Inkluderede studier i forskningsoversigten: Naturoplevelser i naturfagsundervisning i grundskolen

	Reference	Abstract
1	Alberghi, S., Foschi, A., Pezzi, G., & Ortolani, F. (2007). Is it more thrilling to ride at the front or the back of a roller coaster?. *The Physics Teacher*, *45*(9), 536-541.	An activity called "Project Physics, a Classroom Without Walls" was started during the spring of 2003 at the amusement park in Mirabilandia (Italy). Many thousands of students from Italian middle and high schools are today participating in the initiative. Under the guidance of trained tutors, they perform physics experiments on some of the attractions at the park such as the roller coaster, the Ferris wheel, and the launch towers. The students involved in the experiments can enjoy learning how to observe reality through the eyes of a scientist and to apply classroom concepts to real situations. They discuss the sensations experienced on the rides, perform measurements with traditional and computer-interfaced instruments, analyze collected data, and discuss the results in an open-air physics laboratory. This paper describes the results of one such activity.
2	Allison, E., Tunks, K., & Hardman, K. (2017). Down by the Bay. *Science and Children*, *54*(7), 29-33.	The development of an outdoor learning environment does not always require building a structure or garden. Sometimes, creating an outdoor space means using existing natural spaces for creative and engaging experiences. Through thoughtful planning and use of tools and volunteers, the beach that many students visit on a regular basis became an outdoor classroom ripe with new learning experiences. Therefore, this process of reimagining an existing outdoor space as an experiential classroom can be done in any environment. Here, Allison et al discuss how educational experiences outside of the classroom support student learning and result in a deeper understanding of subject matter.
3	Almeida, S., Bombaugh, R., & Mal, T. K. (2006). Involving school children in the establishment of a long-term plant biodiversity study of an urban green space. *The American Biology Teacher*, *68*(4), 213-220.	The decrease in urban green spaces limits the opportunities for adults and children to experience nature and learn about the environment. Yet, it is only when children experience nature in the outdoors that they can learn best to love it and strive to preserve it. As such, the need to include biodiversity studies in the curriculum becomes a pressing demand on today's teachers. In this article, the authors describe how

		they established a long-term plant biodiversity study of a forested urban green space and suggest how other teachers and students could implement this study. In their study, the authors worked with middle school and high school students, both within a classroom setting and as a part of extracurricular activities. The authors found that the effectiveness was uniform across the entire spectrum of age groups and settings; the level of motivation and enthusiasm among students was very high in all groups. In this article, the author provides details of how they set up plots and initially collected data for their long-term plant biodiversity study, as well as suggestions for how such data may be analyzed. The authors also show how their project tied in with the "National Standards for Science Education" and its interdisciplinary connections. In the second part of the article, the authors highlight changes to conduct the study even with limited resources. Their guidelines can be used to set up plots in any forested green space in any school's vicinity. (Contains 5 figures and 3 tables.)
4	Almers, E., Askerlund, P., & Kjellström, S. (2018). Why forest gardening for children? Swedish forest garden educators' ideas, purposes, and experiences. *The Journal of Environmental Education*, *49*(3), 242-259.	Utilizing forest gardens as urban settings for outdoor environmental education in Sweden is a new practice. These forest gardens combine qualities of a forest, e.g., multi-layered polyculture vegetation, with those of a school garden, such as accessibility and food production. The study explores both the perceived qualities of forest gardens in comparison to other outdoor settings and forest garden educators' ideas, purposes, and experiences of activities in a three-year forest gardening project with primary school children. The data were collected through interviews and observations and analyzed qualitatively. Four reported ideas were to give children opportunities to: feel a sense of belonging to a whole; experience self-regulation and systemic dependence; experience that they can co-create with non-human organisms; and imagine possible transformation of places. Four pedagogical forest garden features are discussed.
5	Amsel, S. (2009). What Grows There?. *Science and Children*, *47*(1), 44-47.	Even though students see plants all around them, they tend to ignore them. Animal studies usually get all the "press." As a naturalist, children's book author, and coordinator for an educational science website for teachers, the author knows from personal experience that

		observing and charting plant growth can be as intriguing as observing animals. Here she shares a simple but thought-provoking activity that teachers can use with fifth- and sixth-grades students: plant research plots. As students monitor the plant growth in one-meter plots over a period of six weeks, they practice science-process skills while learning about plant life cycles and how plants compete with each other. (Contains 2 figures.)
6	Anderson, A. E., & Meier, J. A. (2016). Second-Graders Beautify for Butterflies. *Journal of STEM Arts, Crafts, and Constructions*, *1*(2), 38-47.	This practical article presents activities that support previous research suggesting the integration of art with science is beneficial to the learning and cooperative processes of children. The project showcased here highlights the ability of elementary school children to collaborate with their peers for problem solving and critical thinking through the artistic use of observation and sketching. This article discusses effective lesson activities in which students combined art and science by creating and cultivating a butterfly garden on the school's property.
7	Ashbrook, P. (2016). Fostering environmental stewardship. *Science and Children*, *53*(6), 26-27.	For young children, a found acorn, stone, or lichen-covered branch can be a touchstone of an experience in nature. Children, however, should also be taught to "leave no trace." As the National Park Service advocates, visitors to natural areas should "Preserve the sense of discovery for others by leaving all natural and cultural artifacts as you find them." This column discusses resources and science topics related to students in grades preK to 2. This month's issue includes an activity that aims to strengthen teachers' awareness of how children learn in the science, technology, engineering, art, and mathematics (STEAM) disciplines as they explore a natural area and create art.
8	Aspinall, C. (2016). Using Outdoor Adventure Settings to Teach Physics. *School Science Review*, *98*(362), 110-114.	A key challenge when teaching physics is to equip students with the ability to apply the concepts to real-life situations. Students do not learn by information alone; they are affected by their environment, their social setting, how their body and mind feel and the interactions between these different aspects. This may explain why wild places and adventurous activities can lead to transformative learning. It also raises the question of how we can harness this knowledge to teach core physics topics that students may struggle to relate to in a school science laboratory.

9	Back, S. R. (2003). " EdZOOcating" children. *Science and Children*, *40*(7), 28-31.	Describes a science program for 3rd and 4th grade students, many of whom have never visited a zoo or seen animals that live in natural areas. (KHR)
10	Ballantyne, R., & Packer, J. (2009). Introducing a fifth pedagogy: Experience-based strategies for facilitating learning in natural environments. *Environmental education research*, *15*(2), 243-262.	Educators have identified four categories of "productive pedagogies" that are considered to lead to authentic student engagement and learning in the classroom. This study was designed to explore and extend these pedagogies in the context of learning in natural environments, in particular, through the programmes of Queensland environmental education centres. In-depth interview and observation data were collected from students, classroom teachers and centre teachers who had participated in 12 environmental education programmes across Queensland, in order to identify the strategies that are most effective in facilitating learning in the natural environment. A fifth productive pedagogy category, "experience-based learning", is proposed. Experience-based learning is particularly important in addressing students' environmental attitudes and actions. The implications for the delivery of environmental education programmes both within and outside the classroom are discussed. (Contains 3 notes, 9 tables and 2 figures.)
11	Bang-Jensen, V. (2012). Reading a Garden. *Educational Leadership*, *69*.	School gardens--and efforts to connect gardening to K-12 learning--are burgeoning. Children's gardens--green spaces that keep in mind the way children play and explore an outdoor space--have been one of the biggest recent trends in gardening. Progressive educators have long promoted gardening as an opportunity to connect knowledge about plants, animals, and ecosystems with personal experience--and as a natural way for students to develop an understanding of science. In addition to generating inquiry about nature, gardens help teachers authentically integrate botanical knowledge and broader science concepts into the school day. Although the relationships among science, math, and gardens are readily apparent, gardening isn't a boon for these two disciplines only. Think of the role that garden exploration might play in strengthening literacy. Gardening can inspire students to read, discover, research, write, and inform themselves and fellow gardeners. In this article, the author discusses three ways teachers can

		use authentic student activity in gardens to enrich literacy--and how literacy meshes with student experiences in a garden. (Contains 1 figure.)
12	Barfod, K. S. (2017). *Subject related teaching in udeskole (outdoor school): Prevalence of problem based teaching in Mathematics and Science in udeskole, an observation study.*. Abstract from The 6th NoFa-conference 2017, Odense, Denmark.	Subject related teaching in udeskole In this symposium, subject related teaching on a regular basis in the outdoors, known as udeskole will be described and discussed. Based on recent and ongoing research and development, the education taking the place of teaching into account of the learning process will be the cornerstone of this seminar. Udeskole is described as a holistic, child centered pedagogy, activating the pupils hands, heart and heads. In this symposium, emphasis will be laid upon the subject related and subject specific elements of udeskole. Firstly, the prevalence of udeskole will identify the necessity of doing research into the field, as 18,4% of all Danish schools is shown to have one or more classes working with udeskole (Barfod et al, 2016). Secondly, the subject related teaching in the outdoors will be exemplified by four research projects. First, the subject 'Danish' in Teaching mother tongue in the outdoors, to read and teach literature on places in secondary and high school (Eggersen, 2016). Secondly, Art and aesthetics learning in the outdoors, how can place based art and relational aesthetics as selected artistic practices be an inspiration and a role model for the development of outdoor education? Thirdly the cooperation between formal and informal learning institutions in History and Last the methodology used in Mathematics and Science outdoors as revealed by a qualitative observation study (Barfod, unpublished results). The key notes emphasizing subject centered teaching in the outdoors will be supplemented with recent research upon barriers for using external learning environments 'the open school' in Skive Muncipiality. Closing the seminar will be a presentation of the national Danish Network UdeskoleNet and its application. Sources: Barfod, K., Ejbye-Ernst, N., Mygind, L., & Bentsen, P. (2016). Increased provision of udeskole in Danish schools: An updated national population survey. Urban Forestry & Urban Greening, 20, 277–281. https://doi.org/10.1016/j.ufug.2016.09.012 Eggersen, D. V. Afsted med jer!: Stedbaseret læsning som

		litteraturpædagogisk metode 20 jul. 2016 in Genrepædagogik : - og andre nye veje i læse- og skriveundervisningen. Christensen, M. V. (red.). 1 udg. København: Hans Reitzel, Vol. 1, s. 195-214 19 s. 9 Andersen, Kirsten Bak: Landskabet som undervisningssted. Landskabet som motiv, landskabet som materiale. Billedpædagogisk Tidsskrift, 2009 nr. 2 s.26-29
13	Barker, B. S., Larson, K., & Krehbiel, M. (2014). Bridging Formal and Informal Learning Environments. *Journal of Extension*, *52*(5), 1-4.	Out-of-school time programs that provide science, technology, engineering, and mathematics (STEM) educational content are promising approaches to develop skills and abilities in students. These programs may potentially inspire students with engaging hands-on, minds-on activities that encourages their natural curiosity around STEM content areas. However, it is also important to align out-of-school time learning activities with what is being taught in the formal classroom so that the experiences are congruent. Two examples of congruent programs are described in this article.
14	Bentsen, P., & Jensen, F. S. (2012). The nature of udeskole: outdoor learning theory and practice in Danish schools. *Journal of Adventure Education & Outdoor Learning*, *12*(3), 199-219.	An increasing number of Danish teachers have started introducing school-based outdoor learning as a weekly or biweekly 'outdoor school' day for school children -- often called udeskole in Danish. Although at least 14% of Danish schools practise this form of outdoor teaching with some classes, it is not mentioned in the national curriculum and little is presently known about the nature of udeskole. Drawing on a conceptual framework about different curriculum domains, we explore outdoor learning theory and practice in Danish schools. We describe and analyse the advocated pedagogy and didactics of the Danish udeskole movement as well as current practice through a review of the literature and a nationwide survey of 107 responding teachers. We also reveal discrepancies between the advocated and practised outdoor learning curriculum. Finally, we present recommendations on how to bridge these gaps and develop the practice further. [PUBLICATION ABSTRACT]
15	Bingaman, D., & Eitel, K. B. (2010). Boulder Creek study. *Science and Children*, *47*(6), 52-56	Boulder Creek runs literally in the backyard of Donnelly Elementary School and happens to be on the EPA list of impaired water bodies. Therefore, a unique opportunity for problem solving opened the door to an exciting chance for students to become scientists, while also

