Biology, Art and Sustainability

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Abstract

How can the teaching of biology contribute to sustainability education? The authors of this article suggest that their approach has the potential to increase the students' level of engagement with the natural environment. The scope of biology teaching can be widened by allowing room for more experience and art-based activities. Such a change may deepen and expand the learners' insights in natural phenomena, which in turn might foster or enhance an attitude of care-taking for the natural environment.

Introduction

Art and science are often conceived of as being polar opposites, despite the fact that both disciplines, each in its own way, relate to nature and empirical phenomena. Seen from a historical perspective, art and science have always been closely tied to each other. From Leonardo da Vinci to Ernst Haeckel, drawing was used as a method for observing and exploring nature. Also in art education, until recent decades, draftsmanship, the study of nature through drawing, was an important exercise and skill for students to master. We, the authors of this article, are teachers with a professional background in biology, anthropology, art education and environmental education. The question we ask ourselves here is: in what way can an infusion of more field experience and art-based approaches in the teaching of biology nurture the students' connection to natural phenomena and increase their understanding of them. In addition, can such a change of focus increase their engagement in social, political and environmental issues?

In the first part of this article we discuss some current research findings that point to a growing need for developing innovative approaches to integrate the theme of sustainable development into the curriculum. In the second part we provide examples of educators working with environmental art education as a way to increase nature awareness. In the final part we provide, on the basis of our own experience, an

[1] An earlier version of this article was published in Norwegian: Jolly, L., Slåttli, S., & Boeckel, J. van (2011). Biologi, bilder og bærekraft. *Norsk Pedagogisk Tidsskrift, 4,* 299-313. The authors wish to acknowledge the help of Ceciel Verheij with translation of the article from Norwegian to English.

example of how methods stemming from art and science education can be integrated in such a way that they enhance each other. Through our description of the teaching methods that we use in an upper secondary school class setting, we hope to contribute to the discourse about methods in science education and sustainability education in general. We aim to provide teachers with new ideas and sources of inspiration for interdisciplinary cooperation. At the end of this article, we present some of the students' evaluations of this approach, and discuss them in light of relevant pedagogical literature and the questions posed in our introduction.

Disconnection from nature

Over the past few years we have witnessed a surge of articles, books and research on children's disconnection from nature. Norway used to be a country where outdoor play was traditionally part and parcel of the culture. The issue first came to the fore in other countries, but more recent research has indicated that similar trends regarding children's lack of access to nature also occur here. For example, a study by Skår and Krogh (2010) of how people in the municipality of Brumunddal use their natural surroundings shows that playing football on a patch of grass or skiing from an improvised ramp have been replaced by organized activities, requiring parents to drive the children, often across long distances. In his *Last Child in the Woods*, Richard Louv (2008) identified a new disorder among children and youth, which he called "nature-deficit disorder." Though not recognized as a medical diagnosis, the term has entered the public debate on many levels. An Internet search for the term "nature-deficit disorder" yields close to 180.000 hits. Louv lists some of the human costs of our alienation from nature as follows: "diminished use of the senses, attention difficulties, and higher rates of physical and emotional illnesses" (Louv 2008, p. 36). The gap between children and nature is possibly widened further through ubiquitous digital media: they invite for multitasking and make it more difficult to tune in to the slower processes of nature.

According to Arjen Wals (2010) we face a "sustainability crisis," characterized by the loss of nature, environmental degradation, and natural resource depletion. Facing this challenge, he says, we are confronted with the circumstance that increased awareness of the seriousness of the environmental crisis in and of itself does not lead to changes in people's values or lifestyles. On the contrary, just raising knowledge and awareness *without* providing inspiring visions and concrete practices that show that there are more sustainable alternatives, will lead to feelings of apathy and powerlessness (Wals, 2010, p. 21).

Constance Russell (1999) questions the position that, given the circumstance that the environmental crisis has been caused by human disconnection from nature, the job of environmental educators thus is to provide nature experience to heal this rift. She warns against treating such experience as some sort of universal panacea. Instead, she seeks more nuanced approaches that can bridge the gap between a direct

encounter with nature on the one hand, and the development of an awareness of its value, on the other, which may lead to a more caring relationship. It is precisely within this field of tension that many educators are eager to explore possibilities for collaboration between art and science education.

