Dancing with the Trees: A New Way to Learn Science with Classical Values

Remya Parameswar Iyer, Kendriya Vidyalaya Khanapara, India

The North American Conference on Education 2014
Official Conference Proceedings

Abstract
Science education has undergone a sea of change with different approaches and methodologies. But value oriented science education has not been given enough thought.Drawing from thinkers like Michel Foucault,Jean Baudrillard, Judith Butler and Louis Althusser,this paper seeks to posit methods of inculcating values through construction of knowledge,transformative pedagogies and how educational institutions can play a vital role in the process.The paper is divided into the following areas:construction of knowledge,both subjective and objective,along with the challenging and transforming task of imbibing values. Most essential part of this area lies in the fact that learners are allowed to develop their cognitive skills in their own pace irrespective of their differences in the power of absorption and retention.2. transformative pedagogies: power of transforming one is the key to radical changes in the society and it will begin with the change in thought and attitude of learners and teachers involved. By involving both learners and teachers in scientific projects where issues -in near by vicinity are addressed, they get involved and absorbed into the societal improvement.Classrooms in educational institutions pave the way for these individual transformations and change in mindset and attitude. Therefore, science education in classrooms should involve an objective learning of concepts and definitions, it should also bring student closer to human values like empathy and cooperation and team spirit. Here in lies the essence of science education in 21st century.

Key words: science education, construction of knowledge, values, classrooms, learners, teachers, scientific projects, transformation

Introduction-Whither bound?

"To be or not to be", the Hamletian dilemma is universal as it touches human life at many points. The American Educationist and Philosopher John Dewey (1933) contended that Education touches life almost at all points. Applying the syllogistic premises of logic on the two stated propositions, it may be deduced that Education sometimes undergoes the Hamletian dilemma. In this paper I try to address such a dilemma: should science be taught within a broader framework of human values, or should it be treated objectively as a subject of amorality. The argument of my paper is to embed values in science education within classrooms. Science education loses its purpose and charm when values are not infused in science education in teaching learning process in classroom transactions. The main objective is to show that the scientific projects undertaken can act as a great medium and tool to bring forth the infusion of values with science education.The student fraternity can greatly benefit and can develop holistically to their fullest potential if this coupling is put into proper effect.Classrooms and the activities undertaken can act as sites of imbibitions.Sensitisation of younger generation towards environment is done through these projects and it combines social values with science education.Along with science, students learn empathy,patience, team spirit, to work cooperatively and colloboratively with each other ,develop self esteem and reach out to the community and environment in their vicinity. The paper boils down to an education with respect to physical nature which has an impact on human nature.

Crossroads

Science education has many overlapping instructional methodologies that are widely used all around, project based, inquiry based, and problem based and place based being some of them. Learning science helps students to think critically, solve problems, develop curiosity and help the students to take decisions that improve the quality of life. All these methodologies share certain commonalities: all of these are student-centric, they are participatory in nature, they involve use of multimodalities, and they are flexible. In spite of sharing these commonalities, these methodologies retain their individual characteristics. The challenge is to construct a model that would at once cater as effectively as the above-mentioned methodologies as well as provide a teaching basis of effective value system to the students. However, before trying to negotiate through this complex crossroads towards an effective model, I will state in brief the efficacies of these methodologies in the teaching-learning process in science classrooms.

In the project based learning of science, all the students work collaboratively in group seeking answers to a driving question of the investigatory project. The questions addressed are very much related to real life and are meaningful. Hence, as Krajcik *et al*. (1999) suggests, "project based science calls for a question or problem that is meaningful and important to learners." (p.9) The source of the question also plays an important role. The question can be real life contextual question from the teachers side or a natural question from the students side. The length of time students are involved in the project is considerably longer than short time activities.And the most important part of project based learning is that students, teachers and community colloborate to meet the end.This is inevitably very important as this helps in building up of the right skills and attitudes in the students.

In regard to the inquiry standards, as mentioned by Llewellyn (2013)the National Research Council (NRC) points out:

> Inquiry is a multi faceted activity that involves making observations;posing questions;examining books and other sources of information to see what is already known in the light of experimental evidence:using tools to gather,analyze and interpret data;proposing answers,explanations ,and predictions;and communicating the results. Inquiry requires the identification of assumptions,use of critical and logical thinking,and consideration of alternative explanations.(p.3).

Students should become conversant with the strategies of using thinking skills, while they learn. This would include hands-on experience such as inquiry and problem-based approaches "including asking questions,planning and conducting investigations,using appropriate tools and techniques to gather data,thinking critically and logically".(Llewellyn, 2013, p.3).Five essential features of inquiry include "engagement of learners in scientifically oriented questions,giving priority to evidence,formulate explanations from evidence,evaluate their experiences in the light of alternative explanations, which reflect scientific understanding and communicate and justify their proposed explanations". ".(Llewellyn, 2013, p.3).

