Nanoscience
&
Technology

Education for Sustainable Development Goals

Teaching & Learning Objective Handbook

Education for

Sustainable Development Goals

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By 2030, ensure that all learners acquire knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non- violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

Source: United Nations, 2015

FOREWORD

The Sustainable Development Goals (SDGs) introduced in the year 2015 is a follow up of the Millennium Development Goals (MDGs) implemented in 2000. It is a vital framework, which calls attention to meet the challenges towards creating a sustainable future with an impressive target of **"Leaving No One Behind"**. Achievement of SDGs calls for collective efforts of stakeholders from Government, Non-governmental organizations, Higher Educational Institutions, Multi-national agencies, Civilian organizations, and Public.

While the countries around the globe are seriously addressing several issues on the way towards achieving the SDGs, it is becoming evident that these goals cannot be achieved in complete if the younger generation are not made aware of the goals. The best possible means of reaching the youth is through the curriculum, either in schools or in universities. The United Nations has called upon the countries to incorporate the SGDs into the existing curriculum, aligning the teaching and learning aspects in line with the goals. JSS Academy of Higher Education & Research has emerged as a renowned institute in the country by providing quality education of highest standards through innovation in academic and research activities even during the most difficult times, for instance, the recent pandemic. JSS AHER has initiated the task of educating students and staff on the SDGs by incorporating the goals into the existing curriculum. Under the able guidance of the HEI, School of Life Sciences is committed to contribute towards achieving the SDGs through its multi-disciplinary academic excellence, research, innovation, environmental protection, and inclusiveness. Since its inception, the School of Life Sciences has seen an exponential growth in a short span of time due to the unique programs, which are being offered in five departments and eight divisions, keeping in mind the problems of the society. The School sees that most of the activities are closely aligned with the vision of sustainable development goals. The programs are designed to address the issues of the society pertaining to water, health, food and environment. The school stands today as a unique institution in the country known for multidisciplinary and interdisciplinary teaching and research in Life Sciences. We have attempted to identify potential courses that can be aligned to the tune of SDGs in the curriculum across the syllabi, which were recently revised according to the NEP 2020.

I take this opportunity to express my sincere gratitude to the leadership of JSS Academy of Higher Education & Research for their constant support and cooperation towards all our initiatives. I thank all the faculty members both teaching and non-teaching for having contributed towards a noble cause of achieving the SDGs through Education.

Dr. K.A. Raveesha
Professor & Head
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Preface

Nanoscience and Technology is at a forefront of modern research today in India and it is seeing an exponential growth in many fields and will have robust future developments. One of the greatest challenges facing society in the twenty-first century is providing better living standards while minimizing the impact of human activities on the global environment and climate as the world population increases.

Therefore, achieving sustainable development goals through the utilization of nanotechnology to address global challenges in water purification, clean energy technologies, agriculture-food industries, greenhouse gases management, materials supply and utilization, green manufacturing and textile industry is the way forward.

The School of Life Sciences at JSS Academy of Higher Education & Research, Mysuru, is at the forefront in implementing SDG through nanotechnology and in making it transition from laboratory to community and to the market. Thus practically implementing a knowledge transfer from university to commercialization.

A MSc Nanoscience & Technology course is offered here which bridges an interface between science and commercialization-and the institutional infrastructure that is necessary to maximize the potential of science and technology. Nanotechnology's rapid development worldwide is a testimony to the transformative power of identifying a concept or trend and laying out a vision at the synergistic confluence of diverse scientific research areas.

I wish all the students/teachers/readers of this compendium on "Education for Sustainable Development", to embrace basic concepts of nanotechnology as one of the mandatory subjects which will provide an outlook of the role of nanotechnology in the convergence of knowledge, technology and society for achieving sustainable development.

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INTRODUCTION

The Sustainable Development Goals – an ambitious and universal agenda to transform our world

On 25 September 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development (UN, 2015). This new global framework to redirect humanity towards a sustainable path was developed following the United Nations Conference on Sustainable Development (Rio+20) in Rio de Janeiro, Brazil in June 2012, in a three-year process involving UN Member States, national surveys engaging millions of people and thousands of actors from all over the world.

