnaires, the number of responses decreased sharply, so we terminated the survey (1 December 2017).

Figure 1. Map of Tochigi with survey schools (elementary school; \( n = 45 \), lower-secondary schools; \( n = 91 \)).

2.3. Ethical Clearance

This study was approved by the research ethics committee at the University of Tokyo (no. H17-008). We informed principals and teachers that participation in the survey was voluntary. Participation in the survey was considered as consent. The survey was anonymous and no personal details (e.g., name, address) were collected from the respondents.

2.4. Implementation Intensity Nature-Based Education

The curriculum of elementary schools and lower-secondary schools in Japan is based on the Course of Study by the Ministry of Education, Culture, Sports, Science and Technology [23,24]. Textbooks used must be approved by the government. Within the broader science curriculum, there is a unit that involves the observation of nature (hereafter referred to as the ‘nature observation unit’). This unit is taught with guidance from government-authorized textbooks to 3rd and 4th grade (8–10 years old) elementary and 1st grade
(12–13 years old) lower-secondary classes with the level adjusted accordingly for the ages of the students. We excluded teachers that reported that they had never taught the unit from our analyses. Note that elementary schoolteachers that taught both 3rd and 4th grades completed questionnaires for each grade.

To determine the intensities (i.e., the frequency and duration) with which individual schoolteachers taught this unit, we asked several questions that fell into six broader metrics (hereafter ‘intensity metrics’; Table 1):

1. Degree of adherence to the recommended time spent teaching the ‘nature observation’ unit;
2. Time spent outdoors in the unit;
3. Time spent observing nature in the unit;
4. Time spent discussing ecology in the unit;
5. Use of wild specimens in the unit;
6. Use of videos in the unit.

The questions were designed to measure whether teachers had enhanced the unit by using increased interactions with nature outdoors, and by using materials such as real wild specimens and videos. We assumed that a more interactive approach would produce better learning outcomes than learning the subject from textbooks only [25]. Table 1 outlines the questions we asked the teachers in more detail, including the scales we asked the teachers to answer the questions with. Questions 1 and 2 required teachers to quantify how much time they spent teaching the nature observation unit and how much of this time was spent outdoors. In both these cases, we used ‘time block’, the standard time unit adopted in schools in Japan, as the unit of time. We considered that schoolteachers would find it easier to report the number of time blocks than estimate the amount of time in hours. The standard time blocks in elementary schools and lower-secondary schools are 45 and 50 min, respectively. The total number of time blocks the elementary and lower-secondary schoolteachers can spend for science classes per year is similar (3rd grade elementary: 90 time blocks; 4th grade elementary and 1st grade secondary: 105 time blocks). In the case of Question 1, we asked teachers to estimate how closely they adhered to the recommended number of time blocks for the nature observation unit by the lower-secondary and elementary schoolteachers’ manuals (3rd grade elementary: 4 time blocks; 4th grade elementary: 8–9 time blocks; 1st grade lower-secondary: 3 time blocks) within the allotted time for science classes. For question two, we asked teachers to estimate how many times blocks they taught outdoors in total. Our questions resulted in six variables that were designed to reflect the implementation intensity of nature-based education by teachers (Table 1). Sometimes, elementary teachers taught both 3rd and 4th grades. In these cases, we asked them to answer this question twice, once for each class, and averaged the scores between the two.

Table 1. The metrics we used (intensity metrics) and questions we asked teachers to determine the implementation intensity of nature-based education in the ‘nature observation’ unit taught in Japanese elementary and lower-secondary schools.

| Variable Name                                                                 | Question(s)                                                                 | Scale                                                                 |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------|
| Adherence to the recommended time spent teaching the nature observation unit | How much more or less time did you spend on the nature observation unit compared to the recommended number of time blocks? | 1 = two or more less than the recommended number, 2 = one less than the recommended number, 3 = same as the recommended number, 4 = one more than the recommended number, 5 = two or more than the recommended number. |
Table 1. Cont.

