TOWARDS ACHIEVING EDUCATION FOR ALL: REALIZING SUSTAINABLE DEVELOPMENT GOALS THROUGH SPACE SYSTEMS AND ARTIFICIAL INTELLIGENCE

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Abstract

Education for All project of Nanritam, an Indian non-profit, is an ambitious yet necessary idea born out of the difficulties faced during COVID-19 pandemic. One of its main projects is the Filix School established in 2014 in a remote rural and economically backward area of Purulia, West Bengal, India with the aim of providing holistic, equitable and quality education to the socio-economically challenged children of surrounding area. Filix School has very successfully implemented a unique research-based experiential pedagogy over the past decade, significantly improving the academic outcomes of these children. However, the pandemic meant that the school had to provide education by digital means. Thus, ideated that the education provided to the students of Filix school could be leveraged to a larger community. Co-created by school students under supervision, the Filix Innovation Hub has created an artificial intelligence enabled system that provides education to remote areas, including through space systems. Whereas the project is based in India, it may be customized for other parts of the world. This project bolsters the idea that excellent and contextualized quality education with the help of digital transformation can be instrumental to achieve the United Nations' Sustainable Development Goals. For this project, Nanritam has partnered with a non-profit space policy initiative - ACES Worldwide, reiterating the importance of interconnectedness and the need of space systems in communications between and with remote areas.

Keywords: quality education; UN sustainable development goals; space systems; partnerships; digital technology

1. Introduction

In June 2024, Antarikchya Pratisthan Nepal (APN), a non-profit organization which is at the forefront of Nepal's space industry, and Navodaya School, Nepal entered into a Space and Sustainability Compact Agreement for APN's Slippers to Satellite program. Under this program, 10 middle school children from remote areas are involved by APN in manufacturing and planning of Nepal's indigenous small satellite on disaster management and climate action and these students would also be provided overall education at Navodaya School. One of the Sustainable Development Goals this project helps in achieving is SDG 4 (Quality Education). While idea of the Slippers to Satellite program was conceived by APN, the Space and Sustainability Compact Agreement helped the program in aligning with UN's Sustainable Development Goals. This Space and

Sustainability Compact Agreement is a part of Space and Sustainability Compact Agreement Initiative (SSCI)[i] of Alliance for Collaboration in the Exploration of Space - ACES Worldwide (ACES Worldwide), a non-profit organization that aims to strengthen international alliances by supporting equitable space policies, laws, regulations, sustainability, safety, education, training and capacity-building.

Relevance of space technology, often complemented with artificial intelligence, in achieving sustainable development on earth is a proven fact and has been recognized in several UN documents. In fact, in 2015, when States adopted the Sustainable Development Goals to be achieved by 2030, they also noted importance of earth observation and geo-spatial information in achieving such goals. Later in 2021, UN General Assembly adopted the Space2030 Agenda which recognizes space as a driver for sustainable development. Space technology can be useful for remote sensing, navigation, broadcasting, communications, etc and can provide useful solutions to developmental needs on earth. Recognizing the role of partnerships in implementing the use of space technology for sustainable development on earth, ACES Worldwide, a not-for-profit entity, created the Space and Sustainability Compact Agreement Initiative which provides for partnership between space providers and end-users with certain specific goals realizing which would be taking steps towards sustainable development. While space technology can be driver of achievement of all the 17 UN Sustainable Development Goals and ACES's SSCI deals with realization of all the 17 SDGs, in this paper we deal with SDG 4 (Quality Education), which is an important goal for development. SDG 4 can be realized through a variety of approaches – while the approach by APN of bringing meritorious students to institutions and facilities providing quality education is an effective one; another approach is to ensure educational facilities reach the remotest corners of a country. The second approach of bringing educational facilities to young children in remote areas is the one which has been adopted by Nanritam, a non-profit organization incorporated in India.

