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Climate Change Science in School Curriculum: Solution to Ignorance of Commons in Developing Countries

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Abstract: In developing countries and to a certain degree in developed countries too, either climate change (CC) consequences or drivers of CC are alien to the mindset of commoners, who after High School had with/without vocational skills entered the workforce. This deficit or ignorance can be rectified only by adding CC education in the school system. We present a school appropriate outline of CC learning content spanning Kinder Garten to High School. Adding CC content in school education is immensely warranted, as a large chunk of high schoolers annually joins the work force with or without vocational or skill training. Further, such a knowledge deficit among the generations of working class can be remedied only by providing appropriate and sufficient knowledge on CC consequences, etc., only through a structured adult education campaign.

Keywords: Climate change sciences; Climate change learning; School curriculum and Skill training.

Introduction

Each year, both Earth Day (April 22) and World Environment Day (June 5) are enthusiastically and fervently observed worldwide by national and local governments, social and environmental activist groups, schools, colleges and NGOs to remind, re-create, motivate and incentivize members of the citizenry, students and children to spread the message on the unstoppable urgency and inescapable need for protecting and preserving the planet Earth from the currently perceived/proved threats due to changing global climate to secure the long term welfare and prosperity of humanity and ecosystems. But, how far are we honestly successful in taking the message beyond this gala of observances? We strongly feel that the manifest enthusiasm on these special days is only like a bubble and soon attention and focus shift to other issues. Secondly, most members of the younger generation opt for skill training through apprenticeships to join the workforce instead of pursuing college and university education, as a consequence of which fail to earn or acquire, add or further their knowledge in the varied aspects of climate change and its consequences.

Therefore, we believe in providing a minimal but important message of the drivers and un-retractable and catastrophic consequences of CC deep into the minds of the school-going kids. Consequently, the only recourse before agencies in charge of school education is to dovetail suitable CC knowledge content in the general school curriculum, covering the student population between the Kinder Garten and class X.

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Such a redesign or revamp of the school curriculum is warranted to expose adolescents and early youths appropriately informed of CC impacts to the society at large and nation, who happened to quit schooling to join the workforce after acquiring one or other technical skill. Or else the majority of pupils quitting learning and education beyond High school shall remain as a lifelong CC ignorant population.

Such a reformat of school syllabus with CC content will be a sure primary vehicle in educating, otherwise un-informed minds of school leaving kids to participate in the national mission of mitigating threatening consequences of climate change by following a lifestyle enabling the carbon neutral and /or zero carbon emitting economy and strive to reduce carbon emission to preindustrial levels.

The large divide among nations (viz., developed, vs. developing ones) in respect of CC education is amply mirrored in the currently followed school curriculum. The education system in these groups of countries, tells the tale of the ground reality of school systems and learning focus on environmental education. Therefore, several advocacy groups and UNESCO call for appropriate refashioning/redesign of content coverage in respect of CC in the school curriculum, especially spotlighting those countries that failed to the wakeup call on CC education.

Government Curating the Environment

The founding of the United States Environmental Protection Agency (US-EPA) in the early ’70s mirrored the response of the United States (US) administration to the growing concern of citizens on the deteriorating environment of the earth. Earth Day and World Environment Day, observed and celebrated more or less globally, originated in the US, targeted primarily an audience of citizens with the goal and intention of creating added awareness on the do’s and don’ts to the various elements of the living and non-living earth systems. More specifically, World Environment Day endeavours to bring to fore, the harms humans do to the subsystems or the earth spheres (viz., lower atmosphere or troposphere, hydrosphere including the life below the sea surface, and more specifically, the coastal ocean plus natural water systems on land, uppermost part of the lithosphere, pedosphere and the biosphere). The recently concluded G7 meeting at Cornwall in June 2021, had a special focus on the CC, despite the backdrop of the COVID-19 pandemic. One overarching agenda item of the COP26 meet at Glasgow, in October-November, 2021, is climate change.

State-of-the-Practice in Developed Countries

UNESCO had developed a blueprint of CC education for sustainable development (https://en.unesco.org>themes>orgcce) for use in member countries, primarily to improve climate literacy among young people and member countries had agreed upon establishing and introducing climate education policy.