Place based education is based mainly in this thought, if we want children to flourish, to become truly empowered, then let us allow them to love the Earth before we ask them to save it. As Sobel (1993), quoting from Thoreau's *Walden* puts it, "the more slowly trees grow at first, the sounder they are at the core, and I think the same is true of human beings."Sobel (1993) locates three important stages in a child's life that deepens her/his relationship with Earth:

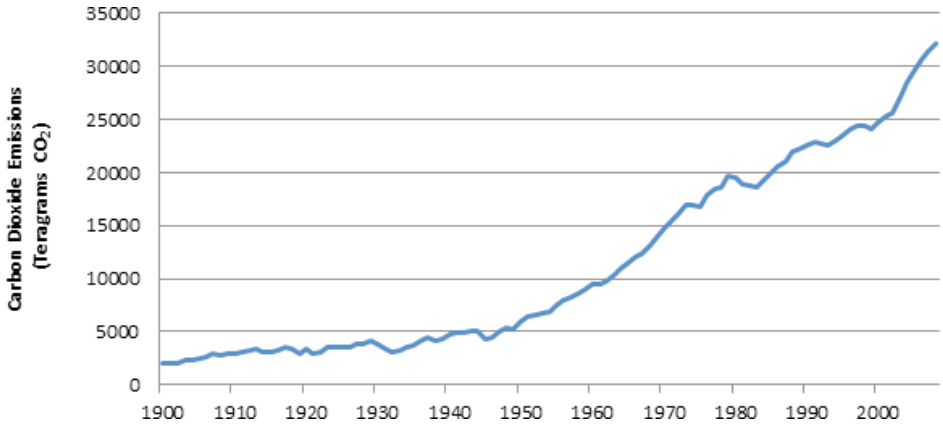
… early childhood from ages four to seven, the elementary years from eight to eleven, and early adolescence from 12 to 15. Though these age frames need to be considered flexibly, my belief is that environmental education should have a different tenor and style during each of these stages. (Source: internet)

Walking into the heart of matter

J.Bronowski (1984) in his essay 'Technology among mankind' and Amartya Sen and John Dereze (1996) in their essay 'Environmental Pollution' contend and point out that if environment is separated from human values, it leads to a world of destruction. A corollary to this is if Environmental science is associated with human values it leads to a world of joy, the heart and the eye locks, beauty becomes truth and here is a world to live in. However, such a utopia does not exist. Let's take a glance at some facts and figures. Worldwide, net emissions of greenhouse gases from human activities increased by 35 percent from 1990 to 2010. Emissions of carbon dioxide, which accounts for about three-fourths of total emissions, increased by 42 percent over this period.[1] Global carbon emissions from fossil fuels have significantly increased since 1900.

> "Emissions increased by over 16 times between 1900 and 2008 and by about 1.5 times between 1990 and 2008".
> "Emissions of non-CO_2 greenhouse gases have also increased significantly since 1900". (Global Anthropogenic Non-CO_2 Emissions: 1990-2000).

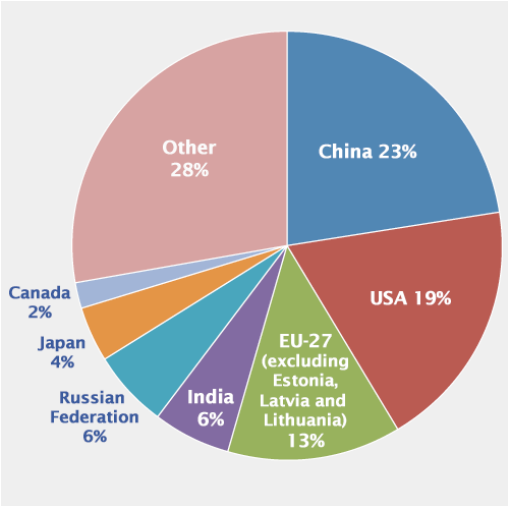
Trends in Global Emissions: Global carbon dioxide emissions from fossil –fuels 1900-2008



Source of data: Boden, T.A., G. Marland, and R.J. Andres (2010). Global, Regional, and National Fossil-Fuel CO_2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2010.

Continued emissions of (CO_2) and global warming arising due to these emissions is going to produce a drastic effect in 21st century than what we saw in twentieth century. The U.S. National Academy of Science has stated that "global climate warming is most pressing international issue of the 21st century. With the population touching the 1.22 billion mark in August, 2014, as per the Indian National census, India remains a major contributor to global warming. The pie chart, Emissions by country, depicts countries which are major contributors of CO_2 gases and India's role can be very easily inferred from the following chart.