The need for innovative approaches in both science education and education for a sustainable future

While it is obvious that we ourselves are responsible for the environmental crisis, we nevertheless still face the challenge in education to find appropriate ways that can help bring about a change of mindset and a reconnection to nature. Louv's book has triggered a host of initiatives in the United States to bring children and youngsters out in nature.[2] Several studies have shown how the quality of learning about nature is connected to the ability to experience it in a direct way (Blair, 2009; Dyment, 2005; Lieberman & Hoody, 1998, 2005).

In the Nordic countries there are several initiatives using artistic practice in the context of reconnecting children to nature. Jan-Erik Sørenstuen writes in his book *Levende Spor: oppdagelse av kunst gjennom naturen og naturen gjennom kunst* (Living tracks: To discover nature through art and art through nature):

> Our era is exceedingly dominated by a negative media focus on our planet's future, therefore there is the impending task of ensuring that young people do not become numbed by apathy. More than ever we must now bring forth a constructive and creative focus upon nature. We must show this generation's youth that each and every person has the ability to re-strengthen their connection, and identification with nature. One way of achieving this is by strengthening perceptual skills and awakening the aesthetic senses whereby creativity is developed through a "green approach" to art, culture and creativity in our natural environment. (Sørenstuen 2011, p. 17, our translation)

Over a period of 20 years, Sørenstuen has facilitated numerous workshops and courses in nature with both children and adults. His research of and experience in working with what he terms "nature art", has provided him with a wealth of practical knowledge of how to build bridges between arts and crafts and the natural sciences.

An example of this is a workshop in which he asked participants to make nature collages related to insects. The students were free to choose to work with, for instance, pebbles, berries, sticks or flowers. The art works were to be made on locations where they would fit into the surroundings due to affinity in form, lines and materials (Sørenstuen, 2009, p. 168).

[2] See: http://www.childrenandnature.org.

In a similar vein, Finnish art educator Timo Jokela (1995) has tried to find out in what ways environmental art could serve as a method of environmental education. He insists that this tradition lends itself to deriving functional models which are both applicable to art education as well as environmental education. In the planning, the art world and the learner's world are combined into one project, in which experiencing, searching for information, and structuring all merge together. In Jokela's view, environmental art is remarkably suitable for field work and research by learners of all ages.

Jokela's approach is just one of several similar research projects in Finland. The history of art teaching as a part of sustainability education in Finland goes back to 1971, when the conference entitled "Environmental Protection in Art Education" was held in Helsinki. Twenty years later, at the time of the UN Conference in 1992 on Environment and Development in Rio de Janeiro (The Earth Summit), Finnish art educator Meri-Helga Mantere from the University of Art and Design in Helsinki articulated the unique Finnish approach to an international audience in the seminal article "Ecology, Environmental Education and Art Teaching" (1992). Mantere wrote that, in her view, ecological thinking and action should be regarded as a guiding principle of all education. She argued that art education can play an important role in the development of new forms of environmental education. To her, a genuine appreciation of nature and motivation to act for the good of the environment are based on highly valued experiences and these are often of an aesthetic nature.

The theoretical basis for the botanical excursion

With this background we will now present our approach in which drawing and painting are integral parts of the biology lesson. The start occurred when a biology teacher asked an art teacher for assistance for an excursion in botany. The biology teacher wanted to find out whether observation through drawing and painting could enhance the students' connection to plants. Eventually this collaboration developed into team teaching on a week-long study trip.

Several sources were inspirational for this pedagogical approach, a major one of which was John Dewey's emphasis on experiential learning (Dewey, 1938/1974). In addition, phenomenological science teaching has been central in our orientation. Currently there is a renewed interest in both phenomenology as a philosophy and as a method in science teaching (Østergaard, Dahlin & Hugo, 2008). In reviewing the historical development of phenomenology, Goethe's nature studies play a prominent role. Dahlin (2001) describes Goethean science as hermeneutic phenomenology in which the phenomena are understood in the context of their observable characteristics, rather than in relation to external forms or models. Goethe's studies of plants and his understanding of the human as a "conscious, reflective and interpreting subject who cannot be separated from the object under study" (Dahlin, 2002, p. 82) has been the foundation for this work.