| Variable Name                          | Question(s)                                                                 | Scale                                                                 |
|----------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------|
| Time spent outdoors in the unit        | How much time did you spend teaching the ‘nature observation’ unit outdoors? | 1 = zero time, 2 = one time block, 3 = two time blocks, 4 = three time blocks, 5 = more than four time blocks per unit. |
| Time spent observing nature in the unit | During the nature observation unit, how frequently did you recommend that students should closely observe or touch wild: | 1 = almost never, 2 = infrequently, 3 = sometimes, 4 = often, 5 = always. |
|                                        | 1 insects?                                                                  | *scores averaged to a single measure for both questions.              |
|                                        | 2 plants?                                                                   |                                                                      |
| Time spent discussing ecology in the unit | During the nature observation unit, how frequently did you discuss the natural history of: | 1 = almost never, 2 = infrequently, 3 = sometimes, 4 = often, 5 = always. |
|                                        | 1 insects?                                                                  | *scores averaged to a single measure for both questions.              |
|                                        | 2 plants?                                                                   |                                                                      |
| Use of wild specimens in the unit      | During the nature observation unit, how frequently did you use wildlife specimens? | 1 = almost never, 2 = infrequently, 3 = sometimes, 4 = often, 5 = always. |
| Use of videos in the unit              | During the nature observation unit, how frequently did you show videos of the natural world to students? | 1 = almost never, 2 = infrequently, 3 = sometimes, 4 = often, 5 = always. |

2.5. Predictors of Implementation Intensity of Nature-Based Education

2.5.1. Orientation Factors

We used three metrics to measure each teacher’s orientation towards nature (Table 2):

1. Nature relatedness;
2. Ecological knowledge; and
3. Nature-related education.

Each teacher’s emotional connectedness to nature (hereafter ‘nature-relatedness’) was measured using the NR-6 scale [26], which is the short-form version of the 21-item Nature Relatedness (NR) scale [27]. The NR scale is designed to measure an individual’s connection to the natural world and concerns cognitive, affective, and physical connections to nature [27]. The NR-6 scale has been demonstrated to have a similar internal consistency and temporal stability to that of the full 21-item scale [26]. Examples of questions on the NR-6 scale include: “I take notice of wildlife wherever I am” and “I feel connected to all living things and the earth”. Teachers reported how strongly they agreed or disagreed with each item on a five-point scale, ranging from 1 (disagree strongly) to 5 (agree strongly). A total NR scale score was calculated by summing the individual scores and dividing by 6 (scores ranged from 1.0 to 5.0). We measured each teacher’s ecological knowledge by accompanying questions with color pictures of six species of each of insects, birds, and plants (insects: *Pieris rapae*, *Lycaena phlaeas*, *Papilio xuthus*, *Eurema hecabe*, *Acrida cinerea*, *Orthetrum albistylum*; birds: *Passer montanus*, *Hypsipetes amaurotis*, *Zosterops japonicus*, *Sturnus cineraceus*, *Hirundo rustica*, *Lanius bucephalus*; plants: *Taraxacum platycarpum*, *Lamium amplexicaule*, *Vicia sativa*, *Oxalis corniculate*, *Capsella bursa-pastoris*, *Plantago asiatica*). We requested that teachers “Please write the species name that you would consider correct for each of the following plant, insect, and bird species”. They were not allowed to use smartphones, computers, or books to help answer the questions. We chose birds and butterflies because these taxa are among the main targets for students’ observation based
on authorized textbooks in Japanese science units of the 3rd and 4th grade elementary and 1st grade lower-secondary school. We selected these species because they appear in several authorized elementary and lower-secondary school science textbooks [28–30] and are considered to be an indicator of a teacher’s ecological knowledge [31,32]. To determine whether they have received any nature-related education themselves, we asked teachers questions about whether they attended nature-related courses at university (Table 2).

**Table 2.** Variables used and questions asked to determine which factors determine the implementation intensity of nature-based education in the ‘nature observation’ unit taught in Japanese elementary and lower-secondary schools.

| Category                      | Name                                   | Details/Question(s)                                                                                                                                                                                                 | Scale                                                                 |
|-------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Nature relatedness            | Nature relatedness                     | We used the Nature relatedness scale (NR-6) scale. Examples: ‘I take notice of wildlife wherever I am’, ‘I feel connected to all living things and the earth.’          | Teachers reported how strongly they agreed or disagreed with each item on a five-point scale, ranging from 1 (disagree strongly) to 5 (agree strongly). Scores were averaged to a single measure for all questions. |
| Orientation towards nature    | Ecological knowledge                   | We measured each teacher’s ecological knowledge by accompanying questions with color pictures of each of six species of insects, birds, and plants. We selected these species because they appear in several authorized elementary and lower-secondary school science textbooks and are proven to be an indicator of teachers’ ecological knowledge. | Number of correct answers out of 18.                                  |
| Nature-related education      | Nature-related education               | When you were a university student, how many times did you take courses: 1 related to nature-based education? 2 that teach methods about nature-based activities? | 1 = none, 2 = once, 3 = more than two times. *scores averaged to a single measure for both questions.                                       |
| Opportunity-related factors   | Green space within school              | 1 Are there natural environments that are suitable for nature-based education within the school grounds? If yes, please report the estimated size. We listed examples of areas for each size: • boxing ring (~37 m²), • convenience store (~100 m²), • tennis court (~250 m²), • rice paddy (~1000 m²) • 50 m length swimming pool (~1250 m²). | 1 = none, 2 = ~50 m², 3 = ~100 m², 4 = ~250 m², 5 = ~500 m², 6 = ~1000 m², 7 = ~1250 m².                                      |
| Degree of urbanization of school surroundings | Proportion of urbanized area within 500 m buffer. |                                                                                                                                                                                                                 | Index                                                                 |
Table 2. Cont.

