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AMIT ROY

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An ICT supported pedagogical framework to provide transformative education for sustainability

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ABSTRACT

Unprecedented changes are required to avoid the devastating consequences of unsustainable human behaviors. Transformative education for sustainability can play a crucial role in promoting sustainable living. Providing transformative learning is a global challenge. Providing transformative learning about sustainability is especially important in developing countries. Many developing countries struggle to provide basic education so the idea of providing transformative education seems to be an unaffordable luxury. These countries face serious challenges in improving their educational systems; and their teachers often lack knowledge in the domains of sustainability. Nine out of ten adolescents live in the developing countries. Not preparing these future global citizens to live sustainably is not a very wise option.

The global thrust of sustainability education has mostly been on policy and institution-level changes. After a decade of efforts to promote sustainability through education, United Nations - one of the largest inter-national organizations- observed that implementing sustainability education initiatives is challenging. The search for outward, policy-level macro-changes seems to have de-focused us from the facts that society is a group of individuals; that individuals need to transform; that transformation for sustainable change requires deeper than mere information transfer; that education is a grassroots process that takes place in classrooms; and that transformation is an individual-level change. Bypassing these grounded facts disorients us to address symptoms and leave the root causes intact.

This thesis focuses on providing a framework -Children as Agents of Social Change (CASC)- for implementing transformative education for sustainability in developing countries. The studies included in this thesis used constructivist learning methods along with appropriate Information and Communication Technologies (ICTs) to provide transformative education for sustainability.

The interventions included in this thesis were conducted in two developing countries: Tanzania and India – located in two different continents. Each intervention dealt with a different domain of sustainability. The first CASC intervention - conducted in Tanzania - aimed to address an issue related to environmental sustainability. The second CASC intervention - conducted in India - dealt with an issue of social sustainability.

An aim of this thesis is to explore and share a set of recommendations with concerned individuals and groups who recognize the need for Transformative Education for Sustainability for their young generations; and are unwilling to wait for national or international bodies to pay attention to their issues. This thesis is meant to support such individuals in making sensible advances.

Keywords: *CASC; Transformative Education for Sustainability; Education for Sustainable Development; ICT-supported Dialogue; Sustainability Education.*

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Lapset yhteiskunnallisen muutoksen käynnistäjinä. Pedagoginen viitekehys kestävää kehitystä edistävään transformatiiviseen kasvatukseen
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TIIVISTELMÄ

Tarvitsemme käytännön toimintatapojen muutosta, jotta voimme välttyä kestämättömän kehityksen tuhoisilta ja koko ihmiskuntaa koskevilta seurauksilta. Tarvitaan kestävää kehitystä edistävää kasvatusta toimintatapojen muuttamiseksi myös kehittyvissä maissa, joissa tosin jo perusopetuksen tarjoaminen voi tuottaa ongelmia. Niinpä kestävään kehitykseen tähtäävä transformatiivinen opetus on opetusta, johon niukkoja koulutusresursseja ei välttämättä haluta kohdentaa. Resurssien niukkuuden vuoksi opettajien koulutus ja tiedot kestävästä kehityksestä ovat usein puutteelliset. Toisaalta, yhdeksän kymmenestä nuoresta asuu tällä hetkellä kehittyvissä maissa. He ovat tulevaisuuden globaaleja kansalaisia, joille pitäisi antaa valmiudet edistää kestävää elämäntapaa.

Kestävää kehitystä on pyritty edistämään lähinnä koulutuspolitiikalla ja instituutioiden toimintatavoilla. Muutoksen aikaansaaminen on vaikeaa, minkä totesi myös Yhdistyneet Kansakunnat sen jälkeen, kun tavoitteli kymmenen vuoden ajan kestävän kehityksen edistämistä koulutuksen avulla. Nämä ulkoa päin käynnistetyt makrotason muutosyritykset eivät ole ottaneet huomioon sitä, että yhteiskunta koostuu yksilöistä ja että nimenomaan yksilöt on saatava muuttamaan toimintatapojaan. Muutoksen aikaansaaminen vaatii muutakin kuin pelkkää tiedonsiirtoa. Kasvatus luokkahuoneessa on ruohonjuuritason prosessi, joka edellyttää muutoksia yksilötasolla. Yksilön merkityksen ymmärtäminen on välttämätön ongelmien alkusyiden ja niihin liittyvien kasvatuksellisten mahdollisuuksien havaitsemiseksi.

Väitöskirjassa esitellään toiminnallinen viitekehys CASC (Children as Agents of Social Change - lapset yhteiskunnallisen muutoksen käynnistajinä), joka on suunniteltu vastaamaan kestävää kehitystä edistävän transformatiivisen koulutuksen tarpeita nimenomaan kehittyvissä maissa. Väitöskirja koostuu artikkelimuotoisista osatutkimuksista, joissa transformatiivista oppimista on tuettu konstruktivististen opiskelumenetelmien ja tilanteeseen soveltuvien tieto- ja viestintäteknologisten (TVT) ratkaisujen avulla.

Artikkeleissa tarkastellaan kahta pedagogista interventiota. Tansaniassa toteutetun ensimmäisen CASC-intervention teemana oli ekologisesti kestävä kehitys ja erityisesti sademetsien liikahakkuu. Intiassa toteutettu toinen CASC-interventio käsiteli sosiaalisesti kestävää kehitystä, ja sen erityisteemana oli nopeasti kasvaneen alkoholin kulutuksen aiheuttamat ongelmat.

Väitöskirjan yhtenä tavoitteena on tarjota koeteltuja toimintasuosituksia sellaisille kestämättömästä kehityksestä huolestuneille ihmisille, ihmisryhmille ja erityisesti opettajille, jotka haluavat vaikuttaa arjessa kestävän kehityksen edistämiseen. Tutkielma pyrkii auttamaan kasvatuksessa kestävään kehitykseen erityisesti kehittyneissä maissa.

***Avainsanat**: CASC; Transformatiivinen kestävän kehityksen kasvatus; Kestävän kehityksen kasvatus; Tieto- ja viestintäteknologisesti tuettu vuoropuhelu.*

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I dedicate this thesis to two people: my inspiring Mother whose unconditional love, dedication and support kept me going; and my mentor who prefers to stay anonymous.

Joensuu 30.5.2019
Amit Roy

LIST OF EMPIRICAL STUDIES

Study I Roy, A., Kihoza, P., Suhonen, J., Vesisenaho, M. & Tukiaianen, M. 2014. Promoting Proper Education for Sustainability: An Exploratory Study of ICT Enhanced Problem Based Learning in a Developing Country. *International Journal of Education and Development using Information and Communication Technology*, 10(1), 70-90.

Study II Roy, A., Ikonen, R., Keinonen, T. & Kumar, K. 2017. Adolescents' Perceptions of Alcohol. *Health Education*, 117(3), 280-296. DOI: 10.1108/HE-05-2016-0021.

Study III Roy, A., Ikonen, R., Kumar, K. & Keinonen, T. 2018. Sustainability Education Using ICT-Supported Dialogue - Towards Transforming Adolescents' Perceptions of Alcohol in the Punjab, India. *Discourse and Communication for Sustainable Education*, 9(2), 49-67.

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MAIN ABBREVIATIONS AND ACRONYMS

AET	Appropriate Educational Technology
CASC	Children as Agents of Social Change
DfC	Design for Change
EE	Environmental Education
EfS	Education for Sustainability
ESD	Education for Sustainable Development
ICT	Information and Communication Technologies
ICT4D	Information and Communication Technologies for Development
MKO	More Knowledgeable Other
PBL	Problem-based Learning
TEfS	Transformative Education for Sustainability
SD	Sustainable Development
UN	United Nations
ZPD	Zone of Proximal Development

1 INTRODUCTION

The historical problems that occupied mankind for several millennia like famine, plague and war have reduced at the dawn of 21st century (Harari, 2016). However, this does not mean human life is now problem-free. At best, we have probably replaced one set of problems with another. Humanity now faces new, unprecedented challenges like climate change and non-communicable diseases. Less people die of starvation caused by famine however more people are dying of over-eating and sedentary lifestyles which cause non-communicable diseases. Overall global food production has increased. However, simultaneously, owing to poor food distribution systems, starvation still persists. A chief among human challenges - sustainability - is the focus of this thesis.

Human behaviors have constantly been pushing the planet to its limits in multiple dimensions. If we don't change our behaviors, the planet may lose us un-regrettably. A saner alternative for us, humans, is to change our behaviors. Fortunately, human capacity to learn, thinking new behaviors is still intact. Human actions originate from our knowledge, thinking as well as circumstances. Education is a known way to help students learn new knowledge, novel ways of thinking and can play an important role in shaping our adaptability.

The focus of this thesis is education for sustainability. This focus emerges from two reasons. First because education for sustainability interests me; and second, because after spending a few years as a student, a teacher and a student of education in India, I saw that education for sustainability in most schools in India was a half-hearted, non-serious and rigor-less affair. Although different kinds of schools e.g. holistic schools that prioritize sustainability - exist in India, they are rare and elitist. I felt a dire need to enhance the quality of education for sustainability being provided to a common person's child. If young population is not provided with new and in-depth knowledge to explore new pathways of thinking, they will keep behaving in the same way. However, can a single educationalist make a large difference? Is overhauling the educational system through political change the only way to change the education? Should I become a political activist despite not being a fan of politics? Are there any other alternatives available? Can any new alternatives be created? These are some of the questions that undergird this thesis.

Before choosing education as a career, I was a Software Engineer. In face of this challenge to reaching out, I wanted to explore, learn and know how simple Information and Communication Technologies (ICTs) could help in up-scaling education for sustainability? Having worked in the field of education after working in the technology industry, I saw that the educational use of ICTs was often divorced from pedagogy. I wanted to derive a set of guidelines to enable ICTs along with pedagogy. My search was to develop a framework (a set of guidelines) that would enable anyone - concerned about sustainability issues - to create educational interventions. The main aim of the educational framework presented in this thesis is not to change an educational system but to provide transformative educational experiences to students.

The kind of education in Finland is different than most schools in the world and it is not merely owing to PISA rankings. Living in India, world's second most-populous developing nation made the potential of huge sustainability dividends obvious, clear and visible. It is crucial to find ways that are inclusive. Both studies in this thesis

were conducted in developing countries and aimed to find low-cost ICT solutions to provide education for sustainability to middle- and high-school students. The first intervention dealt with forest fires and thus addressed environmental sustainability; and second intervention dealt with the effects of alcohol and non-communicable diseases and hence, dealt with social sustainability.

Over the decades, need to live sustainably has become a key educational goal (see Section 2.3). Global conferences keep taking place and the term 'sustainability' has gained considerable weight over the years. Global policy level changes have been agreed to. However the biggest challenge in providing education for sustainability lies in implementation. Even after United Nations Decade of Education for Sustainable Development, the world is still struggling to find ways to implement educational solutions – specially in the developing world (UNESCO, 2014). Developing countries face even more difficult challenges in implementing education. They lack of teachers, their teachers' lack expertise in domains of sustainability and they, also, lack resources to boost education for sustainability. Resultantly, such educational conditions do not promote any transformation among the young in these countries. This condition is highly dispirited as 9 out of 10 adolescents live in developing countries. Generally, developing countries invest less in education. After all, about 90% of global adolescents - lives in developing countries (Sawyer et al., 2012). Ignoring education for sustainability for this significantly large proportion is not a wise idea. This thesis provides a framework to implement transformative education for sustainability in developing countries through ICT supported pedagogy. The propositions of the framework are based on two empirical studies in two domains of sustainability. These interventions were implemented in two different countries in two different continents. The first intervention was conducted in Tanzania and dealt with environmental sustainability; and second intervention was in India and dealt with social sustainability.

This doctoral thesis consists of three articles and a thesis summary. The latter is divided into eight chapters.

The second chapter describes multiple ecological crises lead to development of the Environmental Education (EE) and Education for Sustainable Development (ESD) discourses; ESD discourse expanded the list of themes under the global sustainability agendas however ESD is also not free of its inherent self-contradictions. The chapter briefly explains that an educational system co-exists with and is interdependent on multiple social systems.

The third chapter describes how education either aims for social transformation through institutional change and changes in educational policy or on transformation of the learners. Both these approaches derive their inherent values from the Mechanistic and ecological paradigms of education. The mechanistic or institutional approach is more restrictive as it is obliged to maintain and promote established values and behaviors. Ecological paradigm's approaches and values are more suitable for individual transformation and hence, for sustainable behavior changes. Choice of the educational paradigm affects educational vision, approach and methods used to decide curriculum, to develop educational content, and choice of methods to deliver educational content. Mainstream education in most countries is guided by the mechanistic paradigm of education.

Chapter 4 points out that the ecological paradigm is not merely an abstract idea but it also affects how education happens on the ground. Alternatives to mainstream education have always co-existed. Alternative educational initiatives have been

engaging in developing transformative learning opportunities based on theories and frameworks. The chapter also explores appropriate use of ICTs in education.

Despite the obvious advantages of ecological paradigm of education, shifting an educational systems' paradigm from mechanistic to ecological one is an enormous challenge. Chapter 5 suggests core ideas of Children as Agents of Social Change (CASC) as a novel approach and a framework to provide transformative learning experiences in mainstream schools in the developing countries. This chapter discusses the research design; as well as provides details of the CASC media artifacts and pedagogical guidelines.

Chapter 6 describes the aims of research and empirical research and design of the studies. Both interventions used experimental and control groups for pre- and post-tests. Chapter 7 describes the empirical studies and their results in some details. Chapter 8 concludes the thesis.

Though the CASC framework aimed primarily at developing countries, and the CASC based interventions were conducted in developing nations only, there is a strong case for using CASC in developed countries as well.

2 SUSTAINABILITY AND EDUCATION

Sustainability is critical to human survival. For decades, scientific evidences have been pointing out that human activity plays a crucial role in the degradation of the biosphere. Through Silent Spring, Carson (1962) challenged the hubristic human claim of being the center of Earth's ecological cosmos; and pointed with profound urgency that human carelessness, greed and irresponsibility were adding toxins in human food and leading to environmental degradation. In The Limits to Growth, Meadows et al. (1972) argued that the foundational assumption of economic development that infinite growth is possible on a finite planet is heavily mistaken and dangerous.

Multiple scientific evidences suggest humans play an active role in multiple planetary crises. In 1992, Union of Concerned Scientists (UCS) strongly asserted that "Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices may put the future at serious risk for human society; the plant- and animal-kingdoms; and may alter the living world that it will be unable to sustain life in the manner that we know". (UCS, 1992). Data collected by US National Snow and Ice Centre Data Centre indicates that Arctic ice has decreased 55% in thickness from early records in 1979 to 2009 (Littledyke & Manolas, 2011).

Similarly, UN's Millennium Ecosystem Assessment report (MEA, 2005) was a comprehensive, peer-reviewed analysis by more than 1200 scientists. The report assessed the consequences of ecosystem change for human well-being and warned that the planet's ecosystem is losing its ability to cope up with the man-made stresses. The report highlighted that 60% of global ecosystems have now degraded; varieties of species face extinctions; more than a billion people experience water scarcity; and deforestation levels have been rising alarmingly.

Sigma Xi, a scientific research society, convened international group of climate scientists at request of United Nations (UN). Their report concluded that even relatively small rise in global average temperature of 0.8ºC since 1750 was accompanied by significant increases in the incidence of floods, droughts, heat waves and wildfires (Friedman, 2008). Scientists expect a rise in global temperatures - between 1.4 and 5.8ºC by 2100 if present levels of greenhouse gas emissions are maintained. Human interference with the climate system is posing serious risks for human and natural systems (IPCC, 2014). Multiple scientific evidences collected over decades suggest that human behavior is a significant causal factor in aggravating multiple sustainability crises.

Djoghalf (2010, p. 2) reported that despite serious urgency, international targets to reduce biodiversity loss have not been met and biodiversity loss is intensifying. UN Secretary General Ban Ki-Moon stated that "the consequences of this collective failure, if it is not quickly corrected, will be severe for us all" (UN, 2010). Reversing degradation of ecosystems will involve significant shifts in policies, institutions and most importantly, in human behaviors.

The accumulation of scientific data regarding human impact on the environment has not translated into sufficient transformative societal action (Boström et al., 2018). In short, human behaviors are constantly pushing the global ecology to its limits. These behaviors are harming human beings, other species, and also, the

planet. Despite decades of rising knowledge about sustainability, the scale of issues caused by un-sustainability has kept escalating. Human survival on earth cannot be guaranteed.

In response to increasing evidences about environmental crisis, global environmental sustainability movements also started to emerge in 1960s. Conferences e.g. UNESCO Biosphere conference in 1968; Belgrade Charter in 1976; and Tbilisi Conference in 1977, among others, started to create opportunities for concerned scholars, practitioners and policy makers to join hands (Nikolopoulou et al., 2010).

Acceptance of sustainability as shared and serious human problem served as a foundation to organize scientific community around the theme. However this community was neither single-minded about the core nature of sustainability issues, nor unanimous about how to deal with them. Resultantly, various paradigms emerged within the field of sustainability.

2.1 EMERGENCE OF THE CONCEPT OF 'SUSTAINABLE DEVELOPMENT'

By 1987, two contrasting camps clearly emerged within the sustainability discourse. While the initial focus of the sustainability community was sustainability itself, in 1987, the discourse of Sustainable Development (SD) sprouted through the World Commission on Environment and Development's report named 'Our Common Future', or the Brundtland Report (BR). BR defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 13). SD did not start with Brundtland Report in 1987; however, this report surely was a major political turning point and made SD a global catchphrase (Mebratu, 1998). The rationale for SD can be very briefly explained through the following points.

- A prosperous and safe future cannot be secured as long as significantly large human population lives in poverty.
- Effective action is becoming more and more challenging with passage of time.
- Distribution of the benefits of globalization is not equitable.
- Inequities heighten threats – local crises evolve into development crisis and then spread to threaten global security itself.
- Diseases perpetuate poverty for whole countries as well as for individuals.
- Investment in basic health care in poorest countries will boost economic growth.
- Innovative funding devices need financial follow through from the developed countries to the developing countries.
- Growth, development aid, democratic change and fairer deal for [the disadvantaged] in the developing countries as they strive for access to global markets can save natural resources.
- More important than investments in new technologies, energy conservation, pollution control, and fossil fuel based economy is investment in people. (Brundtland, 2002.)

Brundtland's report added an important logic to Sustainability discourse by emphasizing that natural ecosystems struggling against human invasions are not the only global concern; and that the list of human challenges is longer. Therefore, other

than natural environment, SD must include additional aspects of sustainability as well. And hence, other dimensions were added.

- Human sustainability. Maintaining human capital such as health, education, knowledge.
- Social sustainability (organizations and networks). Maintaining social capital.
- Economic (financial) sustainability. Keeping capital intact.
- Natural (environmental) sustainability. Protecting natural capitals (e.g. water, land, air, minerals, etc.) (Schroter, 2010).

Emergence of SD divided the sustainability community in two clear camps. Unitary focus of one camp was environmental sustainability; while the focus of the other camp was pluralistic agenda of sustainable development. SD view point is instrumental while sustainability movement's thrust is on intrinsic values. SD surely added valuable topics to the sustainability discourse. However, this does not mean that SD is completely wholesome and balanced. Despite its appreciative additions of domains, SD's main discourse, its approach and rationale are highly contested. Following points briefly discuss some of the objections raised against SD discourse.

Epistemological Flaws

Mebratu (1998) identified some fundamental conceptual running flaws between different versions of sustainability as 'epistemological flaws'. He argued that while majority of literature on sustainability and SD agrees on limitations of reductionist, scientific thinking and their causal role in aggravating the sustainability crisis. However there are two distinct styles of thinking: holistic and reductionist. The holistic camp argues that whole is larger than the linear sum of 'parts' while the reductionist approach emphasizes more on individualistic parts only. The implied epistemological flaws can be overcome by recognizing that holistic thinking is based on the 'parts', the 'whole' and the interaction between the parts and the whole (Mebratu, 1998).

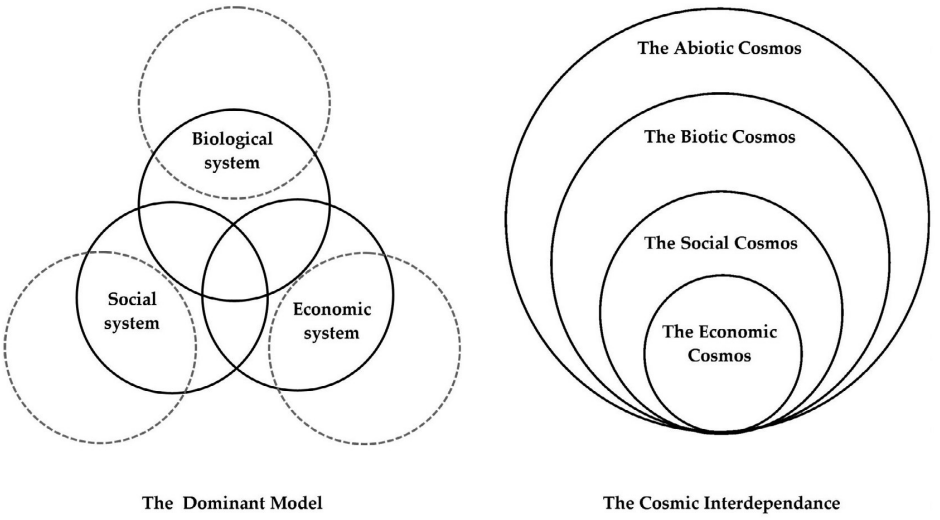

Figure 1. Sustainable Development misperceives the Cosmos (Mebratu, 1998)

The epistemological differences extend themselves into how the world/cosmos is understood by the two different ways of meeting the challenges. The reductionist camp treats natural, economic and social systems as independent systems. These systems interact where as the area outside their interaction is considered the area of contradiction. The ultimate objective of sustainability is to fully integrate natural, economic and social systems. Contrary to the reductionist approach, Cosmic inter-dependence model (Figure 1) provides a perspective more grounded in reality. Cosmic inter-dependence model grounds itself in facts that the economic and social cosmos have never been; nor will be ever be separate from the natural universe: biotic and abiotic cosmos.

Mebratu identified a lack of clear distinction between environment and ecology. While environment is something that an organism has; ecology studies the relationship between the organism and the natural environment. A natural extension of these concepts implies that the environmental crisis includes the economic, social, political and cultural crisis; and the ecological crisis is a crisis between humans and the natural universe.

The appeal to change our attitudes and lifestyles for human interest is likely to be ineffective. Eco-centric ethics take a reverential attitude towards nature while anthropocentric ethics are driven by 'great visions'. The problem with great visions of sustainability is that "a single globally accepted end point will either be so general as to invite the same old criticisms or so culturally specific that it will be rejected by many who do not identify with it" (Mebratu, 1998). Eco-centric ethics consider the anthropocentric ethics as dangerously 'human-centric'.

Shallow definition

A key foundational concept of SD is prosperous future for all. USA surely is a prosperous country. Robinson (in Robinson & Aronica, 2016) agrees to the expert opinion that "if everyone on Earth consumed at the same rate as the average person in India, the Earth could sustain a maximum population of fifteen billion. On that basis, we are halfway there. The trouble is that we don't all consume at that rate. If everyone consumed at the same rate as the average person in North America, we're told, the planet could sustain a maximum population of 1.5 billion. We are nearly five times past that already." Is human quest for prosperity -as defined by West- sustainable? Current global population is about 7.2 billion people. SD discourse promises to make everyone more prosperous.

Mistaken foundations increase the risk of misdirecting the rest of the effort. Critics argue that SD discourse heavily discounts its inherent self-contradictions. Contrasting views about SD have been derived from two contrasting concepts of *shallow ecology* and *deep ecology*. Shallow ecology group (Weston, 1985) argues for policy reform, improved technology and better practices would improve situation. The concept of shallow ecology argues the treatment of environmental problems without tackling their underlying causes and without confronting the philosophical assumptions that underlie our political and economic thinking. In contrast, the concept of deep ecology was formulated by Arne Naess to indicate that the deeper roots of environmental problems lie in Western cultural values that legitimize the domination of nature (Naess, 1973). Deep ecology group argues that SD discourse is a shallow approach to counter the accelerating sustainability problems.

We need to rethink, redesign and recreate our social orders to keep planet inhabitable for everyone. ESD insists that way out of current crisis is maintaining the

old patterns. Critics of SD point out that their evidences ask us to reconsider whether human equality, prosperity and population growth as suggested by proponents of SD can be achieved if the present rate of natural degradation for expansion the 'economic pie' to include the most dispossessed will need ever more natural resource consumption. These reservations point to the self-contradictory nature of the solutions based on SD discourse (Harari, 2016, p. 250).