Nanritam began a movement of Education for All (EFA), motivated by the opportunity of wave of digital transformation during the recent pandemic to address the widespread inequality in receiving education in remote areas, that was further exposed by the pandemic. Nanritam's Filix school, located in Para, Purulia, West Bengal, India was already committed to providing quality education in education to the young local children of surrounding rural and socio-economically backward area. However, the importance of providing quality education in other remote and rural areas of India was realized and thus was born the EFA project. While providing the quality education to underprivileged population in remote areas is a difficult task, this can be achieved through communications networks, space systems and artificial intelligence.

This EFA project is important and relevant as according to World Bank 2022 data, only 76% of the adult Indian population is literate.[ii] Though Nanritam's EFA project aims to provide education to young children, the data on adult literacy provides an idea about state of literacy in the country. Further, studies published under Annual Status of Education Report[iii], have indicated that in rural India, less than 50% students in grade 5 can read text of grade 2, while less than 30% children of grade 5 can do simple mathematical division. In recent decades though there has been rise in literacy rates, much more needs to be accomplished to ensure quality education for all. A study[iv], published by a joint effort of UNESCO, World Bank, USAID, UNICEF and Bill and Melinda Gates foundation, reported that "even before COVID-19, the world was facing a learning crisis, with nearly 6 out of every 10 ten-year-olds in low- and middle-income countries suffering from learning poverty—meaning they were unable to read and understand a simple story."

Thereafter, the COVID-19 pandemic school closures and disruptions have deepened the crisis, sharply increasing learning poverty and exacerbating the inequalities in education". EFA project, essentially aims to alleviate this

learning poverty by utilizing best in class technology to unlock and enable the full potential of this vast human resource.

As the EFA project is customizable according to situational needs of other countries too, this project is an important stepping-stone for "ensure inclusive and equitable quality education for all" (UN Sustainable Development Goal 4). As the EFA project relies on interconnectedness of networks for achieving SDGs, it aligns with the goals of ACES Worldwide. ACES Worldwide's SSCI, ACES Worldwide encourage a space provider and a potential space user to enter into a non-binding agreement on how space systems can help in achieving SDGS and thus the agreement contains, *inter alia,* the type of space systems used, specific space application to be provided parties to the Agreement, projected future use and goals and SDG Goals addressed. Whereas, ACES Worldwide usually only facilitates entering into such Space and Sustainability Compact Agreement, exceptionally it has agreed to enter into a Space and Sustainability Compact Agreement with Nanritam considering the innovative and important work carried out by Nanritam towards EFA, including creation an artificial intelligence enabled system that provides education to remote areas. Nanritam's education technology platform includes teaching foundational literacy and numeracy to the educators and assessment of students on the same by use of Good old fashioned artificial intelligence (GOFAI). The platform is also training a specified generative pre-trained transformer (GPT) model using the educational materials developed at Filix school and using technologies such as retrieval augmented generation, This project is an endeavor to fulfil the literacy needs of the children in remote areas and thus aims to impart education for all and to identify how the existing space systems, particularly space communications systems, can be improved to further address these needs.

2. Digitalisation for achieving SDGs in the context of UN and ITU

The UN document "Transforming our world: the 2030 Agenda for Sustainable Development" that establishes the 17 SDGs, recognizes that "[t]he spread of information and communications technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies, as does scientific and technological innovation across areas as diverse as medicine and energy."[v] The International Telecommunication Union (ITU), the United Nations specialized agency for telecommunications/ICTs, plays an important role in communications technology and global interconnectedness thus plays an important role in realization of SDGs. The ITU's Connect 2030 Agenda, revised in 2022, also recognizes "the need for broadband connectivity for sustainable development" and "that the crisis caused by the COVID-19 pandemic has not only highlighted the critical role of telecommunications/ICTs for the continued functioning of societies but has also brought to the fore the digital inequalities between and within countries."[vi] This interconnectedness, especially when it comes to remote areas, has heavy reliance on outer space infrastructure and technology. According to the UN Office for Outer Space Affairs, "by gaining access to space technologies, developing countries can achieve a rate of gross domestic growth of 7% (or more for the least developed countries), along with higher levels of economic productivity through diversification, technological upgrading and innovation."[vii] While India has a robust space program which has helped in its developmental activities and goals, much more efforts are needed for all pervasive realization of the SDG Goals through space applications and technology. Further, space technology is one of the important and critical tools and infrastructures that contribute significantly to the implementation and monitoring of 2030 SDG goals. Space technology and applications are typically cost-effective and provide for effective service to rural and remote regions and space systems can excel in areas such as broadcasting, communications and networking. Likewise, space-based Earth Observation (EO) are critical

