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Contact with Nature in Green Schoolyards

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Abstract

Green schoolyards often provide one of the few opportunities for children to play outdoors. The aim of this study is to investigate the influences of schoolyard characteristics and children's age on their contact with nature in green schoolyards. The researchers conducted 71 observations at three schools with green schoolyards in small towns in southern Germany, with students between 6 and 16 years of age. Analysis of the observations indicate that younger children tend to have more contact with nature on the schoolyard and make different use of green areas both in and outside the schoolyard than older children. Additionally, the study found that specific functional features of green schoolyards have a positive or negative impact on children's contact with nature.

Keywords: nature contact, nature experience, environmental education, green schoolyard, school environment

Introduction

Schools as Access to Nature

Many children spend only a small amount of their free time outdoors in nature (Wheeler, Cooper, Page, & Jago, 2010). The amount of time children spend in nature varies considerably, depending on where they grow up. Children living in cities have a disadvantage to those living in rural areas, as access to nature proves to be more difficult in cities (Thomas & Thompson, 2004). Furthermore, social problems can limit perceptions of nature in residential environments (Dyment & Bell, 2008b; Fisman, 2005). According to Hallmann, Klöckner, Beisenkamp, and Kuhlmann (2005), every fifth child feels the least safe in nature. Environmentalists all over the world are working to counteract this trend and are looking for approaches to bring children more frequently into contact with nature.

One approach is the green transformation of schoolyards, as they may provide one of the few opportunities for many children to play outdoors. Schoolyard greening involves a redesigning of established schoolyards to create ecologically rich environments. Ideally, these combine nature and ecological sustainability with site-specific learning, active participation, and creative gameplay, while celebrating community (Danks, 2014). A green transformation includes the break up, redesign, and planting of paved surfaces. A green design can be divided into four categories: habitat restoration, theme gardens, spaces for active play, and landscape to enhance stormwater management. In individual cases, these approaches are combined with selected priorities. Habitat restauration aims to imitate the local ecosystem as closely as possible (e.g., meadows, forests). Theme gardens (e.g., food gardens, herb gardens) are either arranged separately on the schoolyard or to supplement the habitat areas and are usually taken care of by the students in a teaching context. Spaces for active play are intended to make exercise and social interaction possible. For this purpose, the green areas are suitably equipped with specific elements. Typical features include seating components, fences, moveable pieces (e.g., logs, moveable stones), interpretative elements (e.g., learning stations, weather stations), water elements, pathways and gathering places. Landscapes for stormwater management are used in green schoolyards to illustrate the importance of green areas for storing and filtering storm water (Evergreen, 2002). Clearly, critical contributions to the realization of such schoolyards are the climate zone and the local ecosystems as well as the pedagogical conception, the commitment, and the financial means of the school.

All these measures share the aim to create spaces that bring children into contact with nature on a daily basis for several years. The idea of a green schoolyard exists not only through the design and the use of the school ground, but also through the culture in which the schoolyard becomes an everyday part of school life (Bell & Dyment, 2008). Depending on the school culture, a green schoolyard may or may not be understood and communicated as learning space (Malone & Tranter, 2003). Much of the contact with nature on schoolyards takes place informally without instructions, as a side effect of the children's stay or play on the schoolyard. Often, however, the possibilities of green schoolyards become part of formal teaching concepts, such as school gardening lessons. In either case, green schoolyards serve as playing and common areas during breaks.

The benefits of green schoolyards that school officials may see are numerous. These go beyond the idea of providing contact with nature to include secondary effects, such as outdoor learning, improved social behavior among children, and positive effects on both their physical and mental health (Bell & Dyment, 2008; Dyment, 2005). Green schoolyards can promote in a child a sense of curiosity and adventurism, healthy living and a connection to nature. Further, by cultivating local ecosystems, green schoolyards can become an important element of urban ecological infrastructure, and strengthen future generations' commitment to environmental actions and dealing with environmental issues (Danks, 2014).

Children's Outdoor Play

Children's play behavior in nature has been well-researched (Raith, 2017). For example, children include elements from green areas into their games, and diversity of the environment leads to diversity within their gameplay (Beach, 2003; Fjørtoft, 2004; Fjørtoft & Sageie, 2000). Loose parts in the gaming environment encourage constructive play and role-playing games (Maxwell, Mitchell, & Evans, 2008). Inside a green area, the games are more diverse (Beach, 2003; Drown, 2014; Dyment, 2005; Dyment & Bell, 2008a; Fjørtoft, 2004; Fjørtoft & Sageie, 2000; Grahn, Mårtensson, Lindblad, Nilsson, & Ekman, 1997). The playing interval of children on green playgrounds lasts longer than on non-green playgrounds, where children spend less time in conversation. In nature, children are motivated to play with others, play role-playing games more regularly, and show less aggressive behavior (Berglez, 2005; Dyment & Bell, 2008a).