Results of a 2019 National Public Radio (NPR) ordered IPSOS (a French opinion polling agency) opinion survey (https://www.npr.org>2019/04/22) among US school teachers reportedly showed ample willingness and self-motivation on the part of teachers to teach various aspects of CC to students (right from Kindergarten to class 12). Results indicated that 82% of teachers supported the teaching of CC science at the school level. Teachers (74% among polled) also believed that CC impacts the environment, economics, and society. Moreover, 74% of Americans viewed CC as a real threat.

In Britain, researchers at the University of Bristol (Jones et al., 2021) gathered and documented views of 626 primary and secondary school teachers across the country on CC teaching in schools. The researchers reported the unified response of teachers favoring CC education and action-filled education at the school level and added that 72% of teachers have been actively and formally talking to students on CC.

Admittedly, there is a deficiency in climate change education programs in Europe, and “climate change is a real and rapidly evolving threat for humanity” says UNESCO “and strive to ensure that all generations understand the impact of climate change” and hence recommends “the importance of education as a key element of the response to climate change”.

For assessing the current status of climate change education in Europe (https://allea.org>wp-content>uploads-2020/5), an online survey channeled through the aegis of 50 academies addressed universities, education providers, and outreach organizations. Among 67 responses from 14 countries (11 from EU) were subsequently analyzed to glean the pattern of initiative, scope, content and age groups. The survey underscored the existence of adequate climate change awareness, but not about mitigative measures or climate action projects. Results also showed a need for aggregation of quality-climate-change-education content for distribution among different age groups through educators across Europe. Instead of spotlighting the causes of CC change, the focus should be on consequences and mitigation measures as well as on the professional development of teachers by retraining.

Lakehead University and Learning for Sustainable Future (LSF) initiated a survey of 3,196 Canadians to create a Canada Baseline Data on Canadians knowledge on CC and perspectives on risks and views on the role of schools and CC education (https:/www.edcan.ca>articles>climate-change-educat). Responses from 1,231 teachers (spanning across K-12), 571 parents, 486 students in grades 7-12 and citizens (908) showed that 85% of Canadians are certain about CC and 79% are concerned about the impacts of CC. Furthermore, 78% believe the threats of CC are real. However, only 51% of Canadians are well informed of CC. Two-third of citizens and three-fourth of teachers believed schools should do much more in imparting CC education. Teachers also wanted allocation of more time for teaching CC, instead of 1-10 hr currently allotted. Canada, in fact, wanted in the 1995 Paris convention, the introduction of CC education in schools.

The state of the post-WW II environmental education policy landscape, including the state of the CC education in Japan, based on a questionnaire-response-data was gathered and analyzed by Glackin and Greer (2021). Though the Social Education Act of 1947 highlighted the environmental education needs of the local community, the Japanese Government continues its response to initiatives such as Education for Sustainable Development (ESD), both in a top-down and bottom-up policy. Respondent-school teachers opined that everyone in schools, including teachers, is responsible for environmental education.

In Australia (https://theconversation.com>ever>wondered>what>our), a signatory of the Paris Accord of 2016, the Australian Institute of Disaster Resilience, has prioritized the responsibility of educating school children in CC. In the syllabus for primary (1-6) classes, there is explicit mention of CC. CC is also covered in Humanities, Sciences and Geography syllabus for Secondary (7-10 y) and Senior Secondary (11 and 12) classes. However, there is a lack of coordination in designing a curriculum between Federal and state-level education agencies

The Indian Scene

But, in India things are different. As per a Yale University study (2020) (climatechange@yale.edu), 65% of Indians are unaware of the CC phenomenon including mitigation measures while of the remaining 35% of educated Indians only 80% are exposed to the drivers of CC and mitigation measures. Moreover, beyond the domain of the NCSC (National Children's Science Congress), the Indian school curriculum is yet to address topics relating to the CC phenomenon per se and/or its implications. Against this backdrop, in order to cover all generations of Indians, it is imperative that our nation launches a program of CC education to educate the large chunk of the youth of both genders, who choose to leave school and do not go for college degrees.

Table 1: Student enrolment in schools, India, 2017

Level	*Enrollment, million*	*% enrolled*
Primary School	129.1	100.0
UP School	67.6	52.36
Higher Secondary	39.1	30.29
Sub Total	235.96	
Senior Secondary	24.7	19.13

Source: mospi.nic.in

Table 1 is self-explanatory and summarizes 2017 student enrolment at various segments of the school classes of India. Glaringly, only 24.7 million kids (19.13%) went to senior secondary classes, even though 129.1 enrolled in primary school. In other words, 80% had quit schools before reaching senior secondary class and joined the work force in the organised and informal sectors. Consequently, the vast majority of school-educated youth grow up sans any formal or informal understanding of the impending CC threats, consequences or potential mitigation measures. Paradoxically, this large chunk of young Indians ends up as CC illiterates, literally unequipped to think, understand and act or to develop or join plans and programs aimed at mitigating impacts of CC as an individual, member of a community or social activist group.