Emissions by country 2008: Global Emissions from fossil fuel combustion and some industrial processes (million metric tons of CO_2)



Source: National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008.

In 2008, the top carbon dioxide (CO_2) emitters were China, the United States, the European Union, India, the Russian Federation, Japan, and Canada. India's contribution was 6% in spite of being a developing country where as US contribution was 23%. These data include CO_2 emissions from fossil fuel combustion, as well as cement manufacturing and gas flaring. Together, these sources represent a large proportion of total global CO_2 emissions.

From this data it can be easily inferred that every environmental issue is very much global as well as local and problems and solutions are shared by all. Every solution is going to have global significance in the long run. India, being one of the most populous countries, has a great share in these emissions and the issue mentioned above still remains a grave area of concern. One important conclusion that we can derive from looking at the data is human activities locally, and regionally can have global repercussions. Even changing the very earth and its atmosphere and finding solutions to the environmental issues remains a challenging endeavor.

The Double Helix Model & Classroom Pedagogy

When we see the double helix, the term that comes to the mind is the blue print of life. This double helix is also the essence of my paper. It's a small attempt to correlate environmental education with values. One of strand representing the environment and another representing the values, strongly intertwined and bonded with each other. The interconnecting bond is day to day classroom transactions. Both of the strands are of the same color showing their equal importance and its bringing together of two disciplines.

Coming to methodologies that form the bulwark of the present model. These five methodologies that are closely related to classroom transactions ae listed below:

1. Constructivist approach meaning making education, working from questions to situate discussions at different levels of proficiency, unique to each group.
2. Historical cases- History is not about high and almighty figures, it's also about common daily incidences of life
3. Classroom transactions inside and outside the classrooms which includes reading materials and talking to specialists.
4. Cultivated through practice stimulated actions in real life situations
5. Theoretical practice takes place in classrooms but real practice takes place in field trips.

Helix model in practice

Groundwater and soil are dynamic resources and undergoes significant variations quantitatively and qualitatively. The quality of the above are dependent on the quality of recharged water and soil, atmospheric precipitation, inland surface water. It also depends on geochemical processes viz., the interaction with aquifer minerals or by the inter mixing among the different groundwater reservoirs and soil along the flow path in the subsurface. Resolving quality of soil and water in developing countries has got global attention. Polluted land and water resource denies the most essential of all rights, the right to life. Fluoride contamination is a major cause of water and soil pollution in many countries. India is among 24 nations in the world, where fluoride in soil and ground water is creating health problems. Of late, in mid of 1999, Assam region of Northeast India has been identified as a fluoride affected area. (Fluoride above the guideline values of WHO, has been found in groundwater of the eastern and southern plains of the city.).Government has also confirmed the prevalence of fluoride in the groundwater and soil of Kamrup district of Assam. The Karbi anglong and the Nagaon districts of the state are the worst affected. As groundwater is a major and preferred source of drinking water in the district and soil for cultivation, the population seems to be vulnerable to the health effects of excessive fluoride in the drinking water and soil.

When fluoride from the air and soil ends up in soil it will settle into the sediment. When it ends up in soils, fluoride will become strongly attached to soil particles. In the environment fluoride cannot be destroyed, it can only change form. Fluoride that is located in soils may accumulate in plants. It leaves severe damages to soil like decline in growth, reduces crop yields. Most affected are corns and apricots. Animals that eat fluoride containing plants suffer from dental decay, bone degradation, causes low birth-weights. The only remedy is prevention by keeping fluoride intake within the safe limits.

Dental fluorosis

Due to excessive fluoride intake, enamel loses its lustre. In its mild form, dental fluorosis is characterized by white, opaque areas on the tooth surface and in severe form, it is manifested as yellowish brown to black stains and severe pitting of the teeth. Normally, the degree of dental fluorosis depends on the amount of fluoride exposure up to the age of 8–10. The effect of dental fluorosis may not be apparent if the teeth are already fully grown prior to the fluoride over exposure. Therefore, the fact that an adult shows no signs of dental fluorosis does not necessarily mean that his or her fluoride intake is within the safety limit.

Skeletal fluorosis

Skeletal fluorosis affects children as well as adults. It does not easily manifest until the disease attains an advanced stage. Fluoride mainly gets deposited in the joints of neck, knee, pelvic and shoulder bones and makes it difficult to move or walk. The symptoms of skeletal fluorosis are similar to spondylitis or arthritis. Early symptoms include sporadic pain, back stiffness, burning like sensation, pricking and tingling in the limbs, muscle weakness, chronic fatigue, abnormal calcium deposits in bones and ligaments. The advanced stage is osteoporosis in long bones and bony outgrowths

may occur. Vertebrae may fuse together and eventually the victim may be crippled. It may even lead to a rare bone cancer, osteosarcoma and finally spine, major joints, muscles and nervous system get damaged.
Therefore, now there is a need to focus greater attention on the future impact of fluoride on water and land resources, and take into consideration all the related issues of fluoride removal.