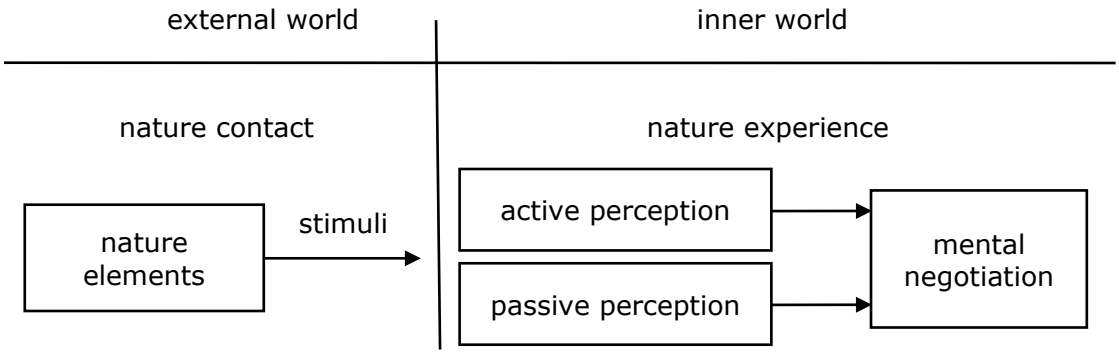
Children's use of natural areas shows age-specific patterns. A survey of children and adolescents in England on their use of woodland showed that preschool children play primarily under parental supervision close to where they live. Children of elementary school age (5-12 years) play with and without parents, in games such as hide and seek, or climbing trees and constructing dens. Children between 12 and 14 years of age have similar play behavior as children between 5 and 12, but they move further away from their place of residence and may use the forest to gain experience with cigarettes or alcohol. At the age of 15 to 17 years, the interest in forests decreases considerably, with an exception being a particular interest in outdoor or early sexual activities. Adolescents aged 17 and above use woodlands to spend time apart from adults. They throw parties, make campfires, are sexually active and, in some cases, consume drugs (Bell, Thompson, & Travlou, 2003).

Nature Experiences

Understanding the characteristics of nature contact and the processes that take place during its occurrence is not easy. Most authors have agreed on the concept of nature experience, which has been explored from different perspectives. In a nature experience, a subject has an encounter with nature that is processed internally (Bögeholz, 1999; Lude, 2001). Research focuses on the effects that this internal process has on variables such as the subject's attitude, recovery, and ability to concentrate (Brügger, Kaiser, & Roczen, 2011; S. Kaplan & R. Kaplan, 2003; Taylor & Kuo, 2009; Wells & Lekies, 2006). Further research has investigated the construct of a nature experience itself. This work has sought to define the dimensions of nature experiences that differ in their modes of negotiation with nature and in the

specific kind of nature encounter taking place (Bögeholz, 2006; Lude, 2001; 2006). The subject having a nature experience does so in response to specific environmental variables that are determined by the natural environment. Stimuli from the environment activate sensory systems, such as sight, hearing, or smell. This sensory perception is combined in mental processes to form an image of experience that is developed from a combination of sensory perception and prior knowledge and expectations. Hence, while environmental variables play an important role, various emotional and cognitive variables of the perceptive subject are also of great importance in shaping one's perception (Gerrig, 2013; Linzmayer, Halpenny, & Walker, 2014). Thus, nature contact is a variable of the external world in which the individual moves, whereas nature experience is a variable of the inner world of the individual, resulting from a mediating authority of subjective perception and its mental processes of negotiation. For the present study, nature contact is defined as "a state of exposure to sensory stimuli by elements of nature" (Figure 1).

Figure 1. Nature contact and nature experience as variables of the external and the inner world



Nature experiences can occur actively or passively. A person can focus their attention on an object of nature and consciously perceive its stimuli. But even when attention is not deliberately focused on the environment, the individual is exposed to the environment's stimuli and perceives them passively with their senses. In relation to the external world of the individual, nature contact occurs inside an environmental dimension, where the elements of nature form the background for secondary activities, and as a behavioral dimension in which the nature elements themselves are the content of activity (Raith, 2015). Due to different directions of attention, the two dimensions allow for the expectation of different perceptions and, hence, of different nature experiences.

Effects of Nature Experiences

The past few decades have presented us with a wide range of studies dealing with the effects of nature experience on different aspects of child development (Raith & Lude, 2014). Nature experiences may have a range of positive effects, such as on children's well-being (Han, 2009; Kelz, Evans, & Röderer, 2015; Martin, 2003; van den Berg & van den Berg, 2011), their self-esteem (Berger, 2008; Griffiths, Elniff-Larsen, & Jones, 2010; Kiener & Stucki, 2001; Murray, 2003; O'Brien & Murray,

2005; 2006; 2007) or their ability to concentrate (Grahn et al., 1997; Griffiths et al., 2010; Häfner, 2002; Kuo & Taylor, 2004; O'Brien & Murray, 2005; Taylor & Kuo, 2009; Taylor, Kuo, & Sullivan, 2001; van den Berg & van den Berg, 2011). Overall, there is research that supports the existence of positive effects on cognitive, affective, social, and physical development variables (Raith, 2015; Raith & Lude, 2014).

Moreover, there are developmental, sociocultural, and psychological explanations for the unique effects produced by the experience of a natural environment. The developmental explanation stems from a genetic disposition to landscape preferences, as mankind has spent most of their development in natural environments and adapted to them (Appleton, 1975; Kellert & Wilson, 1993; Orians, 1980). The sociocultural explanation points to a cultural imprint of "identity," which is linked to certain natural environments (Carlson, 2009; Proshansky, 1987; Tuan, 1974). Attention Restoration Theory (R. Kaplan & S. Kaplan, 1989) is currently the most recognized psychological explanation (Steg, van den Berg, & de Groot, 2012). It refers to specific characteristics of green environments that make recovery from directed attention fatigue possible and thus have a relaxing effect. The Stress Recovery Theory (Ulrich et al., 1991), according to which certain characteristics in the surrounding area trigger unconscious affective reactions, provides us with an alternative psychological explanation. Positive affective reactions, which are particularly common in green areas, have recuperative effects.