Development First

For SD, sustainability is an after-thought (Rees, 1992; Meadows et al., 1972; Kopnina & Meijers, 2014). The essence of development has been to persuade less knowledgeable people to accept the new information because it will then benefit them in their pursuit of whatever it is that is considered to be development. Some information and scientific knowledge, primarily from the 'developed' countries lead to green revolution and increased production, however this has been used as a pretext to encourage people to globally accept and adopt the Western ideas unquestionably (Unwin, 2009). The notion of development is rooted in Western imperialism and colonialism. Development has served as an excellent tool for marginalization and diminishing the power of certain countries (Klarin, 2018). Critics posit that SD is an ungrounded idea being forced upon the world.

Critics of the Brundtland report base their reservations on empirical evidences from multiple fields including medicine, education, social sciences and media. These evidences point out that development very often clashes with sustainability. The report does not clarify about unhealthy practices that boost narrowly defined - Gross-Domestic Product based - development at the substantial environmental, human, social and biodiversity sustainability costs (Campbell & Campbell, 2006; Jackson & Jamieson, 2007). They point out that SD is a continuation of human greed and the anthropocentric worldview which has lead us to multiple sustainability crises.

Wicked Plurality in SD

Boström et al. (2018) have noted that even after thirty years of sustainable development discourse, concerned citizens feel deep disappointment with its ability to confront key sustainability problems. It has been decades since we have been listening to and know about sustainability crisis. Humans, as Species, have not changed much.

Critics argue that SD has enforced 'wickedness' onto the problems of sustainability. A problem is considered 'wicked' when it is difficult or impossible to solve it because of its incomplete and contradictory requirements that are often difficult to recognize. The term "wicked" denotes resistance to resolution (Churchman, 1967). Wicked problems often have complex interdependencies. The effort to solve one aspect of a wicked problem may reveal or create other problems. Wicked problems of sustainability represent the tensions that emerge between causal social explanations, scientific-evidences from natural sciences; and the benefits and beneficiaries of continuing causal factors. While scientific evidences since mid-20th century have been indicating that the planet has limits, modern economics is still holding onto its outdated foundational assumption of unlimited growth. Steady change in the state of affairs requires that humans change their behavior.

2.2 ENVIRONMENTAL SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT IN EDUCATION

The idea of Education for Sustainability was shaping up somewhat in parallel to the development of concepts of Sustainability. The discourse of Environment Education (EE) was officially recognized in UNSECO's Biosphere conference in 1968. The conference defined EE as "the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture, and his biophysical surroundings" (Quoted in Palmer 1998, p. 5).

Belgrade Charter in 1976 and Tbilisi Conference in 1977 followed the spirit of Biosphere conference. Belgrade Charter summarized EE's objectives as:

- Awareness. To help individuals and social groups acquire an awareness of and sensitivity to the total environment and its allied problems.
- Knowledge. To help individuals and social groups acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.
- Attitude. To help individuals and social groups acquire social values, strong feelings of concern for the environment and the motivation for actively participating in its protection and improvement.
- Skills. To help individuals and social groups acquire the skills for solving environmental problems.
- Evaluation ability. To help individuals and social groups evaluate environmental measures and education initiatives in terms of ecological, political, economic, social, and educational factors.
- Participation. To help individuals and social groups develop a sense of responsibility and urgency regarding environmental problems to ensure appropriate action to solve those problems. (Kopnina & Meijers, 2014).

A decade after the Brudtland Report, in 1997, Thessaloniki Declaration started the attempts to unify the two contesting discourses of Environmental Education and Education for Sustainable Development (Nikolopoulou et al., 2010; Kopnina, 2012; Kopnina & Meijers, 2014). In 2009, the World Conference on Education for Sustainable Development defined ESD as "an approach to teaching and learning based on the ideals and principles that underlie sustainability". The list of key issues considered under ESD at the conference included human rights, poverty reduction, sustainable livelihoods, climate change, gender equality, corporate social responsibility, protection of indigenous cultures in an integral way, it constitutes a comprehensive approach to quality education and learning (UNESCO, 2009).

In Environment Education, environment was the central concern. In ESD, human concerns are central. A heavy risk involved in the shift from EE to ESD is regarding the loss of the worldview that humans are part of nature (Wals & Kieft, 2010. p. 16). ESD is a turn away from 'environment' in environmental education; it promotes pluralism to maintain dominant political ideologies and consolidate corporate power; and obscures environmental concerns. Plural interpretations of ESD underprivilege eco-centric perspective and are likely to mislead ecologically ill-informed teachers and students into the dominant neoliberal ideology (Kopnina, 2012).

An alternative to ESD that has gained currency is Education for Sustainability. Figure 2 depicts Kaivola and Åhlberg's vision of Education for Sustainability.

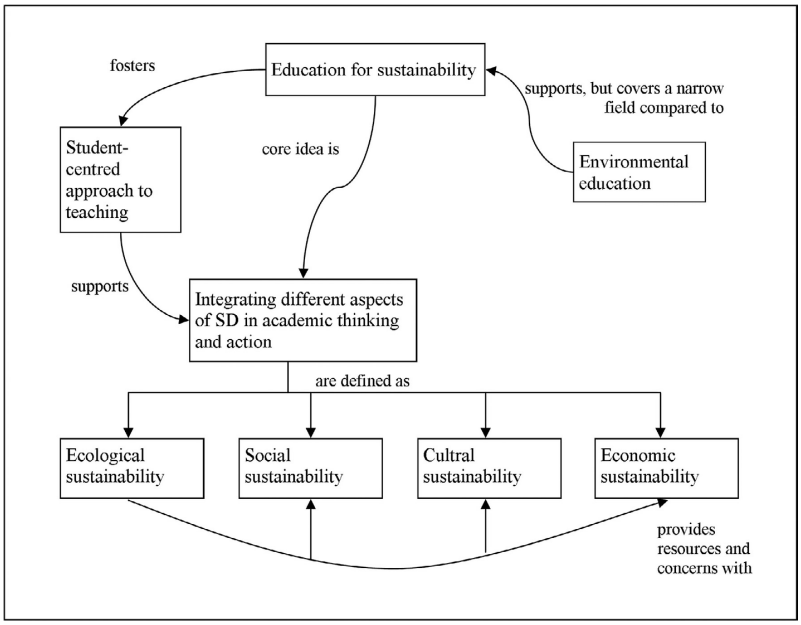

Figure 2. Education for Sustainability (Adapted from Kaivola & Åhlberg, 2006)

Åhlberg (1998a, 1998b) defines Education for sustainability as "pedagogical approach in which different aspects of sustainable development – economic, social, cultural and ecological – are integrated in academic thinking and action". Education for sustainability (EfS) is student centric, research-based, and focuses on improving academic, higher-order thinking skills through meaningful teaching and learning. EfS is action-oriented; and considers the principles of sustainable living important (Kaivola & Åhlberg, 2006).

2.3 EDUCATIONAL ENDEAVORS AND SOCIAL CHANGE

The idea of transformation through educational interventions implicitly calls for a deeper investigation of the very vehicles of change: the educational endeavors. This thesis specifically focuses on the pressures on the educational movements (such as Education for Sustainability movement) in the developing world.

A modern educational system is complex, adaptive system that has evolved overtime. Educational systems are inter-dependent social systems; never divorced from their social contexts; and are influenced by multiple facets of social reality. These contexts affect educational institutions, educational content and content delivery methods as well as education policy, theory and practice. To improve the quality of Education for Sustainability discourses, it is crucial to understand various pressures that shape the nature of a learning ecosystem in which such education takes place (Robinson & Aronica, 2016; Sterling 2011).

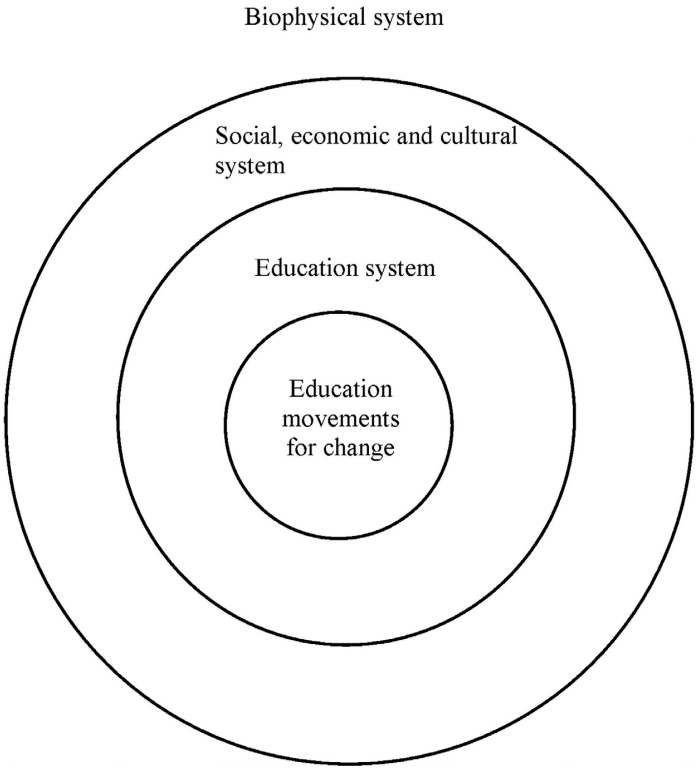

Figure 3. Systems affecting educational movements (Sterling, 2011a).

Education is always programmatic, never politically neutral, and is designed to produce specific social outcomes. Education programs pupils to accept its assumptions about power, reality, morality, and the formulations of knowledge that the curriculum imbues. Most education today aims for social maintenance than social change. (McWhinney & Markos, 2003.)

Sterling (2011a, p. 32) posits that

- Education aiming for change is often outweighed by larger educational system which enacts and can cancel out radical educational endeavors;
- Often, social systems affect and shape educational systems; and
- Other than formal education, mass-communication plays an important role in informing and shaping people's views, ideas and beliefs.

Multiple economic, social and political pressures force educational endeavors to adopt structures and methods that hinder learning. These pressures affect what and how learners learn through education.

2.4 PROBLEMS WITH ONE-SIZE-FITS-ALL APPROACH

ESD aspires to create a qualitative difference however it does not discuss the details of quality of education in-depth. Many developing countries do not think pragmatically or strategically - beyond receiving funding - when they sign themselves into ESD (Wals & Kieft, 2010, p. 15). Myopic educational vision leads to serious gaps in providing transformative education (Nikolopoulou et al., 2010; Kopnina, 2012; Kopnina & Meijers, 2014).

2.4.1 Challenges related to content in developing countries

Freire (1972) and Dewey (1916) strongly argued that education is a medium aiming to evoke critical reflection in learners. They also stressed that education must consider learner's views of the world. Manifestations of unsustainability can be rooted in local histories as well as in political and cultural traditions which are most often overlooked by the global approaches like ESD (Wals & Kieft, 2010. p. 7). Very often, ESD content is grounded in the content writers view of the world.

- Lack of connection to previous knowledge: Lot of research emphasizes the importance of incorporating learner's previous knowledge in new learning however most of the educational content, including ESD content, does not make any effort to learn from the learner. Lack of such knowledge can open the topic in conflicting ways and close learner's mind towards the topic. Content that lacks connection with life-world of the learner promotes learning in which the learner acquires new information without learning about its applicability in their actual life-world (Perkins, 2009).
- Content interpretation: When ESD content is communicated in non-native languages, it is less easy for the learner to understand; and s/he may not fully grasp the concepts properly.
- Cognitive over-load: High reliance on text, poorly-illustrated text, lack of illustrations, and excessive use of text leads to additional mental strain also known as cognitive over-load (Mayer, 2010).
- Authoritarian approach to education: Educational content about ESD does not base itself on learner's previous knowledge and beliefs. Rather, it provides one-way discourse from the expert to the learner. In most cases, the content-writers are not accessible for questioning even when the content does not fit with learner's previous understanding.

2.4.2 Challenges related to content delivery

UNESCO (2014, p. 86) claimed that "Effective ESD is contingent on a shift in pedagogical approaches, from traditional teacher-centered pedagogies towards teacher-facilitated and collaborative discovery and problem-solving approaches." However the claim does not reflect the ground-reality in most developing nations. Multiple obstacles block the way.

- Limited educational budgets: Most educational systems lack educational budgets and hire less than required number of teachers so there is no one to deliver the content (Tooley, 2009). Over-burdened with academic pressures, teachers may lack interest in topics of sustainability.
- Limited access to research: Even when teachers are interested, not many schools can afford access to latest research on topics specially because lot of research gets imprisoned behind the paywalls. This situation can easily lead teachers to teach outdated knowledge.
- Quality-deprived teacher training programs: Insufficient teacher training programs supply teaching certificates to students with limited understanding of children, learning and pedagogy. They may have read the theory but lack actual understanding and practice of these concepts (Kindleberger & Richmond, 2012).
- Lack of expertise among teachers: Lack of key understandings among teachers often results in teacher centric educational practices. Hence, content is delivered however it has very limited effect. Freire argued that teacher-centered education is based on teacher's views of the world and called it the 'banking model'. In the banking model, teacher deposits knowledge in students (empty) brains (Freire, 1972).
- Lack of hands-on-experience in problem domain among teachers: Despite its urgency and importance, teacher education courses in sustainability are not yet a norm in most developing countries. While teachers may have asymmetric and incomplete information about topics of sustainability. Most teachers do not have actual hands-on experience about sustainability, access to various tools and metrics and may fail to understand the complexities involved in domains of sustainability (Tooley, 2009).

2.4.3 Challenges related to learning environment

Educational systems provide the background context for learning. Perkins argues that almost everything students learn in school has its hidden aspects. Students learn the hidden values of the game by playing the game again and again and in the process they begin to ingest the hidden game concealed within the grown-up games (Perkins, 2009). Hidden games behind ESD make learning more strenuous and promote rote and inert learning.

- Rote learning: Education in many if not most countries takes place under high stake and rigorous test-based environments. Lot of existing research points out that tests do not enhance deeper learning (Jones & Egley, 2007; Berliner, 2011; NCTE, 2014). Living in high stake test-oriented systems, students inherently absorb the hidden assumption that the purpose of all information is to memorize it and successfully reproduce it during tests.
- Infusion approach: Rather than being an independent subject by itself, ESD is mostly taught as a topic contained in several subjects spread over several years. Infusion approach is used to avoid problems that surface when learning about multiple dimensions of an issue needs teachers of various subjects come together and simultaneously co-ordinate. Infusion approach is known to be a weak approach as interrelated aspects of a topic are shared with the learners over a large period of time. Learners can forget one aspect of problem by the time, they get to learn the next one. (WHO, 2003.)

- Knowledge hierarchy: Generally, like all subjects, content providers are unquestionable and inaccessible authority and teachers act as their miniature versions. Poor teacher training, lack of knowledge, lack of expertise, lack of resources, lack of systems level support for learning or lack of interest among teachers makes teachers act fearfully and they discourage questioning from students. Education in such scenarios is not an empowering process in which both teachers and learners are 'co-investigators of reality' (Freire, 1972).

When offering aid for ESD, the donor countries feel entitled to interfere with the educational policy and practices in order to help. Selinger (2009) mentions that education policymakers in the developing countries often face contradictory pressures of prioritizing between preparing for better international standardization races like PISA; or helping their new generations understand the context of their own cultural and social traditions, identify and associate with what makes them unique. Dependence on the West is less likely to support transformative education about sustainability in developing countries. Western interests prefer to maintain their dominant status through maintenance of the colonial social values, traditions and mind-sets.

ESD is top-driven global vision of sustainability. It offers abstract information and ignores the local manifestations of a global problem. Students should be factually knowledgeable however owing to its inherent contradictions, ESD is less likely to empower or transform a child. Students feel empowered when they actively participate in problem-solving. Despite its limitations, ESD should be credited for expanding the horizon of sustainability problems. In this thesis, I use the term 'Education for Sustainability' to mean education about problems related to various aspects of sustainable development however unlike ESD, it aims promote clarity and empower to empower the students.

3 SOCIAL TRANSFORMATION AND EDUCATION

Education impacts people's lives, outlook and shapes their perspectives. Education crucially shapes people notions, values and identity. Changes in education can lead to shifts in perceptions, outlook and values; and hence, it can affect one's relations with ideas, people and the world. Education is a well-known path to social and behavioral change.

3.1 TWO APPROACHES

There are two approaches to society and social change. The first – and more popular - approach argues that the society is based on its institutions and structures and therefore, to bring about a change in the society, one should start with changing its institutions first. This *institution-centric approach* can be reformist or revolutionary or both. Central to this approach are power and ideologies. The institutional approach to education posits that individuals (learners) do not know; and should be told what is right and what is not; it expects individuals to obediently remember and follow what is being told to them. The focus is on memory and assessment; and on the reward and the punishment. The key educational idea in the institutional approach is transmission of the right message (as per the managing authority). This approach posits that unsustainable behaviors indicate masses are either ignorant or misguided; and therefore, should be supplied with a new message which can be done (only) through power and institutional control. This approach believes that dominance of new kind of ideas (indoctrination) will lead to new kind of culture and civilization which would be (more) perfect than the current ones. Mainstream education in many parts of the world is highly influenced by the institutional approach. Movements of social change through changing institutions can originate from public sentiment, research findings, political and media pressures as well as vested interests. (Thapan, 1991; Ardagh, 2005.)

The second approach is more of *individual-centric approach*. It posits that the society is nothing except a group of individuals and their social relationships. Therefore, social transformation automatically follows individual transformation; and that mere institutional changes are meaningless if individuals do not change. The focus of the individual-centric approach is individual's transformation. Krishnamurti argued that "it is only when the individual changes radically that there can be a fundamental revolution in society. It is always the individual, never the group or the collective, that brings about a radical change in the world" (Krishnamurti, 2012). It makes sense that to transform a society, we must first change ourselves.

Central to individual-centric educational approach is transformation of the individual. From an educational point of view, this approach believes that education is the grassroots activity that takes place in classrooms; and if this activity can be free from the unwholesome pressures from institutions and promotes reflective learning, it is likely to produce lifelong learning. This approach posits that learners are naturally curious and intelligent. When they are provided engaging educational opportunities to think critically and reflect, they are more likely to delve deeply and understand the object being learned (Thapan, 1991; Ardagh, 2005).

Education is a social provision founded upon human's natural capacity to learn. The grassroots activity in classrooms can potentially affect learners for a lifetime. Education is effective only if learning takes place. While education is socially driven; learning is a natural, lifelong process that is hallmark of human beings. A key reason why humans survived and thrived on planet Earth is their ability to learn and adapt. Humans can change their behavior quickly; and transmit new behaviors to future generations without any need of genetic mutations (Harari, 2011, p. 37). If education connects to the organic faculties of humans, learning is natural, organic and its effects are sustainable.

3.2 ORDERS OF CHANGE AND LEARNING

Sterling (2011a) points out that Education for Sustainability should re-organize itself from transmissive education towards transformative education. He mentioned three orders of change and learning in order to clarify the differences in transformative learning and change through education. This idea of three orders of learning (Table 1) was influenced by proponents of similar ideas e.g. Bateson and others (Sterling, 2011b).

The first order learning includes education within the accepted boundaries. In this order, basic values are left unexamined and unchanged and the focus is on adaptation and maintenance. Second order learning involves critically reflective learning i.e. 'thinking about our thinking'. Critical reflection and adaptation are encouraged. Third Order learning is creative. Learners are able to see things differently; gain deep awareness of alternative worldviews and ways of doing things. This involves creative revisioning.

Table 1. Orders of learning and change. Source: Sterling (2011b)

Order of change/learning	Seeks/leads to	Can be labelled as
First order change/learning: cognition	Effectiveness/efficiency	'Doing things better'- Confirmative
Second order change/learning: meta-cognition	Examining and changing assumptions	'Doing better things'- Reformative
Third order change/learning: Epistemic learning	Paradigm change	'Seeing things differently' – Transformative

I have noticed from personal experiences as well as by asking friends and colleagues from other developing countries that a serious problem with education for sustainability in developing countries is that most education for sustainability stays within the first order and at most, peripherally touches the second order learning. Tooley's (2009) work in multiple developing countries also suggests poor quality of education is common. Lecture-based, transmissive education dominates mainstream education. Transformative aspects (e.g. use of inquiry- and problem-based learning methods) are required for third order learning however, they are largely missing in mainstream education (and thus, in Sustainability Education). The first-order methods are based on indoctrination, non-reflective learning, rote learning, and incidental learning.

Multiple sustainability crisis need second and third order learning responses from social and cultural systems (Sterling, 2011a) however we are falling short of providing such education.

Information exchange is an important part of education however not all our knowledge is based upon reflection and deeper learning. Jarvis (2008, p. 113) points out that most of our learning is incidental i.e. learning without reflection. Non-reflective learning is often a norm in high-stake, test-oriented education where memorizing and ability to reproduce information are keys to educational success. Jarvis lists varieties of learning being fostered that are not reflective: rote learning; indoctrination; non-reflective learning; and incidental learning are all examples of shallow learning.

Indoctrination is the process of teaching people systematically to accept doctrines uncritically. Individuals have little or no freedom of consent about being exposed to the information. Indoctrination aims to implant ideas into mind by putting pressure on an individual in a way in which his conscious mind cannot fully resist or cannot reflect upon. Indoctrination aims at getting people to believe something, unquestionably, uncritically. Rote learning is also a way to indoctrinate that stresses on exact reproduction of the fed information. Similar to indoctrination, nonreflective learning implies transmitting information to learner without giving him/her an opportunity to reflect or ask the meaning of information; why and how this information is being transmitted, and whether its claims are valid. Non-reflective learning encourages conformity and does not allow dissidence. Non-reflective learning is most often related to distribution of power in society. Jarvis argues that most of our learning is incidental, unintended (i.e. we internalize a message and undertaking acts of conformity) and nonreflective (i.e. lacking rational inquiry and rational communication). Watching TV or from witnessing an event leads to incidental learning. Much of what we learn in life is neither deliberate nor intentional (Jarvis, 2008).

3.3 TWO EDUCATIONAL PARADIGMS

As we experience the complex flow of life around us, we try to create, re-create and navigate mental models, classifications, and frameworks to navigate the world safely and successfully. Kuhn (1970) suggested the idea of *scientific paradigm* as a set of shared concepts, values, and techniques used by any scientific community. Scientists subscribe to *paradigms* to simplify their understanding about the world, individuals, society, the universe and their profession. Paradigms affect practitioner's perceptions and views. Paradigm's influence what a scientific community perceives as important, reasonable, legitimate, and possible (Kuhn, 1970, p. 23-65). Paradigms constitute all scientific activity including underlying assumptions e.g. problem definitions, kinds of questions asked, data interpretation, and ways of drawing conclusions. Scientific theories embody paradigms. While learning a paradigm, its theory, method, and standards are acquired together.

3.3.1 Mechanistic and ecological Paradigms

Science and technology have steered human societies towards better quality of living and dominated human thought for several centuries. Since 16th century, rise of industrial era and the dominance of machines led to emergence of mechanistic

paradigm. Francis Bacon, Issac Newton, and Rene Descartes pioneered mechanistic paradigm in the West. This paradigm provided the foundational ideas of Western civilization and effected the rest of the world later. Ideas of these paradigm pioneers shaped the worldview of Western society. Descartes suggested mind-body dualism; Copernicus, Galileo and Newton looked at the world as a machine governed by immutable laws; and Bacon viewed world as patriarchal and sought knowledge to control and exploit nature (Grierson, 2009). Some of the key ideas that entrenched this paradigm (Capra, 1982) included:

- View of Universe as a mechanical system;
- View of human body as machine;
- View of life as competitive;
- Belief in unlimited material progress;
- Belief in male superiority.

Paradigms are part of our mental safety nets. Dominance and prevalence of mechanistic paradigm was successful in expanding industry however, it also led to problems like climate change, pollution, deforestation, and dependence on fossil-fuels. O'Sullivan (2002) argued that 'the breakdown or crisis motivates the system to self-organize in more inclusive ways of knowing, embracing, and integrating data of which it had been previously unconscious'. When our pre-established goals are no longer valid in the present, it leads to a loss of meaning or crisis which can lead us to adopt new meaningful views (McWhinney & Markos, 2003).

Roots of the mechanistic paradigm lie in industrial capitalism. Mechanistic paradigm became dominant in human thought because of its usefulness in efficiency and large-scale production. These core values served specific industrial and social purposes; and seemed valuable at the dawn of the industrial age. However, the dominance of mechanistic paradigm is no longer uncontested. The core Industrial values are being questioned now.

We constantly try to make some taken-for-granted assumptions about life and lifeworld and try to reach an unshakable understanding (Jarvis, 2008). The world around us keeps changing constantly and rapidly (Bauman, 2000). Our learning (sensational, cognitive, social etc.) happens when we experience some form of crisis or disjuncture (Jarvis, 2009, 2012). The state of disjuncture occurs when we can no longer presume upon our thinking about the world so we cannot act upon it in an almost unthinking manner. Disjuncture points out gaps in the mental model (or thought patterns) we hold and the reality. A disjuncture is a complex phenomenon that causes one to experience dissonance in knowledge, skills, senses, emotions, beliefs and so on. Hence, any crisis - whether personal, social or global - represents a form of disjuncture. Disjuncture provides us with a learning opportunity in which we improve on our understanding of our lifeworld. The mechanistic paradigm has lead us to disjuncture in natural (ecological) as well as artificial (financial) domains of life.