Fieldwork with pencils and paint brushes: methodological remarks

The research design is based on action-research, in such a way that the set-up gradually developed through several cycles of planning, implementation and evaluation (McNiff, 2002). The framework has continuously been adapted and developed on basis of feedback that the students gave each year on their own learning experiences and the teaching methods. The student evaluation from the excursion in 2005 (with 16 students) was conducted six months after completion of the fieldwork, and the one on the course in 2010 (with 20 students) was conducted immediately after the fieldtrip. At the end of the article we include the words from one pupil of a more recent course (2015). Pupil evaluations from 2005 and 2010 were collected and analyzed by means of the so-called meaning condensation method (Kvale, 2006) and the quotations used here are taken from the evaluations made by 37 students. Next to the students' written evaluation, their drawings were an additional data source. Some of these are presented as illustrations in this article.

In a qualitative study such as the present one, the goal is to provide examples of experiences that can be considered in the light of relevant theory and have validity in the given context. Our aim is not to collect representative data with regard to the effectiveness and applicability of teaching in general, but to present the students' own experiences. The discussion is based on a thematic classification of the students' written assessments, and we refrain from drawing any general conclusions.

Description of the teaching framework

The framework for teaching is a weeklong fieldwork period for students at the upper secondary school level. A relatively isolated island, lacking shops and frequent ferry connections, proves to be an excellent location for 17 year olds to practice observing something as slow as the growth of plants.

The learning goals for the week are related to topics like the stages of growth of a plant, taxonomy and use of identification keys. The students are to learn to identify 20 different types of trees and 12 main families in the plant kingdom. In addition, issues related to the cultural landscape and biodiversity are discussed during the trip. To a large degree, the learning goals are consistent with the competency goals set for this age group. The artistic exercises are an intrinsic part of the methodology: students familiarize themselves with different materials and techniques, and practice using these as tools in plant and landscape observations. The lessons alternate between an introductions to topics such as plant development and pollination, and hands-on drawing and painting sessions. Both the biology teacher and art teacher participate in all sessions and take turns in facilitating exercises with the students. The course also includes nature excursions.

First session: the growth of the plant

We begin with a session in which we study the stages of development of a plant. We follow the plant's growth from seed to fruit and germination, and draw the different parts of the plant on A3 size posters. By way of example, we describe here how we work with the topic of seeds, being the first stage in the plant's growth process.

When the weather and season allow for it, students are sent out in nature to collect seeds, just as they are asked to address other parts of the plant as part of our lessons. The students also get a teaspoon of different seeds to study. As a start, the students sort out and observe the seeds without any prior instruction. After a while they are asked to write down words describing what the different seeds have in common. We ask what kind of properties they have: what characterizes seeds despite all variation; what tells us that they indeed *are* seeds? Each student is asked to come up with at least one characteristic, which the teacher then writes on the board. When they cannot think of any more properties, the biology teacher elaborates on their descriptions and connects them to a larger context. When for example one student describes a seed as being "small," the teacher relates the aspect of size to the property of seeds as being the most condensed stage of a plant. Coconuts are also seeds! By contrast, some seeds are so small that they can only germinate in combination with the appropriate fungus. When it comes to sprouting, it is important to look at the storage capacities of seeds and how long they can retain their ability to germinate. Some may still sprout after several thousand years, such as the seeds of dates that were found in a desert during an archaeological excavation. Other seeds can only retain their capability to germinate until the next growing season. When characterized as "edible," we see that most of the seeds under scrutiny can be described as "kitchen seeds"; seeds used in bread and main dishes, herbal seeds, oil seeds, nuts, peas and beans, seeds for beverages, etc. This provides the opportunity to discuss seeds as a source of nutrition, their role in world trade and agricultural policy, as a component of cultural heritage and as an object of patenting.

The seed, the part of the plant smallest in size but biggest in potential, has become a key to understanding many processes in nature and society. The students' own observations are thus linked to other relevant facts and understood in a larger context. We take up the theme of germination once again at the end of the teaching period, when we discuss the process of pollination and fertilization.

After this group exercise of making observations, the students are now asked to choose two or three different seeds and to study these individually through drawing. The art teacher gives an introductory instruction with regard to the use of drawing materials and reflects with the students on how a seed manifests itself through color, shape and texture. Once they have drawn the seeds of their own choice, the students write a short text regarding the seeds as the first stage of plant growth. At the end of

the day all drawings are posted on the wall and are jointly discussed before the next teaching session.