At the core of the 2030 Agenda are 17 Sustainable Development Goals (SDGs). The universal, transformational and inclusive SDGs describe major development challenges for humanity. The aim of the 17 SDGs is to secure a sustainable, peaceful, prosperous, and equitable life on earth for everyone now and in the future. The goals cover global challenges that are crucial for the survival of humanity. They set environmental limits and set critical thresholds for the use of natural resources. The goals recognize that ending poverty must go together with strategies that build economic development. They address a range of social needs including education, health, social protection, and job opportunities while tackling climate change and environmental protection. The SDGs address key systemic barriers to sustainable development such as inequality, unsustainable consumption patterns, weak institutional capacity, and environmental degradation.

For the goals to be reached, everyone needs to do their part: governments, the private sector, civil society and every human being across the world. Governments are expected to take ownership and establish national frameworks, policies, and measures for the implementation of the 2030 Agenda.

A key feature of the 2030 Agenda for Sustainable Development is its universality and indivisibility. It addresses all countries – from the Global South and the Global North – as target countries. All countries subscribing to the 2030 Agenda are to align their own development efforts with the aim of promoting prosperity while protecting the planet to achieve sustainable development. Thus, with respect to the SDGs, all countries can be considered as developing and all countries need to take urgent action.

The 17 Sustainable Development Goals (SDGs)

Out of the 17 sustainable goals, Division of Nanoscience & Technology is focused on the following goals:

Zero Hunger – End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Good Health and Well-Being – Ensure healthy lives and promote well-being for all at all ages

Clean Water and Sanitation – Ensure availability and sustainable management of water and sanitation for all

Affordable and Clean Energy – Ensure access to affordable, reliable, sustainable, and clean energy for all

Climate Action – Take urgent action to combat climate change and its impacts


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
17 PARTNERSHIPS FOR THE GOALS
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND

SDG 2 - Zero Hunger

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Teaching & Learning objectives for SDG 2: "Zero Hunger"

Agriculture is one of the most important sectors as it produces and provides raw materials for food and feed industries. The foremost universal challenge on our planet is the question of establishing food security for a rapidly increasing population in the world. Predictions show that food demand is likely to rise from 59 to 98% for the world population reaching 9 billion by 2050. Despite an increase of the world population particularly in developing countries, the global food supply interrupted by the expenditure of bio-resources for production of energy, manufacturing chemicals, high post farming loss, less value addition, inefficient distribution and marketing systems, and other factors. Farmers throughout the world have their sights set on enhancing the production of crops through intensive and extensive agriculture. Newer technology that will increase the production and reduce food wastage to maintain sustainable living standards of the nation and improve food security. Therefore, sustainable agricultural strengthening the practical opportunity to get rid of poverty and hunger around the globe.

Agricultural efficiency, soil improvement, secure water use, distribution of food in stores, and its quality are basic factors of securing food that may be improved via advances in nanotechnology research. In the present century, there is a big demand for fast, reliable, and low-cost systems for the detection, monitoring, and diagnosis for biological host molecules in agricultural sectors. Nanotechnology is one of the promising areas to boost the availability of food and to manufacture newer products for beneficial purposes in agriculture, food, water, the environment, medicine, energy, and electronics. It is a developing and quickly growing region with new and exclusive applications in agriculture and food research. Growing productivity and declining postharvest expenditure via better outcomes with the support of newer technical investigations with the help of nanotechnology and biotechnology in food stuffs might be the best answer.

Few evolving areas regarding nanomaterials in agriculture are to reduce the number of spread chemicals, minimize nutrient losses in fertilization, and increased yield through pest and nutrient management. Some of the emerging topics of nanotechnology for food can be largely improved in the aspects of smart delivery of nutrients, bio separation of proteins, rapid sampling of biological and chemical contaminants, nano-encapsulation of nutraceuticals, solubilisation and delivery. Nanotechnology-based applications have put

forward the growing requirement of using nanoparticle in food biotechnology, science, food processing, food packaging, functional food development, food safety, detection of pathogens in food, and extended shelf-life of food. The nanotechnology can take an important part in the productivity through control of nutrients as well as it can also participate in the monitoring of water quality and pesticides for sustainable development of agriculture.
The implication of nanotechnology research in the agricultural sector has become a key factor for the sustainable developments. In the agri-food areas pertinent applications of nanotubes, fullerenes, biosensors, controlled delivery systems, nano-filtration are becoming popular. Such technology offers good resource management, drug delivery mechanisms in plants and helps to maintain the soils fertility.