		becoming active in their community. With the help of the Idaho Department of Environmental Quality (DEQ), a teacher from Donnelly Elementary School and a faculty member at the University of Idaho's McCall Outdoor Science School (MOSS)--fifth-grade students tackled this local environmental problem through an inquiry-based project. (Contains 3 figures.)
16	Boeve-de Pauw, J., Van Hoof, J., & Van Petegem, P. (2019). Effective field trips in nature: the interplay between novelty and learning. *Journal of Biological Education, 53*(1), 21-33.	Educational field trips are common practice in environmental education and education for sustainable development, well recognised by researchers for their potential to achieve cognitive and affective educational outcomes. One of the factors that influences learning during field trips is their novelty. The current study focuses on the interplay between novelty, preparation and environmental learning outcomes of 5th and 6th grade students during a typical field trip in Flanders. Our dependent variables are Inclusion of Nature in the Self, the two major ecological values Preservation and Utilisation and ecosystem knowledge. The sample includes 484 students (10-12 years old) and their 24 teachers. Key questions addressed are: (1) What is learned during the field trip? (2) What is the level of novelty for students during a field trip? (3) How does the novelty effect relate to learning? Results show that participation in the field trip leads to a substantial increase in ecosystem knowledge, but fails in reaching the affective goals set out by the field trip organisers. Our results furthermore provide support for the hypothesised non-linear relationship between novelty and knowledge gain, showing that while a little novelty is positive, too much novelty can stand in the way of learning.
17	Bosse, S., Jacobs, G., & Anderson, T. L. (2009). Science in the air. *YC Young Children, 64*(6), 10-15.	Supplement a bird feeder visible from a classroom window with an illustrated field guide, binoculars, and a clipboard for documenting the numbers and types of winged visitors. Some programs set up an outdoor art area where children can create with natural materials, a music area, a building area, a messy play area, or a water feature (National Arbor Day Foundation 2007). Note the topics that children raise in conversations - perhaps the wildlife in your area, the water

		system, seasonal changes, mechanical operations (eleva- tors, dump trucks, cranes), or recycling.
18	Braun, M., Buyer, R., & Randler, C. (2010). Cognitive and Emotional Evaluation of Two Educational Outdoor Programs Dealing with Non-Native Bird Species. *International Journal of Environmental and Science Education*, *5*(2), 151-168.	Non-native organisms are a major threat to biodiversity. This statement is often made by biologists, but general conclusions cannot be drawn easily because of contradictory evidence. To introduce pupils aged 11-14 years to this topic, we employed an educational program dealing with non-native animals in Central Europe. The pupils took part in a lesson giving general information about the topic, followed by a species identification quiz. Attitude, emotions and state of knowledge of each pupil were surveyed throughout the program using standardized questionnaires (pre-/post- and follow up tests). One week after the first lesson, a field trip followed, focusing on one out of two non-native bird species in the city of Heidelberg, Baden-Wurttemberg, Germany. The first species was the Ring-necked Parakeet ("Psittacula krameri") from the Indian subcontinent, and the second species was the East Asian Swan goose ("Anser cygnoides"). Life history information was delivered through a teacher and own observations during the excursions and after four weeks, the newly gained knowledge was tested in a third lesson. The "goose group" scored higher in goose-related questions, whereas the "parakeet-group" scored higher in their topic. The most impressive aspect of the whole program was, that the pupils rated the field trip per se as highest, and secondly, learning about unfamiliar species. Interestingly, the general attitude towards non-native species did not change as a result of this educational intervention. (Contains 3 tables.)
19	Braun, T., & Dierkes, P. (2017). Connecting students to nature–how intensity of nature experience and student age influence the success of outdoor education programs. *Environmental Education Research*, *23*(7), 937-949.	Nature connectedness counts as a crucial predictor of pro-environmental behavior. For counteracting today's environmental issues a successful re-connection of individuals to nature is necessary. Besides the promotion of knowledge transfer the aim of the educational program presented in this study is to connect students to their environment. This research explores the impact of an outdoor environmental education program on primary and secondary school students' nature connectedness with regard to the extent of their nature experience and participant age. The intervention was implemented in

		two durations: one-day and five-days. Participants were divided into four subsamples from seven up to 18 years of age. Findings suggest that both intervention types evoke immediate shifts towards a stronger nature connectedness among students ($p < 0.001$). Notably, the five-day outdoor education interventions were significantly more effective in sustainably promoting nature connectedness compared to one-day field trips ($p < 0.001$). Seven to nine year old students performed the strongest shifts towards nature. The value of short-term and residential outdoor environmental education interventions is discussed.
20	Braund, M., & Reiss, M. (2006). Towards a more authentic science curriculum: The contribution of out-of-school learning. *International journal of science education*, *28*(12), 1373-1388.	In many developed countries of the world, pupil attitudes to school science decline progressively across the age range of secondary schooling while fewer students are choosing to study science at higher levels and as a career. Responses to these developments have included proposals to reform the curriculum, pedagogy and the nature of pupil discussion in science lessons. We support such changes but argue that far greater use needs to be made of out-of-school sites in the teaching of science. Such usage will result in a school science education that is more valid and more motivating. We present an „evolutionary model" of science teaching that looks at where learning and teaching take place, and draws together thinking about the history of science and developments in the nature of learning over the last hundred years or so. Our contention is that laboratory-based school science teaching needs to be complemented by out-ofschool science learning that draws on the actual world (e.g. through fieldtrips), the presented world (e.g. in science centres, botanic gardens, zoos and science museums) and the virtual worlds that are increasingly available through information technologies.
21	Breiting, S. (2012). Konceptet Haver til maver som undervisningstilbud. *MONA-Matematik-og Naturfagsdidaktik, 2012*(2), 65-70	I en nylig artikel i MONA beskrives sider af projektet "Haver til Maver" under overskriften "Lyst til at lære. Evaluering af konceptet "Haver til Maver"" (Wistoft & Stovgaard, 2012). Den glimrende artikel er skrevet i forlængelse af evalueringsrapporten (Wistoft et al., 2011) som jeg selv er medforfatter til. Jeg er af redaktionen blevet bedt om at give MONA-artiklen nogle kommentarer, hvad jeg gerne gør

		idet jeg har beskæftiget mig med feltet ekskursioner og deres potentiale for læring gennem mere end 25 år. Forfatterne Wistoft & Stovgaard (2012) søger at give en mulig forklaring på elevernes lyst til at lære ud fra en systemteoretisk fortolkning af oplevelsesbaseret undervisning og kærlighedskommunikation i Luhmanns fodspor (Luhmann, 1995). Da Luhmann ikke er mit gebet, bliver mit teoretiske udgangspunkt et andet, og det bliver meget baseret på mine egne erfaringer og konklusioner. Det håber jeg kan være med til at give problemfeltet andre relevante perspektiver som let kan overføres til hvad der har betydning for elevers udbytte af ekskursioner og andre ud af huset-aktiviteter generelt.
22	Briten, E. (2006). Sowing the Seeds of Creativity. *Primary Science Review*, *91*, 22-25.	The exciting world of plants may be something of a mystery to many children, and the often-dry content of a curriculum taught indoors inhibits real understanding of many complex biological processes. Moving outdoors opens up an unexplored world and presents rich opportunities for imaginative learning. The "Life processes and living things" part of the National Curriculum for England can be taught in a creative way through cultivation of a small plot of land within the school grounds, to engender a love of the living world outdoors. In this article, the author discusses how a school garden can be used as a "research station" to help children carry out thought experiments on plants. (Contains 1 box and 1 online resource.)
23	Britton, S., McCullough, A., Ortwein, M., & Parker, M. A. (2016). The “nature” of Common Core: Connecting science and literature through the natural world. *Science Activities*, *53*(1), 4-12.	The unit described in this article targets lower elementary students, encouraging them make connections between literature, nature, personal explorations, and the Earth. Students were encouraged to keep a daily journal from our outdoor nature visits, drawing pictures of what they see, and recording activities from class that improved their understanding of the content being introduced. While multiple content areas could be integrated through this lesson, we focused this unit on one guiding question: Why does the Sun appear to move throughout the day? Additionally, the classroom teacher was encouraged to integrate activities and to make learning interdisciplinary. (Connections

		are provided throughout this unit and in the Appendix.) We found that the repetition of ideas was very helpful for the students to actually begin making sense of what rotation meant in their life and was provided through the center activities. We also found that students were naturally curious and expressed great interest in discussing the changes they observed, and they were able to make connections with the constant change of seasons they experience in the Northern Hemisphere.
24	Brown, D., Francis, R., & Alder, A. (2013). Supporting the outdoor classroom: an archaeo-astronomy project. *School Science Review*, *94*(349), 76-84.	Field trips and the outdoor classroom are a vital part of many areas of education. Ideally, the content should be taught within a realistic environment rather than just by providing a single field trip at the end of a course. The archaeo-astronomy project located at Nottingham Trent University envisages the development of a virtual environment with associated resources and projects, allowing pupils (key stages 2-4; ages 7-16 years) to experience and explore ancient landscapes in the Peak District National Park both in the classroom and in the field. This project will motivate schools to overcome the initial problems of the outdoor classroom and bridge the gap between higher education and secondary schools or colleges. (Contains 8 figures, 4 boxes, and 3 online resources.)
25	Bruun, J., & Johannsen, B. F. (2014). *The interplay between dialogue, cognitive schemata and kinesthetic learning: Bodily explorations of force related concepts in physics*. Abstract from The First Conference of the International Association for Cognitive Semiotics, Lund, Sweden.	We ask how students use communicative signs (e.g., speech and gesture) to shape and develop cognitive schemata during a bodily exploration of force and motion in a physics teaching-learning activity. We refer to this interplay between dialogue, cognition, and bodily exploration as kinesthetic learning. In essence we ask: to an outside observer (e.g. a teacher), what signs exist that students derive formally correct meaning and understanding from kinesthetic learning?
26	Bølling, M., Niclasen, J., Bentsen, P., & Nielsen, G. (2019). Association of Education Outside the Classroom and Pupils' Psychosocial Well-Being: Results From a School Year Implementation. *Journal of school health*, *89*(3), 210-218.	Background: Education Outside the Classroom (EOtC) is a teaching method that is gaining traction, aiming to promote learning and well-being. However, research on the association between EOtC and well-being is limited. Methods: This quasi-experimental trial involved pupils (9–13 years) from 16 Danish public schools which implemented EOtC in some classes. Pupils (N = 511) from 27 classes were regularly exposed to EOtC (2–7 hours per week), and pupils (N = 120) from 7

		parallel comparison classes were much less exposed (less than 2 hours per week). The pupils' psychosocial well-being was measured at the beginning and end of the school year using the Strengths and Difficulties Questionnaire. The results were compared between the groups. Results: Pupils regularly exposed to EOtC showed the greatest improvement in prosocial behavior. Negative associations were seen between EOtC and hyperactivity-inattention and peer problems in pupils of low socioeconomic status (SES). The observed improvements were smaller when the EOtC was spread over a larger number of sessions. Results were independent of sex. Conclusions: Regular exposure to EOtC was found to promote social well-being, especially for pupils of low SES, and was most beneficial when concentrated in fewer, longer sessions.
27	Caballero, A. M., & Dashoush, N. (2017). Planting Deeper. *Science and Children*, *55*(2), 56-61.	The Arnold Arboretum Field Study Program provides outdoor experiences for children in order to develop authentic firsthand knowledge of life sciences. The Arboretum welcomes approximately 3,200 children (preK-5) from greater Boston annually. During the program called Explorations with Head Start participants, the children visit three times throughout the school year to observe seasonal change. The program's mission is to provide depth over breadth by encouraging hands-on exploration of seasonal phenomena and thoughtful conversations with students about the plants they encounter. Outdoor spaces, such as the Arnold Arboretum, allow children to gather their own evidence of plant biodiversity. Unlike most states, Massachusetts has science standards for preK children as part of the Massachusetts Science Technology and Engineering (STE) Framework. The Massachusetts STE are an adaptation of the "Next Generation Science Standards" ("NGSS"). The educational framework at the Arboretum adheres to their state's framework for teaching life science to children, which reads: Using evidence from the local environment, explain how familiar plants and animals meet their needs where they live (PreK-LS2-2). The practices described in this article have been identified as key for moving past the listing of what plants need, aligning more with standards such as emphasizing scientific

		practice and requiring children to look for evidence. Furthermore, through these practices, children begin to see variety within plants, which will help rectify misconceptions. Although all of the practices recommended herein were originally used by an Arboretum educator, they are intended to give teachers tools to explore any outdoor setting.
28	Campbell, A., & Williams, J. (2015). Connecting Kids and Nature: Lessons to Ignite Learning and Appreciation of the World around Us. *Dimensions of Early Childhood*, *43*(3), 18-23.	This article describes a semester-long project developed by the authors to create a positive connection between children and nature. The project integrated reading instruction with science activities to emphasize the natural world in the lives of children. This intervention involved the authors visiting an elementary classroom five times over the course of a semester to teach nature and reading activities. Each lesson consisted of a literary component wherein students read and discussed a single issue of "Keeping Texas Wild," a Texas Parks and Wildlife magazine for children. The purpose of these lessons was to emphasize activities that would necessitate student observation of animals indigenous to the area where the students currently reside. Focusing on such animals increased the probability that students might encounter the wildlife during random outdoor experiences, thus increasing their interest in nature.
29	Çapkınoğlu, E., & Yılmaz, S. (2018). Examining the Data Component Used by Seventh Grade Students in Arguments Related to Local Socioscientific Issues. *Egitim ve Bilim*, *43*(196), 125-149.	The purpose of this study is to examine the quantity and quality of the data component used by seventh-grade students in their arguments related to issues unique to the city of Bolu: Seben Lake, chicken coops, leather tanneries, base stations, and Hydroelectric Power Plants (HPP). Three different study groups, with 12 participants in each group (in total 36 participants), were the subject of this research, which was conducted over a total of 10 weeks. Each study group interacted with a different data source: the outdoor group collected data on field trips, the newspaper group read and examined related articles in the press, and the presentation group listened to visual presentations. The groups reflected the data obtained from their data sources to the argumentation implementations. The resulting of content analyses, based on the items in Toulmin's (1958) argument model showed that, of the total of 847 data components generated in the participants' argumentations, the newspaper group used the most data in their arguments, while the

