



Part One – how can nature inspire?

It's the end October now and a bit chilly. But let's have a look outside. Have you noticed that the leaves have turned brown and starting to fall down? Did you see the squirrel collect nuts from the beech? It makes you wonder. How did the tree grow those nuts and how does the tree know it's time to shed the leaves? The more you look, the more questions starts coming.

Nature has evolved over 3.8 billion years into model of sustainability. Nature recycles waste efficiently, uses renewable power from the sun, is resilient to sudden changes, is adaptable over time to new conditions, and self regulates through feedback. What if we could use the operating principles found within nature to rethink how we live as humans? To flourish without damaging the natural ecosystems we depend upon for our survival?

Nature-inspired learning takes us on a journey to discover the principles which makes nature a model for sustainability. It offers an opportunity to explore how these principles can help tackle some of the greatest challenges facing humanity today such as climate change and increasing levels of waste and pollution. And finally empowers students to apply their new competences to create with real solutions that work.

The BioLearn project helps young people think about what sort of future they would like to live in. How can they contribute to that future? Can it become reality? BioLearn challenges traditional assumptions about how things are made and how entire economies are managed. BioLearn is about re-thinking the future, a future that is already happening because many companies are already fascinated by nature and are innovative enough to create 'bio-inspired' design.

Subjects

Subjects including science, technology, engineering and maths (STEM) including offers the ideal vehicle for this inspiring and engaging approach. Biology teaches us about how nutrients cycle in a woodland and can help us see how technical nutrients can cycle in produce design. Chemistry shows us how nature creates infinite shapes and forms using simple formulas with degrade back into harmless elements and compounds. Physics demonstrates how forces can be harnessed to reduce energy use. Technology and engineering can use the science of nature to build new products, processes and systems which elegantly mirror nature's sustainability.

Bio- whattt?

Some people don't believe this 'bio-thing' because they don't really think that we depend on nature...don't believe it? Just breath in... we are nature and we depend on nature!

1. What are the principles at the heart of BioLearn?

Whenever we take a walk in nature, we can observe how it functions. If we look closely we can observe that the same principles are repeated

What's in a name?

Include definitions of nature -inspired learning here and different terms.

Bio-inspired

Bio-based

Bio-learning

Biomimicry

Learning from nature

Bionica



again and again; these are the basic operating conditions which make nature sustainable. We call this nature-inspired learning.

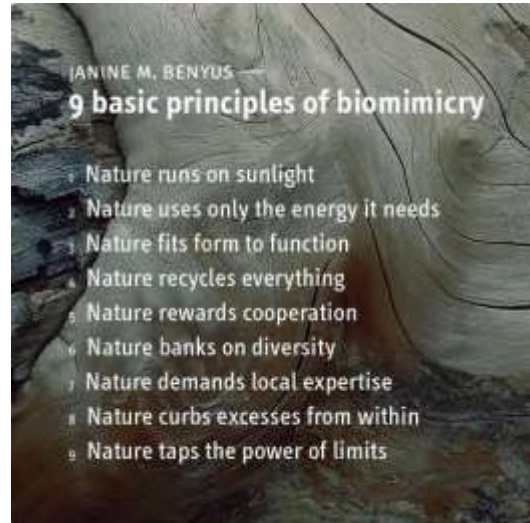
Learners who are connected with nature will discover that nature can be a mentor, offering insights that inspire the building of a brighter future. Inquiry-based learning can be utilised to foster inspiration and to stimulate a desire for understanding.

Background

In the late 1990s, a revolutionary idea arrived on the scene, shepherded by an innovative thinker and nurtured by scores of curious and passionate individuals. In the book *Biomimicry*, Janine Benyus introduced the notion that we could be better off by simply mimicking the ways problems are solved in nature; this idea has proven transformative.

In the book (*Biomimicry* 1997), Benyus lists nine principles that govern and define how nature operates.

Below we explain more about the 9 principles.



1 Nature runs on sunlight

Nature uses the sun the main source of energy. Organisms use the heat and the UV radiation from this never ending source. So we can say that nature is powered by sunshine. Why don't we do the same and save our planet from heating up? Humans use oil and coal, these sources are not renewable and the burning of it creates too much CO₂ which is responsible for climate change. If we were wise to mimic the ways of nature, we would rely solely on renewable power.



2 Nature uses only the energy it needs

Nature takes only what it needs. So why don't we do the same? Our economy is focussed on maximizing output and is therefore a big energy consumer. We transport food around the world because that is cheaper. Only money seems to count in a lot of decisions. How can we learn to optimize the performance of goods and services to sip energy rather than gulp it?