When problems and anomalies unexplained by a paradigm increase, existing paradigms start to crack. Critics start to identify the outdated, dominant paradigm as the single source of multiple crisis; and stress the need to update the paradigm to a more holistic one. Pioneers of this alternative paradigm– the ecological paradigm - include Saint Francis of Asisi, Henri David Thoreau, John Muir and Aldo Leopold among others. These thinkers perceived the world through holistic and spiritual cosmologies. They perceived nature as organic; its various aspects as mutually

interdependent; and Earth as Mother Earth. Though the mechanistic paradigm sidelined these voices, the ecological paradigm has re-emerged in recent times in response to the multiple global crisis. Current advocates of the ecological paradigm – also, called *Greens* - often draw on works of Michael Faraday's ideas of electro-magnetism; Einstein's theory of relativity, quantum theory, and James Lovelock's Gaia hypothesis (Grierson, 2009). Faraday's ideas of electromagnetism refute Newtonian mechanical universe as the only model of physical reality; Einstein's relativity theory suggested an inter-connected Universe; quantum theory explores the interrelations between subatomic particles; and Gaia Hypothesis suggests earth as human-impacted but not human-controlled self-regulating organism.

Kuhn (1970) suggested that paradigms color a practitioner's perspectives and guides the selection of problems worth studying and research; the nature and structure of the permissible questions in a domain; and how the results of any research are interpreted. He perceived scientists differently than the popular notion of highly objective and non-social being. He suggested that scientists and scientific communities are not mere objective problem-solvers but they are also social beings and part of professional communities. Professional communities train scientists into paradigms. The subscription to a paradigm serves as a basic glue of the scientific communities.

Human behaviors have lead to several crises. Humans learn their behavior and habits from their societies, cultures and the world. When social values are rooted in un-sustainability, they will lead to sustainability crises. Sustainability crises results from human behavior and indicate gaps in the underlying unsustainable information, knowledge and thought-patterns. Therefore, we cannot solve these crises till we shift the very basic thought-patterns underlying the paradigm (Bohm, 1996; Jarvis, 2009).

A most fundamental tension of our current times is between the mechanistic approach and the ecological approach to life; and mechanistic root metaphor is becoming increasingly unsustainable (Sterling, 2011a). Ecological paradigm is a result of 'a new perception of reality which has profound implications not only for science and philosophy, but also for business, politics, health care, education and everyday life' (Capra, 1982).

3.3.2 Educational Paradigms

Historically, education was the monopoly of a privileged minority. The idea of compulsory formal education as a birthright of every child emerged from a liberal opinion of justice and enlightenment. Mass education was supposed to bring an era of happiness and well-being for mankind (Toynbee, 1946).

Robinson and Aronica (2016) point out that systems of mass-education got established as a part of Industrialization in Europe and education was meant to cater for the social and economic needs of the Industrial Age. Other than producing goods, Industrial Revolution significantly changed social and economic systems. Both the nobility and the working class aspired for education - previously exclusively reserved for the elite children - for their children as well. Since their inception, schools have become an essential part of social grooming and through schooling, civilizations have been affected by some Western ideas. Table 2 briefly describes some of the pressures Industrial values exerted on the educational systems.

Table 2. Influences of Industrial value-system on the educational system (Derived from Robinson & Aronica, 2015)

Industrial value	Industrial aim	Corresponding educational practice
Compliance	Produce identical versions of the same product.	*Compliance* with specific rules and standards in curriculum, teaching and assessment.
Linearity	Group processing of raw materials through sequential stages.	Segregation in classes based on date of birth. Linear movement from elementary school to high school to higher education.
Testing	Testing as a gateway to the next stage.	Exams to go to next class.
Market Demand	Adjust production to meet market demand and supply. Emphasis on marketable production.	Emphasis on marketable production STEM disciplines.
Division of labor	Change to next task.	Periods for particular subjects.

The industrial influences in education taught masses to think mechanically. The implications of paradigm on theory, practice and research are deep. The field of Education for Sustainability is divided into mechanistic paradigm and ecological paradigm. In mechanistic paradigm, the focus of Education for Sustainability is tokenism (i.e. no change) or accommodation (i.e. adaptation and maintenance) while ecological paradigm is oriented towards reformation (i.e. critically reflective adaptation) and transformation (i.e. creative re-visioning) (Sterling, 2011a).

Key proponents of mechanistic education in 20th century were behaviorists including B. F. Skinner. Skinner perceived at education as a process of information transmission. He argued for a *teaching machine* to replace teachers to bring about a revolution in education (Skinner, 1958; Benjamin, 1988). Freire (1970) has criticized such suggestions heavily under his idea of *banking model of education*.

Mechanistic education is highly oriented towards keeping the *machine* of society running and producing parts that fit into its existing structures nicely. However mechanistic education has been criticized by those who advocated for education for enlightenment. Child-centered *progressive education* movements have emerged from time to time to resist mainstream educational values. The ideology of progressive education cannot be attributed to a single thinker. However, Rousseau was perhaps the first progressive educator in the West followed by Dewey, Neill, Montessori, Steiner (Waldorf Schools) and others in the West (Thapan, 1980).

The core prepositions of progressive education include: education is growth from within of the potentialities rather than molding from without; the curriculum should arise from the needs and interests of the child rather than from the demands of the teachers (or social pressures); children should not be coerced or punished and should be allowed to learn from experience rather than be told things. The progressive ideology challenges the right of the teacher to be anything more than a facilitator, responsive to the expressed desires of the learner (Thapan, 1980). These schools view the role of teachers, learners, knowledge and the relationship between the teacher and the student differently than the mainstream schools.

Well-rounded alternatives to mechanistic paradigm are not limited to the developed world only. They are already present in the developing countries as well. Krishnamurti and Rabindranath Tagore are two prominent names among progressive Indian educators who started their own schools.

Nobel laureate Tagore wanted schools to be lively and enjoyable. He posited that flowering of learners minds is possible only in an encouraging, devoid of fear atmosphere (Guha, 2013). He strongly opposed education that undervalues contemplation. Tagore tried to impart an authentic education which he believed was more true to the needs of rural India's children than conventional, didactic British pattern guided schooling (Thapan, 1980).

Krishnamurti pointed out that our environments – both physical and psychological – compulsively influence us and these influences shape us; and set us up for narrow living (Krishnamurti, 1981). He pointed out that becoming aware of one's condition and conditioning is essential to flowering of an individual. Education plays a crucial role in making us aware of the influence. Fears prevalent in societies lead students to accept destructive and exclusive social tendencies such as nationalism and groupism. Such narrow focus divides us as humans and we lose sight of the larger issues of life like climate change.

Tagore started a school at Shanti Niketan to implement his vision of education. Krishnamurti also started several schools in India and one each in USA and UK. He viewed the school as a transformative community, established with a view towards eventually transforming the social order, one aspect of the ideology may be viewed as being communitarian (Thapan, 1980).

Ardagh (2005, p. 274) gives example of Waldorf schools as a safe space in which child's innate natural curiosity about the world is safely guarded and preferred over test scores. Students in such schools are involved in their education with a sense of empowerment and enjoy learning. They are delightful, open, intelligent and responsive people who grow up to be lifelong learners.

> *"I have met hundreds of families who have chosen such an alternative approach, and it is virtually impossible to find any who regret their decision. The majority of problems that plague conventional education simply evaporate. Truancy does not exist. Even excused absences are less than half of the state average, as kids in (these) schools want to be there everyday. Disciplinary problems become less frequent and much less serious. Teachers stay for decades and feel replenished by the quality of the contact they have with their children. And, most important, such schools are successful at the job they set out to do: kindle the lame of confident inquiry, curiosity and creativity in children, so they may grow up to be innovators of a new world rather than obedient participants in the existing one."*

3.3.3 Educational Paradigms in Education for Sustainability

Sterling provides a comprehensive summary of the contrasts between mechanistic and ecological paradigm from the point of education for sustainability. Table 3 (adapted from Sterling, 2011a) provides a basis to understand the Mechanistic and Ecological paradigm's perspectives of education; learning environments; and learner and learning.

Table 3. Two contrasting educational paradigms.

	Mechanistic Paradigm	**Ecological Paradigm**
The main objective	Preparation for economic life	Participation in all dimensions of sustainability transition – social, economic, environmental
View of teaching and learning	Transmission	Transformation
	Product oriented	Process, development and action oriented
	Emphasis on teaching	Integrative view: teachers also learners, learners also teachers
Methodical approaches	Competition	Cooperation, collaboration,
	Specialization	Integrative understanding
	Socialization, integrating to fit	Autonomy-in relationship
	Standardization	Diversity with coherence
	Accountability	Responsibility
	Modernity	Ecological sustainability
Evaluation & Assessment	External inspection	Self-evaluation, plus critical support
	External indicators, narrowly prescribed	Self-generated indicators, broadly drawn
	Quantitative measures	Qualitative as well as Quantitative measures
Management	Top-down control	Democratic and participative
	Curriculum control and prescription	Curriculum empowerment and determination
Views of learner	As a cognitive being	As whole person with full range of needs and capacities
	Deficiency model	Existing knowledge, beliefs and feeling valued
	Valuing intellect	Intellect, intuition, and capacity valued
	Teachers as technicians	Teachers as reflective practitioners and change agents
	Learners as individuals	Group organizations and communities also learn
Teaching and learning styles	Non-critical inquiry	Critical and creative inquiry
	Analytical and individual inquiry	Appreciative and cooperative inquiry
View of learning	Simple learning (first order learning)	Also, critical and epistemic (second/third order)
	Meaning is given	Meaning is constructed and negotiated
	Needs to be effective	Needs to be meaningful first

Choice of paradigm deeply affects education. Afterall, education is inseparable from its aims, content and method of communication and transmission. Jarvis (2008) listed: the intentions of people who transmit information; the techniques used in teaching and learning process; the content that is taught and the extent to which it is open to examination; and relationship to the truth – the content must be true and valid – as four most critical aspects of educational communication that must be free from all forms of indoctrination.

In mechanistic approach to ESD, learners are unwittingly set by the authorities or are given the illusion of participation. At its core, mechanistic approach to ESD is guided by manipulation, control, tokenism and false participation (Hart, 1997).

We can deduce from Kuhn (1970) that the choice of paradigm deeply affects not only the core educational values of an educational system, but also, how teachers are trained and learn to perceive education, teaching and learning; and how students learn, what they learn and how they perceive themselves and their roles in life ahead. Paradigm affects how the learning content is developed, its rationality; the methods used to teach; a teacher's views of best suitable approaches and methods for teaching and learning; and methodical approaches considered most suitable to achieve educational objectives. Therefore, choice of the educational paradigm is a key to understand success and failure of educational process; as well as educational systems and their approaches.

Global dominance of mechanistic paradigm has led to dominance of *pedagogy of fear* through education (Kizel, 2016). Kizel argues that in education, competition and test-centered learning create fear. Preferring competition over cooperation and test-centered learning over relaxed, dialogic learning forces students to champion the measuring yardstick (of assessment) over reflective and deeper learning. Test-centered learning is neither sustainable, nor does it help learners become passionate, lifelong learners.

In contrast, the ecological approach is guided by participation, self-determination and autonomous thinking (Wals & Kieft, 2010. p. 18). (Wals and Kieft (2010) have used the terms *narrow* and *broad* to convey the ideas similar to mechanistic and ecological paradigms.)

Ecological paradigm philosophers like Tagore and Krishnamurti suggested that freedom, art, beauty and love energize the atmosphere of learning while mechanical way of being degenerates us. They emphasized that competition contributes to fear and does not promote care, love, goodness or peace in person's life and therefore, in society. Focus on standardization over freedom, indoctrination over dialogue and competition over contemplation inhibit a person's growth as independent thinker and creative person (Guha, 2013).

Despite the facts that we need to be serious about sustainability; and that ecological paradigm is more authentic approach to promote sustainability; global mainstream schooling is largely dominated by the values and world-view of the mechanistic paradigm.

Ardagh (2005) points out a deeper crisis that students face in a mechanistic school culture. On one hand, students have a pressure to succeed in the society i.e. they are constantly being told to fit into the social machine. On the other, they do notice that their society's priorities are causing rapid extinction of species, global warming, increasing economic and social disparity and numerous other problems. They notice that the tests of school are not preparing them for tests of life. Some choose to blunt this dichotomy of meaninglessness, disillusionment, depression and anxiety through

sex, violence, drugs, alcohol and other behaviors that can be termed 'unsustainable'. Passive learning and knowledge accumulation takes place in the mechanistic education, however such learning does not transform individuals. Many students are passing their exams in exam-centric school systems, however the short-sighted mechanistic paradigm is failing to address the larger issues of life.

Parents who do not wish to force their children into the 'one-size-fits-all information feeding machine' of the mainstream, mechanical education are considering options like home-schooling, un-schooling, and de-schooling. Ecological paradigm schools have have been gaining ground globally. Existence of ecological paradigm schools in developing nations (e.g. Krishnamurti schools, Montessori schools, Waldorf Schools among others) exemplifies that providing education through ecological paradigm is possible even in developing countries.

4 LEARNING AND TRANSFORMATION

Transformative learning has been strongly endorsed by educational philosophers such as Krishnamurti, Freire and Dewey (Dewey, 1916; Freire, 1972; Krishnamurti, 2006). Transformative learning is concerned with not merely with the change in the learner's knowledge but with the change in the learner. Transformative learning calls for reexamination of one's assumptions, values, critical thinking and new creativity (Sterling, 2011b). I subscribe to the idea that personal transformation is more important than institutional change.

4.1 TRANSFORMATIVE LEARNING

McWhinney and Markos (2003) define transformation as "those psychological, cognitive, and social processes of learning and education that follow from a variety of reflective and maturing experiences". Boström et al. (2018) argue that transformative learning is a critical learning perspective that enables reassessment of one's assumptions and expectations. It convenes epistemological shifts and change of meaning (Boström et al., 2018). Cranton (1992) provided framework of three types of change: change in assumptions, change in perspective, and change in behavior. Boyd (1989) suggests that an outcome of transformative learning is a change in self.

Transformative learning theory, proposed by Mezirow, is based on the critical-constructivist notion that prior experiences shape our decisions and actions; and on humanistic notion that people can deliberately change their frames of reference (Boström et al., 2018). Kuhn's idea of paradigms provided a basis for Mezirow's notion of transformative learning (TL). TL has become a paradigm by itself as it explained many important unsolved learning problems (Kitchenham, 2008). Mezirow (1997) suggests that we do not make transformative changes in the way we learn as long as the new material fits comfortably in our existing views (or frames of reference or prior knowledge). He suggested that experience, critical reflection and rational discourse are crucial to transformative learning and that learner's life experiences are a good starting point for transformational learning.

Prior knowledge plays a crucial role in transformative learning. Mezirow emphasized that perspective transformation needs revision of meaning structures. Meaning structures are culturally defined frames of references (or points of view). Frames of reference are often acquired uncritically through socialization and enculturation (Mezirow, 1997). He (2000) argued that changes in behavior and attitude imply transformative learning. For Mezirow, personal transformation is sufficient condition to change society. The very act of personal transformation leads to social change (Mezirow, 1997).

People's learning is mostly incidental, unintended, non-reflective and far wider than just cognition. In order to add to one's internalized understanding, information transfer must not violate the criteria of critical or rational inquiry otherwise it is indoctrination (Jarvis, 2008). Transformative learning is more reflective and critical so that we can aim to contribute in the world positively. However, it may not be reflective or analytical or based on sufficient knowledge and expertise.

While transformative learning can lead to changes in one's values, beliefs, attitudes and behavior; learning provided by educational setups is often a form of indoctrination

(Jarvis, 2008). When the children learn to not question the educational discourse, their minds are in an intellectual danger-zone and at the mercy of propaganda by either the state or the private entrepreneurs (or religions). Repeated training to passively accept the educational discourse ends up becoming training into unquestionable acceptance of discourses in other arenas of social discourse. Transformative learning has been a luxury in the past (McWhinney & Markos, 2003). To make TL more commonly available, we need to figure out innovative ways to provide it.

4.2 EXAMPLES OF ECOLOGICAL APPROACH

This section describes the ecological paradigm's approaches to address Jarvis' concerns regarding the educational content; content's relationship to the truth; its openness to examination and his concerns regarding the techniques used in the teaching and learning process.

4.2.1 The Ecological content

Ecological approach to education is deeper than superficial, first-order, information transmission. It traces a child's learning influences back to sources in society and family. The approach is reflected in context-based learning content that encourages reflection, reason and meaning-making.

We act on the basis of our knowledge and cannot separate our behavior from our knowledge (Jarvis, 2005, p. 4). Therefore, sustainability crises that result from human behavior are results of human knowledge. According to the individual-centric view, the causes of outer crises of manmade problems lie in the realm of human psyche. These crises are manifestations (or outer expressions) of what goes on inside the human mind. Psyche used to be a sub-domain of religion in medieval times. The realm of psyche is invisible and difficult to understand (Krishnamurti, 1991a).

Sustainable change in human attitudes is less likely to emerge from systems based on reward and punishment. Sustainable change can come from changing our thinking. In order to save ourselves from self-destruction, we need to re-investigate the knowledge, beliefs, ideologies and their underpinnings. If we think differently, then we behave differently. Institution-based social change approach is not grounded however institutions can definitely support the educational change.

Behaviors are learnt from multiple contexts and backgrounds that promote unsustainable beliefs and thought-patterns. Man-made unsustainability indicates gaps in human consciousness. Our actions emerge from our memory (knowledge, beliefs, opinions etc.) and thinking processes. Actions of the mind precede outer manifestations.

Learning involves and affects different levels of consciousness (Mezirow, 1997; Sterling, 2011b). Deeper perceptions and conceptions inform and influence ideas which in turn, affect our everyday actions. Our operative assumptions may be largely unexamined, misinformed or absorbed non-reflexively (Jarvis, 2008).

Quantum physicist and Einstein's colleague David Bohm suggested that our actions and behaviors emerge from our conscious and unconscious thoughts (Bohm, 1994). Figure 4 depicts Bohm's model to understand how our thoughts and our actions link up.

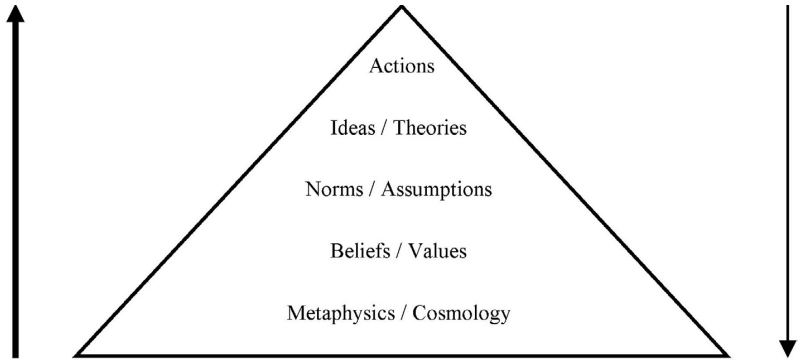

Figure 4. Levels of Knowing based on Bohm's systems view of thought (Sterling, 2011b)

A human infant depends on others for its survival and soon, starts to learn things from his primary caretakers through interaction. Many aspects of our ideas, beliefs, theories, ideologies and worldview are not as personal as we may assume them to be. We internalize ideas, beliefs, theories and worldview from our significant family members, schools, society, and media. The importance of the inter-subjective learning is well-known in education (Stables & Scott, 2002). We know that most human learning is not reflective but incidental (Jarvis, 2008). Humans learn values and attitudes dominant in their cultures and societies through socialization and enculturation.

Socialization

Jarvis (2008) argues that learning always occurs within the life-world or in society. Therefore, socialization is an important aspect of learning. It is important for development as a socialized individual, and for his/her functional adaptation. Socialization plays an important role in one's learning, internalizing values, notions, beliefs and skills; and disseminating them. Sociologists distinctively perceive socialization at home and in society at large. Primary socialization happens through significant family members and near ones; while secondary socialization takes place in sub-cultures e.g. school, clubs and work (Jarvis, 2008).

Vygotsky (1978a; 1978b) mentioned that a child's cultural development takes place on inter-psychological and intra-psychological domains. A crucial Vygotskian idea is that children internalize their culture's tools of intellectual adaptation from adults. This idea indicates that children learn their society's value systems from the adults. This internalization could be a mechanism through which dominant social values are internalized by the next generation (Valsiner, 1988).

Jarvis (2008) suggests that "at birth, culture is external to one but it is internal to our significant others and through interaction with them we internalize (learn, often non-reflectively and unintentionally in the first instance) it". Primary socialization is important for development of self-confidence, self-identity and selfhood. We accumulate memories through which we can negotiate meaning and interpret our life-world. The family impacts child's conceptions of health and environment (Jeronen et al., 2008). Secondary socialization happens primarily at school, clubs and work and teaches us 'role behavior' to confirm to norms and social expectations. One internalizes his/her cultural values like obeying implicitly or to accept punishment without questioning, etc. Our culture's values are validated in our own experience.

Our meanings and interpretations are socially constructed and are based on and validated by our culture. Socialized individuals continue learning, however, in a more restrictive fashion.

Enculturation

Enculturation is the process by which people learn the requirements of their surrounding culture and acquire values and behaviors appropriate or necessary in that culture (Grusec & Hastings, 2007). It is through enculturation that one learns the language, values, and rituals of the culture. Kottak suggests enculturation is the process where the established culture teaches an individual the accepted norms and values of the culture or society where the individual lives. It teaches the individual their role within society as well as what is accepted behavior within that society and lifestyle. (Kottak, 2016.) The influences of enculturation limit, direct, or shape the individual thoughtfully as well as without thinking. These influences include those of parents, other adults, and peers.

Socialization and enculturation are strong experiences that create deep effects on a person's brain and mind and hence, behaviors (Dill, 2007). Old values, thinking patterns and hence, behaviors find novel expressions in the next generations. Upholding current social values and promoting sustainability can, at times, become a self-defeating exercise. Krishnamurti suggested that negation ('what not to do') leads to emergence of intelligence (Krishnamurti, 1991b). Cultural and social experiences consciously and unconsciously influence one´s choices and practices. Education for understanding must begin with investigation of the dominant ideas, beliefs and values in our societies that have lead to un-sustainability. Ecological educational content reflects seriousness through connecting the content with students' life-world.

4.2.2 The Ecological Learning Methods

The ecological learning methods are more active. They are likely to involve research, reasoning and reflection. Some of these methods are discussed here.

Problem-based learning: Using disjuncture as a learning opportunity

Constructivist methods such as project-based learning and problem-based learning (PBL) motivate students to think deeply about the domain being learned (Ram & Leake, 1995). PBL was introduced for medical students by Barrows and Tamblyn in 1960s to stimulate learning by allowing students to see relevance in problems. The approach was subsequently adopted by school educators as well. PBL is a student-centered pedagogical approach which uses problems as learning opportunities. PBL is often used for Education for Sustainability (Thomas, 2009; Steinemann, 2003; Dobson & Tomkinson, 2012).

PBL was a response to cover the limitations of traditional lecture-based teaching in medicine. It is based on constructivist educational approach that organizes curriculum and instruction around "ill-structured" problems (Barrows, 1988). The constructivist theory of learning is based on the ideas

- that the learner is an active organism seeking meaning; that s/he constructs her/his knowledge;
- that knowledge is constructed, not transmitted;
- that prior knowledge impacts the learning process;
- that our initial understanding of the world is local, not global; and
- that building useful knowledge structures requires effort and purposeful activity.

From our learning, we generate our own rules and mental models to make sense of our experiences.

There are several advantages of using PBL promotes students' interest and helps them see the real-world application of their learning (Barrows, 1996). Students often attribute their lack of subject interest to the poor real-world relevance of the educational content. In contrast to passive learning methods, PBL actively engages students with meaningful and relatable problems (Yewa & Gohb, 2016). PBL learners take the responsibility of learning; tend to be more motivated and better learners (Bereiter & Scardamalia, 1989). Through PBL, school children learn by solving open-ended problems. During the PBL process, students reflect and reason to construct their own learning; and work in small groups to solve problems. PBL assists them in developing crucial skills like critical thinking, teamwork and problem-solving. It helps students develop problem-solving skills and construct domain knowledge base simultaneously (Malopinsky et al., 2000).

PBL fosters deep learning as students try to think new concepts and link it meaningfully with their prior knowledge. Thus, PBL enhances their knowledge and understanding and they learn to build on and improve existing conceptual knowledge frameworks (Wood, 2003). Students take self-initiatives to improve their learning (Vernon & Blake, 1993). PBL activities add meaning, applicability and relevance to the learning materials as students have to relate the material with their real life contexts and problems. It enhances the transferability of skills and knowledge from the classroom to real life situations (Albanese & Mitchell, 1993; Gallagher et al., 1992). As PBL involves team activities, communication with others, it provides opportunity for development of communication and team-coordination skills.