		presentation group employed the least data. The outdoor and presentation groups generally utilized data based on the data cited in their data source, while the newspaper group used more data based on their daily life experiences. The highest amount of data was employed in relation to the issue of leather tanneries based on data acquired during field trips in the outdoor group, in relation to HPP based on visual presentations in the presentation group, and in relation to Seben Lake based on daily life experiences in the newspaper group. In conclusion, the quantity and the quality of the data component used in students' arguments with regard to local socioscientific issues changed according to the data source with which they interacted and the content of the socioscientific issue. In light of this, a few suggestions are made in this paper's conclusion.
30	Carr, K. (2001). Leading students to a world of interdependence. *Science Activities*, *37*(4), 3-5.	Discusses the importance of maintaining links between school children and the outdoors. By creatively looking for outreach programs and simple animal activities, teachers can keep students' innate interest in nature alive. Studying nature can also teach students about interdependence. (SAH)
31	Carrier, S. J., Thomson, M. M., Tugurian, L. P., & Stevenson, K. T. (2014). Elementary science education in classrooms and outdoors: Stakeholder views, gender, ethnicity, and testing. *International Journal of Science Education*, *36*(13), 2195-2220.	In this article, we present a mixed-methods study of 2 schools' elementary science programs including outdoor instruction specific to each school's culture. We explore fifth-grade students in measures of science knowledge, environmental attitudes, and outdoor comfort levels including gender and ethnic differences. We further examine students' science and outdoor views and activity choices along with those of adults (teachers, parents, and principals). Significant differences were found between pre- and posttest measures along with gender and ethnic differences with respect to students' science knowledge and environmental attitudes. Interview data exposed limitations of outdoor learning at both schools including standardized test pressures, teachers' views of science instruction, and desultory connections of alternative learning settings to "school" science.
32	Carrier, S. J., Tugurian, L. P., & Thomson, M. M. (2013). Elementary science indoors and out: Teachers, time, and testing. *Research in Science Education*, *43*(5), 2059-2083.	In this article, we present the results from a mixed-methods research study aimed to document indoor and outdoor fifth grade science experiences in one school in the USA in the context of accountability

		and standardized testing. We used quantitative measures to explore students' science knowledge, environmental attitudes, and outdoor comfort levels, and via qualitative measures, we examined views on science education and environmental issues from multiple sources, including the school's principal, teachers, and students. Students' science knowledge in each of the four objectives specified for grade 5 significantly improved during the school year. Qualitative data collected through interviews and observations found limited impressions of outdoor science. Findings revealed that, despite best intentions and a school culture that supported outdoor learning, it was very difficult in practice for teachers to supplement their classroom science instruction with outdoor activities. They felt constrained by time and heavy content demands and decided that the most efficient way of delivering science instruction was through traditional methods. Researchers discuss potentials and obstacles for the science community to consider in supporting teachers and preparing elementary school teachers to provide students with authentic experiential learning opportunities. We further confront teachers' and students' perceptions that science is always best and most efficiently learned inside the classroom through traditional text-driven instruction.
33	Cha, H. (2001). Collecting Planarians: A good choice for a field trip. *Science Activities*, *37*(4), 33-37.	Describes a field trip to collect planarians as successful in generating interest in the sciences. This activity is suitable for all grade levels as a field trip or biology lab. Planarians can be easily collected from streams across the United States. Once in the classroom, planaria are easily fed and cared for. (SAH)
34	Chaniotis, P., & Delaney, J. (2010). The Science of Survival: Desert Island Life Explored. *Primary Science*, *113*, 29-32.	It has long been understood that children's interest in science generally declines during the transition from primary to secondary school. The English government's "Every Child Matters" agenda states that pupils should "make a positive contribution" and "achieve economic wellbeing", and so there is a need to develop a workforce that is well grounded in all aspects of science and for educators to adopt relevant pedagogical approaches that ensure pupils' engagement with science is sustained. Additional attention is required to ensure that pupils' engagement with science is sustained during this transitional period

		and beyond. This article discusses how the authors use desert island science to solidify key scientific concepts and encourage interest in science during primary to secondary transition. (Contains 3 figures.)
35	Chin, C., & bin Rajib, T. (2010). The Tropical Rainforest: A Valuable Natural History Resource for Students in Singapore. *School Science Review, 91*(337), 115-121.	Students living in cities seldom experience the rural outdoors when learning science. This lack of first-hand experience with nature is of concern, especially when they are learning about animals, plants and ecosystems. This study investigated how a teacher in Singapore organised a field trip to the rainforest to help his students bridge the gap between what they learnt theoretically in school and experientially from the natural environment. The teacher first identified students' ideas and questions about tropical forests. Based on this formative feedback and using a "bottom-up" approach, he then designed investigative activities that resolved around students' questions and that addressed their preconceptions. (Contains 1 table.)
36	Christie, B., Beames, S., & Higgins, P. (2016). Context, culture and critical thinking: Scottish secondary school teachers' and pupils' experiences of outdoor learning. *British Educational Research Journal*, *42*(3), 417-437.	Limited research exists that considers the usefulness of outdoor learning as a legitimate pedagogical approach for the delivery of a mainstream secondary school curriculum. To address this shortcoming, we investigated the ways in which mathematics and geography teachers and students from three secondary schools in Scotland responded to the Outdoor Journeys programme, which is a school-based teaching approach that enables pupils to learn about the people and place in which they live. Data collection included participant observation, short questionnaires and interviews with approximately 150 students (11-14 years old) and 10 teachers. In most cases, pupils enjoyed the opportunity to guide their own learning experientially and beyond the familiar classroom context. Teachers acknowledged that such an approach presented an opportunity to develop pupils' critical thinking skills and that these skills can, in some cases, be overlooked in early secondary education. Following these findings, we discuss the pedagogical implications arising from the inclusion of critical thinking as a key outcome of outdoor learning, and as part of the Outdoor Journeys programme, within a secondary school context. We continue by adding our voice to the nascent literature addressing outdoor

		learning approaches that seek to gain traction within the broader social ecology of established school cultures.
37	Cole, A. G. (2004). Outdoor ecology school. *The Science Teacher, 71*(5), 52-54.	As part of the first annual Outdoor Ecology School, third graders, led by high school environmental science students, conducted field research and scavenger hunts, discovered animal habitats, studied population growth, and explored predator-prey relationships. The elementary students rotated through a series of inquiry-based activities.
38	Connors, M. M., & Perkins, B. (2009). The Nature of Science Education. *Democracy & Education*, *18*(3), 56-60.	A number of studies have shown that spending time in nature produces cognitive benefits. What if a child's exposure to the out-of-doors is considered not just a beneficial extracurricular activity, but a fundamental building block to an elementary education in math and science? The Young Achievers Science and Math Pilot School operates a 9:30 a.m. to 4:30 p.m. school day that integrates regular classes with recreation, tutoring, and community service in a seamless way. Ninety percent of the school's 350 kindergarten through eighth-grade students come from five Boston neighborhoods--Dorchester, Roxbury, Mattapan, Hyde Park, and Jamaica Plain. The school's mission combines social justice and inquiry-based learning to achieve its goal of achievement for all students. There are three components to this mission: (1) A "democratic process that relies on active partnerships with families, students, community members, and institutions; (2) A collective commitment to "social justice" through academic excellence for the diverse student body; and (3) "Critical thinking," intellectual curiosity, community involvement, and responsible leadership. The school faculty have found that teaching the sciences through real-world experiences using nature can accomplish three goals: (1) Generate a love of science through exploration, discovery, and immersion in inquiry learning; (2) Improve standardized test scores and other academic skills by aligning an experience-based science curriculum with the kinds of questions and intellectual strategies found on state-wide standardized exams and grade-level core subject math and science material; and (3) Integrate a concept of wellness into academic studies through kinesthetic learning. (Contains 1 note.)

39	Cwikla, J., Lasalle, M., & Wilner, S. (2009). My two boots… A walk through the Wetlands. An annual outing for 700 middle school students. *The American Biology Teacher, 71*(5), 274-279.	Project WetKids (www.projectwetkids.net) provides wetland, environmental, estuary, and watershed experiences with local scientists, engineers, and naturalists to Pascagoula, Mississippi students and their families. Extensive activities provide participants: (1) real world, locally relevant science-based events; (2) meaningful scientific experiences and interactions with field scientists; and (3) exposure to science, technology, engineering, and mathematics career opportunities in the Gulf Coast region. The Project WetKids program and accompanying research were funded by the National Science Foundation and have been further supported by local and regional partners. The idea and concept for Project WetKids was spawned in part from the success of the annual "My Two Boots" event in the Pascagoula School District (PSD). This article focuses on this day-long event for 700 Pascagoula and Gautier sixth-graders that tackles wetlands and environmental science. (Contains 5 figures and 1 table.)
40	De Dominicis, S., Bonaiuto, M., Carrus, G., Passafaro, P., Perucchini, P., & Bonnes, M. (2017). Evaluating the role of protected natural areas for environmental education in Italy. *Applied Environmental Education & Communication, 16*(3), 171-185.	Two quasi-experimental field studies (N = 419; 248) tested the effects of an outdoor environmental education program based in local Protected Natural Areas (PNAs) on 3rd-to-6th-grade students' proenvironmental attitudes and behaviors. Results show the program increases children's place attachment, proenvironmental attitudes, ethics and self-reported behavior, and their parents' proenvironmental attitudes: Young people's experience with PNAs enhances their attitudes and behaviors toward environmental sustainability. The research addresses the crucial role of local PNAs in promoting proenvironmental attitudes and behaviors, highlighting the strategic importance of intervention procedures and moderators for environmental education activities applied to specific social-physical contexts.
41	Deaton, C., & Hardin, C. (2014). Exploring Nature Through a New Lens. *Science and Children, 51*(7), 38-44.	One way to encourage students to interact with science content and materials is to make science relevant and meaningful. By focusing on the school yard as the context for science lessons and activities, teachers can incorporate students' interest in learning outdoors and help students make connections between science content discussed in school and their everyday lives. Here, Deaton and Hardin present the lesson

		that provided their second-grade students with opportunities to examine the habitats surrounding their school and discuss how these environments meet the needs of various animals and influence the types of organisms that inhabit the area. While their lesson is specifically for second grade, it could easily be adjusted for other grade levels.
42	Demirbas, C. O. (2017). The Effect of Out-of School Activities on Conceptual Change in Environmental Education. *Journal of Education and Training Studies*, *5*(2), 232-242.	The objective of this study is to determining the change in secondary school students' cognitive structure related to the concepts of environmental problems. There were 21th grades students of two middle schools in Kirsehir. In this research, the students participated in outdoor activities on environmental education programmes during 5 weekends consecutively. The data of the research were collected via word association test as pre-test and post-test. The conceptual change process was examined in collected data, and their pre-test and post-test results were analysed by using cut-off point. Conceptual network was constituted by using cut-off points. When pre-test and post-test results were compared, it was found that there is a positive shift in students' conceptual change. In addition, when their concept network was examined, it was observed that there is an upturn in the number of answered words in post-test. However, the numbers of the words associated to the keywords in pre-test were limited. Besides, the connections not provided among the concepts in pre-test emerged in post-test which shows that students' independent knowledge related to the keywords is associated in the post-test. Finally, when pre-test and post-test are compared, both are the increased in response words and emergence of the connection shows that qualitative change accompanies to quantitative change. Furthermore, keywords emerged in upper tabs out of post-test results. This specifies that the out-of school activities is successful in creating conceptual structure.
43	Dhanapal, S. & Lim, C. C. Y. (2013). A comparative study of the impacts and students' perceptions of indoor and outdoor learning in the science classroom. *Asia - Pacific Forum on Science Learning and Teaching, 14*(2), 1-23.	The increasing awareness among educators around the world on the specialities of indoor and outdoor learning in enhancing students' academic performance and development of skills and attitudes influenced the purposes and background of this research study (Fägerstam, 2012; Jordet, 2010; Martin, 2010; Rickinson et al., 2004).