| Category                   | Name                                                                 | Details/Question(s)                                                                 | Scale |
|----------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------|-------|
| Experiences of nature as a child | Childhood was defined as aged from 6 to 12 years (elementary school age). During childhood, how frequently did you: | 1. visit neighborhood natural places (e.g., green space, woods, and grasslands)? 2. touch wild plants in neighborhood natural places? 3. observe wildlife (e.g., birds or insects) in neighborhood natural places? 4. catch insects in neighborhood natural places? 5. pick plants in neighborhood natural places? | 1 = never, 2 = once a month, 3 = a few times a month Scores were averaged to a single measure for all five questions. |
| Other personal factors     | We asked the schoolteachers to report their:                           | 1. age, 2. gender (male; female), and 3. length (year) of career as a schoolteacher. | Age, gender, and length of career in years. |

2.5.2. Opportunity-Related Factors

We used two metrics to measure the opportunities available for teachers to enrich nature-based education in the nature observation unit, assuming that more green space both within and around the school would increase opportunities to enrich the education of the unit (Table 2):

1. Greenness within school; and
2. Degree of urbanization of school surroundings.

To measure the greenness (vegetation) within the grounds of the school, we asked teachers whether there was green space within the school grounds. If their answer was yes, we asked them to estimate how much (Table 2). We determined the level of urbanization around the school by calculating the proportion of urbanized areas (i.e., impervious surfaces such as roads and buildings) within a 500 m radius of each school using Land Use Fragmented Mesh Data [33] within QGIS 2.18 [34]. A preliminary analysis indicated that using different buffer sizes (500, 1000, and 2000) did not affect the results of our study.

2.5.3. Other Personal Factors

We used four additional metrics related to the personal factors of the teachers:

1. Experiences of nature as a child;
2. Age;
3. Gender; and
4. Length of teaching career.

We calculated the frequency of each teacher’s direct experiences with nature during childhood based on five questions about their participation in nature-based activities during childhood (Table 2). These five questions were adopted from previous studies [35,36]. Finally, we asked the schoolteachers to report their age, gender (male; female), and length (year) of career as a schoolteacher. Since age and length of career were highly correlated to each other ($r (1104) = 0.872; p < 0.0001$), we excluded age from further analyses.
2.6. Statistical Analysis

To determine the key factors that predict the intensity of nature-based activities in class, we used linear mixed models. We treated the answers to our questions about the implementation intensity of nature-based education as continuous response variables (Table 1). Although the answers given by teachers in the surveys were on ordinal scales, we used these variables as continuous response variables, assuming a normal distribution. While this approach has courted some controversy, we decided that, on balance, this was the best way to test the relationships between our response and predictor variables [37]. We firstly wanted to compare the intensity metrics of answers from teachers in elementary schools with those from teachers in secondary schools. To do this we fit separate linear mixed models of the scores for each of our questions against a factor variable of school type. We included school name and teacher ID as random intercept factors in these models to account for the correlation between teachers in the same school and also to account for those instances where teachers answered the survey for two grades.

To test the effects of teacher orientation, opportunity, and personal factors on the implementation intensity of nature-based education (intensity metrics), we conducted a model-averaging procedure using the Akaike’s Information Criterion corrected for small sample sizes (AICc) [38,39]. To allow direct comparisons of the effects of our predictor variables, we treated them as continuous variables [37,40] and scaled them all to have a mean of zero and a standard deviation of 1, apart from the gender variable, which we treated as a factor with two levels (male, female). To account for the correlation between teachers at the same school and teachers who took the survey twice for different grades, we included school name and teacher ID as random intercept factors in the elementary school models and school name as a random intercept factor in the secondary school models. Analyzing data from elementary and secondary schools separately, and for each response variable, we were able to fit all subsets of a full model that contained all of our explanatory variables and performed model averaging on all models within ∆AICc = 6 [38,41]. After averaging across the subset of models, we calculated the mean estimates and 95% confidence intervals for each explanatory variable. Note that our results enable comparisons of each variable as a predictor of each response variable, and as such the reader should be careful to understand that effect sizes represent the relative effects as determined by the range of each variable.