The new and future technology is nanotechnology that possesses very unique property in food supply chain (from the field to table: crop production, use of agro-chemicals such as nano-fertilizers, nano-pesticides, nano-herbicides, precision farming techniques, intelligent feed, enhancement of food texture and quality, and bioavailability/nutrient values, packaging and labelling) round the world agricultural sector. In spite of being relatively advantageous in agriculture process, still developing countries are suffering from lack of high importance of food products.

With nanotechnology the goal of "Zero Hunger" can be reached in the near coming future. All that is required is an in-depth interdisciplinary approach to solving world hunger through international cooperation for regulation and legislation for exploitation of this technology.

Cognitive Teaching & learning objectives	• The learner knows about hunger and malnutrition and their main physical and psychological effects on human life, and about specific vulnerable groups. • The learner knows about the current global situation when it comes to world hunger. • The learner knows the main drivers and root causes for hunger at the individual, local, national and global level • The learner knows about the conventional methods in currently being used to reduce would hunger. • The learner gets to understand how nanotechnology is being used to reduce hunger through agriculture • The learner understands how nanomaterials can be used to improve crop yield, soil remediation, disease control. • The learner understands the possible toxic effects of nanoparticles in the environment and the need for regulations in its use.
Socio-emotional Teaching & learning objectives	• The learner can communicate on the issues and connections between combating hunger and promoting sustainable agriculture and improved nutrition. • The learner can create a vision without world hunger through the use of different nanomaterials • The learner can reflect on their own values and deal with diverging values, attitudes, and strategies on the use of nanotechnology when it comes to developing a sustainable living through agriculture

SDG 3 - Good Health and Well-being

Ensure healthy lives and promote well-being for all at all ages

<u>Teaching & Learning objectives for SDG 3: "Good Health & Well-being"</u>

The use of nanotechnology in healthcare is opening new frontiers across the life sciences industry. With the ability to manipulate matters at atomic levels, nanotechnology has huge potential to revolutionize myriad aspects of medical care, including diagnostics, disease monitoring, surgical devices, regenerative medicine, vaccine development, and drug delivery. It is also opening doors to better treatment options for various diseases through advanced research tools that can be used for drug discovery.

Nanotechnology products have become increasingly useful in healthcare and have led to the advent of novel nano systems for the diagnosis, imaging, and treatment of various diseases, such as cancer, as well as cardiovascular, ocular, and central nervous system-related diseases. Nanomaterials integrate well into biomedical devices as most biological systems are also nanosized. In the field of drug delivery, nano systems offer the precise delivery of drugs to the target tissues or organs with a controlled release and enhanced retention time as compared to conventional techniques. Nano-liposomes are one of the best examples of the nano systems currently developed for targeted drug delivery to treat various types of cancers and cardiovascular diseases. Drug delivery to target tissue, good biocompatibility, and the control of drug flow in the bloodstream are the most significant reasons for the usage of nano-liposomes.

Advancement of technology has allowed for the development of smart pills for example PillCam which is a capsule with a miniature video camera, and dose-tracking pills along with more advanced ones like Atmo Gas Capsule', which when ingested, examines the gases in the human gut to report any disorders. Such nano sensor based application allow for improved healthcare through real time data monitoring of oxygen level, carbon dioxide and the presence of other harmful substances in the body. Such applications help in diagnosing gastrointestinal disorders, detecting malignant digestive organs, and tracking food sensitivities to enable personalized diet and nutrition plans, hence improving general well-being of patients.

At a more advanced level the development of nanobots have been revolutionary in the medical fields as they serve as miniature increasing the probability of success during surgery as they help eliminate human error. Such materials can be inserted in to the body to repair

and replace intracellular structures. They can also replicate themselves to correct a deficiency in genetics or even eradicate diseases by replacing DNA molecules. Nanobots are currently being tested to perform eye surgery, through a microscopic needle inserted into the retina while on the other hand they are being used to clear artery blockages by drilling through them.

