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FACULTY DEVELOPMENT FOR SUSTAINABILITY AND SUSTAINABLE COMPUTING:

FACULTY ATTITUDE TOWARDS COMPUTING FOR SUSTAINABILITY

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Abstract

For a sustainable economic growth of a nation, it is an imperative to consider the educational transformation in the country. The higher the quality of education, the higher the value it adds to the overall growth and prosperity of the nation. Therefore, the teaching learning process plays a vital role in both institutional transformation and nation building. This emphasizes on Faculty development at its core and hence the Faculty attitude towards computing for sustainable education ecosystem in the country.. In view of the significance of sustainability in the economic and industrial growth of nations, there has been a serious consideration in undertaking teaching and research in sustainability and sustainable computing. This paper presents the results of a survey on faculty development in computing for sustainability.

Keywords: Computing, Sustainability,economic growth**,** Climate change**,** Product Design, Clean manufacturing, Social networking, biodiversity, IoT (internet of Things), Smart energy, Analytics,

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1.Introduction

The global growth in the population, the efforts to provide better standards of living to the masses everywhere, the use of natural resources at an ever-increasing rate, and the evolution in and the application of technologies to meet the demand for goods and services have contributed to depleting natural resources, changing climate, and uncertainties about the future for all. However, there has been a serious recognition of the changes in the last 20 years, especially with regard to harmful emissions, warming global climate, melting of the ice in the polar regions, extreme changes in weather pattern, severe drought and water shortages in parts of the world, and frequent forest fires, violent hurricanes and other calamities. As a consequence, people and governments all over the world have started talking about and taking actions to correct the problems. Today, almost everyone recognizes that the global economic growth must be sustainable in terms of healthy and clean environment and enable the future generations to have the resources to enjoy and have better standards of living.

This paper deals with the means to promote sustainability through the application of computer technology. It specifically addresses the issues relating to preparing the faculty who will be involved in teaching the computer technologies for sustainable growth.

2. Sustainability

Sustainability may be defined as the outcome of balancing the use of naturalresources and maintaining their long-term availability. Human societies all over the world have been searching for better resources from the beginning of time. Wars have been fought for thousands of years to gain and use resources. Increase in population, and the concentration of power in various parts of the world have contributed to uneven access to and utilization of available resources. Depletion of the resources and the fear about the availability of the resources for the future generations have created a global movement towards a sustainable future. Scientific, technological, economic and social developments have created modern and interdependent societies that are interested in protecting and preserving the natural resources.

Sustainability is directly linked to the preferences of individuals, priorities of a society, the society's economic interests, and how it deals with the living environment [1, 2]. The International Sustainability Council looks at sustainability in economic terms and considers resource utilization as part of the process and advocates the means to enhance the economic growth [3]. Political, social and non-governmental organizations all over the world have advocated various measures in the name of becoming green societies. Looking into the future, the advances in science and technology and their utilization to conserve and efficiently use the resources will assure a sustainable environment.

3. Computing for Sustainability

Science and technology have evolved over the last two hundred years to create the kind of modern society that we live in. With the advances in industrialization and the unplanned use of resources have also brought us to the point of rethinking about their adverse impact on the environment and the society. Part of the rethinking has also led us to consider steps towards sustainability. The challenges in achieving sustainability will involve, but not limited to, the following:

- Life cycle management of products, from product design to production, and from usage to disposal of the used products
- Management of raw material from discovery to mining, and from processing to usage
- Generation and efficient usage of power from a variety of sources
- Management of the living environment, the naturalresources, land, water, space and habitats
- Facilitating communication to supporting modern ways of linking humanity
- Supporting safe automation in all walks of life, from transportation to logistics and from management of businesses to addressing healthcare and other needs

- Exploring unknown entities from under the seas to far away planets
- Helping human beings make decisions based upon enormous amounts of information