We analyzed and plotted our data in R [42] using the ‘AICcmodavg’ [43], ‘ggpubr’ [44], ‘ggplot2’ [45], and ‘lmerTest’ [46], ‘lme4’ [47], and ‘MuMIn’ [48] packages.

3. Results

We received completed surveys from 46 out of 51 elementary schools and 90 out of 122 lower-secondary schools, constituting a total of 697 and 259 valid questionnaires from 363 and 259 different teachers, respectively. Figure 2 shows a summary of the answers given to the questions we asked to determine the implementation intensity of nature-based education.

3.1. Elementary vs. Lower-Secondary Delivery of Nature Observation Unit

Elementary schoolteachers adhered to the recommended time teaching the unit more than secondary schoolteachers (p < 0.0001, Figure 3; Table S1). Further, they spent more time outdoors (p < 0.0001), more time observing nature (p < 0.0001), and more time discussing the ecology of nature (p < 0.001) with their students than secondary schoolteachers (Figure 3). Both types of teachers spent an equal amount of time using wildlife specimens in class (p = 0.588), but elementary schoolteachers used videos to enhance their teaching (p < 0.0001) (Table S1; Figure 3).
Figure 2. Frequencies of answers given to the questions asked to determine the implementation intensity of nature-based education in the ‘nature observation’ unit taught in Japanese elementary grades 3 and 4 and secondary grade 1 schools. G3 = Grade 3, G4 = Grade 4, G1 = Grade 1. Note that answers from the 3rd and 4th grades contained a majority of teachers that taught both classes and answered the survey twice.
3.2. Effects of Orientation-Related Factors

Schoolteachers’ levels of nature-relatedness were significantly positively associated with the amount of time spent observing nature and discussing ecology, as well as the use of wild specimens in class (Figure 4; Table S1). This was true for both elementary and secondary schoolteachers. Schoolteachers with more ecological knowledge tended to adhere to the recommended guidelines more, and elementary schoolteachers with more ecological knowledge spent more time teaching the unit outdoors (Figure 4; Table S1). Secondary schoolteachers with a history of nature-related education spent more time observing nature and discussing ecology.

Figure 3. Modelled averages of scores of the answers given to implementation intensity questions between elementary and secondary schoolteachers. See Table S1 for model summaries, including p values. Error bars represent 95% confidence intervals.

Figure 4. Effect size plot of the effects of our predictor variables (columns) on the implementation intensity response variables (rows). All continuous variables were scaled to enable direct comparisons. Colored points represent significant effects. Error bars represent 95% CIs. See Table S1 for model summaries, including p values. Effects can be interpreted as significant if their 95% confidence intervals do not cross the zero-effect line [49].
3.3. Effects of Opportunity-Related Factors

More green space within elementary school grounds was significantly positively associated with the time that teachers spent outdoors, observing nature and discussing ecology (Figure 4; Table S1). Elementary schools with more urban surroundings resulted in teachers discussing the ecology and using wild specimens more in class (Figure 4; Table S1).

3.4. Effects of Other Personal Factors

Secondary schoolteachers who had more experiences with nature as children spent more time observing nature and discussing ecology in the unit (Figure 4; Table S1). Elementary schoolteachers who had more experiences with nature as children tended to use videos more than average (Figure 4; Table S1). Male elementary schoolteachers spent more time outdoors and discussing ecology than female elementary schoolteachers (Figure 4; Table S1). Elementary schoolteachers with a long teaching career spent less time discussing ecology and using videos in the unit (Figure 4; Table S1).

4. Discussion

Whilst previous studies have looked at various factors influencing the implementation intensity of nature-based education in schools, the relative contribution of each component remains poorly quantified. Against this background, our study makes an important contribution to the literature by simultaneously investigating the effects of multiple opportunity- and orientation-related factors, as well as other personal factors, on the implementation intensity of nature-based education in schools. Using a large sample of Japanese schoolteachers, we clarified the relative importance of different contributory factors previously referred simply as ‘important’. We also found that the effects of these factors on the implementation intensity varied between elementary and secondary schoolteachers. We discuss these findings below and explore why certain factors predict the implementation intensity of nature-based education by elementary and secondary schoolteachers.