The State of Research on Nature Contact in Schoolyards

To date, the relatively little research on green schoolyards has focused on the effects of both nature contact and experience on secondary variables. In general, studies have indicated that children's well-being is increased in green schoolyards (Kelz et al., 2015). Children identify strongly with green schoolyards and think positively of them (Moore, 1986; 1989). Children's playing and social behavior in green schoolyards changes positively (Dyment, 2005; Dyment & Bell, 2008b; Malone & Tranter, 2003), and their social behavior remains on a more positive level even after the break (Dyment, 2005). Generally, vegetation on the schoolyard leads to a higher level of movement among the children (Boldemann et al., 2006). Green areas are the most active areas on the schoolyard and there children notably achieve and maintain a level of physical activity that is defined as moderate (Dyment, Bell, & Lucas, 2009). More vegetation in schoolyards leads to slightly positive effects on attitudes towards nature and botanical knowledge (Harvey, 1989), as well as improved school performance (Lopez, Campbell, & Jennings, 2008).

However, nature contact as a dependent variable has still not been studied in any real depth. Little is known about the factors that influence whether children have contact with nature, and if so, what type of contact that is. We know that not all children choose to spend time in green areas on the schoolyard. For example, at a school in Australia, 33 percent of the children from pre-school to sixth grade spent time in green areas, whereas at a school in Canada, it was 14 percent of the children from pre-school to eighth grade (Dyment et al., 2009). A known relevant variable in the differing use of green areas is the teachers' attitude towards the schoolyard, which they communicate to the students as a hidden curriculum. If

teachers understand the schoolyard to be an extended learning space, children have more contact with nature during breaks than if the schoolyard is only used as a space to work off their excess energy (Malone & Tranter, 2003). Gender differences only seem to play a subordinate role. While the sexes are known to use schoolyard areas differently, green areas have been found to have the fewest differences in usage, and have therefore a balancing effect (Bell & Dyment, 2008; Fjørtoft, Kristoffersen, & Sageie, 2009; Lucas & Dyment, 2010; Moore, 1986). As noted above, age effects are to be expected as different age groups make different use of green areas outside the schoolyard (Bell et al., 2003). Further, investigations at schoolyards without a green transformation show that the yards are used differently among age cohorts. Children of grades 1-4 spend most of their time in open and play areas and follow their urge for movement. Children of grades 5-7 play increasingly communicative games and use sports areas on the schoolyard. Children of grades 8-10 retreat to peripheral areas of the schoolyard and spend their breaks socializing (Derecik, 2013). Still, the impact of the cohort effects on nature contact in the schoolyard remains unclear.

As green areas have a balancing impact on gender effects, a balancing effect for nature contact could also be expected for age effects. If nature contact is age-related, research should determine the age ranges at which children are especially open to nature contact in the schoolyard, and variables in the decision-making among children and adolescents for spending time in certain schoolyard areas. Both the possible age effects and the influence of environmental variables on nature contact on the schoolyard need clarification in order to identify more clearly the effects of nature experiences on the schoolyard, and furthermore, to design schoolyards in such a way that the largest possible proportion of students have access to regular contact with nature.

There is an increasing interest in informal approaches to nature experiences at educational institutions. However, at present, there exists no adequate empirical database to make decisions about design for green schoolyards. Reliable findings are necessary to both ensure more effective planning, and to make persuasive arguments for implementing pedagogical measures around green schoolyards, which as a rule require a lot of commitment. If extensive greening measures prove to be ineffective or are effective only for small groups of children, then important supporters would fall away, and subsequent projects would be harder to implement. Hence, the purpose of this study is to determine the influences of age and environmental factors on children’s contact with nature in green schoolyards. The study pursues the following questions: To what extent do children of different age groups have contact with nature in green schoolyards? Do specific schoolyard characteristics influence contact with nature in green schoolyards?

Accordingly, the following hypotheses were formed:

1. The younger the children, the more contact with nature they have in schoolyards with green areas (the environmental dimension of nature contact—i.e., just being there, and the behavioral dimension of nature contact—i.e., observing/playing with nature objects).

2. Specific schoolyard characteristics affect contact with nature in green areas differently for different age groups (environmental and behavioral dimensions of nature contact).

Method

Participants

A total of 1278 students in grades 1-10 used the three schoolyards under investigation, across an age span from 6 to 16 years. All schools were combined elementary and secondary schools. In Germany, grades 1-4 belong to elementary school (age 6-10), while grades 5-10 are part of secondary school (age 10-16). At all schools in the study, the children from elementary school and secondary school shared the same schoolyard simultaneously, without any restrictions by the school administration or playground duty.