3 Nature fits form to function



A tree is rooted in the ground to draw water and nutrients from the soil, it spreads its branches and leaves wide to increase its surface area and soak up the sunlight it needs to produce energy and grow. Seeds are lightweight and equipped with a sort of umbrella to be able to float in the air. Nature creates its design from the function it should serve, so should our buildings, transportation system and schools.

4 Nature recycles everything

There is no 'away' to throw things..... Think about it, everything produced in nature is biodegradable, there is no waste. Yes, there can be abundance (an overshoot of leaves, flowers) but that all serves a purpose and will be food and nutrients for others. Once the natural life of a pinecone has come and gone, it breaks down into essential elements and compounds that are repurposed.

5 Nature rewards cooperation

Yes, we see competition in nature, but only when it's impossible to avoid; in general it just costs too much energy. On the other hand, very little in nature exists in isolation. So what is the interaction? Plants cannot reproduce without pollinators, which in turn feed on the nectar they collect. Ladybirds feed on lice and help plants to stay healthy. Nature works cooperative because the benefits all.



6 Nature banks on diversity

Diversity is one of nature's best insurance policies. It create a sort of 'back-up' not to depend on only one food source, or to depend on only one strategy to spread seeds or to defend against predators. We also know that species with limited genetic diversity have more difficulty adapting to environmental change, and that ecosystems rich with diversity are more stable.

7 Nature demands local expertise

Nature's systems are inherently local and do business locally. Certain species thrive under specific conditions; local and regional weather patterns matter, as do the types of soil, air particulates and water temperatures. Relationships are created locally and local sources are used. Of course a lot of birds travel long distances but have you seen them take their food with them?

8 Nature curbs excesses from within

Ecosystems will always try to keep the balance. More mice? Then you will see more owls appearing feeding on the mice and keeping the population in balance. Forest fires are a great example of a natural phenomenon that renews and refreshes, cutting down on excessive growth and allowing for regeneration. But we also know that every natural system has a tipping point where the balance is no longer useful and it will flip to a new balance.





Let's be honest, unlimited growth on a finite earth is not a good idea. All living things are governed by limitations; age, climate, population density and many other factors determine how species and systems develop. Growth in nature is only seen in a young stage. Eventually every organism will grow-up.

Janine Benyus' simple list of natural principles shows us that there is an endless amount we can learn if we just pay attention to our surroundings.

2. Nature inspired innovation is not new

Since humans first started to hunt, we have been learning from nature (think off the shape of a spearhead...it is mimicking the beak of a bird). Leonardo da Vinci spent many hours observing how nature worked and designing miraculous inventions based on his discoveries. He wasn't very successful in building an airplane but the reason we are able to fly around the globe today is because Leonardo da Vinci observed how birds used their wings to create lift and wondered if we could do the same.

A significant number of employers already rely on nature-inspired approaches to innovation for the success and further development of their products and services. This is true in economic sectors and industries ranging from technology (e.g. Google and Apple's use of neural networks, a nature-inspired artificial intelligence technology), medicine (e.g. immunotherapy, a nature-inspired medical intervention), infrastructure, transportation, manufacturing, and more. The approach is known in industry and academia as "biologically-inspired" innovation or "biomimicry" (or some variant thereof). Nature-inspired innovation is already a major driver of economic growth worldwide. One study estimates that nature-inspired innovation-related employment opportunities are producing over 1.5 million jobs in the United States alone.

The company Parker Hannifin, for instance, a Fortune 250 global leader in motion and control technologies, specializes in aerospace, climate control, electromechanical, and filtration engineering solutions. They recently used nature-inspired innovation in the development of industrial hoses now used in the cement industry. Their Vice-President of Technology and Innovation explains the company's calculation: "You don't want to invest in solutions that have to be abandoned in the future," Peter Buca says. "Nature offers solutions that are practical and sustainable. As an industrial company, understanding what value is important to us."

Explore a wealth of case studies

BioLearn.eu contains a wealth of case studies and examples...exploring them with students opens their eyes to a new world of possible solutions.

Looking to the natural world for innovative ideas is a fixture of the research and development efforts at Airbus. Airbus pursues research into shark skin as a model for reducing drag on aircraft through the application of micro-texture on airplane bodies. They also consider birds like albatrosses as models for pursuing improvements in wing design. Airbus's innovation manager in flight physics, Lee-Ann Ramcherita, explains that "[u]nderstanding how insects, birds or bats detect and respond to fluctuations in the surrounding air flow may potentially help us identify opportunities to



apply on our aircraft.” Industries are increasingly looking to nature for innovative ideas, and looking for employees that can help lead the way there.