4.1. Effects of Orientation-Related Factors

Among the factors we considered, nature-relatedness was the most important predictor of several aspects related to the implementation intensity of the nature observation unit. Schoolteachers who were more nature-oriented were more likely to spend more time observing nature, discussing ecology and using wild specimens. This finding is in line with a recent study showing that student teachers’ nature relatedness and their willingness affect outdoor education [50]. Our results suggest that increasing teachers’ emotional affinity towards nature is a way to improve nature-based education. Teachers’ nature-relatedness could be increased in various ways, including adulthood nature experiences [51] and environmental education programs [52–55].

Teachers who are more knowledgeable about wildlife spent more time teaching the unit than those that were not very knowledgeable about nature. This relationship could be interpreted from two angles. If teachers learn more about nature themselves, this might have the effect of increasing their confidence in regards to nature-based education in class [56]. Conversely, those teachers with greater ecological knowledge might be those people that are more likely to be interested in nature in general [57]. In either case, our results suggest that increasing ecological knowledge has an important role in enhancing nature-based education in school.

In Japan, elementary schoolteachers teach all subjects, but lower-secondary schoolteachers teach only their specialist subject (e.g., science, maths, languages). Secondary schoolteachers, therefore, are more likely to have completed courses related to their specialist subjects during their university training than elementary schoolteachers. Our results suggest that this training has positive results on schoolteachers discussing ecology and observing nature closely. Whilst we did not show this for elementary schoolteachers, Lindermann-matthies & Knecht (2011) reported similar results for Swiss elementary schoolteachers who participated in forest education during their teaching education. Increasing opportunities
of nature-related education into preservice education for elementary schoolteachers will therefore promote the intensity of nature-based education for students [20].

4.2. Effects of Opportunity-Related Factors

Greenness within school was significantly positively associated with increased time spent outdoors, observing nature and discussing ecology, among elementary schoolteachers. This finding suggests that natural environments in schools (e.g., grasslands, woodlands) may be triggers for teachers to engage more with nature-based activities. Our results suggest that maintaining and restoring natural environments within school grounds has the potential to increase children’s frequency of direct engagement with nature [58].

Contrary to our expectations, elementary schoolteachers who work in more urbanized areas spent more time discussing the ecology of wildlife and using wildlife specimens. One possible explanation for this unexpected finding might be that schoolteachers who work at more urbanized areas have more concerns about the negative consequences of the extinction of experience among children (i.e., reduced nature orientation), which may in turn increase their motivation to promote children’s positive emotions and attitudes towards wildlife. In order to test this hypothesis, more studies are needed to fully understand the motivations of schoolteachers to teach nature-based education in their classes.

4.3. Effects of Other Personal Factors

Schoolteachers who experienced nature frequently during their childhood included wildlife observation more and spent more time discussing the ecology of wildlife in their classes. This might indicate that experiences with nature during childhood increase schoolteachers’ likelihood of interacting with wildlife, which may in turn promote their pro-wildlife behavior. It is well known that an individual’s participation in nature-based activities in adulthood is positively associated with their levels of childhood nature experiences [59]. Our results suggest that there is likely a feedback loop in which an increase in people who do not experience nature in one generation (i.e., schoolteachers) will lead to a further decrease in nature-oriented people in the next generation (i.e., students)—a cycle of disaffection towards nature [4].

Senior (i.e., older) teachers reported lower frequencies of using wildlife videos in their classes. This result could be explained by the fact that senior schoolteachers tend to use digital materials (e.g., DVD, YouTube) less than comparatively younger schoolteachers [60]. Recent studies have suggested that, along with direct experiences of nature, vicarious experiences of nature such as watching wildlife documentaries, can help promote positive emotions towards nature and improve conservation attitudes [61,62]. It is therefore likely that showing wildlife videos in science classes could help mitigate the negative consequences of the extinction of experience, especially when direct experiences with nature are not possible.

Both the amount of time spent outdoors and the amount of time discussing the ecology of nature in elementary schools were greater for male teachers. This result appears to be a reflection of the differences in preferences and attitudes toward wildlife (e.g., insects) between the genders; men are more likely to favor wildlife than women [39,61,63]. However, since the magnitude of gender differences in preferences/attitudes toward wildlife might depend on cultural and the socio-economic context [64], additional studies are needed to understand more fully the role of gender in determining the intensity of nature-based education.