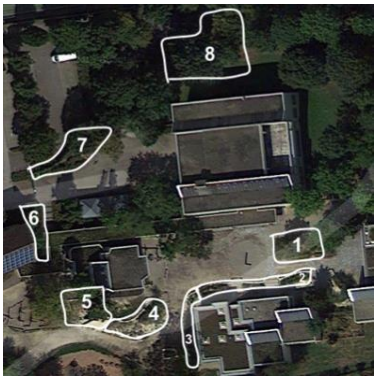
Settings

The three schools in the study have green schoolyards and are located in small towns in southern Germany (with 5,000, 5,700 and 11,000 inhabitants, respectively), with immediate rural surroundings (Figures 1-3). Each school consists of an elementary school (grades 1-4) and a secondary school (grades 5-10). The schoolyards were approx. 5500m^2, 6000m^2 and 7000m^2 in size. At each of the schools, the green schoolyard areas consisted of a combination of habitat restoration and spaces for active play. None of the schoolyards had a theme garden or stormwater management. The green areas were enriched with elements for active play (e.g., seating components, moveable pieces, pathways, and gathering places). The selection criteria for the green schoolyards conforms to the following criteria for nature playgrounds derived from Schemel and Müller (2010):

- Green areas have to be large enough to allow activities for a minimum of one-third of all students at the school.
- Alternative non-green areas have to be provided and accessible to all students.
- Contact with the soil and plants must be possible, and less than 10 percent of the natural area should be paved.
- The natural surface has to vary; at least one-third must be shaped by natural elements (such as bushes, trees, or rocks).
- At least one-third of the green area has to be made available for children to express themselves.
- Noise and emissions cannot interfere with the playing activities.

Across the three schools, the researcher identified a total of 24 green observation areas. The observation areas had to be at least 25 m^2, but small enough for an observer to detect children playing. The areas had to be functionally separate. These areas had to be open enough for the playing children and their actions to be observed.

Figure 2. School 1



Picture 1: observation areas (Google, DigitalGlobe, GeoBasis-DE/BKG, GeoContent)

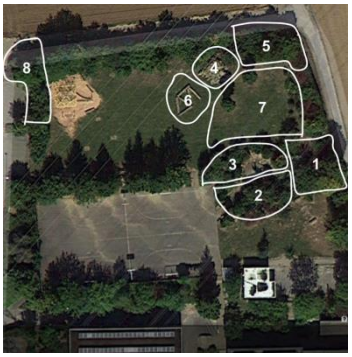
Picture 2: area 4

vegetation density: 225
terrain structure: 3.97
functional features: balancing opportunity, seat

Picture 3: area 5

vegetation density: 250
terrain structure: 2.68
functional features: slide, balancing opportunity, seat, climbing opportunity

Figure 3. School 2



Picture 4: observation areas (Google, DigitalGlobe, GeoBasis-DE/BKG, GeoContent, Landes-hauptstadt Stuttgart)

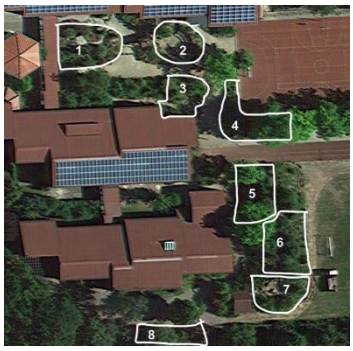
Picture 5: area 3

vegetation density: 550
terrain structure: 3.23
functional features: hideout, seat, climbing opportunity

Picture 6: area 1

vegetation density: 175
terrain structure: 0.83
functional features: climbing opportunity, seat, shelter

Figure 4. School 3



Picture 7: Google, AeroWest, (DigitalGlobe, GeoBasis-DE/BKG, GeoContent, Landeshauptstadt Stuttgart)

Picture 8: area 5

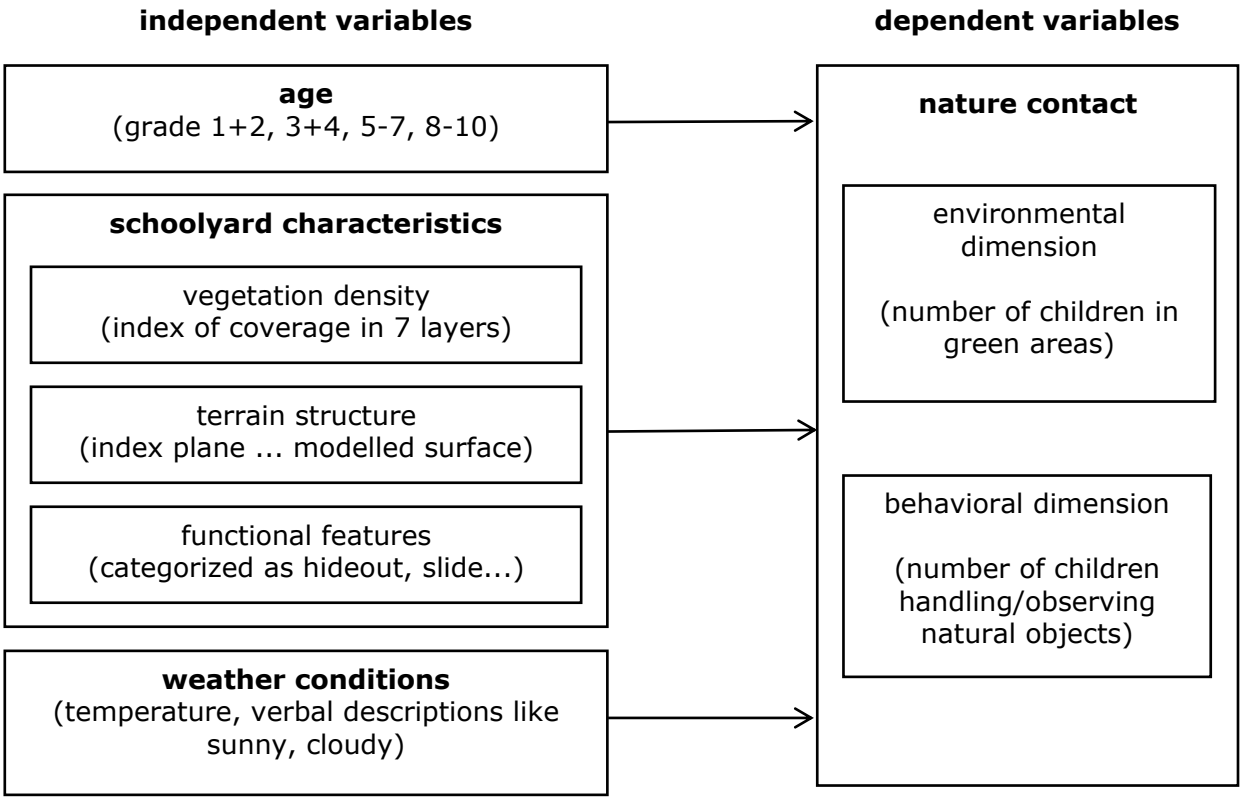
vegetation density: 200
terrain structure: 3.0
functional features: seat, water, balancing opportunity, shelter