As Steve Jobs put it, in an interview shortly before his death: “I think the biggest innovations of the twenty-first century will be at the intersection of biology and technology.”

3. How can BioLearn fit into my classroom?

Because it leverages the wonder of the natural world and all it has to teach us, nature-inspired learning is both fascinating and solution-oriented, an extremely potent combination. This is why nature-inspired education creates the observed optimism, ambition, and ultimately a student sense of empowerment. As Angela Nahikian, Head of Sustainability at Steelcase has put it: “Biomimicry offers a fresh lens for all the dreamers and doers remaking the man-made world.”

The net result of enriching school subjects using nature-inspired educational approaches can be a dramatic increase in students’ appreciation for the world around them, their interest in creating positive change in themselves and society, and in pursuing further education and careers to help them do so.

Three reasons to use nature-inspired learning.

- Nature-inspired education does not require new content be added to the curricula.
- A wide variety of academic ideas and subjects can be approached through nature-inspired learning.
- Academic ideas and subjects are explored in connection with the engaging context of the natural world.

Nature-inspired education has the power to generate interest and enthusiasm in teachers just as it does in students, revitalizing their energy and teaching practice. Teachers respond much like students to having subject matter enriched by a nature-inspired approach. Years of working with teachers through workshops and professional development has made this fact abundantly clear. Here’s a small sample of the things teachers say after learning about and using Nature-inspired education approaches:

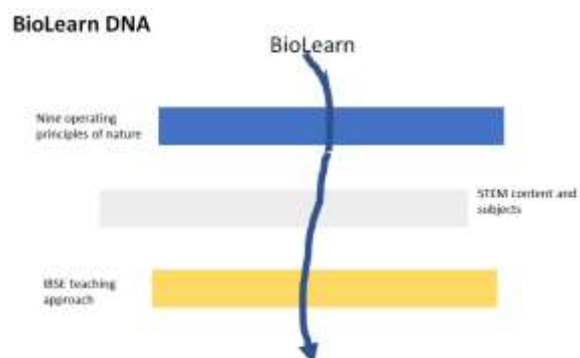
“I feel that this class has offered me a mind blowing professional development experience! A tsunami inside me is bursting to share all that I learned in our class with my students.”

Lillian Ortiz, IC Community School, Oakland, California

4 The pillars of the project (BioLearn)

The pillars of our project are

- Stem/science education
- 9 principles of Janine Benyus
- IBL (inquire-base Learning)



5 What is STEAM?



STEAM is an educational approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking.

Tackling some of the world's greatest challenges necessitates cross-disciplinary thinking; STEAM offers this.

- An art teacher exploring shading has students find something living or once-living around the schoolyard to sketch, focus in on a detail of it, and sketch it at different times of day.
- A teacher exploring the scientific method has students observe natural phenomena outside the classroom over a period of time, preparing questions about features students notice about Nature and what functions these features might serve (e.g. *Why do squirrels have big, bushy tails? Why are tree branches often crooked? Why purpose do our toes serve?*). Students then choose one question about which to design an experiment and test a hypothesis about a feature's possible functional role.
- A physics class learning about atomic interactions reads research papers about how geckos scale smooth glass applying van der Waals forces.
- Students exploring climate change solutions in an afterschool chemistry club make carbon-negative cement out of car exhaust fumes, based on a chemical process coral use to build their stony reefs.
- Students in a maker lab create prototypes of car tailpipes that remove outgoing pollutants, whose design is based on the students' research into how marine sponges filter food out of seawater, how spider webs bend towards flying insects (due to electrostatic attraction), and other biological strategies for filtering.
- A teacher exploring the material science and structural engineering concepts of stress and strain has students examine a tree in the schoolyard for clues as to how it withstands the passing breeze, despite its massive canopy.
- A teacher exploring the mathematical ideas of volume and mass has students look up from their desks, textbooks, and chalk/white/smart boards, and look out the window or go outside to determine how to weigh a cloud passing over the school.

This optimism about what's possible through nature-inspired learning, and what students aspire to be and do with their lives, is one of the most important potential benefits. Without hopefulness and ambition, what can humankind really achieve? And yet students too frequently come away from their education feeling disempowered, the very antithesis of why we educate our young in the first place.