to services such as the management and protection of ecosystems, improved water-resource management, and a better understanding of the water cycle.[viii] The 2016 Dubai Declaration noted, "in order to strengthen socioeconomic development, an integrated approach is required among the space sector and other sectors, including environment and climate change, health, water, information, communications technology, and management of resources, to better understand and meet the needs of end users and society at large."[ix]

The Space 2030 Agenda stresses the following: "We emphasize that space tools are highly relevant for the attainment of the global development agendas, in particular the 2030 Agenda for Sustainable Development and its goals and targets, either directly, as enablers and drivers of sustainable development, or indirectly, by providing essential data for the indicators used to monitor the progress towards achieving the 2030 Agenda and the Sendai Framework for Disaster Risk Reduction 2015–2030 and the commitments by States parties to the Paris Agreement."[x]

The Space 2030 Agenda also states: "We also aim to leverage to a greater extent new, innovative technologies, such as space technologies and their applications, to contribute to improved delivery of the mandates of the United Nations as a whole."[xi] Further, in the same lines, the present zero draft dated 17 July 2024 of the Pact for the Future notes that the heads of the States and governments commit to strengthening digital cooperation and harnessing the potential of science, technology and innovation for the benefit of all humanity and accelerate the use of science and digital technologies to help us to realize the 2030 Agenda.[xii]

In line with SDG Goals, Space 2030 Agenda and ITU's Connect 2030, ITU's Strategic Plan for 2024- 2027, also believes that as the world is looking for solutions and moving towards sustainability, the digital solutions should take the center stage where no one is left behind. The two strategic goals of the ITU are universal connectivity and sustainable digital transformation. As we focus particularly on the second goal, we believe in fostering "equitable and inclusive use of telecommunications/ICTs to empower people and societies for sustainable development."[xiii]

3. Achieving Education for All through expertise, technology and collaboration

Nanritam's Education for All project aims to achieve its goals through expertise, collaboration and use of technology. The EFA project believes that best quality education should be imparted equitably and should reach every corner possible. Nanritam's EFA is a play-based, hands-on pedagogy for children aged 3-8 with sessions on Foundational Literacy and Numeracy, social skills, conversational English and holistic development.[xiv] The project is being expanded to include hands-on, in-class-demonstratable Foundational Math and Science sessions for children between ages of 8-16 years. While quality education is the aim, the students are taught learning as a fun activity and their progress is regularly monitored through assessments. The uniqueness of this EFA project is that it plans to work on a minimum cost model.

The EFA project aims to improve the existing education system to align with tomorrow's needs and expand productive capacities for sustainable development and embrace new technologies. Thus, the project works towards realization of SDG 4 (quality education). It particularly focuses on SDG 4.6 ("By 2030 ensure maximum men and women achieve literacy and numeracy"; SDG 4.4 ("Substantially increase the numbers with skills for employment and entrepreneurship"); SDG 4.C ("By 2030 substantially increase the supply of qualified teachers even through international collaboration for such training"). The project also addresses SDG Goal 8 (decent work and economic growth), among other developmental goals. Last but not least, EFA program sincerely believes and pursues SDG goal number 17, that is collaboration at all levels. On one hand the

program partners with experts on the supply side for technology and content and on the other hand, partners with various organizations rooted in the community with direct access to children for fast proliferation of those knowledge and technology.

The EFA project uses the following innovative approaches in order to make real and sustainable change:

(a) It relies on local population of remote areas to spread education there. In order to reach every remote corner, it is not sufficient to depend on only highly qualified and formal teachers.