		Two key purposes of this study are to compare and contrast between the impacts of indoor and outdoor learning in improving students' academic performance and also, to discover students' point of views about the integration of both indoor and outdoor learning in science. Predominantly, this is a comparative study of the impacts and students' perceptions of indoor and outdoor learning in understanding science that focuses on raising the standards of academic achievements of primary school students. This study takes on the methodology of mixed methods in which research findings are obtained qualitatively and quantitatively. The findings of this study have proven that indoor and outdoor learning complement each other in improving students' academic performance and have also showed positive responses among the students in choosing outdoors than indoors for learning science. This study can be used as a reference point for further research by investigating the impact of indoor and outdoor learning science with reference to different multiple intelligences and also, how they could also augment students' communication skills.
44	Dieser, O., & Bogner, F. X. (2016). Young people's cognitive achievement as fostered by hands-on-centred environmental education. *Environmental Education Research*, *22*(7), 943-957.	In line with previous studies, where outdoor nature experience was shown to support adolescents' environmental knowledge, our study monitored the influence of a hands-on environmental programme within a National Park on cognitive knowledge achievement. A sample of 4th and 5th graders (n = 289) completed a week-long outreach conservation programme with two follow-up options: the first group (n = 170) interacted with thematic posters, the second group (n = 128) also completed a thematic board game. In a quasi-experimental design, we analysed both versions with regard to achievement efforts and individual situational emotions. Altogether, programme participation added cognitive knowledge, while group one (poster and board game as follow-up option) outmatched group two (just the poster option). Measures of 'state' and 'situational' emotions regarding the programme and right after game participation revealed positive effects toward knowledge. Thus, we conclude, direct experiences with nature and additional hands-on follow-up activities may foster a student's cognitive achievement in such programmes.

45	Djonko-Moore, C. M., Leonard, J., Holifield, Q., Bailey, E. B., & Almughyirah, S. M. (2018). Using culturally relevant experiential education to enhance urban children's knowledge and engagement in science. *Journal of Experiential Education, 41*(2), 137-153.	Background: Children living in urban areas often have limited opportunities to experience informal science environments. As a result, some do not have a deep understanding of the environment, natural resources, ecosystems, and the ways human activities affect nature. Purpose: This article examines how experiential science education supported urban children's science knowledge and engagement through cultural relevance and eco-justice during a 1-week summer camp. Methodology/Approach: Third- through sixth-grade children from African American and Latinx urban communities in Colorado participated in a weeklong program using experiential learning opportunities including environmental and climate change lessons, activities at a local community-based site, and field trips to nature- and science-themed sites. Pre- and posttests, focus group interviews, journals, and student work samples were analyzed. Findings/Conclusions: Children's science content knowledge as well as their engagement in science lessons and field trips were positively influenced during the study. Implications: This study provides a template for establishing culturally relevant experiential learning opportunities to engage underrepresented children in science.
46	Dolan, A. M. (2016). Place-based curriculum making: Devising a synthesis between primary geography and outdoor learning. *Journal of Adventure Education and Outdoor Learning, 16*(1), 49-62.	Outdoor learning provides children with an opportunity to experience the interdisciplinary nature of the real world through interactions with each other and the planet. Geographical enquiry involves exploring the outdoors in an investigative capacity. Space, place and sustainability are three core concepts in primary geography, although sustainability is applicable to all curricular areas. This article argues that the disciplines of primary geography and outdoor learning have much to gain through mutual cooperation and collaboration. For instance, primary geography programmes should include extensive outdoor learning initiatives using local sites such as the school grounds and the local area. This article attempts to make links between the two disciplines of primary geography and outdoor learning, in the interests of promoting education for sustainability. Specifically, the article argues for a conscious synthesis which blends the three dimensions of place, space and sustainability into geographical place-based curriculum making.

47	Drissner, J. R., Haase, H. M., Wittig, S., & Hille, K. (2014). Short-term environmental education: long-term effectiveness?. *Journal of Biological Education, 48*(1), 9-15.	The "Green Classroom" in the Botanical Garden of the University of Ulm is a learning forum outdoor school that is used by about 2500 school students annually. Its educational concept is based on experiential learning and is geared towards expanding students' biological knowledge and developing positive attitudes towards small animals and invertebrates such as insects. In the first study, 104 secondary-school students (49 who had previously visited the "Green Classroom") were asked to write an essay about small animals such as insects. Students who had visited the "Green Classroom" before showed more biological understanding and portrayed more positive emotions towards small animals, and had fewer misconceptions than their peers. In the second study, 121 students (grades 3 and 4) were asked to draw a picture of a forest as a habitat; 65 of these students had previously visited the "Green Classroom" (test group). Students of the test group drew more smaller types of animals in their pictures and furthermore more different species than the control group.
48	Elm, A., & Liljestrand, J. (2019). Preschool Teachers' Design for Learning Physics in Early Childhood Science Education. Presented at the ATEE 2019 Winter Conference Science and Education in the 21st Century. University of Minho, Braga, Portugal. 15-17 April 2019.	This paper reports on an ongoing practice-based research project in which preschool teachers and researchers collaborate on the content in physics. The aim is to contribute to a deeper knowledge of preschool teachers' design for teaching physics (friction) and how children create meaning of the content. The research questions are: How do the preschool teachers design learning opportunities so that the children can create meaning about friction? How do young children create meaning from the teaching aids that are offered to them? A number of studies have reported on preschool children's (aged 5-6 years) and older children's misconceptions in their reasoning about natural phenomena and how this differs from accepted scientific ideas. Previous research has also shown that there is a gap in preschool teachers' knowledge of natural science and physics. Most of the research in this field has focused on the effect of preschool teachers' teaching of natural phenomena rather than children´s meaning-making and learning processes. Research on young children´s (aged 3-7) learning often highlights their individual knowledge and emphasises cognitive understanding and conceptual development. The most

		common methods used are interviews, pre- and post-tests that aim to show cognitive understanding and scientific conceptual development as an effect of the teaching intervention. When it comes to preschool education and young children's learning, children´s experiences of natural phenomena are seldom verbal, but are instead physical and practical. In this respect, there is a need to use different methods to investigate preschool activities in order to acquire more knowledge about preschool teachers' teaching and young children's meaning-making of natural phenomena. In order to deal with these challenges, this study adopts a multimodal design-oriented qualitative approach and makes use of the concepts of representation and transformation. Here, the focus is on preschool teachers' and children's creation of symbols as a social activity. The use of symbols combines content and form in order to carry meaning and create and express conditions for meaning-making. The data consists of audiotaped video self-reflection seminars (focusing on children's verbal, physical and practical actions) and semi-structured interviews with nine preschool teachers. The findings indicate that preschool teachers' teaching of physics is closely linked with their vision of how the subject will stimulate the children's learning. They also show how friction is represented in connection with play, outdoor activities and experimental activities. The results of the children's meaning-making show that they become familiar with friction as a notion in relation to everyday experiences and are in that way introduced to what friction means in scientific terms. Further, the children relate their experiences of play to their own bodies and preferences, for example, by learning that icy slopes are slippery (low friction), that surfaces are slippery or rough (have different friction) and friction has force (over-under effect). These findings address the relevance and implications for science education and research by moving from the idea of focusing on children's verbal communication and their conceptual understanding of natural phenomena towards an approach that includes their learning processes and physical experien
49	Endreny, A. (2007). Watershed seasons. *Science and Children*, *44*(9), 20-25	All schools are located in "watersheds," land that drains into bodies of water. Some watersheds, like the one which encompasses the school

		discussed in this article, include bodies of water that are walking distance from the school. The watershed cited in this article has a brook and wetland within a several-block walk from the school. This watershed was used as a hands-on research cite during the school year. In the process, students and their teachers explored Earth, life, and physical science concepts, learned about the local environment, and became engaged in a truly interdisciplinary study that hasn't stopped yet. A description of the ongoing adventure is included in this article. (Contains 4 figures, 1 resource and 3 online resources.)
50	Enghave, M. (2007). Tværfaglig naturfagsuge i felten. *Geografisk orientering, 37*(1), 24-29.	På Søndermarksskolen i Rønne flyttede lærere og elever undervisningen ud i naturen.
51	Erol, T. A. Ş., & GÜLEN, S. (2019). Analysis of the influence of outdoor education activities on seventh grade students. *Participatory Educational Research*, *6*(2), 122-143.	It is thought that the results of teaching some of the subjects in science through outdoor education will be more positive. The purpose of this study is to find out the effects of activities done through outdoor education on students' academic achievement, students' thoughts about the activities and the permanence of information. Mixed research design was used in the study. Academic achievement test was prepared to collect quantitative data while a test consisting of open-ended questions in fully structured interview form was prepared for qualitative data. For the analysis of quantitative data, statistical analysis techniques such as average, frequency, percentage, standard deviation and Wilcoxon signed ranks test were used with the help of SPSS program. In qualitative analysis, the data were coded, common themes were formed with their categories and content analysis method was used. According to the results, it was found that outdoor activities increased students' achievement and did not have a significant relationship with students' recalling information. The results of the qualitative analysis showed that the students liked these activities and the activities were effective in understanding the subject and learning the concepts. In addition, it was found that the activities influenced the friendship between students positively. It was suggested for outdoor activities to be used in science teaching.
52	Fančovičová, J., & Prokop, P. (2011). Plants have a chance: outdoor educational programmes alter students' knowledge	Outdoor educational programmes are generally believed to be a suitable alternative to conventional biology settings that improve

	and attitudes towards plants. *Environmental Education Research*, *17*(4), 537-551.	participants' environmental attitudes and knowledge. Here we examine whether outdoor educational programmes focused solely on practical work with plants influence participants' knowledge of and attitudes towards plants. It was found that mean scores of participants' attitudes towards and knowledge of plants significantly increased after the outdoor programme. These effects remained significant even after three months' post-testing. No similar patterns were found in the control group. Interestingly, the proportion of participants who liked biology as a school subject also significantly increased after the outdoor programme in the experimental group. Females showed better knowledge of plants than males, but attitudes towards plants were similar between genders. Having a garden at home was not associated with better knowledge or attitudes towards plants. Our results reveal that outdoor programmes significantly relieve "plant blindness" and make biology more attractive to pupils. (Contains 1 table and 1 figure.)
53	Fontaine, J. J., & Decker, K. L. (2009). Exploring predation and animal coloration through outdoor activity. *Science Activities*, *45*(4), 3-8.	Although children often characterize animals by the animals' color or pattern, the children seldom understand the evolutionary and ecological factors that favor particular colors. In this article, we describe two activities that help students understand the distinct evolutionary strategies of warning coloration and camouflage. Because both of these strategies effectively allow prey animals to avoid predation, they can help explain considerable variation in animal coloration. (Contains 1 figure.)
54	Frissell, V., & Cayton, P. (2009). Becoming wildlife investigators. *Science and Children*, *47*(1), 30-34.	Students love learning outdoors, but how do you ensure they are absorbing the science and gaining skills as they do so? The authors found a way--a fourth-grade classroom teacher, a gifted/science resource teacher, and a group of fourth graders--embarked on a yearlong study of birds and the plants they depend on. They used their school yard as the backdrop and incorporated community resources into numerous hands-on experiences that transformed students into eager wildlife investigators and stewards of their local environment. Here they share their inspiring story. (Contains 1 figure.)
55	Fägerstam, E., & Blom, J. (2013). Learning biology and mathematics outdoors: effects and attitudes in a Swedish	This research suggests that learning biology in an outdoor environment has a positive cognitive and affective impact on 13-15-year-old,

	high school context. *Journal of Adventure Education & Outdoor Learning*, *13*(1), 56-75.	Swedish high school pupils. Eighty-five pupils in four classes participated in a quasi-experimental design. Half the pupils, taking a biology course in ecology or diversity of life, had several lessons outdoors and the other half were taught indoors. All of the classes, but one, also had mathematics lessons outdoors once a week. Twenty-one pupils were interviewed five months after the course and all were positive towards the new learning environment they had experienced outdoors in biology and/or mathematics. They also valued the higher degree of interaction among the pupils. Other findings from the interviews were that the pupils from the outdoor classes showed a higher degree of long-term knowledge retention. They remembered both activities and contents better than the pupils in the indoor classes. An essay-type question assessing their biological understanding qualitatively according to the Structure of Observed Learning Outcome taxonomy revealed no differences between the groups. The results are discussed in the light of neurocognitive models of long-term memory. [PUBLICATION ABSTRACT]
56	Genc, M., Genc, T., & Rasgele, P. G. (2018). Effects of nature-based environmental education on the attitudes of 7th grade students towards the environment and living organisms and affective tendency. *International Research in Geographical and Environmental Education*, *27*(4), 326-340.	The purpose of this study was to determine the effects of nature-based education on the attitudes of 7th grade students towards the environment and living organisms as well as to assess the affective tendency of this education on the students. The study was carried out with 30 7th grade students at an elementary school. For this purpose, scales for "Attitudes towards Living Organisms", "Environmentally Oriented Affective Trends", and "Environmental Attitude" were used. In the study, an experimental research design using one group with pre- and post-testing was employed. The analysis of the data was conducted using the SPSS statistical software program. The study was conducted over 11 days in a natural setting. The participants completed 18 activities dealing with the natural environment, water and water pollution, pollution in general, natural habitats, recycling and biodiversity. At the end of the program, it was found that student' attitudes towards the environment and living organisms, and the affective tendency on the 7th grade students were shown to be more highly developed than before the program. These results demonstrated