PBL is often criticized for its emphasis on higher-order thinking and problem-solving skills while ignoring the lower-level knowledge acquisition. This concern has been expressed by teachers (Angeli, 2002) as well as by students (Schultz-Ross & Kline, 1999). Even though PBL students understand the content more thoroughly and performed comparably to traditional students on assessments, some PBL students do complain about inadequate coverage of the content (Dods, 1997; Lieux, 2001). Insufficient content coverage in PBL curriculum is not very uncommon.

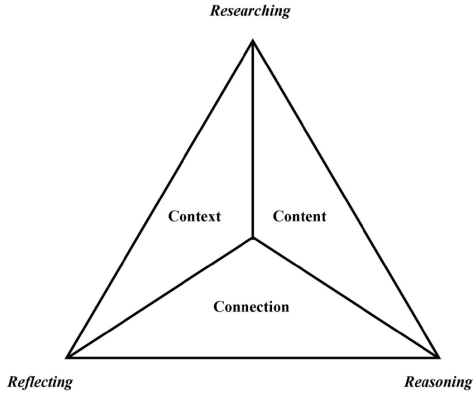

Figure 5. The 3C3R Model of Problem Based Learning (Hung, 2006)

In order to overcome its shortcomings, PBL problems should be well-contextualized (Hays & Gupta, 2003); should ensure that students' gain detailed domain knowledge (Hoffman & Ritchie, 1997); and should learn the abilities to interlink diverse sources and knowledge and to cross-reference related concepts (Jacobson & Spiro, 1994; Spiro et al., 1988). Hung (2006) strongly emphasizes that core components in PBL —content, context, and connection— support content and conceptual learning, while processing components — consisting of researching, reasoning, and reflecting — concern students' cognitive processes and problem-solving skills (Figure 5).

Example of PBL: Design for Change (DfC)

DfC's architect and chief promoter, Kiran Bir Sethi claims it to be the largest global movement to give children an opportunity to express their own ideas for a better world and put them into action. Sethi is a teacher, principal, and a social-entrepreneur who runs her school (Riverside School) in Ahemadabad, Gujarat in India. The idea of DfC spread around the world through a TED talk given by Sethi (TED India, 2009).

Design for Change pedagogy aims to train students in the Gandhian principle of "be the change you want to see" (Roy et al., 2013; Drenttel, 2010; DfC, 2012). According to Sethi, DfC implements Howard Gardner's Disciplinary Thinking and gives children an opportunity to find a task for social good. *Design for Change* approach has four key aspects: Feel (find a problem); Imagine (imagine a solution); Do (act out the solution); and Share (share it with others). (Roy et al., 2013). DfC smartly uses problem-based learning concept in which children have freedom to define the problem.

Design for Change offers three products: the FIDS (Feel, Imagine, Do and Share) pedagogical model, the DfC competition, and Design Thinking Guide (DTG). DfC's pedagogical model uses social-constructivist learning principles. DfC has been open to all kinds of social issues that may interest a child and their website shows that they are now inclining towards sustainability goals as well.

A pilot study conducted by Harvard University, in 2014 about Design Thinking Guide (DTG), a thirty-hour program, included 60 Indian schools suggested improvements in students' empathy as well as enhanced problem-solving abilities (Easley et al., 2015). Table 4 depicts SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of DfC products - particularly the DfC competition.

Table 4. DfC SWOT Analysis

Strengths	Weaknesses
• FIDS is ready-to-use (Do-It-Yourself) approach used by schools willing to participate in DfC competition. • Can be used in all kinds of schools. • Activity-based. • Transformative educational method. Increases participants' confidence level. • Easy to follow details	• Students may lack in-depth investigation about the activity/phenomenon. • Expert-level knowledge may or may not be there. • DfC's most popular and pervasive product is competition-based. • More focused on action over understanding. • Some projects are less likely to produce lifelong learning. Learning can be easily betrayed by the student after the competition entry has been sent.
Opportunities	**Threats**
• Transformative educational method for mainstream schools • Small timeframe • All kinds of schools	• Kiran's TED video underplayed the role and importance of teachers and emphasized that DfC is children-driven. (However, she, benevolently, gave me time for Skype conversation and unequivocally emphasized the importance of teachers). • DfC competition needs not only the social change activity but also, the skills to make videos. Showmanship may shift the focus away from authentic interventions. • Strong urge to win DfC competition can lure participants into un-grounded or exaggerated claims.

DfC competition started off in India and had reached 33 countries and over 300,000 schools by 2011 (Drenttel, 2010; DfC, 2012). In 2018, DfC's website shows participation of 60 countries, 25500 stories of change and 67000 teachers trained in FIDS (as on 11th Sept2018). DfC has clearly been very ambitious. Nandini Sood, DfC's India Global Catalyst, says "The plan is to scale the *Design for Change* Movement in India and work with the institutional partners. The end goal is to develop a bouquet of 'design thinking' products and services, and transit DfC India into a sustainable social enterprise" (Wygant, 2015).

Dialogue

Dialogue is an ancient transformative learning practice used for authentic and egalitarian social discourse. It is a participatory manner of collective communication being used since human beings lived as hunter-gatherers in tribal cultures. Dialogue creates a nonhierarchical ecosystem in which participants can question and reflect upon personal and collective beliefs (Jenlink & Banathy, 2005). Dialogic approach is naturally suitable for transformative learning (Robinson & Aronica, 2016; Littledyke & Manolas, 2011; Sterling, 2011a).

Bohm emphasized that other than non-authoritative communication, the microcosm of the society and impersonal fellowship are two important features of a dialogue. A dialogue represents the microcosm of the society i.e. it represents various opinions and assumptions (or thoughts) of different sub-cultures regarding an issue prevailing with in a culture (Bohm, 1996, p. 13).

Dialogue brings awareness to the collective and personal assumptions held by the participants (Cayer, 2005). It opens possibilities to understand things differently

and opens new ways to construct meaning and has been used in Education for Sustainability (Hasslof, 2015). As a process, dialogue is an important educational tool in paradigm shift towards sustainability (Gadotti, Undated). The structure of dialogue enables linking of the inner world with the cultural context and consequently, permits participants to be aware of the personal and cultural assumptions prevailing in the society and modify them (de Maré et al., 1991). Just like spectators partaking together in a football match, participants of a dialogue partake together in an impersonal fellowship. (Bohm, 1996, p. 32.) Dialogue can be of considerable value even under slightly regulated conditions and for specific purpose (Bohm, 1996, p. 42). Cayer (2005) emphasized that there is a dire need to re-invent dialogue to suit contemporary contexts.

For a sustainable future, we must focus on learning new behaviors. In contemporary world, new behaviors cannot be imposed but should be learned through transforming older behavior patterns. Non-transformative learning methods - such as indoctrination, non-reflective and non-critical learning – will surely transmit and add new information to the learner's knowledge base and will also lead to learning experiences. However such learning experiences are inadequate for learners' transformation. Transforming old behavior patterns needs transformative learning experiences. An implementation of dialogue is conducted in Krishnamurti Schools in India through 'culture classes'.

Culture Classes

Krishnamurti was a philosopher from India who was raised to be a world-teacher and to lead the Theosophist movement. He dissolved the organization meant to convene his coronation; and proclaimed that 'Truth is a pathless land' and 'no one can take you there' (Lutyens, 2003). Despite his non-involvement in educational policy, Krishnamurti had an illustrious career as an educationalist and a public speaker. Krishnamurti viewed education as a way to transform individuals and through them the society. He suggested many philosophical principles for educating the young; and started holistic schools around the world (Thapan, 2001).

Conversation classes, culture class, enquiry time or K-time are important parts of Krishnamurti schools in India (Gautama, 2013; Sahyadri Scribbles, 2013). The basic idea behind culture classes to give students a place in which they can share their life-experiences and ask questions and reflect upon and learn life together in presence of caring adults. In a sense, the idea of culture classes is very much rooted in the ecological paradigm.

In culture classes for the senior students, students take up one single global problem e.g. world food crisis. Once they decide about a problem with their teachers, students investigate the problem deeply from multiple viewpoints. They do in-depth research in library and through other modes, note their findings and bring it to discussion. They repeatedly dialogue and discuss their findings with their teachers and fellow students. They learn about the other student's findings. Through dialogues and discussions, they keep moving deeper and deeper; and in the process, learn about human systems, structures, their advantages, their short-comings and mainstream and alternative ways to solve the problems. In a way, the crisis under investigation becomes an opportunity to investigate the human aspects of the problem; they investigate the causal behaviors and thinking patterns behind these causal behaviors; they analyze the mainstream and popular as well as the alternative responses to the problem. They study the relationship patterns that create and maintain the problem. They start to observe how popular modes of thinking - e.g. ownership and consumerism - may lead

some people to obesity and others to starvation. In culture classes, students may also learn about how some patterns such as greed, apathy, indifference could be a part of their personal behavior as well. Culture classes can deepen their experience and understanding of being human and is likely to transform students without explicitly pointing gaps in a student's personal choices and behaviors. Table 5 summarizes the SWOT analysis of the culture classes.

Table 5. Culture classes SWOT Analysis

Strengths	**Weaknesses**
Transformative approach In-depth learning, likely to last a longtime/lifetime Very knowledgeable teachers (Many hold PhDs from Ivy League universities.) Expensive and resourceful schools. Approach in line with the Ecological paradigm Persistent shift in understanding	Exclusive – high-end schools are not accessible to everyone. Time taken. Lack of topic related expertise among teachers
Opportunities	**Threats**
High transformative potential Should be made available to larger audiences.	Time-frame. Lack of teacher's expertise in most schools School's educational paradigm is already ecological – not the general case for schools.

4.2.3 Role of Teacher in Ecological Paradigm

Russian psychologist Lev Vygotsky stressed the importance of social and cultural factors in child's learning and development. He argued that these factors seriously affect human learning. Vygotsky argued that children's environment will influence how they think and what they think about. Two towering concepts from Vygotsky were the More Knowledgeable Other (MKO) and the Zone of Proximal Development (ZPD). The concept of ZPD conveys that there can be a difference between what a learner can do by herself/himself and what s/he can learn through guidance and encouragement of a skilled person (Veer & Valsiner, 1991) (see Figure 6).

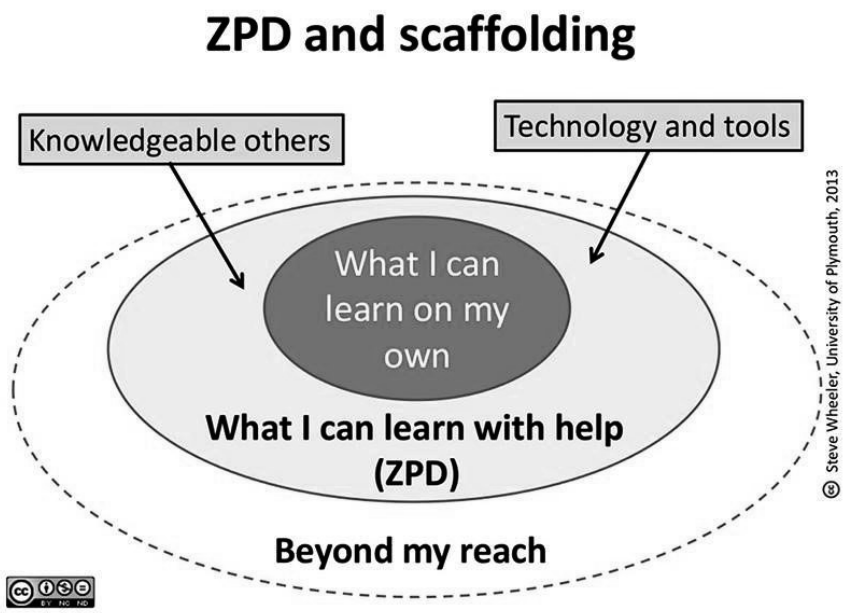

Figure 6. Zone of Proximal Development (ZPD) and More Knowledgeable Others (MKO) (Wheeler, 2013).

The more knowledgeable other (MKO) can be a teacher or a peer who is supporting one's learning. In ZPD, learners and the MKO co-construct knowledge. Such social interaction leads to cognitive development. Parents, siblings, relatives, friends, teachers, educational content, educators, various media and social and cultural environments among other influences play the role of MKOs in our lives (Veer & Valsiner, 1991).

4.3 ICTs ROLE IN EDUCATION FOR SUSTAINABILITY

In 20th century, advances in medicine, transportation and architecture increased human optimism and faith in science and technology to such an extent that technology was considered as infallible means to overcome social ills like poverty. Technological progress was considered to boost productivity and hence, rate of development (Kaplinsky, 2011). Therefore, technological transfer from developed countries to the developing countries emerged as a popular development model. Importing the developed world's sophisticated, large-scale and capital-intensive technologies was considered a prime mode to enhance productivity and development.

These technology-intensive models of development were rooted in the mono-cultural view of science that undermined provision of any formal recognition or status to indigenous or traditional knowledge systems. In developing countries, technology intensive approach lead to serious drawbacks. Some of these significant negative side-effects were noticed by British economist E. F. Schumacher. He suggested these technologies from above (imported technologies models) were inappropriate and created 'the process of mutual poisoning'. Capital-intensive technological imports

lead to effects like technological concentration leading to over-population in urban centers; and high rates of unemployment, poverty and declining access to basic needs in other areas. This capital-intensive approach maintained the dependence on the developed countries and hence, extended and continued the power relations between the rich and the poor countries (Schumacher, 1973).

4.3.1 Appropriate technology

Inspired by his trips to India and Burma, and the ideas of Gandhian as well as Buddhist economics, Schumacher advocated for the concept of *intermediate technologies*. Schumacher used 'intermediate technology' to signify "[technology that] is vastly superior to the primitive technology of bygone ages but at the same time much simpler, cheaper, and freer than the super- technology of the rich" (1973, p. 154). He also called it self-help technology, or democratic or people's technology. Unlike large-scale capital-intensive technologies, the intermediate technologies were small, affordable, human centered technologies that were low-cost and labor-intensive; and suited to the cultural and social needs of the developing countries.

Schumacher co-founded the Intermediate Technology Development Group (ITDG) in London in 1965 to promote intermediate technologies. This organization convened some major conferences to promote simple, low-cost technologies for small-scale industries in the third world. In time, as the term 'intermediate technology' seemed to suggest inferior or second-rate solutions. This lead the movement to adopt a new title: *appropriate technologies* (AT). Though Schumacher must be credited for spreading awareness about the AT in the West, some scholars consider Gandhi to the father of the appropriate technology movement. They believe that Gandhi's emphasis on charkha (the spinning wheel) and khadi (charkha spun fabric) created losses for British clothing mills; and played a role in forcing the British out of India. Gandhi was also instrumental in development of the village technologies in India (Pattanaik & Dhal, 2015). Appropriate technology approach frames the technological questions in socio-technological terms rather than considering them as merely technological terms.

AT has multiple definitions. Morawetz (1974), Pellergrini (1979), and Harrison (1980) have each defined AT from their personal perspectives (Akubue, 2000). These definitions emphasize the need to re-orient technology towards less developed nations, and on making technology culture-specific, need-specific, or context specific. AT peaked as the popular community development approach in 1970s and 80s. AT's underlying philosophy focused on solutions characterized by simple, low-capital investment, labor-intensive, small-scale, efficient, replicable, readily-operated, maintained and repaired units; producing low-cost final products, and their compatibility with local cultural and social environments. AT considers technological innovations and solutions not merely as technological artifacts but as manifestations of heterogeneous collection of social, cultural, ethical and environmental values. The proponents of AT movement suggested that such solutions were organically suitable for developing countries (Akubue, 2000). While AT is the term most often used for such approach in developing countries, AT for developed world is commonly called 'alternative technologies' indicating connotations of counter-culture and freedom from dominant institutions (Pattanaik & Dhal, 2015).

Despite strong interest and momentum of the AT movement, rise of neo-liberalism driven globalization and military-industrial complexes lead to scarce governmental funding for AT projects. Funding cuts lead to program cuts, and ultimately, closure of thriving AT centers. New dominant values rendered AT movement irrelevant (Pattanaik & Dhal, 2015; Smith et al., 2014).

History of the AT movement exemplifies that *help* in form of aid and loans is not mere humanitarian assistance from one group of species to another and is often guided by hidden agendas. While research and development work often provide development funds to create "un-up-scalable" pilots that may keep the researchers and academics busy and well-funded in developed countries. These experts are alien to the cultural and social value systems of their hosts. A serious problem with this approach is that in the process, generations of the host country may end up being hostage to repayments of international loans which did not benefit them.

Emmett et al. (2006, p. 9) noted: "as much as 70 per cent of aid for education globally is spent on technical assistance, much of it to highly paid Western consultants". With such practices, the interventionists are more likely to benefit through aid rather than the receivers of aid. The aid-receivers may wind up in constant financial dependence on developed countries and stay in endless, vicious and hefty financial repayment loops. A movement towards self-reliance would necessitate that developing countries break away from these established practices and move towards innovative approaches, solutions and ideas that encourage self-reliance among developing countries.

4.3.2 Appropriate ICTs for education in developing countries

Since 1920s, technological gadgets from audio-tapes to the latest mobile apps have claimed to have revolutionized education (Mayer, 2010). However, rigorous research has been questioning and dismissing these claims as the marketing hype-cycles that accompany each gadget and ICT-solution (Toyama, 2015).

Schumacher had left us few grounded guidelines about use of technology in disadvantageous circumstances. "It is too often assumed that the achievement of western science, pure and applied, lies mainly in the apparatus and machinery that have been developed from it, and that a rejection of the apparatus and machinery would be tantamount to a rejection of science. This is an excessively superficial view. The real achievement lies in the accumulation of precise knowledge, and this knowledge can be applied in a great variety of ways, of which the current application in modem industry is only one. The development of an intermediate [or appropriate] technology, therefore, means a genuine forward movement into new territory" (Schumacher, 1973, p. 187).

Use of technology (ICTs) in education does not essentially mean better educational outcomes. A more realistic assessment of technology for social change cannot be understood merely in terms of hardware and software; and must be understood through the social processes that spawn from use of technology (Arora, 2010b). While using latest gadgets is reasonable for developed countries where educational systems and people can relatively easily afford these devices, use of same devices and technologies could be wasteful, presumptuous, overtly sanguine and unrealistic in low- and medium-income countries (LMICs).

Hefty costs of the ICTs, renewable software licenses, misleading marketing tactics, techno-centric and Euro-centric nature of ICT projects and processes, unsure returns

on investments and under-trained staff are serious challenges faced by ICT projects aimed at improving education in LMICs.

Educational ICT solutions aimed at LMICs like Hole-in-the-wall (HiW) and one-laptop per-child (OLPC) were need-based solutions; yet they have failed miserably because of their gross ignorance of pedagogical aspects of education and in their device-orientation, they largely discounted the need for caring adult supervision (Arora, 2010a; Toyama, 2015).

ICT projects in development domains (or *ICT4D projects*) are known to have poor success rate (Day & Greenwood, 2009). Technology in itself is an insufficient solution to social problems; and more technology does not automatically result in development. There are lessons from Appropriate Technologies that may help ICT projects achieve a higher level of success.

AT is already embraced by architecture and agriculture; however very few attempts have been made to root AT in ICT. van Rejiswoud (2009, p. 6) defines Appropriate ICT as "The integrated and participatory approach that results in tools and processes for establishing ICTs that is suitable for the cultural, environmental, organizational, economic and political conditions in which it is intended to be used." Sensitivity towards cultural, environmental, organizational, economic and political aspects of and on technology provides a more holistic and grounded template to use of ICTs ICTs (refer to the figure 7).

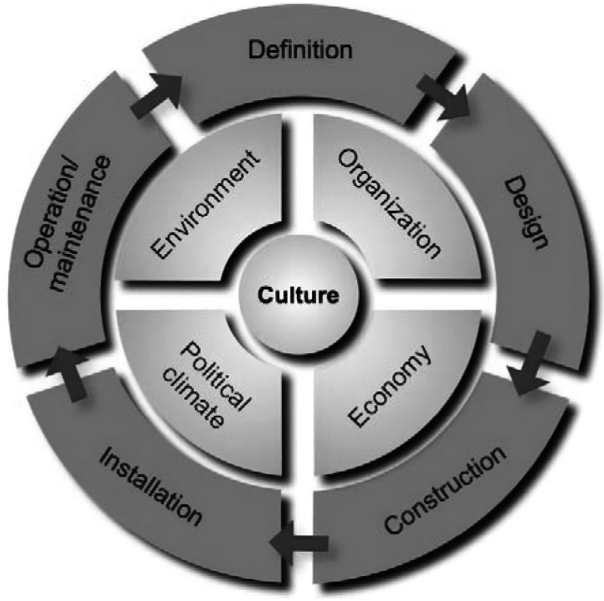

Figure 7. Foundation of the Appropriate ICT Framework (van Rejiswoud, 2009)

Researchers from developed world favor state-of-the-art ICT solutions without even considering local capacities, technological and non-technological restraints of the developing countries. Many places could be struggling with electricity supply. Implementing latest, sophisticated ICTs without deeply analyzing opportunities and challenges in targeted context is least likely to lead to sustainable problem-solving. Appropriate ICTs can be low-tech and yet be effective.

4.3.3 ICTs in education for sustainability

Low- and medium-income countries house the largest number of the global poor. In 2007, 900M people were making less than US$1/day and about an additional 1.7 Billion earned less than US$ 2/day. An insight from Schumacher was: "The poor can be helped to help themselves, but only by making available to them a technology that recognizes [their contextual] boundaries and limitations" (Schumacher, 1973,p. 189). However large numbers of ICT4D (ICT for Development) solutions developed for them are neither needs-based; nor context-sensitive. These populations may even lack resources for basic needs; their children suffer from malnutrition; and go to schools that lack toilets and clean drinking water. Decade of ESD's final report mentions ICTs cursorily only (UNESCO, 2014) and mentions issues like access to social media; online face-to-face; and online group-interactions assume device and network availability (Willard, 2009; Creech, 2012; Booth, 2012). UNESCO's Bangkok office has an ICT for ESD section as well. A cursory look at their use of ICTs in education points to projects with website; some online games and some TV related programming (UNESCO, 2018). Their use is not grounded in the social strengths available in their host countries. Techno-centric first-world assumptions could be very invalid for large percentage of population in developing nations. It suggests a focus on very first-world assumptions which could be very invalid in the developing nations scenarios.

Skillfully used ICTs can amplify social strengths and promote Transformative Education for Sustainability (TEfS). ICTs can facilitate increased flexibility in offering educational materials; and can make high-quality lectures available to wider audience (Wals & Kieft, 2010. p. 22). However, as educationalists, we must never forget that stress on mechanical tools and procedures undermines the fact that children and young people are impressionable, sensitive living beings and need great understanding and patience; and that education is not a merely technical transfer of information problem. In our search for marvelous results through large-scale mechanistic educational change, we end up approaching education, learning and the learner in reductionist ways. Appropriate Technology does not encourage technology for sake of technology – which is a proven inappropriate, carried over practice. Appropriate Educational Technology (AET) acknowledges and considers the non-technological aspects of education as well. And hence, its approach to education of ICTs is broader, more grounded and more suitable for developing countries.

Educational use of ICTs in the developing world suffers from technology push and calls for innovative approaches and solutions that offer substantially more value than mere purchase of ICTs. This thesis aims to provide one such innovative solution. Appropriate use of ICT in education must take the social and cultural aspects of ICTs into account.

5 CHILDREN AS AGENTS OF SOCIAL CHANGE FRAMEWORK

In this chapter, I present Children as Agents of Social Change (CASC) framework as an approach to massively provide transformative Education for Sustainability. The core ideas of CASC emerge out of the discussions in previous chapters.

5.1 TOWARDS TRANSFORMATIVE EDUCATION FOR SUSTAINABILITY

It is good for students to become aware of global problems like climate change and its causes. However, such learning can become self-contradictory as well. A student may listen to a teacher telling about climate change and its causes like vehicular pollution and industrial pollution. After the lesson, the students may notice that their teacher comes to school on a fossil-fuel driven two-wheeler that releases harmful gases into the atmosphere. They notice that they themselves cannot stop coming to school from their distant homes on a vehicle running on fossil fuels; and that there are no separate cycling lanes on the highway connecting their home and school. Most students do not contest with their teachers as they have been very well trained into the school's educational belief that good students are obedient and must not trouble the teacher unnecessarily. Arguing with teacher may risk their chances to score well; and hence, such arguments may risk their educational success. Most students also don't have any access to the textbook writers e.g. textbooks in India do not provide such contact details; even if details are there, responding to the queries is optional. The content writers neatly hide behind the iron curtains of the educational system. By and large, they are invisible.

Students may feel frustrated about the content being taught and find it not relatable with what they see in their real life. They slowly learn that what is taught in the school and what happens in actual life are two very irreconcilable and different things. However to do well in life, they need good scores from school which in turn needs skillful memorization of the text and its reproduction in exams. They end up finishing school with a divided mind. The student passes the test of environmental education well; and the real person keeps living life according to the contemporary social standards and values. Mainstream education does not help students become integrated human beings.