Picture 9: area 7

vegetation density: 175
terrain structure: 1.69
functional features: climbing opportunity, balancing opportunity

The investigation follows the study model shown in Figure 5.

Figure 5. Study model



Procedures

At each of the schools, observations were conducted by a team of eight observers from May to July 2015 during three long lunch breaks (25 to 30 minutes between 9:00 am and 10:00 am). The children ate in their classrooms right before the break. During the breaks, all children were free to move around the schoolyard. Each observer was responsible for one observation area in the schoolyard. Thus, all 24 areas were covered during three breaks. This resulted in 71 observations (on one occasion, one observer was absent) with a total of 1586 one-minute observation intervals for each of the four class cohorts (grade 1+2, grade 3+4, grade 5-7, grade 8-10). Hence, 6344 cases were documented.

The dependent variable, contact with nature, was determined through observations at one-minute intervals. Two aspects were documented:

1. The environmental dimension of contact with nature: the number of children who stay in an observation area per minute.
2. The behavioral dimension of contact with nature: the number of children who handle or observe natural objects (plants, animals, stones, and the like) per minute.

The observers wore small earphones over which they heard a signal after every minute. Between the signals, they counted both the total number of children and the number of children who handled or observed natural objects. For each minute interval, both numbers were documented in a table. For example, minute #1: eight children staying, two children handling a natural object; minute #2: four children staying, no children handling a natural object.

Hypothesis 1 was directly depicted using the variable "age." Hypothesis 2 on schoolyard characteristics was implemented based on criteria for the description of terrain from landscape ecology (Steinhardt, Blumenstein, & Barsch, 2005) using the variables "vegetation density," "terrain structure," and "functional features." The weather conditions were included as a control variable.

1. Age of the children: During each observation interval, the observer documented the number of cases in each age group. To do so, the observer had to judge to which age group the children belonged. In order to minimize overlaps in determining the age groups, observers clustered their observations into four major age cohorts: grade 1+2, grade 3+4, grades 5-7 and grade 8-10. Before each observation, observers practiced assigning the individual class cohorts using image maps. More than 100 image maps showed schoolchildren from different age cohorts with the age span noted on the back of the picture. The observers were trained in the classification process by comparing their age assessment with the actual age of the children.
2. Vegetation density: Before observation, all areas of observation were classified by vegetation coverage. Specifically, for each of seven vegetation layers, the percentage coverage in plan view was determined separately and added to a total value. The layers included: three herb layers: H1 up to 20

cm, H2 between 21 and 50 cm, H3 between 51 and 100 cm, H4 more than 100 cm; two shrub layers: S1 less than 150 cm and S2 over 150 cm; and a tree layer over 5 m.

3. Terrain structure: The horizontal plane structure of all observation areas was determined with a point-score system by using the degree of surface unevenness and the number of structuring elements on the area and adding them to form a total value. Degrees of surface unevenness include: 0 points - flat surface; 1 point – less than 50% of the plane surface is interrupted by unevenness of at least 50 cm height; 2 points - flat and uneven surface are balanced; 3 points - uneven surface dominates, comprising more than 50% of the area. The number of structuring elements (such as a rock or tree trunk, with a minimum height and width of 50 cm) was multiplied by 25 (minimum area size in m^2) and divided by the real area size.
4. Functional features: All elements of equipment that could be used by children in each of the areas of observation were determined in advance of the observations and afterward inductively categorized. The following categories were established: walking ground, seats, area of retreat (open), hideout (closed), climbing opportunity, balancing opportunity, tunnel, slide, water, artwork, lookout, path. The areas were coded based on these categories.
5. The outside temperature and the weather conditions, such as sunny or overcast, was recorded.

Validity and Reliability

Six experts (three social scientists and three biologists), all experienced in socio-scientific research, evaluated the operational viability of all variables. The experts criticized the assignment to age groups by the observers and a possible overlap. Therefore, two observers carried out test observations (60 minutes total) in each case. For differentiation of the age cohorts in the observation of the environmental dimension, the test observations resulted in an intercoder reliability of $\kappa=0.7$, $p<0.001$ and for the behavioral dimension, the intercoder reliability was $\kappa=0.76$, $p<0.001$.