Due to the fast life that people leave, the use of nano sensors in wearables is becoming increasingly very popular. The use of cloth-based nanotechnology in healthcare is a new yet popular form of remote patient monitoring. Such wearables have embedded nano sensors in the cloth that record medical data such as heartbeat, sweat components, and blood pressure. It helps save lives by alerting the wearer and medical professionals of any adverse changes faced by the body. Not only is such an application medically beneficial in terms of data, it does tend to restore confidence in people indirectly improving their general well-being.

Currently, nanotechnology in healthcare still has a lot of hurdles to overcome. More research is needed on the long-term impact of nanotechnology, and its environmental implications. Nanotech-based devices are often highly-priced which hinders their mass manufacturing. Affordable production alternatives for these devices will aid in making this technology mainstream. However, there is an increasing sense of optimism that nanotechnology, when applied to healthcare, will be able to bring about significant advances in the diagnosis, treatment, and prevention of diseases. There is growing interest among innovators in the future applications of nanotechnology in healthcare, and how it can guide the industry into a new era of development.

Cognitive Teaching & learning objectives	• The learner knows conceptions of health, hygiene and well-being and can critically reflect on them. • The learner knows about diseases along with current diagnosis and treatment methods • The learner understands the various types and medical applications of nanomaterials (diagnosis, medicine, treatment, imaging) • The learner knows the risks and rewards of using nanotechnology for medical applications • The learner gets to know the most recent nano-based products in the market like medicine and nano sensor-based products

Suggested topics for SDG - "Good Health and Well-being"

The following activities and projects are being carried out:

- Drug delivery systems for delivery to CVDs
- Pharmacogenomics for Black Box drugs
- Targeted drug delivery for neurodegenerative diseases.

SDG 6 - Clean Water and Sanitation

Ensure availability and sustainable management of water and sanitation for all

<u>Teaching & Learning objectives for SDG 6 "Clean Water and Sanitation"</u>

Current WHO statistics are damning, making this an issue that must be addressed urgently as it is thought that around 2 billion people are using a contaminated water supply. In addition, over 485,000 people die each year from diarrhoeal related illnesses and diseases such as polio, typhoid, and cholera are once again being transmitted as a further consequence. Based on current trends and data, it is thought that by 2025 half of the total global population will be living in water-stressed or water-scarce areas. Crowded, expanding cities in many parts of the world are experiencing an increased demand for fresh water, and planners are unclear as to how the water needs of tomorrow will be met.

India to be precise has 4% of the global freshwater resources but ~18% of the world's population. The country, which was largely rural years ago, has *en masse* become urban in the past two decades. The urban population has risen from 28% in 2000 to 33% in 2016. With a growth rate over 6% in gross domestic product (GDP), the most populous countries, such as India and China, are increasing their chemical, pharmaceutical, agrochemical, automotive, petrochemical, semiconductor, and many other outputs all aimed at enriching the various economical ecosystems. On this note, The World Bank has predicted that achieving a growth rate of 8% or above for India will be possible only with a robust water management system.

While there are a wide-range of effective water purification methods and techniques which are already widely accepted to include boiling, filtration, oxidation, and distillation, but these often require high amounts of energy. Other treatment processes may include the use of chemical agents which is only possible in areas having infrastructure that is up to par. The more affordable and portable devices currently available are not failproof as they cannot guarantee 100% removal of harmful viruses, bacteria, dust, and even microplastics. Therefore, a nanotechnological approach could offer affordable and accessible clean water solutions to the world's most vulnerable populations.

Clean water challenges are highly interdisciplinary, and solutions therefore must cut across boundaries of disciplines. Water in its diverse forms is related to climate, food, health, and many other aspects of life. Over the past half century, 83% of freshwater species have also drastically diminished due to mankind's contribution to the ecosystem through poor sanitary conditions. Henceforth, water and sanitization is and will continue to be one of the most important interdisciplinary subjects of research.

Nanotechnology is a process that involves manipulating and controlling matter on the atomic scale. In the process of water purification, this involves using nanomembranes to soften the water and eradicate biological and chemical contaminants as well as other physical particles and molecules. Recent advances in the field of nanoscience provide many solutions to alleviate needs with regard to reducing scarcity or removing contamination. Operating at the nanoscale makes assembling atoms and molecules to exact specifications easier. In reference to water filtration, this means materials can be tailored, or tuned, to filter out heavy metals and biological toxins.