The same procedure – observe, describe, discuss, draw and write – is repeated with the other parts of the plant during the following days. At the end of the period we have studied roots; cotyledons; the forms of leaves, starting from the first leaves on the stem up to the last; flowers and fruits; and we have discussed the role and function of each part of the plant in nature. Every student has made a series of drawings and texts that is an expression of his or her understanding of the plant's development and its role in nature and society.

Figure 1.

Second session: flower of the day

Next to drawing the plant's stages of growth, students make drawings of the plant as a whole. Here the challenge is to draw the parts of the plant in proportion to each other, identifying all the details. Some details, such as the stigma and stamen, are drawn on an enlarged scale, next to the drawing of the whole plant. Finally they write the name of the plant, family name and the location where it was found. The drawings are posted on the wall and they become the point of departure for a new exercise the next day.

Figure 2.

Figure 3.

These exercises are informed by the idea that students thus train their observation skills, become familiar with plant growth and with drawing and painting as means of expression. Through the daily artistic practices, the students develop their skills, and when looking at their own drawings they see for themselves how much progress they make in just the course of a few days. They also learn from studying each other's drawings, in that way becoming aware of an individual perception of plants.

Third session: painting exercises

The next step is to look at the plant in the context of the landscape. After having worked with sharp pencils and having made detailed studies, the students now get to paint large surfaces and lines in the landscape, using color paints and big brushes. First the students do an exercise in which they experiment with different colors: through studying the meadows and trees they discover all the different shades of green to be found in the landscape. How much red is needed to depict the pine trees, and how much yellow is there in the birch leaves? Just by looking at the color, one can distinguish different types of forest: a cultivated spruce forest with its monotone

green color stands in contrast to the deciduous bushes beneath with their wide array of greens. Quite often the students say that it was not until this moment that they become aware of all the different shades of green in nature.

The next painting exercises focus on how all the colors of the flowers surface in the sea of green. We look for places in the landscape where we can sit down and immerse ourselves in this abundance of hues and be inspired to make new color studies. We discover that we find the most flowers, and therefore colors, at places where people have kept the land open. The students study the quality of the meadow from a biodiversity perspective, by looking at the variety of grasses and flowers, and also at the range of insects and birds that are to be found there. Nowadays the flower meadows are no longer easy to find on the island with only two farmers left; often we must resort to edges of a field or abandoned agricultural fields that are not yet completely overgrown. The fact that the farmers play such a key role in preserving the richness and diversity of cultural landscapes, is something most students have never been aware of.

Fourth session: walking through the landscape

Going on a daily hiking excursion can also be a way to learn about the landscape and its plants, which is the focus of our study. We can find rocks and fossils that in their own way tell about the geological structure beneath our feet. This provides important factual information in regard to abiotic factors affecting vegetation. We see old farms about to give way to rapid emerging scrublands. We might come across an old trail leading to what once was a meadow, but where now junipers spread and flourish. The students learn to interpret the landscape as a testimony of the way it has been used in the past. Young trees and overgrown berry bushes bear witness of change in living conditions and former settlement. Likewise, the farmer's fields testify of a change towards monoculture, whereby farmers cultivate just a limited number of crops.

During the excursions we also study biotopes and different types of trees. The students are asked to choose one type and prepare a presentation for the whole class on that particular tree, its history in the landscape, and its use, seen in a cultural-historical perspective.

Through drawings with charcoal and pastel chalks the students study selected trees and their environment. They observe the characteristic shape of a tree and its growth pattern, while at the same time familiarizing themselves with yet different kinds of artistic materials and ways of expression.

In the course of these excursions students are also asked to look at the main plant families in the flora. The flora in the old cultural landscape is so rich that it allows us to study several related plants in a dozen of the most common plant families. We take botany books with us on the excursions and use identification keys to identify

unknown plant names. During the course, the students gradually improve their skills in identification of plants. For instance, they become able to tell whether certain characteristics of a plant they have drawn could be a key to recognize other plants of the same family.

Figure 4.