Foreign-driven Education for Sustainability is more likely to end up as an educational liability and not transformative educational asset in developing nations. In the developing nations, there is a need for education for sustainability that is grounded in people's day to realities and problems. In this thesis, I am suggesting an alternative approach, 'Transformative Education for Sustainability' (TEfS) to challenge un-sustainability. Similar terms have been used in studies in various disciplines (Sipos, Battisti & Grimm, 2008; Burns, 2015; Iyer-Raniga & Andamon, 2016). I am using 'Transformative Education for Sustainability' (TEfS) as I feel that Education for sustainability should shift its focus from information transmission to individual transformation. My steering concern is implementation or operationalization of the theoretical concepts so I am more interested in 'how to' put these two concepts

of transformation and Education for Sustainability to actual use in places where teachers lack expertise. For me, TEfS is not a reaction against ESD; and learns from both education for sustainability and ESD discourses; and incorporates values to add meaning to education in developing countries. Table 6 lists the features of Transformative Education for Sustainability.

Table 6. Features of Transformative Education for Sustainability

	Transformative Education for Sustainability
Official orientation	Non-formal learning in formal educational institutions
Scope and Focus	Local problems
Approach to Sustainability	Understand the problem, Negate its causes; learn to think and act with clarity.
Problem-base	Globally aware; locally responsible.
Pedagogical orientation	Constructivist - Problem-based learning
Educational Paradigm	*Ecological paradigm;* creative
Knowledge	Life-world connected knowledge from multiple domains
Order of learning and change	Second and third order (transformative) learning
Structure	Middle-way; Non-hierarchical
Content drivers	Localized experts with hands-on experiences in reducing suffering
Educational Methods	Transformative (Dialogic; involving 'reflection, meaningful negotiation and active learning)
Functional Orientation	Egalitarian, service to reduce suffering
World view	Locally relevant, globally responsible
Guiding Description	Grounded in reality of the learner, facts first
Role of Publicity	Mostly unsung, unpublicized, grounded, meaningful work
Likely Effect	Empowering
Use of EdTech	Appropriate EdTech
Guiding Forces	Local people and organizations

Transformative Education for sustainability (TEfS), as it is discussed here, includes local contextualization of the educational content (local problem-context images); providing educational content in local language; being sensitive towards cultural-values of learners; and being sensitive towards learners' world-view. All these factors are important. The learner-centric aspects of TEfS include keeping the cognitive overload optimal; and connecting the learning with learner's actual life-world.

TEfS's approach is learner-centric, non-hierarchical and dialogic in nature. It values learners and their present knowledge and builds on it. Prior knowledge may or may not be accurate. TEfS concerns itself with negotiating new meaning, correcting misinformation and misconceptions learned earlier need deeper reasoning and accurate knowledge. Technologies can play a role in amplifying social forces however such approach should emerge from the pedagogical needs of the educational projects and should not be ICT-intensive.

5.2 IMPLEMENTING TRANSFORMATIVE EDUCATION FOR SUSTAINABILITY

Appadurai (2001) termed changes rapidly happening around the world, due to globalization, as a *world of flows* undergirded by 'ideas and ideologies, people and goods, images and messages, technologies and techniques' that move from one corner of the world to another. He suggests the creation of 'globalization from below' (to counter hegemonic aspects of globalization through grassroots movements) and the creation of *new forms of dialogue*. The riddle of providing Transformative Education for sustainability (TEfS) should provide both the 'globalization from below' and a new form of dialogue.

Culture classes (Gautama, 2013; Sahyadri Scribbles, 2013) and *Design for Change* (Drenttel, 2010; DfC, 2012) epitomize that transformative education is possible in schools in developing countries. However, this does not change our basic larger problem: teachers are not experts in domains of sustainability (see Tooley, 2009). If teachers don't have knowledge and/or are not well trained in pedagogical skills; they simply cannot inform and update their citizens properly.

Providing TEfS in developing world can inspire students and teachers to experience a different kind of education and can slowly begin to tilt the paradigm from mechanistic towards ecological. However, even after spending a decade in promoting ESD, one of leading global organizations UNESCO pointed out that implementing ESD is challenging (UNESCO, 2014). Implementing Transformative Education for Sustainability in such situations can be an arduous challenge. However, TEfS offers suggestions for its implementation.

With regards to implementing Transformative Education for Sustainability, TEfS has three-fold solution for its implementation: its first aim is to create a framework - *Children as Agents of Social Change* (CASC) – that suggests theoretical guidelines for low-cost, Do-It-Yourself approach to sustainable education that can be handed over to the teachers in the developing countries to teach middle- and high-school students about locally relevant sustainability issues. In most cases, the educational content can be produced by some responsible, concerned individuals and/or non-profit institutions; and they may organize the content sharing. TEfS's second aim is to create interventions based on CASC principles and to disseminate how these interventions can be created, used and assessed. TEfS's third aim is to keep updating the CASC framework with each new cycle of learning.

5.3 NEED FOR NOVEL APPROACH

On micro-level, there are pragmatic challenges in providing TEfS in schools in developing countries as they do not have adequate teaching staff; and those trained as teachers are most often not sustainability experts (Tooley, 2009). Shortage of expertise in sustainability is not an exclusively third-world problem. Lack of such expertise is not uncommon even in the developed countries (Blumstein & Saylan, 2007). Overloaded teachers may not have time, interest, energy to go in depth of a new topic. Lack of teachers' subject knowledge is likely to affect the quality of education negatively (Barber & Mourshed, 2007). On macro-levels, common ESD implementation challenges in developing countries include need for assistance in generating financial support for ESD; reforming and re-orienting educational contents, methodology and curricula

to address ESD-based skills, knowledge and values; facilitating and strengthening networking between educational institutes and other higher-level partners; producing material and tools in ESD; designing ESD oriented teacher training programs for teachers as well as educationalists; promoting ESD research, monitoring evaluation and dissemination (Wals & Kieft, 2010, p. 9).

A country's tradition in governance might also affect its pedagogical orientation towards narrow (or mechanistic) or broad (or ecological) paradigm for ESD (Wals & Kieft, 2010, p. 19). One can deduce from the above arguments that developing countries are less likely to provide education rooted in the ecological paradigm.

Though knowledge can be empowering however it surely is not equally distributed in the world. On one hand, there are researchers who understand dimensions of sustainability deeply however their influence is often limited to academic circuits. Their deep observations, experiences and insights often stay imprisoned behind the pay-walls of academic research. At times, their specialized scientific nomenclature is not easily understandable for novices. Well-established knowledge-dissemination mechanisms like academic paywalls further limit the reach of the sensible work. On the other hand, in educational system, there are teachers, who disseminate information to large number of young people and adults yet teachers may not understand topics of sustainability very well. Cultural forces also influence how people learn new knowledge. Celebrities -singers, actors and players- are often more influential and penetrate the developing world cultures much more deeply than researchers and teachers (Fletcher & Melewar, 2001; Hofstede, 1991).

Easterly (2006) points out that the working-level experts in different problem domains are good resources to understand a local problem as they understand issues in-depth at localized level. He puts these experts in category of *searchers* and argues that searchers may be more successful, more pragmatic and understand which methods work before scaling-up can be envisaged. Applying Easterly's ideas to the domains of sustainability, we can see that working-level sustainability experts exist within societies and are important social resources. They can come from variety of professions and academic disciplines. These experts are aware of the research in their domain but also are aware of the social and cultural conditions that may have some contributory effect.

There mostly are working-level experts with hands-on expertise in global knowledge, local conditions and uniqueness affecting the issue and its contributory causes. They are aware of the pervasive local thinking- and behavior-patterns; and have been devoting themselves to rescue the situation. It is a reasonable proposition that these searchers' (or working level experts') in-depth, contextual knowledge and experiences make them invaluable resources to cover up for deficits in teachers' knowledge.

If we can get working-level experts to visit schools and share their in-depth, first-hand experiences, insights, hold dialogues with students, then schools will become Zones of Proximal Development for both the students and the teachers. Children as well as teachers can ask questions to these experts. In this way, both researchers and schools can negotiate meanings and meaning-making patterns, and learn from each other. Children are more likely to undergo a transformation through such dialogue.

So far, so good. However, if I want to convene such dialogue in my hometown, Patiala, in Northern India, I will face a next level of pragmatic issues. Let me create a hypothetical case. Let us say that I want to promote TEfS in Patiala to raise awareness about effects of alcohol among school-going adolescents. As per our discussion this far, to provide TEfS, I need to find experts in problem domain (in this case, experts

in domains of alcohol). Personal discussions with school teachers in Patiala have repeatedly revealed that despite good intentions, most teachers in Patiala district are not well-versed about the effects of alcohol as they don't have any in-depth knowledge of the topic (though they may have some superficial knowledge about it). I only have to find doctor/s; social worker/s; knowledgeable teacher/s; and researchers and take them to schools and facilitate dialogues. In these dialogues, the experts will explain the problem of alcohol in local context; will talk to students' in students' native language; will not use any terms that students' find difficult to understand; students can ask questions or share personal experiences and this interaction is likely to be fruitful and transformative learning experience.

Next pragmatic challenge in this plan for actual social transformation is upward scalability. There are 949 government primary schools in Patiala district; 107 Senior Secondary Schools; 89 high schools and 179 middle schools in Patiala District (D.Edu. Pta, 2018). (It is not clear from the data if private schools were included or not.) So effectively, I need to have experts who do nothing else other than visit schools for dialogues and can relieve themselves of their job responsibilities.

We must keep in mind that we are talking about a country where (if we ignore those who don't have a medical qualification) there are only 36 doctors per lakh population (1 lakh = 0.1 M) (Bansal, 2016). Among these few doctors, qualified experts in alcohol-related specialties are even fewer. In Punjab, there are 2.2 M alcohol addicts. If a specialist doctor visits the school dialogues, s/he will risk breaking her/his Hippocratic oath of helping patients who need help.

It is difficult to create a Zone of Proximal Development in which the experts can play the role of More Knowledgeable Other to the students and teachers. Teachers cannot take the baton from the experts; and make learning about alcohol a continuous team effort. So what happens to the ambition of providing TEfS? Given the shortage of human resources, is it even realistic to think that we can really provide TEfS in developing countries about authentic sustainability issues? Is there a way we can break this jinx? Is it possible to solve this conundrum of having a large problem, having little human resources, limited budgets, and ending up with doing nothing to proactively prevent the social sustainability crisis visible on the horizon? We end up in catch 22 situation.

5.4 AMPLIFYING LIMITED SOCIAL STRENGTHS

Traditional beliefs and behavioral manners maintain the thought-patterns and habit patterns in societies. People stick to their habits because either the new knowledge does not reach them or it comes from a paradigm that is not sensible to them.

According to Toyama's Law of Amplification, ICTs can strengthen social forces (Toyama, 2015). CASC approach posits that the limited social capacities present in the developing countries can be amplified through two streams: first, education and second, ICTs. By appropriately combining these two streams, educational deficit generated by teacher's lack of expertise can be covered at least to some extent by working-level experts. CASC combines ICTs and classroom pedagogy to address these problems.

In addition to amplification, ICTs offer several other benefits as well. Through inexpensive ICTs like educational videos to show expert-interviews, ICTs can be used to create virtual ZPDs. This method has several pragmatic advantages. After all, what

needs to be spread is experts' knowledge; not the experts themselves - so recording videos of experts frees experts' obligation to be physically available at each school.

Experts often live in exclusive circles with fellow specialists from their problem domains. In case, an expert uses specialized nomenclature; or speaks in a language non-native to the students; it may become difficult for a student to understand what is being said; and s/he may feel shy in asking questions. When I record videos, I can dub the voice for these specialists in native language. This can help students understand the message more easily.

Non-hierarchical communication is a key value of the ecological paradigm education. Students may have questions for experts and not getting an expert answer can render the intervention questionable and hierarchical. Such a case might make physical presence of experts mandatory. However, ICTs can rescue such situation as well. ICTs provide facilities of synchronous or asynchronous responses. If we can get a *synchronous or asynchronous* response from experts for students' questions, we can let go of experts' physical presence in the same space. This is an additional advantage of using ICTs.

Another advantage of educational videos is reducing students' cognitive overload. If an expert explains a complex aspect of the problem that the learners may not be familiar with – animated visualizations of the complex phenomenon may help in reducing cognitive overload.

A dialogue about sustainability can be more meaningful to learners if they can establish the life-world connections between the lessons and the real world they inhabit. Using visuals from local area can support such link and enhance student's understanding of their life-world.

Digital content is scalable and can be easily provided at multiple locations. However, scalability does mean that one-size will fit all. Minor content-editing may be required – especially to help students make real-life connections. In some cases, where social assumptions about the problem domain differ significantly, another round of CASC process might be required. Students and the thoughts around them about the theme are of utmost importance.

5.5 CASC FRAMEWORK

According to Macmillan dictionary (Framework, n.d.), a framework is a set of principles, ideas etc. that can be used to form decisions and judgments. A framework is also a system of rules, laws or agreements that establish the way that something operates in social domains. Framework is also defined as a structure that supports something and makes it a particular shape.

Eisenhart defined a theoretical framework as "a structure that guides research by relying on a formal theory…constructed by using an established, coherent explanation of certain phenomena and relationships" (1991, p. 205). Thus, the theoretical framework consists of the selected theory (or theories) that undergird thinking with regards to how a researcher can understand and plan to research a particular topic, as well as the concepts and definitions from that theory that are relevant to the topic. The theoretical framework not only serves as the guide on which to build and support a particular study, but also provides the structure to define how the authors will philosophically, epistemologically, methodologically, and analytically approach the study as a whole.

CASC's guidelines can be used by teachers or concerned individuals or Non-Governmental Organizations (NGOs) to create transformative educational interventions about multiple themes related to sustainability.

5.6 CASC CORE IDEAS

As working-level experts are in short supply, it is not an option to ask them to put aside their job and visit schools and convey their key points to students and teachers in all the schools of an area. ICTs can be used to connect these domain level experts and create *virtual Zone of Proximal Development* in which these experts are the More Knowledgeable Other for students and teachers. These teachers then act as facilitators of group discussions and for problem-based learning activities which are decided by the students themselves. Experts remain available virtually to answer any questions that may arise from students or teachers.

The CASC intervention is balanced and inclusive i.e. before the development of content an informal survey should be conducted among the target group to know their present ideas, beliefs and understanding about the issue. Working level experts are asked questions based on the ideas, beliefs and understanding of the target population. This ensures that knowledge is heavily grounded in the reality.

The language used by experts at times can be technical and it may be difficult for the learners to understand it. Images and animations are used in the content to reduce the cognitive load of the learners. Domain related images from local culture/areas are used along with local data to ensure that learners can understand the prevalence of issues and relevance of the knowledge in context of their life-world. Various experts from different aspects of the issue contribute towards the content. Educational content can be presented in form of both video and the book or either of them. After the video is shown in the class, students are divided into groups and asked to come up with an activity through which they can do something to stop the promote sustainability in their community. Through discussion, students come up with their own action plans to promote sustainability.

The survey of beliefs and exercise of deriving questions from these beliefs is done to ensure grounding of knowledge. However, students and teachers may still want to ask more questions to the experts. Inexpensive technologies like videoconferencing, email, SMS or calling (whichever is preferred by the expert) are used to connect experts with schools. Two-way loop of communication ensures that knowledge dissemination is non-authoritative and non-hierarchical in nature. Table 7 summarizes the technological and pedagogical solutions that can be used to solve educational challenges in providing Transformative Education for Sustainability.

Table 7. Solving educational challenges with technological and pedagogical solutions

Social and Educational Challenges	Technological & Pedagogical Solutions
1) Challenges related to content	
Lack of connection to previous knowledge	Informal and inclusive survey of beliefs among the target population. Expert interviews based on list of questions derived from informal survey of beliefs among target population
Content interpretation	Use of native language, use of voice dubbing in native language and translation where required
Cognitive over-load	More emphasis on multi-media based technologies like images and animation
Authoritarian approach to education	Two-way communication loop
2) Challenges related to content delivery	
Limited educational budgets	Use of inexpensive technologies, use of ready to use content,
Lack of expertise among teachers	Using working-level-experts as resources and expand expertise
Poor teacher training programs	Virtually available working-level sustainability experts to provide in-depth knowledge in summarized form with help of ICTs
Over-burdened teachers	Working-level experts who are interested in topic
Limited access to research	Working-level experts who have access to research in problem domain
Lack of expertise in problem domain among teachers	Working-level experts with hands-on experience in problem domain
3) Challenges related to learning environment	
Rote learning	Use of Dialogue based content; group discussions and PBL.
Infusion approach for ESD	Virtual collaboration among experts from various fields
Knowledge hierarchy	Two-way communication through inexpensive ICTs
Up-scaling the intervention	Create ICT based solutions that can be contextualized easily with minor editing in similar cultural scenarios.

5.7 RESEARCH DESIGN

Well-grounded creation is an aspect of action research. Action research was a natural choice for CASC's research design. CASC makes educational use of ICTs to solve practical problem. Two kinds of action research (from two disciplines: Education and IT) have influenced research design for CASC: the educational action research and Development Research.

5.7.1 Educational action research

Father of Action Research, Kurt Lewin, was a social psychologist who specialized in Industrial research. Lewin's radical findings, based on empirical studies, suggested that group-participation in decision making could lead to enhanced productivity – without technological change. He proposed action research to improve social formulations and as an alternative to de-contextualized research which was most prevalent in his day (Lewin, 1948, p. 202-06). His ideas challenged the overtly positivist worldview in its stronghold: the industrial production houses. Lewin's findings started a movement in social sciences where by social formulations seemed to be important even in the technological environments (Manfra, 2009).

Lewin's core premises had an intrinsic appeal for teachers who idolized democratic schooling and society. In 1953, Stephen Corey formally integrated and promoted action research into the field of education with the publication of his book *Action Research to Improve School Practices* (Manfra, 2009). In the 1950s, Corey and his colleagues at the Horace-Mann-Lincoln Institute of School Experimentation at Columbia University joined forces with school districts and teachers across US and used action research to understand multitude of school issues.

Today, educational action research (EAR) is as an effective, globally-used, tool to foster reflection and visioning in education. Varieties of action research e.g. emancipatory action research; critical action research, participatory action research, experimental action research and transformative action research among others have emerged (Somekh & Zeichner, 2009; Adelman, 1993). These variations influenced the research design of the two interventions discussed in this thesis.

In spirit of Lewin and Corey, this thesis explores ways to use ICTs to create a sense of group-participation and inclusion to facilitate deeper learning about sustainability. This thesis challenges the mainstream education and hierarchical information dissemination through social inclusion and novel social formulations.

5.7.2 Development research

CASC proposes to use technology to amplify human effort. The initial era of use of technology in education was based on assumptions like if technology is available, students will use and cherish it naturally; and e-learning will force the faculty to teach differently (Zemsky & Massy, 2004). However, these expectations have not matched reality. Students view e-learning as a convenience as well as a distraction; and availability of ICTs has not radically changed how faculty teach (Reeves et al., 2005). Using technology for education does not automatically imply better learning.

Reeves et al. (2005) pointed out that educational use of technology is at risk of becoming inconsequential and irrelevant. However, design research can advance the quality and usefulness of a field. Design research, also known as Development research (DR), was first conceptualized in early 1990s. DR agrees to the core premise that learning is most directly influenced by pedagogical methods and not technology. DR focuses on integrating authentic learning tasks into technology-supported learning environments (Reeves et al., 2005). It focuses on learning problems, integrates design principles with technological affordances, continually refine solutions through rigorous and reflective inquiry; and commitment to theory construction and explanation while solving real-world problems (van den Akker, 1999).

From a technological point of view, in DR, the focus is on extending the boundaries of human and organizational capabilities by creating new and innovative artifacts (Hevner et al. 2004, Peffers et al. 2007). DR is a problem-oriented approach to solve the real-world problems; and aims to develop innovative, practical, transferable, and socially responsible solutions. DR is closely related to evolutionary prototyping (de Villers, 2005a). Evolutionary prototyping clarifies problems and refines potential solutions through iterative phases of analysis, design, development, implementation and formative evaluation (Reeves, 2000). Iterations are manifestations of critical reflection and lead to the refinement of problems, solutions and research methods. Iterations are useful in assessing how the proposed solutions work in the real world. Through iterations, DR also tries to derive some generic design principles for further developments (de Villiers 2005b). DR seeks to find transferable, practical and socially responsible solutions (de Villiers 2005a). CASC's approach to use of ICTs in education was derived from DR. The second CASC intervention was a refined version of the first CASC intervention. Figure 8 depicts the evolution of the CASC framework.

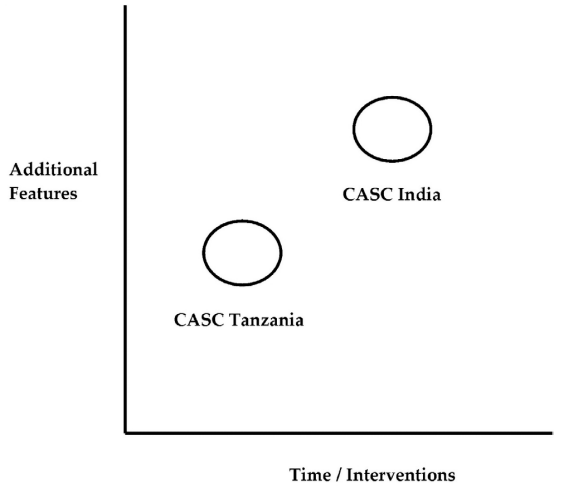

Figure 8. Iterations in CASC interventions

Westernized educational technology solutions for developing countries are often technocentric, expensive and do not fit naturally in the developing world context. Such solutions grossly ignore the knowledge, language, culture, social reality and world views of the learners (Selinger, 2009). In contrast, CASC suggests a set of generic design principles for educational technology solutions for the developing nations. Although CASC used evolutionary prototyping for enhancing the effectiveness of ICTs, in spirit of DR, CASC is not ICT-centric and keeps pedagogy central to the interventions.

The overall design of CASC framework is grounded in the ecological paradigm of education (Sterling, 2011a). It aims to use searchers (Easterly, 2006) from domains of sustainability to cover up for teachers' lack of knowledge in the problem domains. As it is not possible for searchers to visit the schools, CASC amplifies their knowledge-base through educational videos and ICTs (Toyama, 2015). CASC aims to create virtual Zones of Proximal Development (ZPD) through ICTs in which the searchers

or working-level experts act as More Knowledgeable Others (MKO) for students as well as their teachers (Vygotsky, 1978b). In order to enhance the learning and reach second and third order learning (Sterling, 2011a), CASC combines this approach with Problem-based Learning (PBL). With regards to development, CASC aims to increase self-reliance in developing countries.

5.8 TWO ASPECTS OF CASC INTERVENTIONS

CASC interventions are meant to acknowledge and focus on an authentic social issue. CASC framework is a combination of two aspects: the media artefact - this aspect is to cover up for teachers' lack of expertise - and the pedagogical aspect – which aims to use ecological paradigm methods and approaches to educate children about the problem in their society. In its most basic form, CASC framework includes child-centric educational videos; group discussion along with problem-based learning (PBL). The videos feature working-level experts, local sites related to the sustainability issue; and local data about effects of unsustainable behaviors. After the videos, smaller groups of the students are formed. Through group discussions, they decide their own choice of PBL activities in order to solve the local sustainability problem of their society.

5.8.1 CASC media artefact

This section presents an overview of the CASC media artefact development approach.

Using educational videos

CASC uses educational videos to promote awareness for TEfS. Videos are much better than vocal discourse as they can demonstrate complex concepts and skills (Choi & Johnson, 2007). Videos are also known to attract student attention, create anticipation and easier memory recalls (Fill & Ottewill, 2006).

Based on social strengths

The discourses of development and aid projects often stand on a mix of good and not-so-good intentions. In best cases, help is extended on humanitarian grounds without any expectations; in worst cases, the country may have to barter its sovereignty in lieu of the *assistance*. For any community, it is better to not be dependent on others perpetually. The donate/aid model often focuses on deficiencies in a society and underplays the social strengths available in the developing countries. CASC amplifies social strengths of societies and promotes social self-reliance.

Highlights local knowledge and wisdom

CASC incorporates local knowledge and wisdom. CASC media highlights the views of working-level experts from developing countries. There are multiple advantages of highlighting the knowledge of these experts is that they understand these issues in-depth. They are likely to be aware of the useful scientific research in the field and are familiar with the problem in local contexts (Easterly, 2006). These experts know their problem domains well and can connect their knowledge seamlessly with the mainstream reality and native world view and cultural systems.

Cultural and worldview sensitivity

ICT solutions for developing countries are often based on western perspectives e.g. Western language, cultural assumptions, social images and Western/European notions (Selinger, 2009). CASC is culturally sensitive and therefore, aims to connect with the learners deeply. As experts and learners share same cultural background, the communication is less likely to create misunderstandings.