Nanofiltration membranes are already widely applied to remove dissolved salts and micro-pollutants, soften water and treat wastewater. The membranes act as a physical barrier, capturing particles and microorganisms bigger than their pores, and selectively rejecting substances. Nanotechnology is expected to further improve membrane technology and also drive down the prohibitively high costs of desalination which are currently in place. For example, pesticide filters have already reached over 7.5 million people by 2016 reducing pesticide levels from over 20 times the safety standard to concentrations substantially below it. On a similar note, use of nanostructured materials to remove arsenic from drinking water has helped deliver clean water to more than 1 million people each day, providing hope for another 80 million or so in India affected. Such a solution does not require electricity and is affordable, even for those living in the poorest parts of the world.

Alternate methods of microbial disinfection, desalination, water harvesting, recycling, contaminant sensing, and monitoring are debuting in the marketplace. Scalability and massive implementation of technologies is slow but encouraging. With nanotechnology, the key principle is to have “More for less”. As constituent materials reduce in dimension, their effective capacity to remove contaminants increases due to additional derivatization of the material to increase charge, solubility, affinity, *etc* giving more effective scavenging capacity per unit mass of the material at the nanoscale than the bulk material, making a purifier composed of nanoscale material smaller and more affordable.

The question remains, can nanotechnologies really help solve water problems in developing countries? There are two positive signs that they will. First, water professionals and scientists are increasingly including local communities in dialogues to understand the problems with, and opportunities for, applying nanotechnology to water improvements. Second, since the commercialisation of nanotechnology is at an early stage, we can hope that such discussions between researchers, communities and industry will encourage scientists and businesses to develop appropriate business models to exploit their inventions.

Cognitive Teaching & learning objectives	• The learner understands water as a fundamental condition of life itself, the importance of water quality and quantity, and the causes, effects and consequences of water pollution and water scarcity. • The learner understands conventional methods being used in water purification and sanitization • The learner knows the different methods of purification using nanomaterials • The learner learns about the various types of nanomaterials that can be used in water purification • The learner understands the mechanism behind nanomaterials' ability in water remediation • The learner knows about regulations and toxicity related to water purification applications • The learner gets to synthesis their own nanomaterials and make their own purification system
Socio-emotional Teaching & learning objectives	• The learner can participate in activities of improving water and sanitation management in local communities. • The learner can communicate about water pollution, water access and water saving measures and to create visibility about success stories. • The learner can feel responsible for their water use. • The learner can see the value in good sanitation and hygiene standards. • The learner can question socio-economic differences as well as gender disparities in the access to safe drinking water and sanitation facilities.

Suggested topics for SDG 6: "Clean Water and Sanitation"

Source and types of water pollution

Conventional purification methods

Nanomaterials and types of purification processes

Nanoparticle characteristics which make them efficient in purifying water

Nanoparticle purification mechanism

Industrial and portable nano-based purification systems

SDG 7 - Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and clean energy for all

Teaching & Learning objectives for SDG 7 "Affordable and Clean Energy"

Nanotechnology utilizes the unique properties of materials at the nanoscale (<100 nm). At this scale, the surface properties dominate the bulk properties of the material. The electrical properties, durability, strength, and activity of the materials are enhanced and engineered to obtain desired features through nanotechnology. Unusual properties and increased surface areas of nanomaterials provide great potential to improve renewable energy applications. Nanotechnology researches mainly focus on solar, hydrogen and biomass energy. The developments in the geothermal, wind and tidal energy applications mainly focus on the construction materials or the used machinery rather than the actual process.

Despite decades of development, solar cells are still relatively expensive. This not only makes solar an unattractive and uncompetitive alternative to fossil fuels, but it ensures that the technology is not deployed where it is most needed. The most efficient cells tend to be made up of layers of expensive crystalline silicon. These have chemicals added to encourage particles of light, called photons, to liberate electrons, which pass from one layer to the other to create a current. While this works, it could be done using cheaper materials and in ways that are more efficient. The amount of energy converted from light into electricity ultimately depends upon how many electrons can pass across the interface between the two layers and this is limited by the size of that interface. One-way nanotechnology can help is by increasing the size of the electron interface layers by making bumpy surfaces which will allow more electrons to pass in turn increasing the amount of electricity produced.