Analytic Strategy

The effect of the independent variable "age" on the dependent variables (hypothesis 1) was determined via descriptive statistics and ANOVA. The values of the variables for the cohorts were weighted, as the total number of students in each cohort differed (the younger cohorts included more children than the older cohorts). Vegetation density, terrain structure, functional features, and weather conditions were considered as covariates in the ANOVA. The homogeneity of error variances was tested using Levene's tests. By comparing the descriptive mean values, the significance of the mean differences was tested using post-hoc tests by Bonferroni.

Linear regression models (step wise) were generated to determine the effect of the independent variables "vegetation density," "terrain structure," "functional features" (schoolyard characteristics), and "weather conditions" on the dependent variables (hypothesis 2). Only linear effects were tested. Collinearities were controlled. Non-significant and correlating variables were gradually eliminated.

Results

Environmental Dimension of Contact with Nature

Children's Age

The students' use of the natural observation areas, and therefore the environmental dimension of their contact with nature, showed distinct differences between age cohorts. The younger the children, the more time they spent in the green areas of the schoolyard (ANOVA: df=3; F=321.34; p<.001; η^2=.129). Children in grades 1+2 were observed in green areas almost nine times more frequently than children in grades 8-10. The mean number of children in green observation areas per minute continuously decreased in accordance with the increasing age of the children and differs between all cohorts significantly (Table 1).

Table 1. Environmental dimension of contact with nature: Mean number of children in green areas per minute

class cohort	*M*	*SD*
grade 1+2	3.56	4.57
grade 3+4	3.09	3.99
grade 5-7	1.64	3.09
grade 8-10	.41	1.93

Note. *n* for every cohort=1585 (observed minute intervals); weighted by number of children in class cohorts

Schoolyard Characteristics: Vegetation Density

The vegetation density hardly influences children's contact with nature in the regression models. In two cases only, it occurs as a weak predictor. For the environmental dimension of nature contact in the model, it is a weak negative predictor (β=-108**) for grades 3+4 (see Table 2). That is, children in grades 3+4 tend to spend a little more time in more open areas.

Schoolyard Characteristics: Terrain Structure

The terrain structure is not significant as a predictor in most regression models. A significant trend was only found in the models of three class cohorts in relation to the environmental dimension of nature contact. For class cohorts 3+4 and 5-7, the terrain structure is a weak negative predictor (grades 3+4: β=-.096**, grades 5-7: β=-.141***); for grades 8-10, however, terrain structure is a positive predictor (β=.310 ***) (see Table 2). For younger children, the extent of the terrain structure seems to play a minor role. They only have a slight tendency to stay in more open terrain. Children of grades 8-10, however, prefer more highly structured terrain.

Schoolyard Characteristics: Functional Features

When looking at the regression models for the dependent variable "environmental dimension of nature contact," a substantive difference between students from elementary school (grades 1+2 and 3+4) and students from secondary school (grades 5-7 and 8-10) becomes apparent. The positive predictors for the elementary school cohorts consist only of elements that are linked to movement (walking ground, path, climbing opportunity, and water). Elements that slow movement down manifest as negative predictors (such as seats, lookout, and area of retreat). This includes the vegetation density and the terrain structure (see Table 2).

When looking at students from secondary school, aspects of movement recede into the background with increasing age. The walking ground remains as a positive predictor, but the observations from the preliminary study suggest that students from secondary school use the walking grounds for taking a relaxing stroll. In the cohort of grades 5-7, the slide serves as strongest predictor, but for grades 8-10, apart from the walking ground, only the terrain structure and area of retreat are significantly positive. This can signify a preference for areas of retreat in general (see Table 2).

Weather Conditions

The weather conditions had no effect on the dependent variables because at all observations the weather was warm (14-28°C) and never rainy.

Table 2. Linear regression of the environmental dimension of nature contact

independent variable	*grade 1+2*	*grade 3+4*	*grade 5-7*	*grade 8-10*
R^2	.305	.312	.156	.190
vegetation densitiy	n.s.	-.108**	n.s.	$corr^2$
terrain structure	n.s.	-.096**	-.141***	.310*
walking ground	.533***	n.s.	.124***	.235*
seats	-.079**	n.s.	n.s.	n.s.
area of retreat	n.s.	-.092***	.168***	.209*
hideout	n.s.	n.s.	n.s.	-211***
climbing opportunity	.108***	.247***	n.s.	-.256***
balancing opportunity	n.s.	n.s.	-.162***	-.158***
tunnel	-.086**	n.s.	n.s.	n.s.
slide	n.s.	n.s.	.229***	n.s.
water	n.s.	.081*	n.s.	-.153***

independent variable	*grade 1+2*	*grade 3+4*	*grade 5-7*	*grade 8-10*
artwork	n.s.	n.s.	n.s.	n.s.
lookout	corr[1]	-.106***	n.s.	n.s.
path	.198***	.441***	-.064*	-.136***

Note. *n* for every cohort=1585 (observed minute intervals), *p<0.05, **p<0.01, ***p<0.001, n.s.= not significant, correlations (IV with the weaker Beta eliminated): corr[1]: lookout/tunnel r=.554, corr[2]: vegetation density/hideout r=.592

Behavioral Dimension of Contact with Nature

Children's Age

Children in grades 1+2 are 44 times more likely to handle or observe a natural object than children in grades 8-10. The overall connection to the class cohort, however, is smaller (ANOVA: df=3; F=77.1; p<.001; η^2=.035). In elementary school cohorts (grades 1+2 and grades 3+4), the mean values of the behavioral dimension of nature contact are similar and do not differ significantly. It is only throughout secondary school cohorts (grades 5-7 and grades 8-10) that the mean values drop and differ significantly (Table 3).