(b) Hence, it is important to identify the existing and potential dedicated and passionate educators and/ or change maker clusters and networks alreadt existing in the remote areas. These people may range from formal school teachers and community teachers to large institutional community volunteers. Nanritam's EFA has identified and trained nearly 2,200 people to spread education, thus impacting more than 65,000 children in 5 states in India.

(c) For a sustainable solution, it is important to equip, empower and train these educators by leveraging the world class proven pedagogy and body of knowledge tested and perfected at the Filix school. The educators can access this gamut of knowledge and pedagogy through an educational technology platform developed. The technology platform imparts education on foundational literacy and numeracy such as addition, multiplication, opposite words, position words, rhyming words, vowels, etc. The platform is also training a large language model based on curriculum developed at Nanritam's Filix school.

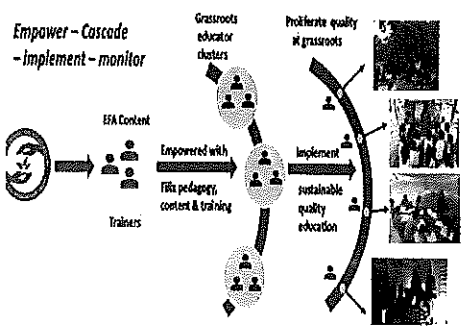
(d) Filibot is an artificial intelligence enabled Ed Tech platform, co-created by bright young minds at Filix school under the supervision of their teachers and experts. The Filibot empowers the EFA program and builds connection between several stakeholders including the students.

(e) As of now, using existing telecommunication network in India, Filibot provides a user-friendly experience for students and provides teachers with valuable insights into assessments and progress tracking.

The Filibot's features includes interactive and dynamic Learning through Filibot's well designed executable lesson plans, contents and visuals together with ChatBot Sequence Design. It also allows users to explore subjects by asking questions to the chatbot. Further, Filibot monitors students' performance and provides grade insights. It also aims to use generative artificial intelligence by training large language model with the gamut of knowledge developed at the Filix school.

This EFA program is a significant step towards India's National Initiative for Proficiency in Reading with Understanding and Numeracy (NIPUN) Bharat Mission[xv] which is a key feature of realization of National Education Policy 2020 (NEP) which aims to achieve universal foundational literacy and numeracy in primary schools by 2025. The EFA is also a major step towards Digital Infrastructure for Knowledge Sharing (DIKSHA) of NEP.[xvi]

Empower grassroots educators with Filix's proven activity based FLN pedagogy



4. Partnership between Nanritam and ACES Worldwide

Nanritam was established in 2002 by a group of professionals who were inspired by the teachings of Swami Lokeswarananda, revered monk of Ramakrishna order. Nanritam has four verticals: health, education, support to agri-livelihood and nutrition and health of developmentally challenged children. Starting just with a handful of dedicated individuals in

2004, today the organization has around 100 employees and 4000 volunteers, rooted in the community. Nanritam's most important facilities include the Lokeswarananda Eye Foundation hospital and Filix School. Inspired by Swami Vivekananda's words that "All knowledge is within the individual, it requires only an awakening", Filix school has been doing wonders in educating the local population in Para, Purulia, West Bengal with its national level secondary and higher secondary examination results being outstanding and is also carrying out community outreach of education for all. An independent evaluation of Nanritam's Education for All program in 2023 found the pedagogy used by Filix school and its community outreach to be extraordinarily unique and that there was an overall positive impact on fundamental literacy and numeracy skills among children enrolled in Nanritam's EFA program[xvii]

ACES Worldwide' mission is to strengthen international alliances by supporting equitable space policies, laws, regulations, sustainability, safety, education, training and capacity-building and engaging in optimizing humanity's potential for space exploration and utilization--both on and beyond the Earth.[xviii] ACES Worldwide endeavors to strengthen and promote international space cooperation and establish new alliances between diverse educational, technological, civil and entrepreneurial organizations. As discussed before, Space and Sustainability Compact Agreement Initiative that caters to sustainable development through space technology via these compact agreements.[xix]