The crowd of school leavers who join the workforce is also ignorant of the basic life style changes and contributions they would be required to make in the changed or changing climate scenarios. So we propose a recipe to reform this ground reality by a new strategy and approach in teaching and exposing this group to CC illiterates by introducing a learning-program-content at all school classes as well as retraining teachers/instructors to remove this continuing generational lacuna in our society. We feel India must initiate a pre-school or playschool to high school curriculum on CC and its implications to the nation and humanity.

In this backdrop, a bold initiative by the Government of India was the launch of the National Children's

Science Congress (NCSC) in 1993 (Anonymous, 1993) which took the process of learning science by doing (stewarded by a teacher) to the school children of the junior (aged 10-14 y) and senior (aged 15-17 y) categories. Yet another remarkable aspect of this program is permission afforded to non-school children (but falling in the prescribed age groups) to participate and compete in NCSC with projects, at the school, district and state meet, in order to qualify for the final NCSC meet in a host city in any one of the Indian states. Furthermore, each state and the Union territories of India have a population based quota on the number of teams (both junior and senior teams combined) permitted to participate in the national meet during the last week of December.

Table 2 lists NCSC's biannual themes since the inauguration of NCSC in 1993, "Understanding Weather and Climate", an explicit climate theme, appears listed only once for two consecutive years (i.e., 2014 and 2015). Other themes in the list are only remotely or implicitly related to some or other aspect of climate phenomenon. Metaphorically, the identified themes of NCSC mirrors the national scientific sentiment, priority and perception of senior scientists and other influencers of the national policy in so far as the selection of focal theme goes. This is in spite of Dr. Pachuri (formerly of TERI, New Delhi) sitting at the helm of the Intergovernmental Panel on Climate Change (IPCC), which so far wrote up the 1 to 5 Assessment Reports (AR). However, the AR-6 report of IPPC 2021 unequivocally red flags (in the context of a BAU policy) the irreversible and catastrophic implications of climate change to the inhabitants of our planet earth by 2025.

Table 2: Focal themes of NCSC, India

Year	*Theme*
1993	Know Your Environment
1994 & 95	Clean-Up India
1996 & 97	India of our Dreams - Lets go for it
1998 & 99	Nature - Let us Conserve, Share, and Care
2000 & 2001	Indigenous scientific knowledge for better tomorrow
2002 & 2003	Food systems - Towards nutrition for all
2004 & 2005	Harness water resource for better future
2006 & 2007	Biodiversity - Nurture nature for our future
2008 & 2009	Planet Earth : Explore, Share and Conserve
2010 & 2011	Land Resources : Use for prosperity, Save for posterity
2012 & 2013	Energy : Explore, Harness and Conserve
2014 & 2015	Understanding weather and climate*
2016 & 2017	Science, Technology and Innovation for Sustainable Development: With Special emphasis on Accessibility for Persons with Disability
2018 & 2019	Science, Technology & Innovation for a Clean, Green and Healthy Nation
2020 & 2021	Science for Sustainable Living

Source: Menon, R, Personal Communication, Aug., 2021

Learning by Doing: Global Climate Change in School

Having said that we propose that school kids from Kindergarten to High school, be provided with an experiential learning programme on CC causes, consequences and mitigation measures. Therefore the CC literacy through action oriented learning right now shall create a large chunk of informed youths that will add to the future responsible citizen of India.

One intended consequence of such a generation of climate change literates will be a great human capital stewarding the earth's environment to stay greener, healthier, safer and sustainable for future generations. Therefore, we have drawn up a blueprint or outline of the curriculum and structure of climate change-action-learning for the kindergarten, elementary and high school classes. Further, we intentionally avoided the continuation of climate change education at the higher secondary classes as the primary focus of both students and parents at that level are national screening tests for pursuing a professional/college degree.

Suggested Approach

Our proposal is couched on playful learning and action learning supervised by a teacher in the kindergarten, elementary and middle school classes, while the high school students go through classroom learning and inquiry into drivers, manifestations and possible remediation measures that the citizens, as well as the local, regional and national governments, need to adopt.