Art and botany: results and discussion

On the background of the botanical excursion described above, we now want to try to shed some light on the reason for and outcome of such an interdisciplinary and rather intensive course. In addition to our efforts to fulfill the concrete learning goals in biology, we also want to give the students the possibility to develop their own relationship to plants, to the landscape, to color and form, to their own skillful potential and to the larger questions that arise with regard to sustainability. We will discuss this as part of our earlier stated aim of developing innovative teaching methods. The students' own evaluations of this approach will form the basis for the discussion.

Training of observation skills

In Louv's description of young children that are disconnected to nature, he maintains that they have a diminished use of the senses and attention difficulties (2008). The context of the classroom, he argues, limits the extent and quality of observations which can be expected from the students. In his book *The Wholeness of Nature* Henri Bortoft claims that "science students are often not interested in observing phenomena of nature; if asked to do so, they become easily bored. Their observations often bear little resemblance to the phenomenon itself" (Bortoft, 1996, p. 2). By leaving the classroom and doing drawing and painting outdoors, the students are more easily engaged in first hand observation. Through finding specific developmental stages of plants, studying them, describing them together with their peers, and by drawing them and mixing colors that match the hues in nature, the students train their senses. When you draw a plant, you do not look at the plant only once, but hundreds of times. There is a constant interplay between observing, trying to put the plant on paper, comparing the drawing to the real plant, and subsequently making adjustments. In this way you are engaged in an ongoing dance between perception, assessment and response. The cause of the students' engagement and apparent lack of boredom seems to be that they enter into a kind of dialogue with the plant. The activity of drawing ignites a curiosity and desire to discover more, which means that the drawing of the plant becomes more and more nuanced.

When the botanical excursion was evaluated in 2005, six months after the course had taken place, the students were asked whether they noticed any differences in the way they looked at nature after having participated in the fieldwork. Here are some responses they gave with regard to their involvement in the observation exercises:

> "I feel I have developed my observation skills considerably and have become much more aware of all there is in nature around me."
>
> "I have learned to observe in a new way; green is no longer just green."
>
> "You see so much more."

These responses do not necessarily indicate that the students will develop a closer relationship to nature in the long run, as a result of partaking in this course. Yet it is interesting to note that the students tell us – six months after the course – that they see more and have developed their awareness of the world around them.

The idea behind the drawing exercise is to reconnect the students with nature and provide them with new experiences, beyond what they already think or know. Goethe put it this way: "What is most difficult? That which you think is easiest, to see what is before your eyes" (Goethe, *Xenien. Aus dem Nachlaß,* 45). The students really have to

put effort into perceiving the world in a more active way, yet they say that they find it enriching – "the green is no longer merely green," as one of the students says. They experience that the way you perceive things does not necessarily always have to remain the same. Rather, it is something that can change over time and can be developed, while it also can help you to understand the viewpoints and experiences of others. Moreover, it implies a sense of taking responsibility for how we experience the world. The world is not static nor something given; it is formed in interaction with our observation skills. Biologist and philosopher Humberto Maturana states that we become more fully human when we acknowledge "that we do not see the world as it is, but as we are" (cited in Senge, Scharmer Jaworskki & Flowers, 2005, p. 203). This focus on immersing oneself in the study of a phenomenon, and simultaneously becoming aware of one's own share in it, has been characterized by Dahlin (2001) as hermeneutic phenomenology. We will now focus on some of the ways in which drawing can contribute to this.

Phenomenology through drawing

The students draw for several hours a day. The coordination between the eye and the hand requires presence and the students usually tend to work in silent concentration. When asked to give feedback on drawing as a tool for learning ("What benefits did you have from drawing?"), some students wrote:

> "I learned a lot more about what I have drawn, compared to what I would have learned otherwise. The organisms become more alive, in a way."
>
> "I would say that I acquire a more profound view, for example of flowers, when I draw them. The more you draw, the better you understand."
>
> "Drawing helps you to think in a completely different way, and I feel I develop a deeper relationship with the object."
>
> "Due to the fact that I had the opportunity to focus on drawing for a whole week, I feel I have developed quite a bit, and I would like to continue to draw, because I now see that it helps me to understand the object I am observing."
>
> "Through this [drawing], 'art' allows you to gain a better understanding and *Gefühl* for science."