For the SSCI Program, these are the following steps that ACES Worldwide has followed/ is following:

1. Established a Board of Directors and Global Advisory Committee of Space Experts including 30 people representing 18 countries in all continents of the world.
2. Created a pilot project for South Asia and begun signing up new "users" of space systems in this region with Compact Agreements.
3. Started discussions with the African Union Space Agency, the Secretary General of the UN Regional Centre for Space Science and Technology Education for Latin American and the Caribbean and others with regard to possibly creating pilot projects for Compact Agreements in other parts of the "Global South". Thus, SSCI aims to become a global initiative with widespread institutional support.
4. Started efforts to work with the U.N. Office for Outer Space Affairs and U.N. Committee on the Peaceful Uses of Outer Space to perfect this process. ACES Worldwide hopes that these efforts will result in perfecting a suitable and mature Compact Agreement document format and an official Registry of these Compact Agreements.

While ACES Worldwide and Nanritam is partnering at the moment for Nanritam's EFA program, the partnership may also extend to agricultural development and health, in the future. ACES Worldwide would be providing technological support with regards to space infrastructure to the said EFA project.

One of the ways EFA program's reach to remote areas can be accelerated is through use of space systems. A similar experiment was experiment for spread of education was earlier carried out through India's EDUSAT. Earlier, in 2004, Indian Space Research Organisation had launched EDUSAT program (satellite GSAT-3) under which the first Indian satellite was built exclusively for education sector.[xx] The said program enabled an interactive distance learning system with virtual classrooms and non-formal education in remote areas. The EDUSAT

program was conceived as need was realized for specialized high frequency band such as Ku band being used for such distance education, so that the regular telecommunication sector is not burdened and this program required powerful transponders. Several universities, higher secondary and secondary school boards, state education departments, several schools were users of the program. GSAT 3 was decommissioned in September 2010. Despite its noble objectives, EDUSAT program failed to achieve its objectives due to deficiencies in planning on network connectivity, content generation and for failure to have a robust management structure.[xxi] However, today with carefully made course content generated by Filix school empowered by artificial intelligence, such experiment to take classrooms to remote areas has more chances of being successful. However, as regular communication network may not be available in remote areas, communication in these areas can be established by next generation high throughput communication satellite (HTS). HTS satellites, unlike traditional satellites, use multiple narrow spot beams which focus their power and bandwidth on smaller and targeted areas, providing these areas with better signal quality and these satellites use higher frequency bands such as Ka band and V band. India launched its first HTS broadband service in 2022 with GSAT-11 and GSAT-29 and these satellites can bridge the digital divide and address connectivity gaps in remote areas.[xxii] Use of HTS would be important for EFA, though such implementation needs proper planning and discussion

5. Conclusion

This project is an endeavour to identify the needs of the target end- users of space systems especially in remote areas. While working on SSCI project, ACES Worldwide realized that one of the reasons space systems are not able to contribute its full potential to sustainable development, is because the space providers, both governmental and non-governmental, are unaware of the needs of the end-users. Hence, the partnership of ACES Worldwide with Nanritam, is also an endeavour to identify the needs at ground level for ensuring education for all and how space systems can be improved to address these needs.

Further, ACES Worldwide's SSCI initiative a way to identify and perfect what might be called "best practices" in the use of space systems forward and create incentives to achieve what the U.N. General Assembly has indicated as key goals for the future in the adopted document in 2012.[xxiii] ACES Worldwide believes that rather than seeking new space policies or creating new international agreements or provisions for the long term sustainability of space, the new mechanism of Space and Sustainability Compact Agreements can become a new and important international tool to move forward new international space policy agreements and international cooperation and sustainable development. In this endeavour, we believe education for all is an important step for realisation of SDGs. We hope that ACES Worldwide can help the Nanritam's EFA undertaking in spreading education in remote areas. This effort in the long run has potential to impact not only children in India and can be adopted to be implemented in other countries too, including the rest of countries of South Asia and in countries around the world.

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