Course content in the pre-service teacher education in the country (2013) (https://incte.gov.in) should be revised to include the details of CC and its various facets and currently practiced or recommended mitigation measures. The administration shall order mandatory retraining of in-service teachers (under the national and state agencies) in respect of aspects of CC.

As far as the learner's content is concerned, we provide in the following, an outline or framework as a path forward. Truly, an expert group of specialized curriculum designers can be assigned with the task of

further developing content and in class contact hours, learning by doing/hands on experience hours and so on, appropriate to various class levels.

Proposed Outline

At Kindergarten Level

The teacher needs to point out to the kids in a storyline style about weather and season dependent changes in the environment around the homes and schools. The teacher identifies the season-appropriate changes, sort of defines the influencer elements and communicates to the kids in the format of a story, a group song, or play or in an anecdotal style. Teachers themselves can develop storylines, games and play sessions adopting suggestions of the district, state or national agencies. The core concept of the program is learning by doing and listening to teachers. Watching and observing rain fall, dry days, plants and earthworms, butterflies and birds in and around the school yard.

At Elementary School

Familiarising with local fruit and food crops; macro nutrients, moisture, and water in plant health: pests and pest prevention. Teacher enabled learning of difference between seasonal plants and tree vegetation; reason for the green colour of leaves and shades of brown of dry fallen leaves; demonstration of measuring quantum of rainfall, training in the use of a thermometer to measure the temperature of drinking water, warm water, and air at different times of the day (such as 10 am, 12 noon and 3 pm). Familiarising with birds, seasonal plants, and perennial plants; food crops and ornamental plants in the school garden with the assistance of the teacher. The teacher supervised catalouging by sketching small animals and birds in the schoolyard or neighborhood. Lesson learned by allowing wet soil to dry up under sunlight and diffused indoor light - Raising a vegetable garden outdoors and a similar one indoors without exposure to direct sunlight. Noting and recording the similarities and differences with explanations.

At Middle School

A brief introduction to the Solar system and factors making Earth livable compared to other planets. Teacher assisted learning of seasonality and causes of seasonality in the region and nation and demonstration of devices for measuring temperature and rain fall. The teacher assisted in learning the weather at various regions on earth; the distinction between weather and climate and a brief introduction to the structure and composition of the atmosphere and air pollution and causers.

Introduce climate study informally through games and activities based on teacher developed content both indoors and outdoors. Learn to use a thermometer to measure and record temperature change through the day and different seasons. Familiarisation with hydrologic cycle, evaporation, transpiration, run off and seepage. Teacher assisted learning on evaporation and water loss, watching condensation and drop formation, and action learning of particle size of soil, sand or gravel. Instructor-led comparison of Well water and rain water. Watching and identifying birds and small animals in and around the school.

At High School Level

At High School, learners are introduced to climate zones of India, solar energy, light and heat, drivers of tropospheric heating, polar ice caps, Himalayan glaciers and Greenland ice sheet, Greenhouse and sources of green house gases. Global status of CO_2 levels in the lr atmosphere. Teacher guided learning of measures for reducing CO_2 emission, and IPCC reports and measures for sustainable future. Teacher's narration on World Environment Day, Ozone Day, Paris Conference, Kyoto Protocol, etc. Teacher guided learning on Current Strategies for reducing or limiting Green House Gas emissions and use of non-conventional energy.

Solid waste management and need for effluent treatment practices in India. Water and air pollution in Indian cities and small towns and methods of keeping the quality within healthy limits or BIS standards.

Afterword

In August 2021, TKP forwarded via internet mail, a CC curriculum content meant for school classes to all the state Chief Ministers in the Union of India. Every Chief Minister's office acknowledged the receipt of the draft curriculum. Interestingly enough, the Odisha state acted on my proposal, refined the content in the proposed curriculum for implementation in the state.

Hopefully, we envision every state of the country to follow the path of the state of Odisha in implementing the CC curriculum in the school system paving the way for an India where practically, in the immediate future, every citizen would have sufficient exposure to the existential threat posed by the CC phenomenon. In addition, the Ministry of Human Resources, Government of India will direct the Teacher Education Council of India /UGC/CSIR, etc., to help in including suitable content on CC in teacher training programmes in the country. We also recommend exposure training

on facets of CC for upgrading the skills of in-service teachers in the country.

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