Table 3. Behavioral dimension of nature contact: Mean number of children handling or observing natural objects in green areas per minute

class cohort	*M*	*SD*
grade 1+2	.35	.91
grade 3+4	.41	1.13
grade 5-7	.20	.84
grade 8-10	.008	.15

Note. *n* for every cohort=1585 (observed minute intervals); weighted by number of children in class cohorts.

By looking at the ratio of the behavioral dimension of nature contact (i.e., number of children handling or observing a natural object) and the environmental dimension of nature contact (i.e., number of children in green areas), the probability by which a child in a green area handles or observes a natural object is obtained. With a maximum of 14 percent, the probability is not high, but here too the cohorts differ with increasing age. With 13 and 14 percent, respectively, the probability is highest for elementary school children. In secondary school, it decreases to 9 percent for grades 5-7 and to 4 percent for grades 8-10 (Table 4).

Table 4. Ratio of the behavioral dimension of nature contact to the environmental dimension of nature contact

class cohort	*M*	*SD*
grade 1+2	.13	.27
grade 3+4	.14	.28
grade 5-7	.09	.23
grade 8-10	.04	.19

Note. *n* for every cohort=1585 (observed one-minute intervals)

Schoolyard Characteristics: Vegetation Density

For the behavioral dimension of nature contact in the model of classes 1+2, the vegetation density is a weak positive predictor (β=-.074**) (see Table 5). Denser vegetation tends to promote the direct handling of natural objects in children of grades 1+2.

Schoolyard Characteristics: Functional Features

The regression models for the dependent variable "behavioral dimension of nature contact" show that the model for grades 8-10, with a mean value of only 0.08 for the number of natural objects of operation per minute, demonstrates an explanation of variance of R^2=.019. Grades 8-10 were therefore not considered in any further evaluations.

As stated above, differences between elementary school cohorts (grades 1+2 and 3+4) and secondary school cohorts (grades 5-7) exist. The strongest positive predictors for grades 1+2 are "water" and "climbing opportunity," and for grades 3+4, "climbing opportunity" and "tunnel." These features involve a rather direct contact with natural objects. Observations from Phase I indicate that children played with gravel and stones in the tunnel. When climbing a tree, they picked branches and leaves. Water and the stones in it are natural objects (see Table 5).

In contrast, the strongest predictors for secondary school cohorts are the "hideout" and the "area of retreat." Older children tend to opt for natural objects in a secluded setting. Strong predictors for students from secondary school are also the "tunnel" and the "balancing opportunity." Both, however, were mainly used as sitting area. Here, it is not possible to fully clarify the connection between these coded areas and the behavioral dimension of nature contact, especially since the "sitting areas" are the strongest negative predictor for the behavioral dimension of nature contact for all the class cohorts (Table 5).

Table 5. Linear regression of the behavioral dimension of nature contact

Independent variable	*grade 1+2*	*grade 3+4*	*grade 5-7*	*grade 8-10*
R^2	.096	.199	.255	.019
vegetation densitiy	.074**	n.s.	corr[3]	n.s.
terrain structure	n.s.	n.s.	corr[2]	n.s.
walking ground	n.s.	-.71**	.192***	n.s.
seats	-.94**	-214***	-.190***	n.s.
area of retreat	.123***	n.s.	.510***	n.s.
hideout	corr[1]	n.s.	.577***	n.s.
climbing opportunity	.169***	.334***	n.s.	n.s.
balancing opportunity	n.s.	.138***	.360***	n.s.
tunnel	n.s.	.241***	.425***	.061*
slide	n.s.	-160***	n.s.	n.s.
water	.238***	n.s.	n.s.	n.s.
artwork	n.s.	-.087**	.067**	.108***
lookout	n.s.	n.s.	n.s.	n.s.
path	.107***	n.s.	-.156***	n.s.

Note. *n* for every cohort=1585 (observed minute intervals), *p<0.05, **p<0.01, ***p<0.001, n.s.= not significant, correlations (IV with the weaker beta eliminated): corr[1]: vegetation density/hideout r=.592, corr[2]: terrain structure/seat r=.561, corr[3]: vegetation density/hideout r=.592

Discussion

The results of the study confirmed both hypotheses. It has become evident that the natural contact occurring on the schoolyard is highly age-related, and it was possible to determine environmental variables that influence the amount and type of nature contact for the different age groups.