Through the work with drawing, the students feel that they experience more of the plants and understand them better. Dahlin (2001) holds that it is very well possible to work scientifically and at the same time emphasize the aesthetic dimension of learning. The aim of such an approach, he writes, is not merely to appreciate the beauty of natural phenomena, but also to understand them better: "Nature 'speaks' through the gestures it makes in its forms, colors, sounds, smells and tastes. From

ancient times, human inquiry has tried to understand this 'language' of Nature (ibid., p. 454)." Being able to "read" nature and develop an understanding of life's processes is termed "ecoliteracy," seen as a fundamental competence for working with sustainable development (van Boeckel, 2006; Orr, 1992; Stone & Barlow, 2005). Stimulating such "reading" of nature in biology should be as important as reading scientific literature.
When drawing, the students create an image based on their own observation. We will now look more closely at the dynamic interplay between observing and drawing.

Finding one's own "signature" and becoming aware of the expression of others

The first drawing the students make are all of the same plant species, usually the Meadow Buttercup. One can recognize the plant in each and every drawing, though none of them are alike. Each drawing has its own expression or "signature," telling something not only about the plant, but also about the person that held the pencils. Each image bears an expression of its author. One student wrote: "Illustrations become more personal; it often takes quite a long time to make them, and through that you are drawn more and more into the process." Sørenstuen (2011) points out that doing art activities in nature can enhance a sense of belonging and knowing who you are.

When another student writes that "it stimulates one's imagination," he gives expression for having participated in creating something, or even though they are trying to copy what they see. Draftsmanship (reproducing objects through drawing) is a part of art education which is not emphasized today. During the botany work, some students say that it is a relief not to feel the pressure to be inventive when they draw and paint. Some lose their fear of using artistic tools. One student writes: "Learning has never been problematic for me, but I didn't look forward to the drawing!" And he then adds: "I dare say I've gone through a drawing metamorphosis and now I almost have the feeling that I am able to draw." The drawings can thus become a concrete manifestation of improvement: "I think I have really developed my drawing skills, as I can tell from my drawings." Making learning visible to themselves and to others enhances the ways in which students communicate among themselves. When they relate to each other through the images they have made and the process that gave rise to them, this quite naturally leads to a stronger sense of community. The students indicate that they, as a result, see (more) and also feel that they are seen by others.

Acquiring competencies and learning through "identification"

The acquired competencies described above include a basic acquaintance with the plant's development stages as well as with the system for plant classification. Being able to recognize the 12 most common plant families and over 20 tree species on the island with and without the help of identification keys is an important part of the final exam. Here we present a few examples of the feedback that students gave with

regard to their own learning (in answer to the question "evaluate your own learning process during the field excursion"):

> "I think I have learned a lot about flowers/plants during this period. After this period, I have learned to recognize tree and plant families … It's amazing how much we have learned in such a short time."

> "I feel in general that I have learned an enormous amount during this trip, thanks to the focus on hands-on learning. I think it worked very well that we started off with focusing on theory, followed by drawing, or teaching oneself, one could also say, and through the field trips."

We often see that students become rapidly adept at identifying plants. The drawing of the plants is a tool for them to identify not only the plants they have worked with, but also plants that are taxonomically related.

According to philosopher R. Brady (2000), the ability to identify ("recognize") a plant is a form of acknowledging. For field botanists, forest service managers, and people working in similar fields, the skill of being able to identify may be self-evident, but for people who have not acquired this competence it may appear as a special talent or some extraordinary ability. They would not easily regard it as something they could learn to do themselves. He goes on to state that this way of observing – whereby seeing is simultaneously identifying – is a widely acknowledged competence in the art world. On the basis of examples from how art can be perceived he shows that "Recognition grasps the whole – not summing up, but integrating the parts" (Brady, 2000, p. 3). This is confirmed as well by our experience of the way in which students acquire knowledge when drawing the plants.

The students become familiar with the use of plant identification keys, but their knowledge about plants is acquired not by reducing the plant to some isolated features. Their recognition of the plant does not stem from analytical deduction – the adding together of separate properties. It is more like an intuitive leap from sensing the wholeness in all of the details. They recognize the plants out of a comprehensive picture they have attained through drawing.