		that nature-based education had improved the students' attitudes towards the environment and living organisms, as well as their affective tendency on the students.
57	Ghadiri Khanaposhtani, M., Liu, C. J., Gottesman, B. L., Shepardson, D., & Pijanowski, B. (2018). Evidence that an informal environmental summer camp can contribute to the construction of the conceptual understanding and situational interest of STEM in middle-school youth. *International Journal of Science Education, Part B*, *8*(3), 227-249.	Youth are introduced to STEM topics through informal settings like science camps, aquaria, and zoos. In these interactive and sensory-rich environments, a well-designed programme can help participants to acquire knowledge and cultivate interest through experiential learning. Given the importance of informal activities in environmental education, it is crucial to identify which contextual components lead to successful learning outcomes. Thus far, research in environmental STEM education has focused on brief experiences, such as one-time visits to curated environments like aquaria. Investigating the impact of multi-day/longer experiences in natural settings is critical because the level of engagement with the STEM topic and the interaction with the learning environment in such experiences have different cognitive and affective impacts. To address these current limitations, we explored whether there is evidence that a four-day, immersive outdoor soundscape ecology camp contributed to situational interest and conceptual understanding of middle-school youth. During the soundscape camp, a variety of evidence was collected through different instruments including drawing activities, questionnaires, an interview, and field-observations. Through a qualitative analysis and open coding, we identified three core principles of informal outdoor curricular design that positively contribute to participants' learning experiences, including direct experience with nature, the use of authentic technology, and exercises that promote collaborative teamwork. We argue that activities that promote scientific practices and engagement with authentic tools in a real-world context creates a learning environment in which participants collaboratively construct deep conceptual understanding of different aspects of environmental STEM topics and foster interest in the context of science inquiry.
58	Gillan, A. L., & Hebert, T. (2014). It's a ZOO Out There!. *Science and Children, 51*(9), 59-65.	The People Learning Urban Science (PLUS) program creates partnerships and coordinates efforts involving a local zoo, university, and school district, seeking to instill within students a sense of the

		natural environment. Even though the majority of students live among concrete and metal structures, their eyes and ears can be trained to make careful observations of nature. Encouraging this collaboration between formal and informal science by partnering with community members via the PLUS program, teachers may extend the classroom learning beyond the four walls and heighten their students' scientific knowledge and skills. This article describes how a typical field trip to the local zoo is suddenly transformed into an exercise in authentic inquiry. The classroom teacher, local zoo curator, a PLUS partner university biologist, and the PLUS program coordinator have designed and together implement an experience that addresses the fourth-grade performance expectation 4-LS1-1 of the "Next Generation Science Standards" ("NGSS)" recognizing that students are expected to "construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction" (NGSS Lead States 2013, p. 38). The PLUS Program includes the local zoo curator who serves as one of the community partners in the design and implementation of the fourth-grade ethogram activity (Table 1). Two Common Core State Standards for fourth grade language arts are also addressed in this lesson.
59	Glaab, S., & Heyne, T. (2020). Focus wildlife park: Outdoor learning at workstations for primary school children. *Applied Environmental Education & Communication, 19*(2), 141-154.	A total of 268 primary school children (age 8.75 ± 0.65) spent one day at a wildlife park attending environmental education aiming at high cognitive achievement and motivation alongside maintained discipline. To accomplish this at an out-of-school learning setting, we compared our preferred ‘guided learning at workstations’ (G) combining the advantages of instructional and constructivist characteristics to a strong teacher-centered (T) and student-centered (S) approach also following workstations. We found higher knowledge values in the approaches with didactic leaders (T and G) while situational emotions did not differ between approaches. Results and implications are discussed in the context of environmental outdoor education.
60	Golob, N. (2011). Learning science through outdoor learning. *The New Educational Review, 25*(3), 221-234.	

61	Graszer, C. L., Gnau, K., & Melber, L. M. (2012). Exploring Ethograms in the Schoolyard: A Lesson on Animal Behavior. *Science Activities*, *49*(1), 7-13.	This article highlights a core lesson that has been used in a number of Lincoln Park Zoo educational programs. The lesson teaches students to conduct an ethological, or animal behavior, study on a bird. This study can be implemented in a variety of outdoor settings, including a park, schoolyard, or zoo. Using an ethogram, students will practice inquiry skills such as making observations, collecting and analyzing data, and sharing results. This type of inquiry-based research is commonly conducted at Lincoln Park Zoo and allows students to make a connection between their work and that of our practicing researchers. Furthermore, this lesson supports the recommendations of the National Research Council by providing students with an opportunity to engage in scientific inquiry and to utilize research skills in an outdoor setting. (Contains 1 figure and 3 online resources.)
62	Guaran, A. (2016). Outdoor Education and Geographical Education. *Romanian Review of Geographical Education, 5*(1), 79-88.	This paper focuses on the reflection on the relationship between values and methodological principles of Outdoor Education and spatial and geographical education perspectives, especially in pre-school and primary school, which relates to the age between 3 and 10 years. Outdoor Education is an educational practice that is already rooted in the philosophical thought of the 16th and the 17th centuries, from John Locke to Jean-Jacques Rousseau, and in the pedagogical thought, in particular Friedrich Fröbel, and it has now a quite stable tradition in Northern Europe countries. In Italy, however, there are still few experiences and they usually do not have a systematic and structural modality, but rather a temporarily and experimentally outdoor organization. In the first part, this paper focuses on the reasons that justify a particular attention to educational paths that favour outdoors activities, providing also a definition of outdoor education and highlighting its values. It is also essential to understand that educational programs in open spaces, such as a forest or simply the schoolyard, surely offers the possibility to learn geographical situations. Therefore, the question that arises is how to finalize the best stimulus that the spatial location guarantees for the acquisition of knowledge, skills and abilities about space and geography.

63	Hagevik, R. A. (2003). Using ants to investigate the environment. *Science Activities*, *40*(2), 6-13.	Describes three inquiry-based activities designed for students to begin to understand complex environmental relationships in their own backyard. Includes investigations of ants, which allow students to establish a baseline survey of ant fauna, test the importance of ants in nutrient cycling and soil structure maintenances, and increase student understanding of the environment and their impact on it. (KHR)
64	Heras, R., Medir, R. M., & Salazar, O. (2020). Children's perceptions on the benefits of school nature field trips. *Education 3-13*, *48*(4), 379-391.	Numerous publications demonstrate that outdoor and nature-based education benefit school children both physically, cognitively, emotionally and socially and may also promote pro-environmental behaviour. This study assesses the perceptions of 22 students aged 11 to 12 years old after a nature field trip. Such students attended a state-funded primary school and participated in an integrated school programme which aimed to promote environmental awareness and to help children value the natural and cultural heritage of their surroundings. After interviewing the school children in focus groups and analysing data through a coding process and comparison system within an interpretative paradigm, the results illustrate that contribution to field trips benefit children mostly emotionally and socially, while cognitive outcomes are less apparent. These results are particularly relevant in multicultural contexts similar to the one studied.
65	Hicks, D. (2016). Teaching Science Down on the Farm. *Primary science*, *144*, 14-16.	Throughout the United Kingdom's (UK's) primary science curriculum, there are numerous opportunities for teachers to use the farming industry as a rich and engaging real-world context for science learning. Teachers can focus on the animals and plants on the farm as subjects for children to learn about life processes. They can turn attention anywhere along the production chain and will see examples of the application of accessible biology, chemistry and physics. Teachers can use the farmed environment as a context to explore habitats, biodiversity and human impact. In this article, the author explores the key role of the farm in teaching science as well as wider educational benefits and suggests activities to engage and excite.
66	Hiller, S. E., & Kitsantas, A. (2014). The effect of a horseshoe crab citizen science program on middle school student science performance and STEM career	The purpose of the present quasi-experimental study was to examine the impact of a horseshoe crab citizen science program on student achievement and science, technology, engineering, and mathematics

	motivation. *School Science and Mathematics*, *114*(6), 302-311.	(STEM) career motivation with 86 (n = 86) eighth-grade students. The treatment group conducted fieldwork with naturalists and collected data for a professional biologist studying horseshoe crab speciation and a mock survey. The comparison group studied curriculum related to horseshoe crabs in the science classroom. A series of measures related to self-efficacy, interest, outcome expectations, choice goals, and content knowledge were given to participants before and after the intervention. It was hypothesized that students would report higher motivational beliefs regarding science and show higher levels of achievement following the intervention than the comparison group. Support was shown for most of the hypotheses. In addition, path analyses indicated that students' motivational beliefs influence content knowledge and outcome expectations, which in turn affect their career goals. These results have implications for incorporating authentic fieldwork within a formal school structure as an effective method for promoting student achievement and STEM career motivation.
67	Isberg, J., Larsson, H. K., & Bjerneby Häll, M. (2012). Förskolor som miljöer för ett omsorgsfullt lärande med fokus på matematik, naturvetenskap och teknik. Presented at the Förskolebiennalen, 15-16 oktober, Norrköping.	Hur kan miljöer i förskolan utformas för att stimulera till lärande i matematik, naturvetenskap och teknik? Vilka förutsättningar för barns utveckling och lärande ger olika miljöer?I ett pågående forskningsprojekt studeras hur olika förskolemiljöer på olika sätt kan bidra till att utveckla barns lärande i matematik, naturvetenskap och teknik. Miljö innefattar den fysiska miljön, de material barn har tillgång till i lek för att bygga, skapa och konstruera och för att lära genom att upptäcka, undersöka och pröva olika lösningar, hur rum används och verksamheten organiseras, såväl inomhus som utomhus.Projektet är mångvetenskapligt både till sin karaktär och med avseende på forskare knutna till projektet. Matematik, naturvetenskap och teknik i förskolan har nära kopplingar till andra målområden, som språkutveckling, skapande och värdegrundsfrågor. Med kunskaper om bl.a. biologi, energi och materia får människor också redskap för att kunna bidra till en hållbar utveckling. Förskolan ska enligt Lpfö 98/10 medverka till att barn tillägnar sig ett varsamt förhållningssätt till natur och miljö. Ett omsorgsfullt lärande kan på så sätt även bidra till att barn utvecklar en omsorgsfull relation till naturen och miljön. Fokus för

		undersökningen är i vilken utsträckning den fysiska och pedagogiska miljön ger barn förutsättningar att möta matematik, naturvetenskap och teknik i olika sammanhang, på ett varierat sätt och genom olika uttrycksformer. Variation är ett nyckelbegrepp och syftar både på variation mellan förskolor som miljöer för lärande, och variation inom en förskola som miljö för lärande. Seminariet bygger på forskning och det pågående projektet om förskolemiljöer. Konkreta exempel på analys av data från undersökningen, bl.a. i form av fotografier hämtade från olika förskolor, presenteras under seminariet.
68	Isberg, J., Larsson, H. K., & Bjerneby Häll, M. (2012). Miljöer för små barns lärande i matematik, naturvetenskap och teknik. Presented at the Nordisk lärarutbildningskonferens, 7-9 maj 2012.	Miljöns betydelse för barns lärande framhålls av forskare (Sheridan, Pramling Samuelsson & Johansson, 2009). I läroplanen (Lpfö 98/2010) understryks vikten av att miljön är öppen, innehållsrik och inbjudande. Med miljö syftas här på vilka material barn har tillgång till i lek, för att bygga, skapa och konstruera och för att lära genom att upptäcka, undersöka och pröva olika lösningar, hur rum används och verksamheten organiseras såväl utomhus som inomhus. Persson (2008) konstaterar att det finns förvånansvärt lite forskning om barns lärande i matematik och naturvetenskap och om den fysiska miljöns betydelse för lärande i förskolan, och han hänvisar till forskare som menar att de rumsliga och fysiska förutsättningarna för barns lärande inte tagits i beaktande i pedagogisk forskning. Barns aktiva lärande sker med hela kroppen och det är genom kroppen och sinnena som människan upplever olika fenomen (Merleau-Ponty, 1962). I sin studie av småbarns möten med matematik visar Björklund (2007) att barn använder sin kropp som utgångspunkt, barnets kroppsliga upplevelser och erfarenheter utgör grunden för förståelse av företeelser i omvärlden.I föreliggande mångvetenskapliga forskningsprojekt1 studeras förskolemiljöer med fokus på i vilken utsträckning den fysiska och pedagogiska miljön ger barn förutsättningar att möta matematik, naturvetenskap och teknik i olika sammanhang och på olika sätt. Resultaten hittills har visat på nödvändigheten av att även rikta uppmärksamhet mot pedagogerna i förhållande till förskolans fysiska och pedagogiska miljö. Det är pedagogen som är ansvarig för miljön, skapare av miljön, och därmed den som påverkar det lärande, lärandets

		innehåll och form, som möjliggörs i miljön. Thulin (2011) beskriver i sin avhandling pedagogen som iscensättare av en pedagogisk miljö som kan möjliggöra barns lärande i naturvetenskap. Pedagogen är samtidigt den som kan berätta om de resonemang som förs och motiv som finns till att miljön utformats på ett visst sätt. Den genomförda datainsamlingen har också tydliggjort behovet av att fördjupa studien genom återkommande kontakter och besök i samma förskolemiljöer, samt nödvändigheten av att samtala med pedagoger ansvariga för miljöns utformning och för förändringar i den fysiska miljön. Variation är ett nyckelbegrepp och syftar både på variation mellan förskolor, variation inom en förskola, och variation med avseende på lärandets objekt.
69	Jesus-Leibovitz, L., Faria, C., Baioa, A. M., & Borges, R. (2017). Exploring marine biodiversity through inquiry with primary school students: a successful journey?. *Education 3-13*, *45*(4), 437-449.	In this work, we present a marine ecology inquiry-based activity, implemented with 164 primary school students. The main goal was to evaluate the activity's impact on students' understanding about biodiversity and scientific procedures. We also aimed to analyse the potential use of personal meaning maps (PMMs) to assess the impact of the activity on students' ideas about the topics explored. The results revealed that fieldwork and the exploration of real data were the aspects most emphasised by all intervenient. Finally, the PMMs proved to be a good tool to evaluate the impact of activities developed outside classroom, with primary school levels.
70	Jickling, B., Blenkinsop, S., Morse, M., & Jensen, A. (2018). Wild pedagogies: Six initial touchstones for early childhood environmental educators. *Australian Journal of Environmental Education*, *34*(2), 159-171.	This article is a small piece of a much larger and still evolving project. Herein we focus on six touchstones for wild pedagogies. The article begins with a short orientation to the larger ideas behind the project and then focuses on exploring six current touchstones with a view towards early childhood environmental educators. The six explored here are: (1) agency and the role of nature as co-teacher; (2) wildness and challenging ideas of control; (3) complexity, the unknown, and spontaneity; (4) locating the wild; (5) time and practice; and (6) cultural change.
71	Jordet, A. N. (2003). Uteskole–en didaktikk for helhetlig utvikling. *Kroppsøving*, *53*(3), 26-32.	