With nanotechnology, energy efficiency can be greatly improved at various steps and types of energy processes. Nanostructured catalysts for example help increase the efficiency of fuel cells while porous nanomaterials are used for hydrogen storage. Nanofluids enhance the heat transfer efficiency of solar collectors while quantum dots and carbon nanotubes increase the energy absorption properties of solar cells. Nanotechnology enables the development of portable energy systems as well as large-scale systems with high-efficiency.

The development of cost-effective renewable energy systems will contribute to the urgent energy global goals while helping reduce the destructive effect of human activities. Even in the area of non-renewable energy generation, nanotechnology is equally very useful. By making the production of fuel from low grade raw material economical, the technology can address the shortage of fossil fuels, such as diesel and gasoline. It can also be used to make

the production of fuels from normal raw materials more efficient. And by reducing friction using lubricants fortified with nanoparticles, energy consumption from conventional engines can be significantly reduced leading to increased service life of engines. Hence, nanotechnology is and will play a major role in the production of clean and affordable energy all over the globe.

Cognitive Teaching & learning objectives	• The learner knows about different energy resources – renewable and non- renewable • The learner knows the effect of particle size between bulk and nanoscale on how they contribute towards efficiency of energy productions • The learner under stands the different applications of nanotechnology in energy production and harvesting • The learner knows about harmful impacts of unsustainable energy production, understands how renewable energy technologies can help to drive sustainable development and understands the need for new and innovative technologies and especially technology transfer in collaborations between countries.

Suggested topics for SDG - "Affordable and Clean Energy"

Following are the projects that are being carried out by our students:

- Nanosolar cells for sustainable energy.
- Energy from waste substrates
- Nanotechnology applications for sustainable energy

SDG 13 - Climate Action

Take urgent action to combat climate change and its impacts

<u>Teaching & Learning objectives for SDG 13: "Climate Action"</u>

The most significant concern to the environment, currently, is global warming and it is probably going to stay a concern for a long time. Carbon-associated gas emission that is made by man, usually causes Global warming, those are also referred to as greenhouse gases, leading to vast climate concern/change.

Fossil fuel combustion is the carbon emissions major source, fossil fuels are oil, coal, and gas in automobiles, power plants, industrial facilities, other transportation vehicles, and other artificial and natural sources. Nanotechnology is believed for lessening the requirement of fossil fuels, therefore being a positive impact when it comes to global warming.

Almost zero emissions are caused by applications of renewable energies (solar and hydrogen fuel cells) Nanotechnology and its products are primarily involved in renewable energy applications. Global warming can be stopped by increasing the efficiency and usage of renewable energy and lessening the fuel consumption alongside. This is one way to finally stop and slow down global warming. Global warming is negatively impacted by the process of manufacturing nanomaterials and nano-devices.Also, a great role is being played by nanotechnology in improving the efficiency of current technology. Green nanotechnology's latest concept has a way to lessen potential health and environmental hazards through the development of new clean technologies with the help of nanoproducts and nanomanufacturing. Also, there is a need to design and develop new nano products and replace the old ones with the new nano products which are environment- and human-friendly.

Mainly, two main aims are possessed by green nanotechnology: making such nanomaterials that end the environmental problems, and the other is to make engineered nanomaterials with no side-effect to human health or the environment. The principles of green engineering and green chemistry are used in this concept for producing non-toxic nanomaterials by using renewable resources, and less energy. During the production, one should keep in mind the product's or material's lifecycle thinking. The major aim of green nanotechnology is to make the process of nanomanufacturing more friendly to the environment.

Nanotechnology can make a significant difference in relation to climate change in fuel

additives to increase the efficiency of diesel engines; photovoltaic technology for solar cells; the hydrogen economy and fuel cells; batteries and supercapacitors for energy storage; and improved insulation for houses and offices. However, the different nanotechnologies that will be brought to bear on this problem will only form part of a much larger technology-based solution, which, in turn, will also be at the mercy of politics, economics and market forces.