In addition to having acquired the ability to recognize the plants, the students also mention that their relationship to nature has changed. Many write that they have become more interested in nature, and that they experience it in a different way. According to both Jokela (1995) and Sørenstuen (2011), "an increased sensitivity" is directly related to doing artistic exercises in nature. One student wrote: "I became more aware of nature," and another student stated: "I have gained a tremendous respect for life." The comments testify of a heightened appreciation of nature, of the kind Russell problematized (1999).

Learning about nature and the current challenges to society

As we mentioned in the description of our teaching about seeds, our aim is to develop links to the larger issues of our time such as aspects of sustainability. "Sustainable" has become a frequently used (and also misused) term in the public debate. We asked the students to what extent they thought the week with botany had contributed to learning about sustainability. Here are some of the answers they gave us:

> "We have gained a lot more respect for nature and plants. We also learned about how dependent we actually are on them."
>
> "I would say that this has been sustainable in the sense that I have become more interested in nature. We have learned about the plant and about the relationship between what humans do and its effect on nature. This will (as I see it now) make me more mindful of the consequences of my behavior."
>
> "I have started to connect the dots in this period and this is a basis for long-term thinking."
>
> "I feel I have learned a lot about important aspects of the world today. Through learning about plants during this period I became interested in preserving biodiversity. I found it very interesting to tie the themes of this period to subjects in the humanities and society at large, because it helps to put everything in a wider context."

Many issues that were discussed during the course arose from the questions the students came up with, for example: What kind of implications will genetic modification have on biodiversity? How do soil conditions and vegetation affect the climate? These are questions that ask for a broader perspective. Wals (2010) suggests that by now we have acquired enough experience in environmental education to know that merely raising awareness is not enough to create the conditions for people to change their behavior. Russell (1999) looks for a bridge from people's experiences of nature to their setting value on nature, as a foundation for sustainable living. We would argue that a positive and artistic focus on plant development and diversity can create conditions for people to engage in the major environmental issues of today. Like Mantere (1992), we argue that a genuine understanding of nature and motivation for a sustainable lifestyle is based on meaningful contact with nature, and that this can often be enhanced through aesthetic experience which may in turn activate the affective dimension in us.

Summary

Today's curriculum in Norway is rather flexible. It allows for method experimentation and trying out new approaches. Moreover, one of the explicit learning goals

formulated both for first and second year courses in biology, is to encourage teachers to take students out of the classroom to do fieldwork. The core of the educational approach presented here is to go into the field, using methods stemming both from art and the natural sciences. As we stated in the introduction, in education it is not exceptional to regard science and art as two opposites. The common idea is that the first one is based on logical, precise steps, while the latter is associated with a subjective inspiration and making intuitive leaps. In this article we described *one* example of how a combination of these apparently distinct disciplines can help stimulate the students' engagement with and interest in natural science and enhance their development, both academically and personally. Moreover, on the basis of the feedback we got from the students themselves, we infer that students establish a closer connection to nature and become more aware of our collective responsibility to take care of it.

We have presented an array of responses given by students from two different classes which serves to underline the potential of such an interdisciplinary educational approach. Additional study, including, for example, the execution of more in-depth interviews, could provide more insight in what the students learned and what they possibly gained from shifting from practicing one approach to the other. The feedback we received has been important to further develop the teaching plan. It gave the impetus to strengthen the theoretical underpinnings of our teaching. We claim that if we are to confront the challenges with regard to creating a more sustainable society, students will need both to acquire factual knowledge and to attain ability in expressing themselves in their own unique and personal ways. The artistic process can strengthen the students' aptitude to be more aware of nature, as well as their creative skills. At the same time it can also strengthen their relationship with and connection to the living processes of nature.