72	Kelemen-Finan, J., Scheuch, M., & Winter, S. (2018). Contributions from citizen science to science education: an examination of a biodiversity citizen science project with schools in Central Europe. *International Journal of Science Education, 40*(17), 2078-2098.	Despite the rising popularity of Citizen Science (CS) projects, there is little empirical evidence for effects on learning outcomes, particularly when young people are involved. It is also often not clear how CS projects are linked to science education (SE) research. The aim of this study was to examine biodiversity CS projects in an outdoor school class context and to measure the effects on individual learning outcomes (ILOs) with a perspective for SE. Five learning outcomes considered important for CS were tested: interest, self-efficacy/mastery, motivation, behaviour and attitude. These ILOs were measured via eight different scales and tested in an evaluation study of a large CS project with 428 students aged 8-18. Students recorded hedgehogs, wild bee activity, birds and butterflies in gardens. Results showed that students' interest and motivation, as well as perceived mastery increased during the project. Most remarkably, positive attitudes towards wild animals, natural gardens and biodiversity rose significantly. For most ILOs there were significant differences between age groups: Primary school students showed the highest ILOs and also provided most database entries. The authors describe how well biodiversity CS projects contribute to SE aims and how discrepancies between educational and scientific aims in CS projects may be addressed.
73	Kilty, T. J., & Burrows, A. C. (2020). Systematic Review of Outdoor Science Learning Activities with the Integration of Mobile Devices. *International Journal of Mobile and Blended Learning (IJMBL), 12*(2), 33-56.	The purpose of this systematic study review was to describe how researchers integrated mobile devices into outdoor science learning, assessment of those activities, and alignment of purpose, integration, and assessment. From initial 980 search results, the authors selected 45 articles based on the eligibility criteria of: (a) empirical study; (b) learning activity with science content; (c) outdoor setting; (d) mobile device integration; and (e) assessment. Researchers designed outdoor science learning activities integrated with mobile devices for the purposes of science knowledge gain, affective domain gain, and scientific inquiry. Researchers aligned components of scientific inquiry including hypothesis formation, observation, data collection and interpretation, and communication and collaboration. Conclusions describe benefits to integrating mobile devices with outdoor science

		learning activities by supporting scientific inquiry skill development. Alignment of purpose and assessment provides evidence of student learning important in meeting accountability standards.
74	King, D., & Ginns, I. (2015). Implementing a context-based environmental science unit in the middle years: Teaching and learning at the creek. *Teaching Science, 61*(3), 26-36.	Engaging middle school students in science continues to be a challenge in Australian schools. One initiative that has been tried in the senior years but is a more recent development in the middle years is the context-based approach. In this ethnographic study, we researched the teaching and learning transactions that occurred in one ninth grade science class studying a context-based environmental science unit over 11 weeks that included visits to the local creek. Data were derived from field notes, audio and video recorded conversations, interviews, student journals and classroom documents with a particular focus on two selected groups of students. This paper presents two assertions that highlight pedagogical approaches that contributed to learning. Firstly, spontaneous teaching episodes created opportunities for in-the-moment questioning by the teacher that led to students' awareness of environmental issues and the scientific method; secondly, group work using Flip cameras afforded opportunities for students to connect the science concepts with the context. Furthermore, students reported positively about the unit and expressed their appreciation for the opportunity to visit the creek frequently. The findings from this study should encourage teachers to take students into the field for valuable teaching and learning experiences that are not available in the formal classroom.
75	King, H. & Achiam, M. (2017). The Case for Natural History. *Science and Education, 26*, 125-139.	Fundamental knowledge of natural history is lacking in many western societies, as demonstrated by its absence in school science curricula. And yet to meet local and global challenges such as environmental degradation, biodiversity loss and climate change, we need to better understand the living and non-living parts of the natural world. Many have argued passionately for an increased understanding of natural history; others have developed successful pedagogical programmes for applying a knowledge of natural history in environmental initiatives. In joining wider calls, we choose here to focus on the educational value afforded by understanding the epistemological bases of natural history

		and its particular forms of reasoning. We also briefly discuss the ways in which an education in natural history provides the foundation for environmental and social justice efforts that directly affect the lives of young people and their communities. We end by highlighting the ease by which natural history may be incorporated in learning opportunities both in and outside of the classroom.
76	Klaar, S. (2016). Arguments for Early Childhood Science Education; a Review of Research Articles 2006-2016. Presented at the 26th EECERA annual conference. Dublin, August 31 - September 3, 2016.	The aim is to analyse research articles connected to Early Childhood Science Education (ECSE) with a specific focus on “why it is important to teach and learn science in preschool practices”. To teach and learn about science in preschool practices can be understood as e.g. learn to care for nature or to create knowledge about natural phenomena and processes. With a specific focus on Early Childhood Education, Hedefalk et.al (2015) and Somerville and Williams (2015) present surveys connected to Education for Sustainable Development, and Zohar and Barzilai (2013) present a review on research in Science Education in the field of metacognition. This present study will use curriculum theory to analyse and critically discuss teaching traditions and learning content (see Svennbeck 2003, Öhman 2006). Words used in the ERIC database search was: early childhood, natural science, science education. Approximately 90 articles from Early Childhood Journals and Science Education Journals will be scrutinized regarding arguments for ECSE, using a coding scheme based on introductions and purposes of the studies. Initial results from this ongoing review of articles show arguments that focus on ECSE as: i) laying the foundation for knowledge and interest in science, preparing for school, ii) making children able to engage in environmental issues, iii) offering children to explore everyday-science as lived experiences. Only peer-reviewed articles were chosen, and the same words were used during the complete search. The result can be used in critical reflections on arguments for teaching and learning science in preschool, to create multifaceted teaching and learning environments.

77	Kossack, A., & Bogner, F. X. (2012). How does a one-day environmental education programme support individual connectedness with nature?. *Journal of Biological Education*, *46*(3), 180-187.	The "Inclusion of Nature in Self" scale (INS) was applied to monitor shifts in reported connectedness with nature within the framework of a school-based environmental education programme. One hundred and twenty-three German students (sixth-graders) participated in a one-day module, which included hands-on indoor (classroom) and outdoor (nearby woods) implementation. Additionally, a control group (n = 116) did not participate in our intervention at all. Seven types of shifts in students' subjective connectedness with nature before and after project participation were analysed and discussed. Individual initial connectedness and a variety of short- and long-term connectedness shifts indicate the necessity of a needs-oriented environmental education. The reliability of the INS scale as a rapid assessment for improving school-based fieldwork settings is confirmed. (Contains 1 table and 2 figures.)
78	Kärkkäinen, S., Keinonen, T., Kukkonen, J., Juntunen, S., & Ratinen, I. (2017). The effects of socio-scientific issue based inquiry learning on pupils' representations of landscape. *Environmental Education Research*, *23*(8), 1072-1087.	Research has demonstrated that socio-scientific issues based inquiry learning has significant advantages for learning outcomes and students' motivation. Further, a successful understanding of landscapes in environmental and geographical education can be achieved by combining informal learning environments with school education. Therefore this case study focuses on how socio-scientific issues based inquiry learning carried out in school and in a Nature Park, influences primary school pupils' (n = 36) representations of landscapes. The pupils were asked to draw and write about landscape both before and after intervention. The data was analyzed qualitatively and quantitatively to investigate the impact of the intervention on the representations that pupils used in their descriptions of landscape. It was found that socio-scientific issues based inquiry learning in varied learning environments, noticeably enriched the pupil's representations and lead to a multifaceted holistic understanding of landscape. Many of the representations produced were considered to be fairly sophisticated.
79	Lackstrom, K., & Stroup, L. J. (2009). Using a local greenway to study the river environment and urban landscape. *Journal of Geography*, *108*(2), 78-89.	Greenways are prominent features of many urban landscapes and synthesize several geographic topics: human-environment interactions, urban ecosystems, and the promotion of sustainability within riverine corridors. Greenways are easily accessible and provide an opportunity

		for students at various grade levels to study interactions across physical and human systems. Students can gain an appreciation of the natural and cultural resources located in a local river environment while building skills linked to the National Geography Standards. Greenway-related activities can be designed so that students practice the acquisition, interpretation, and integration of geographic information obtained from a variety of sources and methods. (Contains 1 table, 3 figures and 2 notes.)
80	LaDue, N. D., & Pacheco, H. A. (2013). Critical experiences for field geologists: Emergent themes in interest development. *Journal of Geoscience Education, 61*(4), 428-436.	Geoscience education researchers are working to understand how we can most effectively increase our overall geoscience workforce capacity. The present study employed an inductive approach to explore the critical experiences that led to the persistence of successful field geologists in this STEM field. Interviews with 29 professional field geologists and 8 upper level undergraduates were analyzed to identify emergent themes. Three overarching themes emerged: Academic Experiences, Connections with People, and Engagement with Earth. Academic experiences, such as introductory courses and field trips, were commonly mentioned as being significant in recruitment. Relationships with people, such as professors and family members, provided encouragement for and exposure to geology-related activities. Participants provided detailed description of the regional geology where they grew up and the geology of locales from family trips as experiences with Earth influenced their interest in geology. The results of this study validate past studies of recruitment and retention of geoscientists, particularly in the influence of academic experiences on interest in geology. However, the abundance of themes related to the role of family, engagement in outdoor recreation, and personal experiences with local geology underscores the importance of informal science experiences for fostering choice and participation in field geology careers. Future models of retention and recruitment for the geosciences could benefit from emphasizing familial relationships and informal science experiences. [PUBLICATION ABSTRACT]
81	Laskowski, J., Gillespie, C., Corral, L., Oden, A., Fricke, K., & Fontaine, J. J. (2016). Teaching animal habitat	We present a hands-on outdoor activity coupled with classroom discussion to teach students about wildlife habitat selection, the process

	selection using wildlife tracking equipment. *Science Activities*, *53*(4), 147-154.	by which animals choose where to live. By selecting locations or habitats with many benefits (e.g., food, shelter, mates) and few costs (e.g., predators), animals improve their ability to survive and reproduce. Biologists track animal movement using radio telemetry technology to study habitat selection so they can better provide species with habitats that promote population growth. We present a curriculum in which students locate "animals" (transmitters) using radio telemetry equipment and apply math skills (use of fractions and percentages) to assess their "animal's" habitat selection by comparing the availability of habitat types with the proportion of "animals" they find in each habitat type.
82	Lee, V. R. (2014). Students' Digital Photography Behaviors during a Multiday Environmental Science Field Trip and Their Recollections of Photographed Science Content. *Education Research International*, *2014*, 1-11.	Taking photographs to document the experiences of an educational field trip is becoming a common activity for teachers and students alike. Considering the regular creation of photographic artifacts, our goal in this paper is to explore students' picture taking behavior and their recollections of science content associated with their photographs. In this study, we partnered with a class of fifth-grade students in the United States and provided each student with a digital camera to document their experiences during an environmental science field trip at a national park. We report the frequency of photography behaviors according to which activities were most often documented by the students and specifically that students tended to document more of their experiences when they were in outdoor, natural spaces rather than inside of visitor centers or museums. Also, through an analysis of students' comments about the science content captured in their photographs we observe that students' comments about photographs of the outdoors tended to show greater depth and complexity than those that were taken in indoor, museum-like spaces.
83	Lehrer, R., & Schauble, L. (2017). Children's conceptions of sampling in local ecosystems investigations. *Science Education*, *101*(6), 968-984.	This study describes how students' intuitions about sampling are informed by extended experiences in investigating local ecosystems. Elementary students in a rural/suburban district in the upper midwest spent a year conducting first-hand comparative field studies of nearby ponds, prairies, and forests. At the close of the term, we conducted task-based interviews with 26 students at Grades 1/2, 3, and 6 to