Cognitive Teaching & learning objectives	• The learner understands the greenhouse effect as a natural phenomenon caused by an insulating layer of greenhouse gases. • The learner knows which human activities – on a global, national, local and individual level – contribute most to climate change. • The learner knows about prevention, mitigation and adaptation strategies at different levels (global to individual) and for different contexts and their connections with disaster response and disaster risk reduction. • The learner knows about the application of nanotechnology to influence or control climate change
Socio-emotional Teaching & learning objectives	• The learner can explain ecosystem dynamics and the environmental, social, economic and ethical impact of climate change. • The learner can encourage others to protect the climate. • The learner can collaborate with others and to develop commonly agreed-upon strategies to deal with climate change. • The learner can understand their personal impact on the world's climate, from a local to a global perspective. • The learner can recognize that the protection of the global climate is an essential task for everyone and that we need to completely re-evaluate our worldview and everyday behaviours in light of this.

Suggested topics for SDG 13: Climate Action

Greenhouse gases and their emission
Energy, agriculture and industry-related greenhouse gas emissions
Climate change-related hazards leading to disasters like drought, weather extremes, and their unequal social and economic impact within households, communities and countries and between countries
Nanomaterials used in controlling greenhouse gases
Nanocomposites and nano catalysts for pollution control
Nano sensors for pollution detections

CONCLUSIONS

Institution & individual can contribute to achieving the SDGs by developing cross-cutting sustainability competencies that are needed to deal with many different sustainability challenges and to relate the different SDGs to each other. Institution can equip learners with the specific cognitive, socio-emotional and behavioral learning outcomes that enable them to deal with the particular challenges of each SDG.

To make it possible for everyone around the world to take action in favor of the SDGs, all educational institutions must consider it their responsibility to deal intensively with sustainable development issues, to foster the development of sustainability competencies and to develop the specific learning outcomes related to all SDGs. Therefore, it is vital not only to include SDG-related contents in the curricula, but also to use action-oriented transformative pedagogy.

Education officials, policy-makers, educators, curriculum developers and others are called upon to rethink education in order to contribute to the achievement of the SDGs within their timeframe, between now and 2030. This guidance provides an orientation to the sustainability competencies and specific cognitive, socio-emotional and behavioral learning outcomes that are relevant to this goal, and it outlines what is needed to implement learning for the SDGs through Educational Institutions.

Education for Sustainable Development Goals - Teaching & Learning Objectives

To create a more sustainable world and to engage with issues related to sustainability as described in the Sustainable Development Goals (SDGs), individuals must become sustainability change-makers. They require the knowledge, skills, values and attitudes that empower them to contribute to sustainable development. Education is thus crucial for the achievement of sustainable development, and Education for Sustainable Development is particularly needed because it empowers learners to take informed decisions and act responsibly for environmental integrity, economic viability and a just society, for present and future generations.

This hand book guides readers on how to use education, especially to achieve the SDGs. It identifies teaching & learning objectives, suggests topics and learning activities for each SDG, and describes implementation at different levels from course design to national strategies. The document aims to support policy-makers, curriculum developers and educators in designing strategies, curricula and courses to promote learning for the SDGs.

Learning objectives for teachers to promote sustainable development

Know about sustainable development, the different SDGsand the related topics and challenges

Understand the discourse on and the practice of in local, national and global context

Develop their own integrative view of the issues and challenges of sustainable development by considering the social, ecological, economic and cultural dimensions from the perspective of the principles andvalues of sustainable development, including that of intergenerational and global justice

Take disciplinary, interdisciplinary and transdisciplinary perspectives on issues of global change and their local manifestations

Reflect on the concept of sustainable development, the challenges in achieving the SGDs, the importance of their own field of expertise for achieving the SDGs and their ownrole in this process

Understand how cultural diversity, gender equality, social justice, environmental protection and personal development are integral elements of ESD and how to makethem a part of educational processes

Practice an action-oriented transformative pedagogy thatengages learners in participative, systemic, creative and innovative thinking and acting processes in the context oflocal communities and learners' daily lives

Act as a change agent in a process of organizational learning that advances their school towards sustainabledevelopment

Key elements for whole-institutionapproaches

An institution-wide process that enables all stakeholder's leadership, teachers, learners, administration – to jointlydevelop a vision and plan to implement ESD in the whole institution.

Technical and financial support to the institution to supportits reorientation, including for instance the provision of relevant good practice examples, training for leadership and administration, the development of guidelines and associated research.

Inter-institutional networks that facilitate mutual supportsuch as peer-to-peer learning on a whole-institution approach, and increase the visibility of the approach to promote it as a model for adaptation.