Age Effects

Younger children have considerably more contact with nature in the schoolyard than older children. Children of grades 1-4 (6-10 years) differ notably from older children in both dimensions of nature contact. Thus, the results of Derecik (2013) regarding the age-dependent usage patterns of schoolyards also apply for green schoolyards. This is a significant finding, since it initially supports the nature contact potential of green schoolyards for younger children. Unlike with gender effects, there appears to be no balancing effect of green areas for age effects (Bell & Dyment, 2008; Fjørtoft et al., 2009; Lucas & Dyment, 2010; Moore, 1986). The early school years seem to be a period in which children are open to contact with nature. The possibility could

exist that willingness to use green schoolyard areas decreases in older schoolchildren. Naturally, interests change as children grow older, as reported for the use of woodlands by Bell, Thompson, and Travlou (2003). Therefore, it is important to look at different age spans in order to provide a green experience for all age cohorts.

Experiences missed in the early school years might not be made later, which could lead to a weak attachment by children to the nearby natural world (Sobel, 1993). If the age effect in contact with nature can further be confirmed, this would have important consequences for planning schools and schoolyards.

Another important finding is the low probability with which children who are in green areas opt to play with a natural object. Even for children in grades 1-4, contact with nature occurs primarily within the environmental dimension (i.e., just being there) and not the behavioral dimension (i.e., observing/playing with nature objects). One explanation for this could be found in the context of the lunch break in which contact with nature occurs. According to Derecik (2013), children of grades 1-4 mainly want to move around the schoolyard. This assumption is further supported by the findings of Dyment and colleagues (2009), in which green areas were the areas with most children at a medium level of movement. Before and after the break, the children sit in the classroom. This suggests that they need the break to give way to their urge to move. It is possible that the relation between the behavioral dimension and the environmental dimension of nature contact would look different on a natural playground outside school where children have more time, peace, and quiet. In a school setting, however, the environmental dimension of nature contact seems to play a more important role. Accordingly, the design of green schoolyards should enable activities in a natural setting, with the focus on interacting directly with nature being of secondary importance.

Effects of Schoolyard Characteristics

The low impact of vegetation density and terrain structure was initially surprising. Both vegetation density and terrain structure appear in other studies as relevant factors with positive influence on movement intensity (Boldemann et al., 2006), and attitude towards nature or botanical knowledge (Harvey, 1989). Why they remain rather weak in this study cannot unequivocally be clarified. The existing tendencies fit, nevertheless, into a common pattern with the results of the functional features. The needs that children meet on the schoolyard are age-specific (Derecik, 2013). Therefore, schoolyard characteristics that influence contact with nature are specific to age groups as well. The environmental variables identified for younger children that positively affect their contact with nature are especially those that allow movement (e.g., walking ground, path, climbing opportunity). The environmental variables identified for older children are mainly those that provide retreat (e.g., terrain structure, area of retreat). This coincides with the assumptions made by Derecik (2013) that younger children want to move around on the schoolyard, while older students want to communicate in a peaceful atmosphere. For younger children, this applies only to the environmental dimension of nature contact, which occurs most frequently on the schoolyard. For grades 1-4, the behavioral dimension of nature contact is influenced by schoolyard characteristics, through which the children can come into close contact with natural objects (e.g., water, climbing

opportunity, area of retreat, vegetation density), including elements that can slow movement down (e.g., area of retreat, vegetation density). Thus, for younger children, green schoolyards should be designed to offer many opportunities for movement. This should be given priority since the environmental dimension of nature contact has proved to be of prime importance. In addition, elements can be included that promote proximity to natural elements. For older children and adolescents, the green areas should be designed to offer opportunities for retreat. Perhaps the significant slump in the frequency of nature contact among adolescents can be dampened that way. When planning schoolyards and especially when laying out green schoolyard areas, the requirements of different age cohorts should be taken into consideration at an early stage. It might be advantageous to think about providing age cohorts with separate, differently designed schoolyard areas. However, this should be examined separately.

Future Research

Further research is particularly needed to clarify adolescents' lack of interest in green areas. It should also be examined whether there exist cohort effects and whether adolescents retreat from younger children on the schoolyard or would potentially use green areas if they were by themselves. This would mean that adolescents need their own schoolyard areas, or that elements that attract younger children should not be placed in the immediate vicinity of elements for adolescents. A first qualitative study has already been carried out by the author of the present study (Raith, 2017). Furthermore, the effects of schoolyard characteristics on the use of green areas should be further investigated. Again, the influence of elements on older children and adolescents is of particular interest. Clarifying the influence of the elements on the different age cohorts is necessary to be able to give specific, empirically founded design recommendations to schools.

Limitations

The complex relationships of everyday school life play a role in the behavior of children on the schoolyard and, thus, present variables that refer to individual children and that could not be included in the present design appropriately. A more accurate picture could have been achieved if the individual children themselves and not the observation units had been evaluated as cases. This would enable social, emotional, or educational variables to be collected and incorporated into the models. This could have been made possible through the documentation of children on the schoolyard using GPS. However, this was not possible in this investigation because of the privacy policy determined by the board of education. Children were not allowed to be addressed and no personal data were collected. It was also impossible to mark children according to age groups. If children were evaluated as cases, the relatively weak explained variance in the regression models would have been improved, while the significance bias caused by the large sample could have been prevented. (The effects of the sample of 6000+ was too low to be statistically significant). Further, the average validity of the assessment of the age groups by observers could have been improved, as the exact age for each child could have been documented.

The minute intervals investigated are hardly independent of each other. There is no balanced probability of a child remaining in an observation area at the end of a minute. Therefore, a design with a time series analysis would be appropriate.

Finally, only three schools were included in the study. Due to the existence of rather different green schoolyards, further studies should be conducted at other schools to generalize the results.

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