		explore their understanding of the nature and role of samples, particular forms of sampling practices in the field, and the ways in which samples and sampling practices influenced their knowledge about ecosystems. Interviews, which lasted from 60-90 minutes each, were conducted individually. Interviews were designed to address parallel topics at each grade level, although questions were couched in the specific ecosystems investigated by students at their respective grades. Across grades, interview responses reflected transitions in students' understanding of: the concept of a sample, ways to construct a sample, potential sources of sample bias, roles of cause and chance in explaining variability in a sample, ideas about growing sample size, and how to coordinate sample representativeness and sampling variability
84	Lewis, S., & O'Brien, G. E. (2012). The Mediating Role of Scientific Tools for Elementary School Students Learning about the Everglades in the Field and Classroom. *International Journal of Environmental and Science Education, 7*(3), 433-458.	There has been an increased use of authentic practices in both science and environmental education in recent years. Such practices can utilize social constructivist frameworks to consider the learning that may be taking place as students become engaged in tool use. The current study focuses on a group of elementary school students studying the Everglades in the field and in a classroom setting during one academic year. In particular, we observed students' use of tools (identified as tool-conventions to include both artifacts and conventions) and compared their use in both settings. We found that in the field, students spent considerable amount of time engaged in data collection activity such as taking observations and measurements that resembled what scientists might be doing and included the invention of new tools to facilitate data gathering. In this context, students generally worked more independently from the teacher, collaborated in small work groups, and engaged in more self-directed inquiry. In the classroom, while some of the scientific field tools were practiced in anticipation of their use in the field, activity included more teacher direction, often resembling what might be found in other types of classroom work and the tools used there often supported this work. Models of tool use based on Yrjo Engestrom's activity approach were constructed for both settings. Implications of the results include the importance of viewing

		tool use in authentic learning with a sociocultural and activity perspective to reflect the socially constructed nature of such learning. (Contains 5 figures, 1 table, and 3 endnotes.)
85	Magntorn, O., & Helldén, G. (2007). Reading nature from a 'bottom-up'perspective. *Journal of Biological Education*, *41*(2), 68-75.	This paper reports on a study of ecology teaching and learning in a Swedish primary school class (age 10-11 yrs). A teaching sequence was designed to help students read nature in a river ecosystem. The teaching sequence had a "bottom up" approach, taking as its starting point a common key organism--the freshwater shrimp. From this species and its ecology, the perspective was broadened to involve studies of the interrelations between organisms and finally to the relationship between biotic and abiotic factors. A large part of the instruction took place outdoors. Students were interviewed three times during the course when they were presented with a tray full of objects (both biotic and abiotic) from the ecosystem. The students' task was to name and describe the objects and then to link them up in as many relevant ways as possible, explaining the reasons for the links. The interviews have been transcribed onto concept maps and SOLO-taxonomy was used to illustrate their developing ecological understanding. Results indicate how students related several abstract processes and correlations back to the key organism studied early in the teaching sequence. (Contains 6 figures, 1 table, and 1 online resource.)
86	Mangiante, E. S. (2009). Forrest or Field?. *Science and Children*, *47*(1), 35-39.	An open field--with its wildflowers, grasses, and vole tunnels--became an instant classroom. Students' senses were awakened there, and upon entering a nearby forest, they immediately detected a difference: less light and cooler air. "Why are there no grasses in the forest? Why aren't there ferns in the field?" These and other questions emerged as fifth-grade students collected and compared data from both a field and forest at a local Audubon Society wildlife refuge.
87	Marty, P. F., Alemanne, N. D., Mendenhall, A., Maurya, M., Southerland, S. A., Sampson, V., ... & Schellinger, J. (2013). Scientific inquiry, digital literacy, and mobile computing in informal learning environments. *Learning, Media and Technology*, *38*(4), 407-428.	Understanding the connections between scientific inquiry and digital literacy in informal learning environments is essential to furthering students' critical thinking and technology skills. The Habitat Tracker project combines a standards-based curriculum focused on the nature of science with an integrated system of online and mobile computing

		technologies designed to help students learn about and participate in scientific inquiry in formal classroom settings and informal learning environments such as science museums or wildlife centers. This research documents the digital literacy skills elementary students used while participating in the Habitat Tracker project, exploring the connections between the scientific inquiry practices they developed and the digital literacy skills they employed as they engaged with the Habitat Tracker curriculum. The results of this research have implications for researchers and practitioners interested in fostering both the scientific inquiry practices and digital literacy skills of elementary students in formal and informal learning environments.
88	McBride, B. B., & Brewer, C. A. (2010). Nature's Palette. *Science and Children, 48*(2), 40-43	Flower petals, acorn hats, exoskeletons of beetles, and lichens are just a few of the objects students may find in a surprising array of vivid colors. These tiny examples from nature's palette can be discovered in a school yard, a park, or even along the edges of a paved sidewalk...it simply takes careful observation! This article describes a color-wise investigation that allows budding ecologists to practice their skills of observation.
89	Meichtry, Y. J. (2005). Teaching the web of life. *Science Activities, 42*(3), 3-9.	This series of activities, which integrates science and social studies, is designed to involve students in experimental learning experiences conducted in an outdoor setting. Throughout the lesson, which is based on a model of instruction called Flow Learning(TM), students (a) simulate the Web of Life, (b) use different senses and scientific processes to experience and describe the living and nonliving environment, (c) develop conceptual understandings about interdependence and diversity of nature, and (d) determine what humans can do to protect the Web of Life. [PUBLICATION ABSTRACT]
90	Melber, L. W. (2000). Nature in the City. *Science and Children, 37*(7), 18-21.	Presents three science activities targeted to help urban students learn about nature: (1) observing coloration patterns of pigeons; (2) measuring local rainfall and comparing it to other areas; and (3) conducting a biodiversity study by observing a patch of lawn. (YDS)

91	Mygind, E. (2007). Udeundervisning - en anden vej til læring, dannelse og faglig indsigt. *Kaskelot, 2007*(161), 12-15.	Udvalgte resultater fra et forskningsprojekt om naturklasser i folkeskolen
92	Nadelson, L. S., & Jordan, J. R. (2012). Student attitudes toward and recall of outside day: An environmental science field trip. *The Journal of Educational Research*, *105*(3), 220-231.	Field trips are effective because they situate learning and facilitate knowledge transfer, thereby influencing students learning attitudes, interests, and motivation. Variations in field trip configurations and the subsequent affective and cognitive influences provided the motivation for this study of Outside Day--an environmental education field trip for 6th-grade students. The participants were immediately postassessed on their attitudes toward the event and 1 month later assessed on their event activity recall. Results indicate the students held positive attitudes toward the field trip and recalled a hands-on orienteering activity most frequently. The discussion provides explanations and implications of findings. (Contains 2 tables and 1 figure.)
93	Ottander, C., Wilhelmsson, B., & Lidestav, G. (2015). Teachers' intentions for outdoor learning: a characterisation of teachers' objectives and actions. *International Journal of Learning, Teaching and Educational Research*, *13*(2), 208-230.	The aim of this study is to examine nine Swedish teachers´intentions and educational objectives for outdoor learning, and how these educational objectives are implemented in outdoor activities. Further, the alignment between teachers´predifined objectives and the kinds of knowledge and cognitive processes reflected in the outdoor activities are investigated. The data sources consists of semi-structured interviews and observations. The intervirw transcripts were analysed using Haldéns theory of intentional analysis to identify teachers' intentions when locating learning outdoors. Teachers´ objectives in the cognitive domain were further analysed by Bloom´s revised taxonomy. The teachers use a diverse set of outdoor activities. Our findings include a typology of four orientations: one that values affective and social objectives and promote activities to understand factual knowledge, another orientation focuses on activities intended to gain procedural knowledge and emphasizes application of practical tasks. The other two teaching orientations primarily focuses on cognitive objectives, partly to reinforce conceptual knowledge, partly to deepen understandings or improve strategies to enhance meta-cognitive knowledge. The degree of alignment between intended objectives and performed activity is higher among teachers promoting affective and

		social goals as well as meta-cognitive and analytical understanding, than teachers who use outdoor activities to mainly reinforce conceptual knowledge. The study shows that there is a range of possible learning goals in outdoor education and teachers are guieded by what they value and how they percive learning.
94	Parott, J. (2004). Birds Make Learning Easy. Science Sampler. *Science Scope, 28*(3), 34-35.	Through this middle school curriculum, students observe bird feeders outside their classrooms, learn to identify birds that visit, and use a simple protocol for counting the birds and collecting other data before sending it to Cornell scientists via the Internet. The activities within the curriculum are inquiry-based and interdisciplinary. This activity strengthened student skills in areas such as classification, information searches, use of dictionaries to determine derivations and definitions, and distinguishing different geographical locations. Students also strengthen several science concepts when they make use of the field guides, gaining a more in-depth understanding of habitat, behavior, anatomy, reproduction, and migration. Moreover, the students improve their geography skills by observing range maps and migration routes.
95	Peacock, A. (2007). Discovering the"-Ologies" on the Jurassic Coast. *Primary Science Review, 96*, 25-28.	The Jurassic Coast is Britain's only natural World Heritage site, a tangible time-line that takes one through 185 million years of history in 95 miles of coast. It provides individuals with a world-famous educational resource and an unrivalled outdoor classroom that has played a key role in the study of earth sciences. The author is keen to ignite children's wish to learn through the things that interest them, which include dinosaurs, fossils, crystals, caves, landslides, and all the other fascinations that this coast can provide. Many of these fascinations fall within what the author calls the "-ologies": subjects largely ignored by school education, such as geology, archaeology, palaeontology and meteorology. None of these feature in the English National Curriculum, but that doesn't mean they are not relevant and fascinating to children, as the popularity of the film "Jurassic Park" demonstrated. In this article, the author encourages teachers to think outside the constraints of subjects in order to learn science from things that fascinate children. (Contains 5 figures.)

96	Pugh, K. J. (2004). Newton's laws beyond the classroom walls. *Science Education, 88*(2), 182-196.	One of the most profound qualities of science is its potential to transform and enrich students' experiences with the world. In prior work, I have conceptualized this quality of science in the construct of transformative experience. In order to illustrate the difference between transformative and nontransformative experience, this article presents the contrasting experiences of two students learning Newton's Laws in a seventh-grade general science class. One student exemplifies engagement in a transformative experience - the learning of Newton's Laws enriches his experience with events of motion in his everyday, out-of-school life. The other student exemplifies the good student who is engaged in the class and learns the content, but does not undergo a transformative experience. The experiences of these two students are analyzed and discussed. Recommendations include a need to focus on student experience outside the classroom and engagement with content (as opposed to engagement with peripheral things, such as humor or mere activity). [PUBLICATION ABSTRACT]
97	Randler, C. (2008). Teaching species identification–A prerequisite for learning biodiversity and understanding ecology. *Eurasia Journal of Mathematics, Science and Technology Education, 4*(3), 223-231.	Animal and plant species identification is often emphasized as a basic prerequisite for an understanding of ecology and training identification skills seems a worthwhile task in biology education. Such identification tasks could be embedded into hands-on, group-based and self-determined learning: a) Teaching and learning should make use of a small selection of species (6-8) and b) these species should be embedded into learning about their natural and life history; c) different materials could be used for identification, i.e. stuffed taxidermies, plastic models or pictures. However, pictures seem only a second choice; d) ideally, pupils use identification books or dichotomous keys for their identification task to foster their methodological skills and to promote lifelong learning by enabling them to make use of such books and keys; e) if the preference is on identification keys rather than on illustrated material, pupils should be trained previously to cope better with the extrinsic load put on them by the difficult material; f) outdoor field trips and excursions should be employed only after a proper preparation in the classroom. (Contains 8 figures.)