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12. Green Pack: Teaching material on sustainability issues http://education.rec.org/green-pack.html
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14. OXFAM: A selection of suggested teaching ideas around the SDGs https://www.oxfam.org.uk/education/resources/sustainable- development-goals
15. Sustainability Gamepedia: A database of games related to sustainability http://www.games4sustainability.org/gamepedia/
16. Teaching and Learning for a Sustainable Future: Resources for teachers about teaching approaches as well as classroom activities on diverse topics related to sustainability http://www.unesco.org/education/tlsf/mods/theme_gs.html
17. Teach UNICEF: Collection of teacher resources on the SDGs https://teachunicef.org/teaching-materials/topic/sustainable- development-goals
18. The Goals.org: Free global education and learning portal on sustainable development solutions http://www.thegoals.org
19. The Lazy Person's Guide to Saving the World http://www.un.org/sustainabledevelopment/takeaction
20. The Story of Stuff: An online resource that investigates the humanity's unsustainable use of materials http://storyofstuff.org
21. The World We Want. A Guide to the Goals for Children and Young People http://www.unicef.org/agenda2030/files/TWWW_A4_Single_Page_LowRes_English.pdf
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people in an engaging and informative manner http://www.youth.ie/sites/youth.ie/files/SDGs_Youth_ Resource%20_Pack.pdf

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24. World's Largest Lesson: Find everything you need to introduce the SDGs to young people, take part and take action http:// worldslargestlesson.globalgoals.org
25. Young Masters Programme on Sustainable Development: Online courses and international exchange between students on sustainable development http://www.goymp.org/en/frontpage
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30. Food and Agriculture Organization of the United Nations (FAO) http:// www.fao.org/home/en/
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32. Global Ecovillage Network http://www.gen.ecovillage.org Global Footprint Network http://www.footprintnetwork.org/en/
33. index.php/GFN/
34. Higher Education Sustainability Initiative (HESI) https:// sustainabledevelopment.un.org/sdinaction/hesi
35. ICLEI: Local Governments for Sustainability http://www.iclei.org International Institute for Sustainable Development
36. http://www.iisd.org
37. Sustainable Development Solutions Network http://unsdsn.org UNESCO ASPnet schools http://www.unesco.org/new/en/education/
38. networks/global-networks/aspnet
39. United Nations Development Programme http://www.undp.org/ United Nations Environment Programme http://www.unep.org World Federation of UNESCO Clubs, Centres and Associations
40. (WFUCA) http://wfuca.org/
41. World Health Organization http://www.who.int/en/
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'Touching the lives of Millions'

Focusing on a purpose as expansive and yet as specific as improving quality of life through Human Development, the JSS Mahavidyapeetha has grown from strength to strength. A long and healthy life, Education for all and a decent standard of living, the indicators of Human development, have been the underlying philosophy of Jagadguru Sri Veerasimhasana Mahasamsthana Math, Suttur Srikshethra, for centuries. This is also the philosophy for which the Mahaidyapeetha today stands for.

Under the untiring efforts of Jagadguru Dr. Sri Shivarathri Rajendra Mahaswamiji, the Mahavidyapeetha has witnessed enormous growth in the field of education and today has over 300 institutions under its fold, from kindergartens to postgraduate centres and postdoctoral research catering to the educational needs of more than 1,00,000 students.

The Mahavidyapeetha continues to play an important role in expanding the scope of its activities to several branches of knowledge, welfare, and culture. Its educational efforts span crèches for toddlers of working rural women, schools to impart primary and secondary education in both Kannada and English medium, Colleges, Polytechnics, Technical, Medicine, etc. For realizing its mission, it has equipped itself with an extensive infrastructure and an army of dedicated and highly qualified human resource. These institutions, located in strategic areas, serve a broad spectrum of society, from virtually remote tribal villages to metropolitan cities such as Bengaluru, Noida, New Delhi, Ooty, and Coimbatore, besides their presence in United States, Mauritius, and Dubai.

Apart from formal education, the initiatives stretch to integrated rural development through training and empowering of rural folk, reaching out healthcare to people through modern and traditional Indian systems of medicine, patronizing literary activities, visual arts, performing arts, restoration of temples and historical monuments.

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