Looking back, after several years of experience with this teaching practice, we now want to share it with others. We find that the teaching approach in its core is actually rather basic and self-evident. When we want to study plants, we go where they grow, to the environment and the cultural landscape where they belong. When we want students to be curious about plants, we make arrangements so that students can interact with the plants through drawing and painting. This tends to generate curiosity and wonder, not only about the plants, but also about their own and other's expressions of what they see. In addition to achieving the learning objectives, we hope students will leave the island being more attentive, more aware, and more sensitive, not only towards each other but also to their place in nature and the world at large. In his written evaluation of his experience in the summer of 2015, a 17 years old student commented as follows:

> I have learned an incredible amount in the time we have been here, about how complex all life around us really is and how little we care for the incredible which is right beneath our feet. I have listened with eagerness because it has

been so interesting. What struck me most after taking in what we have learned in this period, is how much plants are like us. I am thinking especially of development and procreation. It has simply become clear for me that plants are living organisms, they too! I feel that we can learn something about ourselves by studying plants. The lessons have been an awakener for me in many ways. By being so thoughtless as we are, we are in fact sawing off a very fragile branch. And this is the branch we ourselves are sitting on. This week has been fantastic. I come to have this with me a long, long time.

References

Blair, D. (2009). The child in the garden: An evaluative review of the benefits of school gardening. *Journal of Environmental Education, 40*(2), 15-38.

Brady, R. (2000). Perception: Connections between art and science. Originally presented as an invited paper, "Perception and hypotheses of perception" at a conference sponsored by the British Museum of Natural History (London, April 4 to 7, 2000). Retrieved from: http://www.natureinstitute.org/txt/rb/ art / perception.htm

Boeckel, J. van (2006). Forget your botany: Developing children's sensibility to nature through arts-based environmental education. *The International Journal of the Arts in Society, 1*(5), 71-82.

Dahlin, B. (2001). The primacy of cognition - or of perception? A phenomenological critique of the theoretical basis of science education. *Science & Education 10,* 453-475.

Dahlin, B. (2002). Den tunge vetenskapen: Aspekter av blivande NA-lärares föreställningar om naturvetenskap. *Pedagogisk Forskning i Sverige 7*(2).

Dewey, J. (1938/1997). *Experience and education*. New York: Touchstone.

Dyment, J. (2005). *Gaining ground: The power and potential of school ground greening in the Toronto District School Board*. Toronto: Evergreen.

Jokela, T. (1995). From environmental art to environmental education. In M.-H. Mantere (Ed.), *Image of the earth: Writings on art-based environmental education*. Helsinki: University of Art and Design, 18-28.

Kvale, S. (2006). *Det kvalitative forskningsintervju*. Oslo: Gyldendal Akademisk.

Lieberman, G.A., & Hoody, L.L. (1998). Closing the achievement gap: Using the environment as an integrating context for learning. Poway, CA: SEER.

Louv, R. (2005/2008*). Last child in the woods. Saving our children from nature-deficit disorder*. New York: Algonquin Books.

Mantere, M.-H. (1992). Ecology, environmental education and art teaching. In L. Piironen (Ed.). *Power of images.* Helsinki: INSEA Finland, 17–26.

McNiff, J. (2002). *Action research: Principles and practice*. London: Routledge Falmer.

Orr, D.W. (1992) *Ecological literacy: Education and the transition to a postmodern world*. Albany, NY: SUNY Press.

Russell, C.L. (1999). Problematizing nature experience in environmental education: The interrelationship of experience and story. *Journal of Experiential Education 22*(3), 123–137.

Senge, P., Scharmer, C.O., Jaworski, J., & Flowers, B.S. (2005). *Presence: Exploring profound change in people, organizations and society*. London: Nicholas Brealey Publishing.

Skår, M., & Krogh. E. (2009). Changes in children's nature-based experiences near home: from spontaneous play to adult-controlled, planned and organised activities. *Children's Geographies 7*(3), 339–354.

Stone, M., Barlow, Z., & Capra, F. (Eds.) (2005). *Ecological literacy: Educating our children for a sustainable world*. San Francisco: Sierra Club Books.

Sørenstuen, J.E. (2011). *Levende spor: Oppdagelse av kunst gjennom naturen og naturen gjennom kunst.* Bergen, Norway: Fagbokforlaget.

Wals, A. (2010). *Message in a bottle: Learning our way out of unsustainability*. Inaugural lecture (May 27th 2010), Wageningen University, Netherlands. Retrieved from http://edepot.wur.nl/157118

Wells, N.M. (2000). At home with nature: Effects of 'greenness' on children's cognitive functioning. *Environment and Behavior 32*(6), 775–795.

Østergaard, E., Dahlin, B., & Hugo, A. (2008). Doing phenomenology in science education: A research review. *Studies in Science Education 44*(2), 93–121.