The elegant science of life: Biology boxed in the classroom?

By Geetha Iyer | Aug 21, 2012

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Introduction

Observation should become the foundation for learning biology. Children need to be moved outdoors for learning. Instead of textbooks, there should be classroom libraries, and perhaps, textbooks should be discarded altogether. Importantly, children need to be given time for learning.

Here is some recent, assorted news making headlines in the field of biology:

It is time to stop thinking we are the pinnacle of evolutionary success—chimpanzees are the more highly evolved species, according to new research.

Over the last half-century, researchers have found that mineral surfaces may have played critical roles organizing, or activating, molecules that would become essential ingredients to all life.

One single molecule determines how stem cells in the hair follicle develop and cells that should give rise to hair can instead give rise to mammary gland cells in mice if they lack this molecule.

The first baby rhino ever conceived by artificial fertilization was born at Budapest Zoo on 23 January, 2007.

Bacteria in the world's oceans can efficiently exploit solar energy to grow, thanks to a unique light-capturing pigment.

Genetic analysis of an obscure, worm-like creature retrieved from the depths of the North Atlantic has led to the discovery of a new phylum.

From Karnal to Coimbatore, genetically modified crops are becoming a matter of great concern for Indians worried about safety as well as loss of biodiversity.

Researchers have identified a gene that affects both a person's sensitivity to short-term (acute) pain and their risk of developing chronic pain after a kind of back surgery. (Source:www.ebiologynews.com)

A look at these statements is enough to make a person's head spin. Yet it is exciting! It is so exciting that somehow teachers want to share it all with their apprentices in school without any notion of how it might be received or what preparation is needed for receiving it. Therefore we have not only just plain old biology being taught at school, but also its new-found branches such as biotechnology. In the coming years one could well see biochemistry and bioinformatics rubbing their noses (or should I say molecules) with biology. Who is to question the relevance of such fancy information as a tool for education?

There is a quiet revolution happening in this world of biology. It is so closely entwined with life that it has not caught the attention of humanity at large. But it is there for anyone who has the time to see it. In the quiet and comprehensive unfolding of biology's new frontiers, we are seeing the beginnings of designer-organisms, driven by the force of nano-technology. And these are not just laboratory bacteria or molecular viruses and prions, but larger animals and soon humans! .They are designed to be small, efficient and chemical rather than biological! We may not be able to stop scientific discoveries and inventions but surely we can empower our children to meet them. Are we equipping our children to meet this eventuality? The key lies in meaningful education and biology education will no doubt be significant in the coming years.

In this technology driven world, where there is this obsessive and compulsive longing for science education, what biology should children be learning in schools? How should they be learning it? For a child, the beginnings of scientific experience and inquiry is biological; from it follows experience of all other sciences. This is perhaps a very reductionist way of looking at science at a time when integration is what would be of greater importance. But biology education as it exists now in our schools is reductionist to the core. Examine it carefully and this is what you will find.

Fragmented organization of concepts

The diversity of this science makes the subject quite complex in composition. Traditionally the vast complexity was sorted out

by dividing it into botany and zoology and then everything else was somehow or the other fitted into the two divisions. What did it do to the learning of the subject? It fragmented the concepts that otherwise unify life. A classic example of this fragmentation lies in the way physiology is dealt with. We have plant physiology and animal physiology; and then human physiology. Ask a high school student simple questions about respiration and eight times out of ten you would get the answer that plants do not take in oxygen and that they give out carbon dioxide—it is only animals and humans that do so. They say that plants take in carbon dioxide and give out oxygen. However, you would never find the essence of this most significant process in their answers, which only reflect the confusion about breathing and respiration. Ask any adult what an insect is and you would get answers ranging from earthworm to centipede to spider. What I found even more shocking during the course of my research was that for many a student and adult, tigers and lions were the same organism! How little biology is understood or learnt!

Repetitive content

Examine the biology curriculum of any school today and be sure you would be left with confusion about its intent. Why on earth is a flowering plant, its parts and functions a topic for learning from primary to middle to secondary school? It seems as though if you were to take away the morphology of flowering plants, taxonomy, photosynthesis and transpiration, there is no botany to be learnt! This is a tremendous injustice to plant biology. It never allows a student to understand how well a plant adapts to the changing environment, to survive the harshest of situations through the simplest of means. If at all any science can teach children the basic truth that problems can be overcome when solutions are kept simple, then it is this biology of plants. There is elegance in the way organisms (be they plants or animals) solve the problems of survival, a concept understood by very few in school. For most it is effective brainwashing into believing that botany is the most boring of sciences. And indeed, why not? There appears to be nothing to learn beyond plant parts and functions! And adaptations are taught like rules learnt in an English grammar class! At the end of it all not many teachers or students learn botany that has any significance to their life.

A contextual learning

A syllabus merely outlines the content. Some school boards give a concise scope of the content. But the life and soul has to be provided by the teachers. And for doing this, teachers today turn to the only easily available source—the textbooks that give a lot of flesh but no soul to the curriculum.

The result? Students learn examples they cannot observe and therefore cannot understand. I still have vivid memories of my ecology lessons. I was taught woodland ecosystems with examples I could never relate to, since the examples were all alien! The library had books (and I have noticed that most schools still have them) that had only American or African examples; these were dutifully reproduced in Indian textbooks and teachers still rely heavily on them. Why do we have such a situation? The biology syllabus has hardly paid any attention to these simple yet important aspects—that the content should be designed to help learn biology from one's own neighbhourhood. Nor does there seem to be any kind of textbook evaluation that schools could take note of, while obtaining their teaching resources.