4.4. Differences between Elementary and Lower-Secondary Schools

The intensity of most of the nature-based activities was lower in secondary schools than in elementary schools. This result is partly explained by the fact that the number of time blocks recommended by teachers’ manuals is lower for lower-secondary schools (three time blocks) than elementary schools (four and eight to nine time blocks for 3rd and 4th grades, respectively). Our finding concurs with Fomichova & Misonou (2015), who reported that the majority of Japanese lower-secondary school science teachers stated that
the instructional time given for biology was less than the recommended time outlined in teachers’ manuals [65]. They also detailed that biology is taught less often than other sciences such as physics and chemistry. Further, the Nature Observation unit in secondary schools designed by the Ministry of Education, Culture, Sports, Science and Technology is intended to acquire biological knowledge rather than promote experiences with nature [24]. The nature observation materials are rarely updated, are smaller in content than other subjects, and tend not to be included in periodical exams. Hughes et al. (2019) reported that the recognition of connection to nature declines to its lowest in children in their mid-teens [66]. To mitigate the extinction of experience, it is very important that nature-related education be taught effectively in secondary schools. In light of this, updating the curriculum to improve nature-based education outcomes should be considered.

4.5. Limitations

This study has several limitations. First, we conducted the survey in only one region in Japan, and thus our results could be influenced by the specific cultural context. Future research could expand and carry out similar studies elsewhere in Japan and around the world. Second, since our data were collected through self-reported questionnaires, they may suffer from some biases (e.g., social desirability bias). Third, this study used a cross-sectional design, and thus we were not able to establish the cause-and-effect relationships among variables. This point is relevant not only for education, but for the extinction of experience in general. Direct evidence for the extinction of experience phenomenon is rare, because of the difficulty of obtaining baseline data on historical levels of human–nature interactions against which to compare more recent levels. This has led some to argue that people’s levels of direct experiences of nature may not have actually decreased [67,68]. Fourth, our study measured teachers’ levels of ecological knowledge using only their ability to identify species of three major taxa (plants, birds and butterflies), although this is one of the common ways to assess it [69,70]. Since ecological knowledge is multidimensional, it would be beneficial to assess it using a greater variety of approaches in the future. Fifth, although we focused mainly on the quantity measures (frequency and duration) of nature-based education, it would be beneficial to study quality measures (i.e., intensity). For example, it is likely that outdoor environmental education conducted in a biodiversity-rich environment (e.g., remnant woodlands, large green space) can have a significant role in developing children’s nature orientation and ecological knowledge compared to environmental education conducted in a poor biodiversity environment (e.g., a highly managed urban green space). Since it is difficult for schoolteachers to substantially increase the time spent on nature-based education (due to the predetermined allocated time), increasing the quality of these activities would be important. Lastly, our research would also benefit from more direct measures of education outcomes in relation to the factors we use in our study. For example, it might be beneficial to assess how the increased intensity of nature-based education affects children’s emotions, attitudes, and behaviors towards nature.

5. Conclusions

Our findings suggest that multiple opportunity- and orientation-related factors, as well as other personal factors, affect the implementation intensity of nature-based activities in Japanese elementary and lower-secondary schools. Focusing on increasing schoolteachers’ opportunities and orientation to participate in nature-based activities in their classes should be a priority. Enhancing nature-based activities at schools would increase children’s opportunities and orientation towards nature, which is likely to contribute to reducing the ongoing loss of human–nature interactions [3].

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su13179663/s1, Table S1: Model-averaged parameter estimates (fixed effects) predicting state of implementation of science class with nature activity.
Author Contributions: T.Y., M.S., and M.J.E. contributed equally to this paper. T.Y. and M.S. conceived the ideas; M.J.E. analyzed the data; K.T. conducted the GIS analysis, T.Y., M.S., K.T. and T.F.K. contributed to the development of the questionnaire, T.K. contributed to the implementation of the questionnaire survey. All authors designed methodology and drafted the manuscripts, edited and approved the final version. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted according to the Declaration of Helsinki, and approved by the Research Ethics Committee of University of Tokyo (no. H17-008).

Informed Consent Statement: We informed principals and teachers that participation in the survey was voluntary. Participation in the survey was considered as consent.

Data Availability Statement: Due to ethical concerns, the supporting data cannot be made available publicly. The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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