Local language

Educational communication in "[students'] own language fosters the kind of true participation in development that achieves lasting results" (UNESCO, 2012). Learning in first language boosts effective communication and learner inclusion. ICTs may reduce cognitive load through visuals however a foreign language can alienate children as they may or may not understand a non-native language well. Children learn more easily about an issue when it is discussed in their local language.

Infrastructure sensitivity

Unlike the developed nations, presence of basic ICT infrastructures can not be guaranteed in all schools in developing nations. Some schools may have access to some equipment as well as access to the Internet; others may have no facilities at all. These things must be considered during the project design phase.

Appropriate ICTs

Developing countries have fewer resources to invest in education than developed countries. In such scenarios, despite digital equipment becoming more affordable in recent years, investing in ICTs may lead to cost-cuttings from other important aspects of education such as qualitative improvements in teacher education or providing basic facilities like toilets and drinking water. Still, as discussed earlier, schools without ICT infrastructure are most often not in a position to purchase ICTs for an intervention. However, even if intervention budgets do not allow purchase of new digital equipment; renting ICT equipment can be an alternative to solve this issue. Renting equipment is common in developing countries. Marriages and conferences often rent out the basic ICT devices like projectors, laptops and speakers etc. In certain circumstances, inexpensive methods such as email, SMS, or some simple communication applications such as WhatsApp messages may also serve as cheap non-synchronous channels for educational communication.

5.8.2 CASC pedagogy

This section presents an overview of the CASC media artefact development approach.

As CASC aims to promote learning about authentic social problems and subscribes to ecological paradigm of education, choices like the use of dialogue, constructivist pedagogy and PBL were natural for the pedagogical aspects of CASC (Thomas, 2009; Mohammad Yasin & Rahman, 2011).

Some scholars root PBL in Dewey's ideas. Dewey (1916, p. 160) pointed out that "Methods which are permanently successful in formal education [. . .] go back to the type of situation which causes reflection out of school in ordinary life". Good educational methods promote students' learning via thinking as well as acting on their thinking.

The constructionist PBL approach augments students' motivation and self-learning, stresses collaboration and self-directed learning and hence, strengthens interpersonal skills and teamwork promotes lifelong learning through inquiry and constructivist learning; and enriches the teacher-student relationship (Schmidt et al., 2011). Three main requirements of PBL are learning by doing, learning in context, and focusing on the student (Chen, 2008). In PBL, the teacher acts a facilitator. Duch et al. (2001) provide few criteria for a problem for PBL. According to them, the problem must motivate students to seek out a deeper understanding of concepts i.e. problem should be authentic problem; the problem should ask students to make reasonable decisions and to defend their decisions; the problem should connect the learning about problem to students' previous courses/knowledge. Sethi's FIDS model is also based on principles of PBL.

Two CASC framework based interventions have already been implemented in two developing countries. These interventions dealt with two different sustainability domains: environmental sustainability and health sustainability. Both interventions shared some basic features however the second intervention conducted in India was an upgraded version of the first intervention conducted in Tanzania. Table 8 below lists some common activities shared by the two interventions.

Table 8. CASC basic phases and activities shared by both interventions

Phase	Activity
Pre-intervention Phase	Identify authentic local problem Prepare the media artifact (educational video) featuring problem-domain experts Connect with schools
Intervention Phase	Pre-Test Show educational documentary Divide students in groups Group conversation for PBL activity Project execution Project Presentation
Post-intervention Phase	Post-test Teacher Interviews

After the CASC based video is shown to the students, they are divided into smaller groups. Each group is asked "If this is a problem of your society, then how are you, as a smaller groups, going to solve this problem of your society?" The students come up with their PBL ideas through group discussions; execute these projects; make presentations about their projects; and show their presentation with all the students.

The PBL-based pedagogical aspect aims to connect the information provided through videos with learners' actual life-world; and suggests changes to the thinking processes, students used to meet their day-to-day reality. Transformative changes among the intervention group students are most probably results of the learner-centric nature of the CASC approach.

Although the Table above shows the basic phases shared by the two CASC implementations implemented so far, the framework was updated after the first intervention. Figure 9 describes the updated information flow used during the Indian CASC intervention.

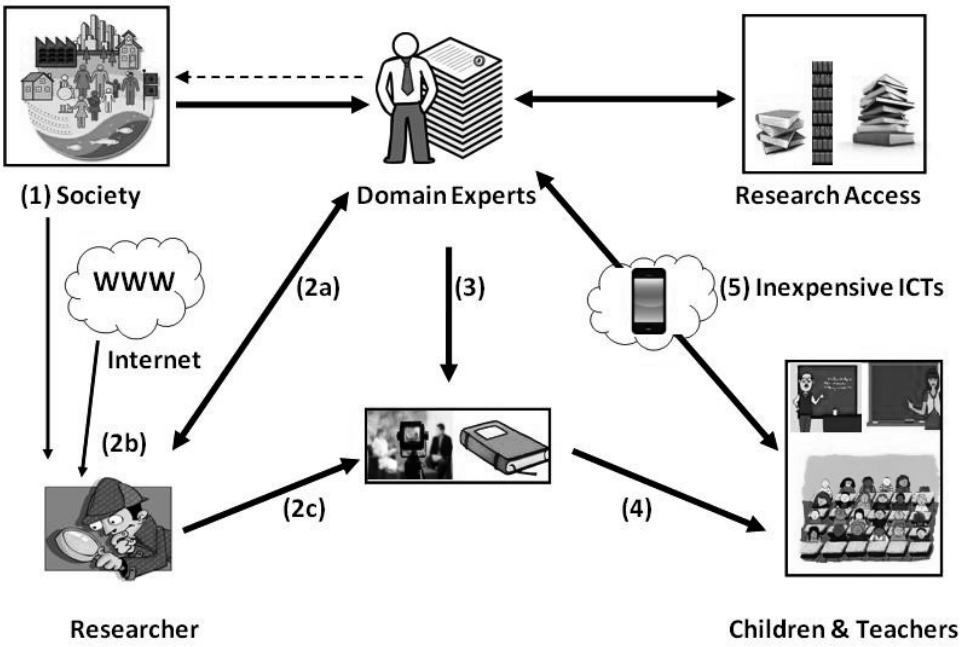

Figure 9. Information flow in second CASC intervention: 1) Informal survey about popular beliefs about alcohol in society. 2 a) Interviews with multi-disciplinary, working-level experts discussing popular beliefs about alcohol. 2 b) Accumulating resources from the Internet 2 c) Creation of learner-centric video and illustrated summary-booklets. 3) Validation of content by experts. 4) Providing video and booklets to schools. 5) Inexpensive ICT-based communication between experts and schools.

A key aim of the CASC framework is to promote reflective and indoctrination-free learning about sustainability.

6 EMPIRICAL RESEARCH

Two empirical studies were conducted to test and inform CASC framework. The first study based on CASC framework lead to specific changes in the framework. The second study was based on the updated framework. This chapter provides details of various aspects of research processes involved in development of the CASC framework.

6.1 AIMS OF THE RESEARCH

This thesis investigates how CASC based educational interventions can support Transformative Education for Sustainability among middle- and high-school students in developing countries.

The first CASC-based intervention was conducted in Morogoro region of Tanzania. The intervention was related to environmental sustainability. In Morogoro region, forest fires - caused by human activity- result not only in losses of flora; but the ash from forest fires also pollutes the local water resources; hence, creates distress for the local community. The research task of the first study was to explore ICTs potential to connect the local sustainability experts with the school students and investigate how CASC's pedagogy could motivate school students. Through the first intervention we wanted to:

a) Explore if appropriate ICT-based solutions can be natively developed and deployed without depending on non-native experts.
b) Explore the potential to use appropriate ICTs to connect the local sustainability experts with the school students;
c) Explore CASC's pedagogy's potential to motivate student action towards social change with regards to forest fires.

The context of second CASC intervention was the India's north-western state of Punjab. This intervention dealt with the larger theme of social sustainability. It was meant to make school students aware of the 'effects of alcohol'. In recent years, Punjab has gained a notorious reputation for use of alcohol and hard drugs. Learning from the first intervention, second intervention expanded upon the CASC framework guidelines used in Tanzania. This intervention explored:

a) Ways to construct a dialogic microcosm of Punjabi society with regards to alcohol (i.e. representing various opinions and assumptions (or thoughts) of different subcultures within a society).
b) Potential use of ICTs in creating a dialogue (based on David Bohm's conception of dialogue) among adolescents and sustainability experts.
c) Effects of using multiple media i.e. print as well as electronic media.
d) The effects of social stratification with regards to pro-alcohol thought patterns. thought patterns.

More details about this upgradation of framework are provided in Sub-section 7.2.1 Extending CASC Framework.

6.2 DATA COLLECTION

The first study was an exploratory study. It aimed to explore two issues: could ICTs successfully connect local sustainability experts with the school students; and could expert knowledge combined with constructivist problem-based learning transform students. The second CASC based intervention was a confirmatory study based on an upgraded version of CASC. The second CASC based intervention was about 'effects of alcohol' and was conducted in Punjab, India. Both interventions used experimental and control groups. Qualitative as well as quantitative data were collected in form of pre- and post-test data along with teacher interviews. Table 9 depicts the research design of the CASC-based studies.

Table 9. Research Design

Article	Subjects (n)	Research design and topic	Data Source	Data Analysis
1	Middle- and high school students (n=176)	Design: Control and Experimental groups Topic: Transformative Sustainability Education about environmental sustainability	Questionnaires (Pre- and posttests) and Teacher interviews	Quantitative and qualitative analysis (Teachers' interviews)
2	Middle- and high school students (n=379)	Design: No grouping Topic: Adolescents' perceptions of alcohol	Questionnaire	Quantitative and qualitative analysis (Content Analysis)
3	Middle- and high school students (n=379)	Design: Control and Experimental groups Topic: Transformative Sustainability Education about social sustainability (health sustainability)	Questionnaires (Pre- and posttests) and Teacher interviews	Quantitative and qualitative analysis (Teacher's interview)

7 EMPIRICAL STUDIES: OVERVIEW AND RESULTS

7.1 INTERVENTION IN TANZANIA: ENVIRONMENTAL SUSTAINABILITY

Article 1: Roy, A., Kihoza, P., Suhonen, J., Vesisenaho, M. & Tukiaianen, M. 2014. Promoting Proper Education for Sustainability: An Exploratory Study of ICT Enhanced Problem Based Learning in a Developing Country. International Journal of Education and Development using Information and Communication Technology, 10(1), 70-90.

Problem Background

I was Junior Researcher at Department of Computer Science (later, School of Computing) at University of Eastern Finland in Joensuu where Patrick from Tanzania was a student. I came to know Patrick Kihoza while teaching some courses at the department. Both of us shared an optimism that ICTs could potentially lead to socio-economic development in the developing world. Patrick visited me to inquire for an idea for his Masters-thesis, by then, the core idea of CASC had formulated in my mind. I shared the idea and Patrick could connect with the idea.

Patrick mentioned that forest fires were a serious sustainability issue back home in Tanzania. Forest fires are a known environmental sustainability issue in Tanzania. Estimates by Tanzanian government suggest an average loss of 420,000 hectares of forests annually through uncontrolled fires and rampant tree felling. Various professional communities e.g. hunters, farmers, livestock keepers, charcoal makers and timber sawyers cause forest fires in Tanzania to meet their personal and professional needs. These groups often ignore the larger disadvantages of forest fires. Apart from the loss of valuable natural resources, forest fires severely increase forest fragmentation and landscape destruction. Forest fires affect the Morogoro region worse as the ashes from the forest fire spoil the drinking water sources affecting the water supply in the region. It was an authentic sustainability problem.

I shared the basic ideas of CASC and asked Patrick if he wanted to do something about this problem. Patrick willingly agreed to the idea of intervention. I created the pre- and post-test questionnaires and discussed them with Patrick and we finalized the questionnaires together. The first CASC intervention was led by Patrick and focused on environmental sustainability problem of forest fires in Tanzania.

The context of the study included four schools in Morogoro region in Tanzania. Two schools were chosen for intervention while the other two served as the control group. CASC framework-based video featuring local forest officials was created for this intervention. Patrick asked them questions that he felt would be useful for the students. The intervention was based on experimental and control groups and pre- and post-test design. Qualitative as well as quantitative data were collected from the pre- and post-test questionnaires from both groups. After the intervention, teachers from the two experimental schools were also interviewed. The data were analyzed using qualitative and quantitative analysis. Pre- and post-test questionnaires used for this intervention -translated from Swahili- are attached in Appendix 1 and 2.

Results

Results of this study indicated that prior knowledge among the experimental and control groups regarding forest fires and environmental education was on similar level. However, in post-test, both groups differed. The intervention group was much more willing to undertake variety of projects to support environmental conservation as compared to the control group. Significant majority learned new knowledge from the educational videos. Student groups carried out projects indoor (i.e. only textual learning based) as well as outside (in gardens, and in society) the school. Students cleared a bush to separate a forest area and farm area; they planted 30 saplings; some spoke to hunters who could cause forest fires. After their projects, the students presented their projects to all fellow students. The school-teachers from intervention schools assessed that students had well understood the topic within a short time. They appreciated students' self-motivated and self-guided plantation initiative. Teachers were positive that the intervention helped students and teachers learn better about environmental conservation. They appreciated that owing to the virtual nature of intervention, students could learn without study tours (which may pose logistical and financial challenges; as well as the time constraints).

In Tanzania, text books are lacking; and teacher-to-student ratio is unreasonably high. Burdening the system with demands to purchase ICTs is obviously not a pragmatic idea. Through the CASC intervention in Tanzania, we chiefly wanted to explore 1) whether connecting local experts to the schools through ICTs was a pragmatic and cost-effective proposition; and 2) how CASC would support students' learning and attitudes about environmental sustainability.

Overall, it can probably be concluded that the Tanzania intervention based on CASC framework was learner-centric, culturally-sensitive, locally-contextualized as well as cost-effective. Features such as: local contextualization of the content; use of native experts and local language; cultural-sensitivity; world-view sensitivity and pragmatism about unavailability of ICT infrastructure were useful and supported students' learning.

There were few unexpected lessons for us from this intervention as well. Before the intervention, we had assumed that students are not being taught about environment in the schools at all. Based on this assumption, we did not analyze the textbooks at all. We later found that our assumption was incorrect. The problem was not complete lack of text but problem lies probably in the quality of the content and how this content is delivered to the students. Teachers either were not much aware of constructivist pedagogical methods or consciously chose to not use them. All such gaps affect students' effective learning.

Although the pedagogical part was developed attentively; we held a pro-technology bias as well. After the students decided their group activity projects, we simply handed over the project-list to the teachers and did not pay attention to the role of the teachers. Children led self-driven activities to enhance environmental sustainability as a result of the intervention. Students' projects were carried out both inside and outside the school.

7.2 INTERVENTION IN INDIA: SOCIAL SUSTAINABILITY

After the Tanzania intervention, Patrick mentioned his overall satisfaction with the intervention however he had doubts about one of the claims made by a Forest Officer. His doubt indicated a serious lapse. Through CASC, I had intended to

provide transformative educational experience - grounded in the ecological paradigm - to the students in mainstream schools in developing nations. Had we ended up indoctrinating the students? Knowingly or unknowingly, we had simply replaced one hierarchical figure (content writers) with another (working-level sustainability experts). The hierarchy and pedestal system were still intact.

7.2.1 Extending CASC framework

More rigorous investigations revealed that the first CASC intervention still incorporated few mechanistic paradigm assumptions and lacked critically in the following educational aspects.

1. Adolescents often have prior learning about recurring societal phenomenon from informal and non-formal sources. Correcting misinformation and misconceptions thus learned need deeper reasoning and accurate knowledge (Ambrose et al., 2010; Minstrell, 1989). CASC intervention in Tanzania skipped investigation of learners' prior knowledge altogether. Information and knowledge prevailing in the society affect children's perceptions. However, this knowledge was not considered in the intervention at all.
2. CASC intervention in Tanzania highlighted the views of the forestry-experts only. This monologue approach could lead to partial understanding of the problem only.
3. CASC framework used educational videos to provide working-level experts' knowledge to the school-students. If these claims did not connect well with students' experiences or beliefs, they could not question the experts. Hence, the intervention only disseminated Forest Official's claims. There was no dialogue between the experts and the students. Consequently, the experts enjoyed an on-the-pedestal status. One-sided, top-driven, hierarchical information flow is indoctrinating; and impedes deeper learning (Krishnamurti, 2006) and hampers co-investigation of reality (Freire, 1970).
4. The CASC intervention in Tanzania screened educational video through projector setup. Low device availability is not uncommon in developing countries. Students therefore could not review the imparted knowledge ever after the video was over.

To be transformative, CASC needed a *paradigm shift* - a shift from its underlying tech-centric, mechanistic paradigm to the ecological paradigm of learning and education. The following steps could remedy the situation and convene this shift.

1. A survey of popular thoughts or beliefs leading members of a society towards unsustainable behaviors could bring forward the basic assumptions that students might have already internalized or could be vulnerable to adopt.
2. Critical reflection is enriched by multi-disciplinary viewpoints.
3. Dialogic approach to education is more conducive to the ecological paradigm. Students' ability to question disturbs the hierarchical communication mode of education and promotes deeper understanding. To avoid indoctrination by experts, innovative ways to question experts could be found. Rather than asking students to believe the experts, the students could connect with the experts (through inexpensive ICTs) and ask questions.

4. In addition to the educational video, illustrated summary-booklets could serve as review-source which students in low- or no-ICT infrastructure schools could use as ready-to-use reference.

Two of David Bohm's ideas – 1. our actions are external manifestations of our thoughts; and 2. his conception of dialogue - were foundational ideas in the second intervention. From this thought-based perspective, any crisis of sustainability does not start with when people start to act unsustainably, rather it starts when they think unsustainably. Clearly, people's thinking patterns play a crucial role in creating and maintaining the sustainability crisis. The second CASC intervention was conducted in India about the effects of alcohol.

In my initial articles, I used CASC as an acronym for Children as Agents *for* Social Change (Roy et al., 2013) and then Children as Agents *of* Social Change (Roy et al., 2018). This change seemed inevitable because of two reasons: first, this shift was to convey the ecological paradigm of education so the aim of these interventions is to provide them conditions and intrinsic thrust (rather than instrumental thrust) - in which learners can listen to their own inner voices and explore their chosen directions further. Second reason was in CASC interventions, the children decide and conduct their projects all by themselves without any active interference from the intervention team – the projects of change belong to the students only.

7.2.2 Alcohol intervention

Article 2: Roy, A., Ikonen, R., Keinonen, T. & Kumar, K. 2017. Adolescents' Perceptions of Alcohol. *Health Education*, 117(3), 280-296. doi:10.1108/HE-05-2016-0021.
Article 3: Roy, A., Ikonen, R., Kumar, K. and Keinonen, T. 2018. Sustainability Education Using ICT-Supported Dialogue - Towards Transforming Adolescents' Perceptions of Alcohol in the Punjab, India. *Discourse and Communication for Sustainable Education*, 9(2), 49-67.

Health is an important aspect of social sustainability. Non-Communicable Diseases (NCDs) or lifestyle diseases are biggest threat to human health globally. Alcohol consumption is one of the four leading causes of NCDs. Alcohol consumption in Punjab in India has gained a lot of popularity, in past decade or so. Punjabi people used to drink in earlier times as well, however not as frequently. An empirical study in Punjab found half of the college-going adolescents had already used alcohol. Adolescent drinking is risky as it can negatively affect an adolescent's developing brain. Drinking is a potential serious health crisis in the region. Alcohol users are more likely to use harder drugs. The second CASC intervention originated from a quest to understand the effects of alcohol. I conceived and conducted this intervention at times with help of eight volunteers and a paid video editor. Complete intervention includes studies presented in both Articles 2 and 3.

Article 2

The main context of this study was Patiala district in Punjab. According to Bohm, external actions originate from thinking patterns. Extending the same point of view to alcohol usage, the crises of alcohol does not start with people drinking but how people think about alcohol. Volume of alcohol consumption in Punjab went up by about 60% between the years 2005-2011. Changed trends of alcohol consumption

reveal that during this time, perceptions of alcohol among Punjabis had undergone a drastic shift. Therefore, it was important to understand the thought-patterns driving these behaviors. Article 2 explored the thoughts-patterns driving Punjabi people to initiate drinking through informal conversations; and used questionnaire to find out how school-going adolescents were entertaining these thought-patterns.

In his conception of dialogue, Bohm suggests that dialogue should be inclusive i.e. different opinions about a topic should be brought into awareness through dialogue. To use a dialogic approach and to be well-grounded and inclusive, I talked to pre-adult adolescents and early-adult drinkers to understand the ideas, beliefs, expectations and thinking patterns that lead them to their drinking initiation. Afterwards, I derived categories from these beliefs and formulated questions based on drinkers' thoughts; and asked multiple experts from alcohol-related fields to share their views and the rationale behind those views. Three categories emerged from this analysis: 1. increasing social acceptance; 2. influence of alcohol promotions by celebrities and through media; and 3. lack of scientific knowledge about the effects of alcohol emerged out as the key reasons which had led the drinkers to initiate.

Five schools were involved in this study. All schools in the intervention mentioned that they try to promote awareness about alcohol among students. Students in one of the schools came from financially marginalized families – where drinking was very frequent in students' families. During the study, students' responses to the questionnaire were used to map the perceptions of alcohol formulated among youth. To understand how education was serving the society with regards to alcohol awareness, a summative content analysis of the textbook content from classes 1 to 10 about alcohol was also conducted. Pre-test questionnaire used for this study -translated from Punjabi - is presented in Appendix 3.

Results

Students' responses confirmed that most of the students perceived alcohol consumption as common and normal activity; they were vulnerable to act as per media's suggestions; they lacked any frameworks to think critically about media and celebrities; and they lacked scientific knowledge about the effects of alcohol and the brain-related risks associated with alcohol consumption. They were susceptible to adopt thinking patterns that had led the drinkers to initiate drinking. The study revealed that students from financially disadvantaged families were more vulnerable to internalize these thought patterns. They were also the most pessimistic about children's ability to change their society.

It is easier to tell others not cause forest fire. However, in contrast, it is more challenging to understand why some people choose to set forest on fire. The second CASC intervention was more influenced by Bohm's approach to communication. To understand our problematic actions, we have to understand our beliefs and thinking processes that lead to those actions. Thinking lies in the realm of invisibility and to understand it, we have to investigate prior knowledge. Potential of transformation lies in the realm of thinking. Consequently, the Indian intervention extended the CASC framework in multiple ways.

Alcohol is a serious social problem in the Punjab region; however, it is a mistaken assumption that problems of alcohol start when people start to drink. Rather these problems start, when people start to accept the ideas prevailing in the society about alcohol. Rather than beginning with experts' conclusions, the Punjabi CASC

intervention took a more grounded and yet radical approach to learn and understand the thought-patterns leading Punjabi youth to initiate drinking.

Many of our beliefs are internalized from the beliefs circulating in our society. The second intervention started with paying attention to prior knowledge and beliefs circulating in the Punjabi society at large. These thoughts had led youngsters to unsustainable action of initiating drinking. The three main causal categories were identified. The pre-test revealed large number of school-going students showed inclinations to subscribe to the thought patterns that had led the current drinkers to start drinking. They uncritically believed in celebrities and media; and were well-aware of the trends of open social acceptance. Their knowledge of the scientifically established facts about alcohol was very poor.

Article 3

Article 3 continues the study discussed in Article 2. Article 3 discusses how an intervention based on the extended CASC framework was conducted to provide transformative health education about the effects of alcohol in Punjab.

Questions were derived from informal conversations with drinkers. These questions were asked to experts from multiple alcohol-related domains to construct a coherent multi-dimensional picture about the effects of alcohol. These interviews were video-recorded. The experts included a psychiatrist; a sociologist researcher in Punjab with expertise in drug and alcohol research; two social workers who run a school for children affected by alcohol- and drug-addictions; and a Physician-turned teacher – director of a school run by Krishnamurti Foundation. To avoid possibility of indoctrination, experts were asked to suggest an ICT-based medium of communication to allow students to question them.

Eight volunteers and one paid video-editor were involved in this project. Two educational artifacts - an educational video and an illustrated book - were created. Both the book and the video shared the same title (translated) 'Is alcohol really harmful?'

The same five schools (as in Article 2) from the urban parts of Patiala district participated in this study. Two of the schools agreed to be the intervention schools while the remaining three schools participated as the control group. One intervention school appointed their own teacher as Teacher-in-charge for the intervention. The second (the financially marginalized one) citing staff-shortage, asked the researcher to be the teacher for the intervention. The intervention used intervention-control groups with pre- and post-tests. Students filled questionnaires during these tests. Questionnaires filled by students, described in Article 2, served as pre-test questionnaire for this study.

Two videos ('Is alcohol really harmful?' and another about project-based learning) were shown only to the intervention group. Multiple steps were taken to make the video learner-centric. After the videos, the students were divided into groups; each group was asked 'If this is a problem in your society, then how are you as a group going to solve this?' Each group came up with its ideas. Both intervention schools disallowed all ideas that involved out of the school activities. Teacher-in-charge from the experimental schools was interviewed. These data were analyzed using both qualitative and quantitative analysis. The post-test questionnaire used for this intervention -translated from Punjabi- is attached in Appendix 4.