Lack of relevance

The selection of the content leaves a lot to be desired. Most students stop studying biology after high school. Would they have learnt anything relevant for life from biology? This is doubtful. When asked to point out where the liver is located, several primary school teachers of science got it wrong! Many students opt for biology with the aspiration to study medicine. What relevance does biology have for them? Is there any continuity or purpose as a student moves from one level to another beyond an opportunity to improve memory? There are innumerable topics that are relevant for life that can be learnt; sadly we are too traditional to change.

Information overload

This aspect does not merit discussion beyond stating that the malaise is not unique to biology but to education at large, for do we not expect children to master counting before they are hardly four years old!

What should be learnt in biology

What a curriculum in biology should attempt is (a) to keep in mind the larger aim of education and (b) to cater to science education at different levels. Leaving aside the first and considering the second, ideally it would be enough if one were to start learning the specific discipline of biological science from Class 11, i.e. at the senior secondary level. Till then biology needs to be the starting point for, and an integration of, science concepts in all classes. It is well known that learning is experiential. There is hardly any concept in science that cannot be learnt with biology as a starting point.

The NCERT design for schools affiliated to the CBSE has been attempting this. We teach only general science till Class 10. As a teacher who has taught this course since its inception way back in the mid-19 80s and has since then seen various modifications, I find that the principle of integration is yet to be achieved. Let us take a topic like Materials. At every stage it is treated merely as a topic in chemistry. Similarly, work, power and energy that can be integrated in the study of general science are treated merely in terms of laws and experiments in physics. Force, Newton's laws, gravity, friction and many more of these abstract laws can make so much sense if you had biology accompanying them. Clearly, our wish to see a new way of education simply does not match our efforts at curriculum design. We are afraid to leave the trodden path. Mere decoration cannot hide the cracks underneath.

My dream biology education

Away from classrooms and laboratories, observation should become the foundation for learning biology. Here are some radical suggestions for learning the sciences:

Shut down the laboratories. In today's learning mode they serve no useful purpose and are mere window dressings for non-existent experimentation.

Use those closed and boxed structures called classrooms minimally and move children outdoors for learning.

Be careful about the standards of books chosen. Instead of textbooks for children, stock up the library, set up classroom libraries and encourage children to write their own materials. Discard textbooks altogether if possible.

This suggestion deserves to be examined in depth: Give time for learning. It is high time the 40-minute, eight period daily regimen is examined thoroughly and replaced by a learner-friendly structure affording time for observation and experimentation.

So what would one be learning? Biology can begin from oneself, from one's home or from nature. This is nothing new, one would say. True, but the learning lies in the direction given by the curriculum. This is best explained by an example—let us take the characteristics of living beings and the differences between living and non-living beings. I chose this example because it is considered as elementary by most, but according to me it is one that has potential for multiple levels of learning and would have great importance in the coming years. This topic certainly rears its head in Class 5, if not earlier.

Class 5

Teaching at this stage usually involves a hotch-potch of activities, of observing a host of features in a limited time span of 80 minutes, then a quick discussion and finally arriving at a list of points that would say why something is called living. This is normally followed by a couple of questions that will enumerate the differences. This topic next only appears again in Class 9. What has been learnt? Ask the teacher in Class 9 or 10 when she questions her students on whether milk and silk are living or non-living. There is no consensus, only confusion.

The characteristics of living beings are not as simple as they seem. Biologists are still grappling with a definition for the term 'life' itself. And students learn the eight to ten point differences at one go in Class 4 or 5. This should ideally be learnt step by step as the students move from Classes 5 to Class 6.

In Class 5, there should be experiments that allow children observe germination by using various materials from the kitchen. Children could measure heights and weights over a certain period of time, of themselves, of their younger siblings, friends and their own teachers. Other activities could be growing crystals and looking at the growth of various other things in their environment. These are a series of experiments that bring students close to a variety of sources, to their environment and to themselves. This gives them the information that would then become the basis for discussions. It could end with some understanding of the phenomenon of growth as a characteristic feature of living beings.

Class 6

At this stage movement as a characteristic of living beings can be introduced. Motion is a topic in physics too. There could be several interesting experiments that would help students learn not merely another characteristic of a living being but also other concepts in physical science. There is nothing more interesting for students than to experience an activity through their bodies. This can become a legitimate platform for discussing changes in themselves.

Class 7

One topic that can be learnt at this level is basic metabolic functions such as energy generation and utilization. Energy is a topic that is central to integrated science. It brings a certain depth to the understanding of living beings.

Class 8

The students are now in their adolescent years and this is just the time to introduce the topic of reproduction as a characteristic of living beings. It is also an interesting entry to understanding plant life as well as theirown physiological and psychological changes.

Thus a topic such as characteristics of living beings can be imaginatively dealt with and taught in an integrated manner. There would be a genuine appreciation, and a glimmer of understanding, of the thin line that divides life from non-life. This topic in biology is futuristic too. Humanity is attempting to create human life artificially.

Biology is not only the science of life but has a sacredness that has evolved through eons along with the planet's energy cycle. The concept of the sacred will cease to exist if we continue to learn science in a fragmented way. .

To conclude I quote Maria Montessori who puts everything I want to say most beautifully and precisely: 'The stars, stones, life of all kinds, form a whole in relation to each other and so close is this relationship that we cannot understand a stone without some understanding of the great sun.'

Category: Teacher Development
Subject: Science & Technology
Board: All boards
Grade/Standard: Class 6-8