98	Randler, C., Ilg, A., & Kern, J. (2005). Cognitive and emotional evaluation of an amphibian conservation program for elementary school students. *The Journal of Environmental Education*, *37*(1), 43-52.	The authors describe a study aimed at enhancing knowledge about amphibian species. Two classes of 3rd and 4th graders aged 9-11 years participated in the study. In addition, approximately one half of the students participated in an environmental conservation action designated to preserve migrating amphibians. During this action, students encountered living amphibians. Students who participated in the conservation action performed significantly better on achievement tests, and 4th graders performed better than 3rd graders, even when controlling for prior knowledge as a covariate, which also showed a significant influence. Pupils expressed high interest and well-being and low anger, anxiety, and boredom. Boredom and anxiety correlated negatively with residualized achievement scores. Major implications are that learning about biodiversity should (a) focus on a small number of species, (b) start in primary schools, (c) take place outdoors, and (d) be linked with classroom teaching. (Contains 2 figures and 2 tables.)
99	Rios, J. M., & Brewer, J. (2014). Outdoor education and science achievement. *Applied Environmental Education & Communication*, *13*(4), 234-240.	Elementary students have limited opportunities to learn science in an outdoor setting at school. Some suggest this is partially due to a lack of teacher efficacy teaching in an outdoor setting. Yet the research literature indicates that outdoor learning experiences develop positive environmental attitudes and can positively affect science achievement. Research also suggests that frequent outdoor learning experiences, implemented by a trained teacher in a familiar setting, like a schoolyard, can result in greater engagement and science achievement for students. Teachers can embrace outdoor learning opportunities as a means to increase science content knowledge and develop environmentally conscious students. In this article, we explore the positive effects of outdoor science education on achievement and suggest practical outdoor activities for classroom teachers.
100	Rogers, M. P., & Steele, M. (2014). Observing Life in a Square. *Science and Children*, *52*(4), 26-31.	Much has been written about developing outdoor classrooms or how to generate effective and integrated learning using the outdoors. However, with the release of the "Next Generation Science Standards," teachers need to consider how they are going to design their science curriculum to include opportunities for students to learn about core disciplinary concepts, science and engineering practices, and the big ideas of

		science referred to as crosscutting concepts (NGSS Lead States 2013). For a seamless integration of all three dimensions, teachers will need to reimagine their approach to teaching science. The study described in this article has elementary students exploring their own backyards to experience the kind of fieldwork scientists might do in order to add value to their learning about the living world around them.
101	Rubino, D. L., & Hanson, D. (2009). CSI for Trees. *Science and Children*, *47*(2), 21-25.	The circles and patterns in a tree's stem tell a story, but that story can be a mystery. Interpreting the story of tree rings provides a way to heighten the natural curiosity of students and help them gain insight into the interaction of elements in the environment. It also represents a wonderful opportunity to incorporate the nature of science. In this activity, appropriate for grades 3-6, students make connections with the work of a scientist as they solve a mini-mystery using tree-ring evidence. (Contains 2 figures and 2 online resources.)
102	Rye, J. A., Selmer, S. J., Pennington, S., Vanhorn, L., Fox, S., & Kane, S. (2012). Elementary school garden programs enhance science education for all learners. *Teaching Exceptional Children*, *44*(6), 58-65.	A national movement is underway to establish elementary school gardens, which can serve both academic and social purposes. These gardens can positively impact students' science achievement and provide the thematic and hands-on approach especially conducive to learning for students with disabilities. Garden-based learning (GBL) broadens the scope of school gardening to include tools and processes such as indoor seed germination and vermicomposting. Teachers at a suburban elementary school leveraged community resources and the assistance of parents to initiate GBL. They employed this strategy to provide standards-based science and cross-disciplinary instruction, as well as to facilitate inquiry and the development of related process skills. A collaborative fourth grade classroom engaged all learners in investigations about the decomposition of vegetable matter, worm populations, and the impact of fertilizer on plant growth. The experiential and interdisciplinary nature of GBL may make it one key to unlocking learning potential in students with disabilities. (Contains 1 table and 4 figures.)
103	Samsudin, M. W., Daik, R., Abas, A., Meerah, T., & Halim, L. (2013). Environmental Learning Workshop: Lichen as Biological Indicator of Air Quality and Impact on	In this study, the learning of science outside the classroom is believe to be an added value to science learning as well as it offers students to interact with the environment. This study presents data obtained from

	Secondary Students' Performance. *International Education Studies*, *6*(6), 28-34.	two days' workshop on Lichen as Biological Indicator for Air Quality. The aim of the workshop is for the students to gain an understanding on various aspects on Lichens and its role as a biological indicator. Students are exposed to the following concepts and skills in the workshop: characteristics of algae, the concept of Lichen, causes of polluted air, the concept of quadrant, how to measure the frequency of Lichen, types of Lichen, determining the air quality index, factors determining the quality of air, the role of Lichen, the function of Lichen as a biological indicator and determining the level of air pollution. Four schools participated in the two day workshop whereby two schools were located in rural and urban areas respectively. A total of 125 students were given a pre-test on the concept of Lichen before the workshop followed by brief lecture sessions, hands-on and field work activities, presentation by students. At the end of the workshop, students were given a post-test. Overall, from the pre and post-test results, there is a significant difference in terms of students' performance from all the four schools, in knowledge and skills relating to Lichen and its role as a biological indicator in determining the quality of air.
104	Schultz, B., Yates, C., & Schultz, J. M. (2008). Digging into inquiry-based earth science research. *Science Scope*, *32*(4), 26-31.	To help eighth-grade students experience the excitement of Earth science research, the authors developed an inquiry-based project in which students evaluated and cataloged their campus geology and soils. Following class discussions of rock-weathering and soil-forming processes, students worked in groups to excavate multiple soil pits in the school yard. They collected soil samples to study the characterization of soil morphology and to conduct petrographic (i.e., thin-section) and scanning electron microscope (SEM) analyses. Students gained hands-on geospatial and mathematic skills from recording compass, distance, and orientation measurements while establishing a base map for their campus research site. (Contains 7 figures and 1 online resource.)
105	Scott, G. W., & Boyd, M. (2016). Getting more from getting out: increasing achievement in literacy and science	This paper demonstrates the positive impact of learning through ecological fieldwork upon children's ability to write, and to write about science. Specifically we have carried out a relatively large-scale study

	through ecological fieldwork. *Education 3-13*, *44*(6), 661-670.	(involving 379 children aged 9-11 years from 8 primary schools in North East England) comparing intervention classes (involved in fieldwork) and comparison classes (no fieldwork). Pre-intervention assessments revealed no differences between classes in mean literacy scores; post-intervention assessments revealed that significantly higher literacy scores were achieved by children who had carried out fieldwork (girls consistently outperformed boys in all classes). Intervention class children achieved higher scores in science (ecology) assessments than their comparison class peers before and after the intervention. We suggest that this may be an effect of these children thinking as scientists throughout the project. Our work confirms that a child-centred outdoor learning experience focused upon science can result in learning benefits across the wider curriculum.
106	Scott, G., Grassam, M., & Scott, L. (2011). Life on Our Shore. *Primary Science*, *117*, 29-31.	St. Martin's Church of England Primary School in Scarborough, North Yorkshire, enjoys a unique location, being approximately 10 minutes walk from a rocky shore and a similar distance from the University of Hull (Scarborough Campus) and its Centre for Environmental and Marine Sciences. A grant provided by the Royal Society (under their Education Partnerships scheme), enabled a year 5 class (ages 9-10), their teacher and scientists (ecologists) from the university to explore the diversity of animals and plants on the shore with the aim of producing a field identification guide. Within a constructivist/experiential learning approach--exploring, enquiring, asking questions and even playing (within appropriate ethical guidelines!) with the organisms--the children engaged with science and their own environment. The project described in this article enabled the children to discover the biodiversity of the rocky shore world on their doorstep in a meaningful way.
107	Short, D. (2013). Relevance of Science through Ownership: Why Study the Bumblebee?. *School Science Review*, *94*(349), 23-28.	In this "Science Notes" feature, Duncan Short, from Inverkeithing High School in Scotland, describes how his school has created a wildflower meadow that is doubling up as an outdoor research laboratory. With guidance, pupils are using the new meadow to monitor what bumblebees are present, thus taking part in real and useful research. Two of the pupils involved present their own accounts

		of the project in the article. (Contains 4 figures, 4 boxes, and 7 online resources.) [This article was written with Ben Kurzman and Fiona Wilson, and is preceded by a one-page introduction by Sue Howarth entitled "The Clubbers' Guide: Creating a Buzz around School" (this issue, p22).]
108	Smeds, P., Jeronen, E., & Kurppa, S. (2015). Farm Education and the Value of Learning in an Authentic Learning Environment. *International Journal of Environmental and Science Education*, *10*(3), 381-404.	Farm education is a newly emerging field of research that utilises authentic learning environments, environments that combine a subject of academic study with its real-world surroundings, actors, and activities--in this case, the practical context of a farm. The aim of the study was to investigate the effects of various learning environments (farm, classroom, and synthesis of the two) on learning and how pupils experience it. Mixed-methods research with experiential interventions was used, and data collection used interviews and pre-learning, post-learning, and delayed tests. The analysis, performed with SPSS software, employed ANOVA and ANOVA repeated-measures design and inductive content analysis. Pupils showed significantly better learning results when allowed to study in authentic learning environments on farm. They experienced learning in an authentic learning environment as easier and found that they learnt more there than in the classroom. They concluded that the reason for this was that the subject to be learnt could be studied comprehensively and first-hand in its original surroundings, including processes. Farm education proved to be a versatile learning environment that encourage learning and support learners who differ in their learning preferences. It supports pupils with moderate learning difficulties, as well as talented pupils, thanks to being allowed to study many aspects of the subject for learning, at their own pace. Including authentic learning environments in education increases long-term retention of what has been learnt and improves understanding. Those involved in teacher education, teachers, and schools alike are urged to take this into account when planning and carrying out education.
109	Spring, P. & Harr, N. (2014). Our World without Decomposers: How Scary!. *Science and Children, 51*(7), 28-37.	Bugs, slugs, bacteria, and fungi are decomposers at the heart of every ecosystem. Fifth graders at Dodge Intermediate School in Twinsburg, Ohio, ventured outdoors to learn about the necessity of these amazing

		organisms. With the help of a naturalist, students explored their local park and discovered the wonder of decomposers and their interconnectedness to other living things. Later lessons challenged students to creatively imagine and write about an ecosystem without decomposers, unveiling their essential roles within the natural world. Due to the nature of the decomposition process, the lessons described herein take approximately three weeks to complete and can be adapted to a variety of elementary settings such as classrooms, home school, and outdoor education. The "Next Generation Science Standards" (NGSS Lead States 2013) identifies fifth grade as an endpoint for basic understanding of ecosystems. For this reason, these lessons aim to help students understand the integral, cyclical, and restorative relationship of decomposers within their own local environment (p. 48).
110	Ting, K. L., & Siew, N. M. (2014). Effects of Outdoor School Ground Lessons on Students' Science Process Skills and Scientific Curiosity. *Journal of Education and Learning*, *3*(4), 96-107.	The purpose of this study was to investigate the effects of outdoor school ground lessons on Year Five students' science process skills and scientific curiosity. A quasi-experimental design was employed in this study. The participants in the study were divided into two groups, one subjected to the experimental treatment, defined as "eco-hunt" group and the other had no experimental treatment, defined as control group. This study used intact four classes which consisted of 119 students and randomly assigned to the treatment (n = 63) and control groups (n = 56). Students' science process skill was measured by a self-developed Science Process Skills Test and students' scientific curiosity was measured using Children Scientific Curiosity Scale adapted from Harty and Beall (1984). The results showed a significant difference in post-test mean scores between students in "eco-hunt" group and control group in both students' science process skills and scientific curiosity. Follow-up comparisons on the dimensions of science process skills and scientific curiosity were analyzed and discussed. The findings of this study will provide a framework for science teachers to teach students through interesting and meaningful outdoor activities.
111	Townsend, C. (2010). Earth-Heart Astronomy: Astronomy-Related Activities to Enhance Education for Sustainable Development. *School Science Review, 92*(338), 97-102.	This article outlines a range of engaging outdoor daytime activities to enhance astronomical understanding and our place in the universe. They are practical activities with "soul" which engender environmental

		and social responsibility on a local (yet planetary) scale. They link astronomical and global considerations with a notion of responsibility, respect, care and love to help nurture a fuller appreciation of the challenges of sustainable development and a sense of purpose in facing them. (Contains 7 figures.)
112	Yalcin, M. N. A. (2016). The Effect of Active Learning Based Science Camp Activities on Primary School Students' Opinions Towards Scientific Knowledge and Scientific Prrocess Skills. *International Electronic Journal of Environmental Education*, *6*(2), 108-125.	It is important for people to be able to judge the nature while actually living in it to gain the scientific perspective which is an important skill nowadays. Within this importance, the general purpose of this study is to examine the effect of active learning based science camp activities on sixth, seventh and eighth grade students' opinions towards scientific knowledge and scientific process skills. In order to achieve this goal, the natural, historical, archeological and the cultural sources of the Cappadocia area were used as a teaching tool. One group quasi-experimental design with pretest and posttest was used in the study. 17 boarding primary school students participated to research. Opinion survey on scientific knowledge, scientific process skills scale, conceptual comprehension survey on environmental problems and observation form were used as a data collection tools. Descriptive and Man Whitney-U analysis techniques were used during assessment of the data. As a result of the study, significant difference was found supporting the students' post-test results of scientific knowledge survey, the number of students' post-application explanations were more than students' pre-application explanations of conceptual knowledge survey on environmental problems.