Results

Results of the study revealed that the intervention students gained scientific knowledge; and started to think critically about media and celebrities. Few control group students also showed tendencies to think deeply and critically however such efforts were few, random and individualistic.

The teacher-in-charge mentioned that teachers also learned from the intervention. She felt that students' learning through this intervention was much better than the previous approaches used by the school. According to her, the students -especially senior students- showed a change in attitude after learning that their brain was not mature just as yet. They started to behave more humbly. She credited the intervention for this change in attitude.

The schools in Morogoro region were more supportive of the CASC intervention as they permitted their students to carry on the projects even outside the school. Schools in Punjab were more restrictive and narrowed the scope of group-projects. However, it was interesting to note that despite schools restricting the scope of the project-based activities within the school walls; many students advocated against alcohol with the adults at homes and in neighborhoods. These adults included drinkers. Some of these adults agreed to not drink. During the pre-test, students from the financially marginalized school were most pessimistic about children's ability to change their society in the pre-test. However, in post-test, they were most coherently positive about this ability.

ICTs were used to facilitate students asking questions to the experts; to shift the focus of ICTs from information dissemination to facilitating dialogue and to disrupt the traditional educational hierarchy in which content writers are unquestionable authorities.

Of all the questions raised by the students, only one could not be answered by the teachers and the researcher. This question was forwarded via an email to the domain expert, the Psychiatrist, who responded overnight. Within 24 hours, the response was publicly shared with the student who expressed complete satisfaction with the answer. This observation seems to support the claim that low-cost, high-tech ICTs improve educational systems. However, few emails were also sent to the Punjab State Educational Board to clarify about the ambiguous textbook content about alcohol in a class 10 textbook. These emails did not get fetch any response. This observation agrees with the claim that mere provision of ICTs is an insufficient condition for change in education.

8 CONCLUSIONS

Interventions based on CASC framework aspired to decolonize the developing world educational systems from legacy of mechanistic education, even if temporarily. Glimpses of freedom may inspire students to ask questions to their own teachers; demand changes in other aspects of education; change personally as well as ask questions in other arenas of social life. Such initiatives may inspire pupils and teachers to approach teaching and learning differently.

For multiple reasons, most developing countries do not invest heavily in education. Educational aid is not a very reliable solution either. However, as our studies exemplify that low-cost solutions can support Transformative Education for Sustainability in developing nations.

Students in both developing countries took self-motivated initiatives and exerted to remove a social problem in their societies. On one hand, these initiatives in two different continents indicate that CASC pedagogy can inspire students. On the other hand, these initiatives indicate that despite their respective country's low ranks in international development indexes, young students in developing countries aspire to solve their societies' problems and are not shy to exert and toil for it. Their self-motivated projects epitomize what ecological paradigm-based experiences can achieve in terms of sustainability. Not providing good-quality education to such aspiring youngsters is a public disservice.

None of the experts asked us for any money for sharing their expertise. They seemed to be inspired by cultural ideas such as Ubuntu and Vasuvaidh Kutumbkum. Ubuntu (the African idea of 'a quality that includes the essential human virtues; compassion and humanity') and Vasuvaidh Kutumbkum (the Indian idea that 'whole world is a family') are among the thought-patterns encouraged in these regions. These ideas are not oriented towards narrow (Western) definitions of development. Experts' generous sharing of expertise resulted in students' reflections and initiated negation of causal factors in the minds of the students.

It is probably worth mentioning that for the Indian intervention, I had interviewed two psychiatrists. One of them was running a for-profit clinic for addicts and his responses to the questions were very fuzzy. He did not share any deeper reflections about the issue. I had to drop him off. It was not intentional that none of the featured experts happened to work for any for-profit institutions. 'How do economic factors broaden or narrow generous sharing of critical knowledge for social good?' is also a question worth investigating.

Good education provides firm and sustainable foundation for development of a country. A developing country's persistent dependence on inter-national or supranational entities opens roads to exploitations and interferences. Developing countries can become self-sufficient in providing education for sustainability; and thus, in challenging their sustainability problems – if they amplify their existing strengths properly.

In age of information overload, what and whom we choose to amplify is extremely crucial. Appropriate use of ICTs can amplify the expert's knowledge and understanding; if the society at large finds their advice sensible, it is likely that they will implement expert's ideas in personal conduct. Pedagogically informed use of ICTs

can support transformative education however it is not a sufficient condition. ICTs are only secondary to social intentions and forces and fail to bypass these stronger powers.

Harari warns us from a historian's perspective: "One thing that history teaches us is that we should never underestimate human stupidity,"; "It's one of the most powerful forces in the world,". He argues: "[populist leaders sell] people nostalgic fantasies about the past instead of real visions for the future". Still, the mankind has to solve today's biggest global problems, namely the threats of nuclear war, climate change and technological disruption. These problems have only global solutions, but the populists do not want to discuss about global commitments. "They put at risk the very survival of human civilization so if we don't come up with a solution; we are in (a) really deep problem." (Huang, 2018.)

We will not be able to solve our shared global challenges with narrowly-defined nationalistic, religious or profit-centric thinking patterns. Stress on these thinking patterns leads to animosity; further development of weapons of mass destruction, defense investments, wars and fact-avoidance. Extensive stress on nationalism is fragmentary; it is neither sustainable, nor wise.

Ideally, the effects of an intervention should outlast its duration. Whether the effects of the CASC interventions are stable overtime or not; whether these interventions need some follow-up booster programs demands further investigations through longitudinal studies. Similarly, 'how does a teacher from the host school taking up the in-charge position for CASC intervention over a visiting researcher playing as the teacher-in-charge affect students' learning?' is also a question worth exploring.

ICTs supported dissolution of hierarchy when it comes to students' ability to ask questions to experts however how important are ICTs in providing the educational content? Can the print-media based content replace the video-based content? Some comparison studies are needed to investigate this theme as well.

In order to figure out the world and its complexities, we absorb and assume multi-dimensional beliefs through non-reflective learning, indoctrination, socialization, and enculturation. These beliefs and even myths are needed for regular functioning of the society. Transformative education for sustainability asks learners to question their deep beliefs; and points out the gaps in their beliefs, belief systems, meanings and meaning-making mechanisms. TEfS is likely to open up new patterns of thinking which may question the larger beliefs systems that hold our current political, economic and social systems.

Explorations in our belief systems and personal transformations are bound to take us back to the eternal aphorism: Know Thyself. This is an area where humans have not shown much interest so far. In the current times, we probably cannot over-estimate the need to know ourselves better.

I end this thesis in hopes that we, as a species, would genuinely re-investigate our understanding of our world, our ideas, as well as our own selves; and that we will be able to overcome our shared human challenges through sincerity of intention and genuine efforts.

BIBLIOGRAPHY

Adelman, C. 1993. Kurt Lewin and the origins of action research. *Educational Action Research*, 1(1), 7-24. DOI: 10.1080/0965079930010102

Åhlberg, M. 1998a. Ecopedagogy and ecodidactics: Education for sustainable development, good environment and good life. *University of Joensuu, Bulletins of the Faculty of Education*, 69.

Åhlberg, M. 1998b. Education for sustainability, good environment and good life. In M. Åhlberg & W. Leal Filho (Eds.) *Environmental education for sustainability: Good environment, good life*. Frankfurt: Peter Lang, 25–43.

Akubue, A. 2000. Appropriate Technology for Socioeconomic Development in Third World Countries. *Journal of Technology Studies,* 26(1). https://scholar.lib.vt.edu/ejournals/JOTS/Winter-Spring-2000/akabue.html

Albanese, M. A., & Mitchell, S. 1993. Problem-based learning: a review of literature on its outcomes and implementation issues. *Academic Medicine*, 68: 52–81. DOI:10.1097/00001888199301000-00012.

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M.K. 2010. *How Learning Works: Seven Research-based Principles for Smart Teaching*. San Francisco: Jossey-Bass.

Amus, G. 2013. An alternative journey into forest kindergartens and the Reggio Emilia approach. In U. Härkönen (Ed.) *Reorientation of teacher education towards sustainability through theory and practice.* Joensuu: University of Eastern Finland, 5-26.

Angeli, C. 2002. Teachers' practical theories for the design and implementation of problem-based learning. *Science Education International,* 13(3): 9–15.

Appadurai, A. 2001. *Globalization*. Durham, NC: Duke University Press.

Ardagh, A. 2005. *The Translucent Revolution - How people just like you are waking up and changing the world*. Novato: New World Library.

Arora, P. 2010a. Hope-in-the-Wall? A digital promise for free learning. *British Journal of Educational Technology,* 41(5): 689–702. DOI: 10.1111/j.1467-8535.2010.01078.x

Arora, P. 2010b. *Dot com mantra: Social computing in Central Himalayas*. Farnham: Ashgate Publishing.

Bansal, S. 2016. WHO report sounds alarm on 'doctors' in India. *Times of India*. https://www.thehindu.com/data/WHO-report-sounds-alarm-on-%E2%80%98doctors%E2%80%99-in-India/article14495884.ece

Barber, M., & Mourshed, M. 2007. *How the world's best-performing educational systems come out on top?*. London: McKinsey & Co.

Barrows, H. S. 1988. *The Tutorial Process*. Springfield: Southern Illinois University School of Medicine.

Barrows, H. S. 1996. Problem-Based Learning in Medicine and Beyond: A Brief Overview. *New Directions for Teaching and Learning*, 68: 3-12.

Bauman, Z. 2000. *Liquid Modernity*. Cambridge, UK: Polity.

Benjamin, Jr. LT 1988. A History of Teaching Machines. *American Psychologist*, 43(9): 703-712.

Bereiter, C. & Scardamalia, M. 1989. Intentional learning as a goal of instruction., In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser*. Hillsdale, NJ: Erlbaum Associates.

Berliner, D. 2011. Rational responses to high stakes testing: the case of curriculum narrowing and the harm that follows. *Cambridge Journal of Education*, 41(3): 287-302.

Blumstein, D.T., & Saylan, C. 2007. The failure of environmental education (and how we can fi x it). *PLOS Biology*, 5(5): e120. DOI:10.1371/journal.pbio.0050120

Bohm, D. 1994. *Thought as a system*. NY: Routledge.

Bohm, D. 1996. *On Dialogue*. Edited by Lee Nichol. London: Routledge.

Booth, S. E. 2012. Cultivating knowledge sharing and trust in online communities. *Journal of Educational Computing Research,* 47(1): 1-31.

Boström, M., Andersson, E., Berg M., Gustafsson, K., Gustavsson, E., Hysing, E., Lidskog, R., Löfmarck, E., Ojala, M., Olsson, J., Singleton, B. E., Svenberg, S., Uggla, Y., & Öhman, J. 2018. Conditions for transformative learning for sustainable development: A theoretical review and approach. *Sustainability*, 10(12), 4479. DOI: 10.3390/su10124479

Boyd, R. D. 1989. Facilitating personal transformation in small groups, Part I. *Small Group Behavior,* 20(4): 459-474.

Brundtland, G. H. 2002. Sustainable Development, Fall 2002, Collage of comment. *New Perspectives Quarterly*, 19: 79-80. DOI: 10.1111/j.1540-5842.2002.tb00109.x

Burns, H. L. 2015. Transformative Sustainability Pedagogy: Learning From Ecological Systems and Indigenous Wisdom. *Journal of Transformative Education*, 13(3), 259–276. DOI: 10.1177/1541344615584683

Capra, F. 1982. *The Turning Point: Science, Society and the Rising Culture*. NY: Simon and Schuster.

Carson, R. 1962. *Silent Spring*. Boston: Houghton Mifflin.

Cayer, M. 2005. The five dimensions of Bohm's dialogue. In Banathy, B. & Jenlink, P. M. (Eds.). *Dialogue as a Means of Collective Communication*. NY: Kluwer Academic Publishers, 161-191.

Chen, N. C. 2008. An educational approach to problem-based learning. *Kaohsiung Journal of Medical Sciences,* 24(3): 23-30.

Choi, H. J., & Johnson, S. D. 2007. The effect of problem-based video instruction on learner satisfaction, comprehension and retention in college courses. *British Journal of Educational Technology,* 38(5): 885–895.

Churchman, C. W. 1967. Wicked Problems. *Management Science,* 14(4): B141-B142.

Clausen, J. A. 1968. *Socialization and Society*. Boston: Little Brown and Company.

Corey, S. M. 1949. Action research, fundamental research and educational practitioners. *Teachers' College Record*, 50: 509-14.

Cranton, P. 1992. *Working with adult learners*. Toronto: Wall & Emerson.

Creech, H. 2012. *Knowledge platforms and local level knowledge sharing*. A Participant Reflection Paper for the 2012 IDRC Canadian Learning Forum. https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/50479/1/IDL-50479.pdf

D.Edu. Pta 2018. Patiala – Official Government Site - Introduction – Education. https://patiala.nic.in/department-of-education/

Day, B. & Greenwood, P. 2009. ICT for rural development. In T. Unwin (ed.), *ICT4D*. Cambridge: Cambridge University Press, 321–359.

de Maré, P., Piper, R., & Thompson, S. 1991. *Koinonia: From hate, through dialogue, to culture in the large group*. London: Karnac.

De Villiers, M.R. 2005a. Three approaches as pillars for interpretive Information Systems research: development research, action research and grounded theory, In (eds.) J. Bishop & D. Kourie, *Research for a Changing World: SAICSIT '05 Proceedings of the 2005 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries*, 142-151.

De Villiers, M. R. 2005b. Interpretive research models for Informatics: Action research, grounded theory, and the family of design- and development research, *Alternation*, 12(2): 10-52.

Dewey, J. 1916. *Democracy and Education: An Introduction to the Philosophy of Education*. New York: MacMillan.

DfC 2012. *Design for Change - Every child can!*. http://www.dfcworld.com/

Dill, J. S. 2007. Durkheim and Dewey and the challenge of contemporary moral education. *Journal of Moral Education*, 36(2): 221–237.

Djoghalf, A. 2008. Secretariat of the Convention on Biological Diversity. https://www.un.org/en/ecosoc/docs/statement08/djoghlaf.pdf

Dobson, H. E., & Tomkinson, C. B. 2012. Creating sustainable development change agents through problem-based learning: Designing appropriate student PBL projects. *International Journal of Sustainability in Higher Education*, 13(3), 263-278. DOI: 10.1108/14676371211242571

Dods, R. F. 1997. An action research study of the effectiveness of problem-based learning in promoting the acquisition and retention of knowledge. *Journal for the Education of the Gifted*, 20: 423– 437.

Drenttel, W. 2010. Design for change contest. *Design Observer*. Published on 05.06.2010. https://designobserver.com/feature/design-for-change-contest/13508

Duch, B. J., Groh, S. E, & Allen, D. E. 2001. *The power of problem-based learning*. Sterling: Stylus.

Easley, L., De, P., Barendsen, L. & Hoe, M. 2015. *Design Thinking Guide Evaluation*. https://www.dfcworld.com/file2015/research_2.pdf

Easterly, W. 2006. *The white man's burden: Why the West's efforts to aid the rest have done so much ill and so little good*. New York: Oxford University Press.

Eisenhart, M.A. 1991. Conceptual Frameworks for Research: Ideas from a Cultural Anthropologist; Implications for Mathematics Education Researchers. In R. G. Underhill (Ed.), *Proceedings of the 13th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. Blacksburg, Virginia Tech, VA, 1: 202-219.

Emmett, B., Green, D., Lawson, M., Calaguas, B., Aikman, S., Kamal-Yanni, M. & Smyth, I. 2006. *In the Public Interest: Health, Education, and Water and Sanitation for All*. Oxford: Oxfam International. http://www.oxfam.de/files/20060831_inthepublicinterest_1916kb.pdf

Fill, F., & Ottewill, R. 2006. Sink or swim: Taking advantage of developments in video streaming. *Innovations in Education and Teaching International*, 43(4): 397–408.

Fletcher, R., & Melewar, T. C. 2001. The Complexities of Communicating to Customers in emerging markets. *Journal of Communication Management,* 6(1): 9–23.

Framework [Def. 1] (n.d.) In MacmillanDictionary.com https://www.macmillandictionary.com/dictionary/british/framework

Freire, P. 1970. The banking model of education. In E. F. Provenzo (Ed.) *Critical issues in education: an anthology of readings*. Thousand Oaks: Sage Publications. 105–117.

Freire, P. 1972. *Pedagogy of the oppressed*. New York: Herder and Herder.

Friedman, T. 2008. *Hot, Flat and Crowded - Why we need a green revolution and how it can renew America*. New York: Farrar, Straus and Giroux.

Gadotti, M. Undated. *Eduction for sustainable development - What we need to learn to save the planet?* Translated by Marcia Macedo. São Paulo: Instituto Paulo Freire.

Gallagher, S. A., Stepien, W. J., & Rosenthal, H. 1992. The effects of problem-based learning on problem solving. *Gifted Child Quarterly,* 36: 195–200. DOI: 10.1177/001698629203600405.

Gautama, G. 2013. Prashanti's Dilemma: Wisdom and Struggle in Students' Voices. *Journal of the Krishnamurti Schools*, 17, 20-25.

Grierson, D. 2009. The shift from a mechanistic to an ecological paradigm. *The International Journal of Environmental, Cultural, Economic and Social Sustainability*, 5(5), 197-206.

Grusec, J. E., & Hastings, P. D. 2007. *Handbook of Socialization: Theory and Research*. NY: Guilford Press.

Guha, M. 2013. Education in a Tagorean Perspective. *International Journal of Humanities and Social Science Invention*, 2(12): 35-41.

Harari, Y. N. 2011. *Sapiens: A Brief History of Humankind*. London: Penguin Random House.

Harari, Y. N. 2016. *Homo Deus – A Brief History of Tomorrow*. London: Penguin Random House.

Harrison, P. 1980. *The Third World tomorrow*. Harmondsworth: Penguin Books.

Hasslof, H. 2015. The educational challenge in 'education for sustainable development' - Qualification, social change and the political. *Malmö Studies in Educational Sciences No. 76; Studies in Science and Technology Education No. 85*. Linköping University: Faculty of Education and Society.

Hays, R., & Gupta, T. S. 2003. Ruralising medical curricula: The importance of context in problem design. *Australia Journal of Rural Health,* 11: 15-17.

Hevner, A. R., March, S. T., Park, J., & Ram, S. 2004. Design science in Information System Research. *MIS Quarterly*, 28(1): 75-105.

Hoffman, B. & Ritchie, D. 1997. Using multimedia to overcome the problems with problem based learning. *Instructional Science*, 25(2): 97-115.

Hofstede, G. 1991. *Cultures and organizations: Software of the mind*. London, UK: McGraw-Hill.

Huang, E. 2018. *'Never underestimate human stupidity,' says historian whose fans include Bill Gates and Barack Obama,* CNBC. https://www.cnbc.com/2018/07/13/never-underestimate-human-stupidity-sayshistorian-and-author.html

Hung, W. 2006. The 3C3R Model: A Conceptual Framework for Designing Problems in PBL. *Interdisciplinary Journal of Problem Based Learning* 1(1): 55-77. DOI: 10.7771/1541-5015.1006

IPCC 2014. *Summary for policymakers. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Iyer-Raniga, U., & Andamon, M. 2016. Transformative learning: innovating sustainability education in built environment. *International Journal of Sustainability in Higher Education*, 17(1), 105-122. DOI: 10.1108/IJSHE-09-2014-0121

Jacobson, M. J., & Spiro, R. J. 1994. A framework for the contextual analysis of technology based learning environments. *Journal of Computing in Higher Education,* 5(5): 3-32.

Jarvis, P. 2005. *Human Learning: A Holistic Approach*. New York Routledge.

Jarvis, P. 2008. *Democracy, Lifelong Learning and the Learning Society - Active citizenship in a late modern age Lifelong Learning and the Learning Society. Volume 3*. London: Routledge.

Jarvis, P. 2012a. Learning from Everyday Life. *HSSRP*, I(1), 1–20.

Jarvis, P. 2012b. Learning to be a person in society - Learning to be me. In Knud Illeris (Ed.) *Contemporary Theories of Learning - Learning theorists … in their own words.* NY: Routledge.

Jenlink, P., & Banathy, B. 2005. Dialogue – Conversation as Culture Creating and Consciousness Evolving. In Banathy, B. & Jenlink, P. M. (Eds.). *Dialogue as a Means of Collective Communication*, NY: Kluwer Academic Publishers, 4.

Jeronen, E., Kaikkonen, M., & Lindh, A. 2008. Investigating students', teachers' and parents' conceptions about environment, health and health education. *The New Educational Review*, 14(1): 102-118.

Jones, B. D., & Egley, R. J. 2007. Learning to Take Tests or Learning for Understanding? Teachers' Beliefs about Test-Based Accountability. *The Educational Forum*, 71.

Kaivola, T., & Åhlberg, M. 2006, Education for Sustainability in Academic

Teaching and Learning. In K. T. Raheem, P. Kupari & J. Lasonen (Eds.) E*ducational Issues for Sustainable Development in Africa - Working Papers 24*. Jyväskylä: Institute for Educational Research, University of Jyväskylä. 80-87.

Kaplinsky, R. 2011. Schumacher meets Schumpeter: Appropriate technology below the radar. *Research Policy*, 40: 193–203.

Kindleberger, H. L., & Richmond, A. S. 2012. Teaching constructivism constructively: What a novel idea! *The Researcher*, 24(2): 86-95.

Kitchenham, A. 2008. The evolution of John Mezirow's Transformative Learning Theory. *Journal of Transformative Learning*, 6(2), 104-123.

Kopnina, H. 2012. Education for Sustainable Development (ESD): the turn from 'environment' in environmental education?. *Environmental Education Research*, 18(5): 699-717.

Kopnina, H., & Meijers, F. 2014. Education for Sustainable Development (ESD). *International Journal of Sustainability in Higher Education*, 15(2): 188-207.

Kottak, C. P. 2016. *Window on Humanity: A Concise Introduction to General Anthropology, 7th Edition*. Columbus, OH: McGrawHill Education, USA.

Krishnamurti, J. 1981. *Why are You Being Educated?*. Chennai: Krishnamurti Foundation India.

Krishnamurti, J. 1991a. *Collected Works - Vol 1 - The Art of Listening*. Motilal Banarasidass, New Delhi.

Krishnamurti, J. 1991b. *The Awakening of Intelligence*. SF: Harper SanFrancisco.

Krishnamurti, J. 2006. *Whole movement of life is learning*. Brockwood Park, UK: KFT.

Krishnamurti, J. 2012. *Social Responsibility: A Selection of Passages from the Teachings of J Krishnamurti*. Ojai, CA: Krishnamurti Foundation America.

Kuhn, T. 1970. *The Structure of Scientific Revolutions. Second Edition, Vol I and II, Foundations of the unity of Science Vol II, No 2*. Chicago: International Encyclopedia of Unified Science, University of Chicago Press.

Lee, S. 2007. Educational Perspectives in the Ecological Paradigm - possibilities and limitations. *Asia Pacific Education Review*, 8(2), 194-204.

Lewin, K. 1948. Resolving social conflicts. In Gertrude W. Lewin (Ed.) *Selected papers on group dynamics*. New York: Harper & Row.

Lieux, E. M. 2001. A skeptic's look at PBL. In B.Duch, S. E. Groh, and D. E. Allen (Eds.) *The Power of Problem-Based Learning: A Practical 'How To' for Teaching Undergraduate Courses in Any Discipline*. Sterling, VA: Stylus Publishing, 223–235.

Littledyke, M., & Manolas, E. 2011. Education for Sustainability Pedagogy. In W. L. Filho (Ed.) *World Trends in Education for Sustainable Development, Environmental Education, Communication, and Sustainability Vol. 32.* Frankfurt: Peter Lang.

Lutyens, M. 2003. *The Life and Death of Krishnamurti*. Brockwood Park, UK: Krishnamurti Foundation Trust.

Malopinsky, L., Kirkley, J., Stein, R., & Duffy, T. 2000. *An instructional design model for online problem-based learning (PBL) environments: The learning to teach with technology studio.* Denver, CO: National Convention of the Association for Educational Communications and Technology.

Manfra, M. M. 2009. Action Research: Exploring the Theoretical Divide between Practical and Critical Approaches. *Journal of Curriculum and Instruction*, 3(1), 32-46. DOI: 10.3776/joci.2009.v3n1p32-46

Marshall, C. 2017. Montessori education: a review of the evidence base. *npj Science of Learning*, 2: 11. DOI: 10.1038/s41539-017-0012-7

Mayer, R. 2010. *Multi-media learning*. Cambridge: Cambridge University Press.

McWhinney, W. & Markos, L. 2003. Transformative education across the threshold, *Journal of Transformative Education,* 1(1), 16-37.

Meadows, D. H., Meadows, D.L., Randers, J., & Behrens III, W.W. 1972. *The Limits to Growth*. NY: Universe Books.