Due to the relevance of the fluoride contamination and Assam being one of the worst affected, analyzing the fluoride levels and finding new ways for de fluoridation is a local yet global issue and was chosen as the driving question of the investigatory project.

Findings

After applying scientific techniques and tools, we arrived at the following findings for estimation of fluoride levels in the water samples collected from 10 foot hills and 10 plains of Kamrup dist., Assam. Fluoride concentrations were above the desired concentrations at some of the sampling areas of foot hills and plains. Fluoride levels were detected by spectrophotometric detection by SPADNS reagent after collection of water samples from chosen sites.

Along with these scientific skills, students develop global perspectives in values consisting of scientific temper, critical thinking, reflective thinking and analytical thinking. Scientific temper is studying an issue or problem under the light of reason. Reason does not remove the use of emotion, it rather moderates and balance emotion leading to a healthy subjective objective continuum judgment. Critical thinking does not involve critiquing others, but a movement of whole to parts and parts to whole. Reflective thinking involves what Einstein defines imagination to be, encircling the world. Analytical thinking pertains to analysis of issues and all the above 21st century skills contribute to problem solving and decision making. They learnt to work cooperatively and collaboratively and reached out to the community better. They developed self-esteem and played a greater role in creating awareness about the fluoride contamination in the nearby vicinity. They were more responsible and turned out to be acquiring holistic skills while executing the project and working towards the cause.

[Table for Fluoride concentrations in water samples (values in mg/L)].

Sr. no.	Places	Ring well	Tube well	Sr. no.	Places	Ring well	Tube well
1	Baghorbori	0.26	1.02	11	Basista	0.58	0.77
2	Noonmati	0.66	0.92	12	Khanapara	0.52	0.98
3	Chandmari	0.52	0.52	13	Hengrabari	0.84	0.84
4	Bhetapara	0.66	0.1	14	Japorigog	0.1	0.32
5	Bhangagarh	0.08	0.42	15	Patharquarry	1.12	1.18
6	Uzanbazar	0.08	0.42	16	Kahilipara	0.1	0.88
7	Panbazar	0.74	0.55	17	Ambari	0.02	0.02
8	Amingaon	0.31	0.14	18	Maligaon	0.44	0.31
9	North Guwahati	0.45	0.32	19	Kamakhya	0.29	0.5
10	Borjhar	0.4	0.18	20	Gorshuk	0.16	1.1

Values and places marked in red are areas of concern where fluoride levels are higher than desired concentration.

Conclusion

"God's in his Heaven and / And all's right with with the world", wrote an optimistic Browning, the British Victorian poet. Such an optimistic vision, in spite of all its aura, cannot be dreamed of in a science classroom. In a large cross-section of the academia, many environmental science classrooms do not give importance to values. However, there is no denying the importance of teaching values along with the concepts of environmental science, as Elliott (1993) suggests:

> " cognitive initiative" or the capacity to initiate a course of action to improve a situation; the capacity to diagnose,discern and discriminate the practically relevant dimensions of the problem situation;the capactiy to share the thoughts and feelings,the points of view,of those who are involved in the situation; and the capacity to reflexively self monitor ones own actions and their consequences in the environment." (p.23).

Holding courage in both my hands, I dare state that following the Helix model in science classrooms would go a long way in the teaching of values in environmental classrooms, leading to a Nature-Value-Pleasure continuum.

Acknowledgement:
I am deeply grateful to the Principal of Kendriya Vidyalaya Khanapara for allowing me to apply the helix model in the school.Students also particpated and contributed to the project.

Bibliography

1. Krajcik J.,Czerniak C.,Berger C.(1999).*Teaching children science A Project Based Approach.*

2..Llewellyn D.(2013). *Teaching High school Science Through Inquiry and Argumentation.*

3. Sobel, D. *Beyond Ecophobia: Reclaiming the Heart in Nature Education. Web: www.orionsociety.org.*

4. Centre for Educational Research and Innovation. (1995). *Environmental learning for the 21st century*. Cited from Elliot. J. (1993),"Handling Values in Environmental Education", *values in Environmental education*, report of the conference held in Stirling, Scotland, 5-7May, Scottish Consultative Council on the curriculum, Dundee.

Contact email: riyer1975@gmail.com