Mezirow, J. 1997. Transformative Learning Theory to Practice. *New Directions for Adult and Continuing Education* 74: 5-12.

Mezirow, J. 2000. *Learning as transformation: Critical perspectives on a theory in progress*. San Francisco, CA: Jossey-Bass Publishers.

MEA 2005. *Millennium Ecosystem Assessment, 2005. Ecosystems and Human Wellbeing: Synthesis*. Washington, DC: Island Press. http://millenniumassessment.org/documents/document.356.aspx.pdf

Mebratu, D. 1998. Sustainability and Sustainable Development: Historical and Conceptual Review. *Environmental Impact Assessment Review*, 18: 493-520.

Minstrell, J.A. 1989. Teaching science for understanding. In L.B. Resnick, & L.E. Klopfer (Eds.) *Toward the Thinking Curriculum: Current Cognitive Research*. Alexandria, VA: ASCD Books.

Mohammad Yasin, R., & Rahman, S. 2011. Problem Oriented Project Based Learning (POPBL) in promoting Education for Sustainable Development. *Procedia - Social and Behavioral Sciences*, 15: 289-293. DOI: 10.1016/j.sbspro.2011.03.088

Morawetz, D. 1974. Employment implications of industrialization in developing countries: A survey. *The Economic Journal,* 84(333): 491-542.

Naess, A. 1973. The shallow and the deep, long-range ecology movement. *Inquiry: an interdisciplinary journal of philosophy and the social sciences*, 16: 95-100.

NCTE 2014. *How Standardized Tests Shape — and Limit—Student Learning - A Policy Research Brief*. Urbana, IL: National Council of Teachers of English.

Nikolopoulou, A., Abraham, T., & Mirbagheri, F. 2010. *Education for Sustainable Development - Challenges, strategies and practices in a globalizing world*. New Delhi: Sage Publications India Pvt Ltd.

O'Sullivan, E. 2002. The project and vision of transformative learning. In E. O'Sullivan, A. Morrell, & M. O'Connor (Eds.) *Expanding the boundaries of transformative learning: essays on theory and praxis*. New York: Palgrave Mcmillan.

Palmer, J. A. 1998. *Environmental education in the 21st century: Theory practice, progress and promise*. New York: Routledge.

Pattanaik, B. K., & Dhal, D. 2015. Mobilizing from appropriate technologies to sustainable technologies based on grassroots innovations. *Technology in Society,* 40: 93-110.

Peffers, K., Tuunanen, T., Rothenberg, M. A., & Chatterjee, M. 2007. A design science research methodology for Information System research. *Journal of Management Systems,* 24(3): 45-78.

Pellegrini, U. 1979. The problem of appropriate technology. In A. De Giorgio &C. Roveda (Eds.) *Criteria for selecting appropriate technologies under different cultural, technical and social conditions*. New York: Pergamon Press, 1-5.

Perkins, D. 2009. *Making Learning Whole: How Seven Principles of Teaching Can Transform Education*. USA: Jossey-Bass.

Ram, A. & Leake, D. 1995. Learning, goals, and learning goals. In A. Ram & D. Leake, (Eds) *Goal-driven learning*. Cambridge: MIT Press.

Reeves, T. C. 2000. Socially responsible educational technology research. *Educational Technology*, 40(6): 19-27.

Reeves, T. C., Herrington, J., & Oliver, R. 2005. Design Research: A Socially Responsible Approach to Instructional Technology Research in Higher Education. *Journal of Computing in Higher Education*, 16(2), 97-116.

Rees, W. 1992. Understanding sustainable development. In B. Hamm, G. Zimmer, & S. Kratz (Eds.) *Sustainable Development and the Future of Cities.* Bauhaus, Dessau*:* Proceedings of an International Summer Seminar, 17-40.

Robinson, K. & Aronica, L. 2016. *Creative Schools*. New Delhi: Penguin, Random House.

Roy, A., Suhonen, J., & Vesisenaho, M. 2013. Children as agents for social change: A technology-supported pedagogical framework. In U. Härkönen (Ed.) *Reorientation of teacher education towards sustainability through theory and practice.* Joensuu: University of Eastern Finland, 157-171.

Roy, A., Ikonen, R., Kumar, K., & Keinonen, T. 2018. Sustainability Education Using ICT Supported Dialogue - Towards Transforming Adolescents' Perceptions of Alcohol in the Punjab, India. *Discourse and Communication for Sustainable Education*, 9(2), 4967.

Sahyadri Scribbles 2013. This matter of culture. *Sahyadri Scribbles - a newsletter by class 6*. Rajguru Nagar: Sahyadri School, KFI.

Sawyer, S.M., Afifi, R.A., Bearinger, L.H., Blakemore, S., Dick, B., Ezeh, A.C., & Patton, G.C. 2012. Adolescence: a foundation for future health. *Lancet*, 379(9826): 1630-1640.

Schmidt, H. G., Rotgans, J. I., Yew, & Elaine, H.J. 2011.The process of problem-based learning: What works and why. *Medical Education,* 45(8): 792–806. DOI: 10.1111/j.1365-2923.2011.04035.x.PMID 21752076.

Schumacher, E. F. 1973. *Small is beautiful*. London: Blond & Briggs.

Schroter, D. 2010. *Sustainability Evaluation Checklist*. Kalamazoo, MI: Western Michigan University. http://www.wmich.edu/evalctr/wpcontent/uploads/2010/06/SECrevised1.pdf

Schultz-Ross, R. A., & Kline, A. E. 1999. Using problem-based learning to teach forensic psychiatry. *Academic Psychiatry,* 23: 37–41.

Sipos, Y., Battisti, B., & Grimm, K. 2008. Achieving Transformative Sustainability Learning: Engaging Head, Hands and Heart. *International Journal of Sustainability in Higher Education*, 9, 68-86. DOI: 10.1108/14676370810842193.

Skinner, B. F. 1958. Teaching Machines. *Science*, 128(3330): 969-977.

Selinger, M. 2009. ICT in education: Catalyst for development, In T. Unwin (Ed.), *ICT4D*. Cambridge: Cambridge University Press, 206-248.

Smith, A., Fressoli, M., & Thomas, H. 2014. Grassroot Innovation movements: challenges and contributions. *Journal of Cleaner Production,* 63: 114-124.

Somekh, B., & Zeichner, K. 2009. Action research for educational reform: remodelling action research theories and practices in local contexts. *Educational Action Research*, 17(1), 5-21. doi: 10.1080/09650790802667402

Spiro, R. J., Coulson, R. L., Feltovich, P., & Anderson, D. K. 1988. *Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains. Tenth Annual Conference of the Cognitive Science Society*. Hillsdale, NJ: Erlbaum.

Stables, A., & Scott, W. 2002. The Quest for Holism in Education for Sustainable Development. *Environmental Education Research*, 8(1), 53-60. DOI: https://doi.org/10.1080/13504620120109655

Steinemann, A. 2003. Implementing Sustainable Development through Problem-Based Learning: Pedagogy and Practice. *Journal of Professional Issues in Engineering Education and Practice*, 129(4), 216-224.

Sterling, S. 2011a. *Sustainable Education Re-visioning Learning and Change – Schumacher Briefing*. Devon: Green Books Ltd.

Sterling, S. 2011b. Transforming learning and sustainability: sketching the conceptual ground. *Learning and teaching in higher education,* 5: 17-33.

TED India 2009. *Kids, Take charge*. TED Talk by Kiran Bir Sethi.

Thapan, M. 1991. *Life at School - An Ethnographic Study*. New Delhi: Oxford University Press.

Thapan, M. 2001. J. Krishnamurti (1895–1986). Prospects: the quarterly review of comparative education. *UNESCO: International Bureau of Education*, XXXI(2): 273-286.

Thomas, I. 2009. Critical Thinking, Transformative Learning, Sustainable Education, and Problem-Based Learning in Universities. *Journal of Transformative Education*, 7(3), 245–264. DOI: 10.1177/1541344610385753

Tooley, J. 2009. *The beautiful tree: A personal journey into how the world's poorest people are educating themselves*. New Delhi: Penguin.

Toynbee, A. J. 1946. *A Study of History*. London: Oxford University Press.

Toyama, K. 2015. *Geek Heresy – Rescuing social change from the cult of technology*. NY: Public Affairs.

UCS 1992. *World Scientists' Warning to Humanity*. Cambridge, MA: Union of Concerned Scientists.

Uhrmacher, P. 1995. Uncommon Schooling: A Historical Look at Rudolf Steiner, Anthroposophy, and Waldorf Education. *Curriculum Inquiry*, 25(4), 381-406. DOI:10.2307/1180016

UN 2010. Secretariat of the Convention on Biological Diversity and the UN Environment Program 2010: 3

UNESCO 2009. Executive Board Session 181 EX/INF.15 PARIS, 17 April 2009 Report by the Director-General on the UNESCO World Conference on Education For Sustainable Development and the Bonn Declaration.

UNESCO 2012. *Why language matters for the Millennium Development Goals,* Bangkok: Asia and Pacific Regional Bureau for Education. http://unesdoc.unesco.org/images/0021/002152/215296E.pdf

UNESCO 2014. *Shaping The Future We Want. UN Decade of Education for Sustainable Development (2005-2014) FINAL REPORT*. Paris: Section of Education for Sustainable Development, Division for Teaching, Learning and Content, UNESCO.

UNESCO 2018. UNESCO, Bangkok. Asia and Pacific Regional Bureau for Education. ICT in education. https://bangkok.unesco.org/theme/ict-education van den Akker, J. 1999. Principles and methods of development research. In J. van den Akker, N., Nieveen, R.M., Branch, K.L., Gustafson, & T. Plomp, (Eds.), Design methodology and developmental research in education and training (pp. 114). Netherlands: Kluwer Academic Publishers.

Unwin, T. 2009. *ICT4D: Information and Communication Technology for Development*. Cambridge: Cambridge University Press.

van Reijswoud, V. 2009. Appropriate ICT as a tool to increase effectiveness in ICT4D: Theoretical Considerations and illustrating cases. *Electronic Journal of Information Systems in Developing Countries*, 38(9): 1-18.

Valsiner, J. 1988. *Developmental Psychology in the Soviet Union*. Bloomington: Indiana University Press.

Veer, V. D. R., & Valsiner, J. 1991. *Understanding Vygotsky: A Quest for Synthesis*. Cambridge, MA: Blackwell.

Vernon, D.T., & Blake, R. L. 1993. Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine*, 68: 550–563. DOI: 10.1097/00001888199307000-00015.

Vygotsky, L. 1978a. Interaction between learning and development. *Readings on the development of children,* 23(3): 34-41.

Vygotsky, L. 1978b. *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

WCED 1987. *Our Common Future, The Brundtland Report*. Oxford, UK: Oxford University Press.

Weston, A. 1985. Beyond Intrinsic Value: Pragmatism in Environmental Ethics. *Environmental Ethics*, 7: 321-339. http://www.cep.unt.edu/5000/Weston%20EE%20Beyond.Intrinsic%20Value.pdf

Wheeler, S. 2013. *Collaborative Learning online communities*. Plymouth, UK: University of Plymouth.

WHO 2003. *Skills for health: skills-based health education including life skills: an important component of a child-friendly/health-promoting school, Information series on school health document 9*. Geneva: World Health Organization.

Willard, T. 2009. *Social networking and governance for sustainable development*.

Winnipeg: IISD. http://www.iisd.org/sites/default/files/pdf/2009/social_net_gov.pdf

Wood, DF 2003. ABC of learning and teaching in medicine Problem based learning. *British Medical Journal, 326(7384): 328-330*. DOI: 10.1136/bmj.326.7384.328.

Wygant, D. 2015. *Nandini Sood - India Global Catalyst*. *Story told by David Wygant*. http://icandfc.blogspot.com/

Yewa, E.H.J. & Gohb K. 2016. Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education,* 2(2): 75-79.

Zemsky, R. & Massy W.F. 2004. *Thwarted innovation: What happened to e-learning and why. Final Report for The Weatherstation Project of The Learning Alliance at the University of Pennsylvania*. Philadelphia: University of Pennsylvania http://www.irhe.upenn.edu/Docs/Jun2004/ThwartedInnovation.pdf

APPENDICES

APPENDIX 1.

Questionnaire Pre-test Questionnaire: Translated from Swahilii
First Name ……..…….Surname…..… ……School……
Class……Age …..
Gender - Male [ ] ; Female [ ]

Part A: Environmental Conservation and forest burning (Tick the right choice in the bracket)

1. Have you ever witnessed a forest fire? Yes [ ]; No [ ]
2. How often have you witnessed a forest fire? Each year during a dry season [ ] Sometimes during dry season [ ]; Never at all [ ];
3. Have you ever been prohibited to burn forest by any authority? Yes [ ] No [ ]
4. Have you ever been into the forest around your area? Yes [ ] No [ ]
5. Was there anything particular that you like in the forest? ……
6. What you did not like while in the forest? ……..……..

Part B: General Questions on Environmental conservation

7. Is the environment around you in good condition Yes[ ] No [ ]
8. Have you ever heard about environmental protection and especially Forest protection? Yes [ ] No [ ].
9. Which activities among the following have you participated/done?
   Planting Trees in my village[ ]; Planting trees at School[ ]; Stopping fire in a burning forest[ ] ;
   Cutting natural trees for firewood [ ]; Picking fruits in the forest [ ] ; Burning a forest[ ]
10. Should we conserve the forest around your place? Yes [ ] ; No [ ]
11. Who do you think should do environmental conservation work? Everyone [ ]; Only Parents [ ]; Experts [ ]
12. Do you think students like you can help conserve the environment? strongly agree [ ]; Agree[ ]; Neither agree, nor disagree[ ]; strongly Disagree [ ]; disagree [ ] 13. Would you like to support conservation efforts in your area? Strongly agree [ ]; Agree [ ]; Neutral [ ]; Disagree [ ]; Strongly Disagree[ ]
13. How important is it to protect the environment?
    Very Important [ ]; Important [ ]; Very Unimportant [ ]; Unimportant [ ]; neither Important nor Unimportant [ ]
14. In general, what would you say that you like forests : Like a lot [ ]; Like a little[ ]; Neither Like Nor
    Dislike them[ ]; Dislike a little [ ]; Totally dislike them[ ]
15. Do you feel that forests currently occupy land which should be used for agricultural purposes**?** Yes [ ] No [ ]
16. How do you get environmental protection education, especially related to the effects of forest burning?

……
…….....……..

APPENDIX 2.

Post-Test Questionnaire : Translated from Swahilli

First Name …….……..... Surname…….....…….
School…….....……
Class……..Age …….. Gender Male [ ] ; Female [ ]

Part C: About the Video that you Watched (Test group only)

1. Was the video meaningful to you? Yes [ ]; No[ ]

2. What did you learn from the video?
   ……
3. Have the video assisted you to understand the environmental problems better now? Strongly agree [ ]; Agree [ ]; Neutral [ ]; disagree [ ]; Strongly Disagree [ ]
4. Is there anything you did not agree from the video?
   …….....
   .....……
5. After watching the video, do you think using video can be an efficient method in providing environmental education than other Medias in the society? Yes [ ] , No [ ]

Part B. About the environment Conservation and your personal opinions (For all groups)

1. Were forests EVER more widespread in around your area than they are today? Yes [ ] , No [ ]
2. Why do you think people burn forests? Farming preparations [ ]; To chess Animals [ ]; To bring new pasture for cattle[ ]; Lack of Environmental Education[ ]; I do not know [ ]

3. Forests could provide a number of potential benefits to Tanzania as a whole. How would you personally rank these 5 potential benefits of forests in order of importance (Which do you think is the most important benefit of forests; and which is the second most important; the third…; the fourth; and the fifth).

Some identified potential benefits of forests	**Score**				
Provides Fire woods and charcoal for cooking	1	2	3	4	5
Business Activity like selling logs and timber and providing jobs	1	2	3	4	5
Nature conservation	1	2	3	4	5
Providing attractive landscape, nice Scenery, etc.	1	2	3	4	5
Climate Change protection	1	2	3	4	5

4. Rank the human activities that contribute much on environmental destruction, especially forests burning. Use score 1-5 with the highest number referring to the fewer contributors and the lowest number to the highest contributor.

Human activities	**Rank**				
Search for energy (charcoal and firewood)	1	2	3	4	5
Hunting animals	1	2	3	4	5
Cattle keeping	1	2	3	4	5
Mining	1	2	3	4	5

5. Rank the following medias according to their contribution in providing environmental education to the society that you belong.(1-most used,2-can be the second used 3-the third etc.)

Media	**Ranking**				
TVs	1	2	3	4	5
Radio	1	2	3	4	5
News papers	1	2	3	4	5
Environmental related magazines	1	2	3	4	5
Watching videos and films	1	2	3	4	5
Internet	1	2	3	4	5

6. In which subject(s) you have learned about the environmental Conservation before?
7. Physics [ ], Geography [ ], History [ ], Civics [ ], English [ ], Biology [ ], Agriculture Science [ ].
8. As a young generation, what should be your responsibility (or responsibilities) in environmental protection?
   ……
   …….....……
9. What has been your experience regarding burning of forest after this project?
   ……
10. How can we protect the forest in our area?
    ……
    ....……....
11. What are the effects of environmental destruction that are caused by forest burning?
    …….....……
    .....……

APPENDIX 3

[Translated from Punjabi]
PRE-TEST QUESTIONNAIRE – SCHOOLS (PUNJAB, INDIA)

Name	**School**
Class Age	☐ Male ☐ Female

Q1. How well do you understand the following languages?

	I can read well	**I can write well**	**I can understand well**
a. Punjabi			
b. Hindi			
c. English			

Q 2. What do the following English words mean?
a. Sleek ……
b. Pervasive ……

	I strongly agree	**I agree**	**Neither gree, Nor disagree**	**I disagree**	**I strongly disagree**
3. In Punjab, it is common to drink alcohol.					
4. People drink in parties and at home as well.					
5. I know someone who drinks everyday.					
6. I have seen a heavily drunk person.					
7. I know about someone who died because of alcohol.					
8. Children can play a role in ending social problems.					
9. People are responsible for their own problems.					
10. Pub & dance clubs encourage habitual drinking.					
11. Now a days, more women drink than olden times.					

	I strongly agree	I agree	Neither gree, Nor disagree	I disagree	I strongly disagree
12. People honestly share if they have a family member who is an alcoholic.					
13. Punjab is one of world's most drinking states.					
14. One should try alcohol sometime.					
15. Two pegs a day are not harmful.					
16. Alcohol enhances the activity of reproductive organs.					
17. I have read about alcohol in my school books.					
18. Alcohol is a drug					
19. Alcohol is more harmful for an old person.					
20. Want to drink repeatedly is a mental disorder.					
21. I can agree to my favorite celebrity's / sportsperson's advice.					
22. It is acceptable to harm others for personal gains.					
23. Media always tells the truth.					
24. Media plays a role in decreasing social problems.					
25. Media plays a role in increasing social problems.					
26. Songs, movies and advertisements play a role in our lives.					

27. What kind of media do you prefer to use? (Choose one)

	A. TV		**B.** Radio
	C. Books		**D.** News
	E. Internet		

28. Who makes advertisements? (Choose one or two)

	(A) Movie actors		**(B)** Models
	(C) Companies		**(D)** Advertising Agencies
	(E) Product Experts		**(F)** Players

29. Which advertisement do you like most and why?
Which one ………………….. ………………….. ………………………
Why …………………..………………….. ………………………………

30. What kind of role do songs, movies and advertisements play in our lives?
…………………..…………………..…………
……..…………………..…………………..……………………...
.........................…………………..…………………..…………………..…………………..

31. Who do you think responsible for uprooting social problems?

	A. Government		**B.** Parents
	C. Experts		**D.** All of us

32. Which of the following is true:

	Amygdala is responsible for understanding long term effects of one's behavior.
	Pre-Frontal Cortex is responsible for understanding long term effects of one's behavior.
	Memory is responsible for understanding long term effects of one's behavior.
	Temporal Lobe is responsible for understanding long term effects of one's behavior.

33. Beer is (harmful/harmless) …………. Because ………………………..

34. How should one watch an advertisement?
……………………..………………………..………………………..……………………..
……………………..……………………..……………………..................................

35. How many years does human brain take to develop fully?

	A. 0-10		**B.** 10-15
	C. 18 - 21		**D.** 25-30

36. How does alcohol affect a young person?

APPENDIX 4

[Translated from Punjabi]
POST-TEST QUESTIONNAIRE – SCHOOLS (PUNJAB, INDIA)

Name	**School**
Class Age	☐ Male ☐ Female

Q1. How well do you understand the following languages?

	I can read well	**I can write well**	**I can understand well**
a. Punjabi			
b. Hindi			
c. English			

Q 2. What do the following English words mean?

a. Sleek ……
b. Pervasive ……

	I strong-ly agree	**I agree**	**Neither agree, Nor disagree**	**I disagree**	**I strongly disagree**
3. In Punjab, it is common to drink alcohol.					
4. People drink in parties and at home as well.					
5. I know someone who drinks everyday.					
6. I have seen a heavily drunk person.					
7. I know about someone who died because of alcohol.					
8. Children can play a role in ending social problems.					
9. People are responsible for their own problems.					

	I strongly agree	I agree	Neither agree, Nor disagree	I disagree	I strongly disagree
10. Pub & dance clubs encourage habitual drinking.					
11. Now a days, more women drink than olden times.					
12. People honestly share if they have a family member who is an alcoholic.					
13. Punjab is one of world's most drinking states.					
14. One should try alcohol sometime.					
15. Two pegs a day are not harmful.					
16. Alcohol enhances the activity of reproductive organs.					
17. Alcohol can cause irreparable damage to a person.					
18. Alcohol is a drug					
19. Alcohol is more harmful for an old person.					
20. Want to drink repeatedly is a mental disorder.					
21. I can agree to my favorite celebrity's / sportsperson's advice.					
22. It is acceptable to harm others for personal gains.					
23. Media always tells the truth.					
24. Media plays a role in decreasing social problems.					
25. Media plays a role in increasing social problems.					
26. Songs, movies and advertisements play a role in our lives.					

27. What kind of media do you prefer to use? (Choose one)

	A. TV		**B.** Radio
	C. Books		**D.** News
	E. Internet		

28. Advertisements are ……

29. How should one watch an advertisement?
…..……..……..……..……
…..……..……..……..……

30. Which of the following is true:

	Amygdala is responsible for understanding long term effects of one's behavior. (Correct Answer)
	Pre-Frontal Cortex is responsible for understanding long term effects of one's behavior.
	Memory is responsible for understanding long term effects of one's behavior.
	Temporal Lobe is responsible for understanding long term effects of one's behavior.

Beer is (harmful/harmless) ……. Because ……..

Name three diseases that are caused by alcohol
1. …….. 2. ……..
3. ……..

33. How many years does human brain take to develop fully?

	A. 0-10		**B.** 10-15
	C. 18 – 21		**D.** 25-30 (Correct answer)

34. How does alcohol affect a young person?
……..……..……..……..……
……..……..……..……..……..

---- Following Questions Were Asked From Experimental Group Only ---

35. I watched the video about alcohol at school (Yes / No)

36. I read the book about alcohol at school (Yes / No)

	I strongly agree	**I agree**	**Neither agree, Nor disagree**	**I disagree**	**I strongly disagree**
37. I came to know many new things about alcohol from the video about alcohol.					
38. I came to know many new things about alcohol from the book about alcohol.					
39. I feel that I understand about alcohol much better now.					
40. I liked this method of learning about a social problem through a video, book and project.					
41. I talked about this project or video or book with a person outside school.					
42. I talked about this project or video or book with a person outside school who drinks alcohol.					
43. Endorsement of products by actors/actresses and sports personalities is a good thing.					

44. Which parts of the video about alcohol impressed you most?

ARTICLES

ARTICLE I

Roy, A., Kihoza, P., Suhonen, J., Vesisenaho, M. & Tukiaianen, M. 2014. Promoting Proper Education for Sustainability: An Exploratory Study of ICT Enhanced Problem Based Learning in a Developing Country. International Journal of Education and Development using Information and Communication Technology, 10(1), 70-90.

ARTICLE II

Roy, A., Ikonen, R., Keinonen, T. & Kumar, K. 2017. Adolescents' Perceptions of Alcohol. Health Education, 117(3), 280-296. doi:10.1108/HE-05-2016-0021.

ARTICLE III

Roy, A., Ikonen, R., Kumar, K. & Keinonen, T. 2018. Sustainability Education using ICT-Supported Dialogue - Towards Transforming Adolescents' Perceptions of Alcohol in the Punjab, India. Discourse and Communication for Sustainable Education, 9(2), 49-67.

AMIT ROY

Unsustainability starts not with unsustainable actions; but with unsustainable thinking. Our thoughts are the deeper causes of our actions and behaviors. Therefore, the aim of Education for Sustainability should be transforming thoughts and perceptions. This thesis presents CASC framework to provide Transformative Education for Sustainability. Ecological paradigm based CASC uses appropriate ICTs along with constructivist pedagogy to help students step out of (or negate) unsustainable thinking.

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