From the point of view of sustainability, efficient, effective and conservative use of resources will assure their availability in the longer run. To that end, sustainable computing mayinvolve addressing the type of material and the processes used to manufacture computers and related devices, theiroperation, use and disposal conducive to keep the land, water and the environment clean and safe, and contribute to better human productivity and healthier living. Sustainable computing may cover a wide spectrum of topics including the use of computers and associated tools for:

- Efficient Product Design and Clean manufacturing
- Clean and renewable energy production and use
- Efficient transportation operation and logistics
- Pollution free environment
- Protection of land, forest, water and Ocean
- Promotion of biodiversity and conservation of wildlife
- Safe and efficient transportation operations
- Management of waste and clean environment
- Managing climate change
- Educating the Masses
- Eliminating Poverty and assuring continuous economic growth
- Promoting health and human welfare
- Utilizing social networks to develop increased awareness, and to promote involvement and participation

in collective governing and prospering

4. Computing for Sustainability in Higher Education

Leaders in education started promoting sustainability measures more than 20 years ago [4, 5]. Today, scores of universities around the world are offering degree programs dealing with sustainability and sustainable computing. The chief among them are the Cornell University, the University of Pennsylvania, the University of Michigan, Stanford University, and others in the USA, McGill University, Canada, Oxford University, England, Norwegian School of Economics, Norway, the Indian Institutes of Technology, India, the National University, Singapore, Fudan University, China, Nagoya University, Japan, the University of Melbourne, Australia and many others around the world. The nature of programs offered in the educational institutions around the world vary in their objectives, scope, and output. Due to the broader scope of topics involved in sustainability and sustainable computing, it would require interdisciplinary programs with wider latitude to attempt at educating the future leaders for sustainability. This project has focused on exploring the interests of a segment of Indian faculty to teach and prepare future leaders for a sustainable world.

5. Computing for Sustainability in Higher Education – A Survey

As part of a broader study on faculty development in Computer Engineering and Technology Education, a preliminary study on sustainability and sustainable computing was undertaken. A group of 121 faculty members, participating in an academic event provided the input for the survey. Although, they were part of a larger group of about 250 participants from all over the country, the survey was limited to the faculty involved in Computer Science and Engineering subjects. A survey instrument was used to gather data on faculty attitude towards development for sustainability and sustainable computing. The results of the survey are presented in this section.

Table -1

Participants' Views on the Needs for Sustainability Issues in Education

Need for Sustainability Issues in Education	Extent of Awareness (n= 121)		
	Well Aware 0f the Needs	Moderately Aware	MinimallyAware
Efficient Design and manufacturing	31	24	66
Renewable energy production and use	43	62	16
Efficient logistics and operation	40	21	60
Controlling environmental Pollution	57	32	32
Protection of land, forest, water and Ocean	31	25	65
Maintaining Biodiversity and conservation of wildlife	25	23	73
Clean Transportation planning and operation	45	31	45
Management of waste and clean environment	42	25	54
Managing climate change	41	17	63
Educating the Masses	103	18	0
Eliminating Poverty and Economic Improvement	51	24	46
Health and human welfare	42	39	40
Promoting Public awareness through social networking	71	50	0
Efficient Design and manufacturing	31	24	66
Renewable energy production and use	43	62	16
Efficient logistics and operation	40	21	60

From the data in Table -1, it seems that the participants' awareness on the need for sustainability issues to be dealt with in education varied widely. Most of the participants seem to recognize the need to educate on matters relating to production and the use of clean energy, controlling the environment to be pollution free, planning for clean transportation and operation, giving an education to the masses, eliminating poverty and improving the economy, and promoting public awareness through social networking. Even for the participating educators, incorporating such sustainability aspects as engineering design, protection of land, biodiversity, climate change, human health seem uncertain. It may be due to their background and focused area of work.

Looking at the same sustainability issues and the use of computer technologies, the participants felt that the interdisciplinary engineering degree programs or the science degree programs are the ideal places to teach the subjects. The data in Table -2 indicates that the participants felt that the Computer degree programs are more suitable for educating the masses, and promoting social networking while the other aspects may be included in science and interdisciplinary engineering programs.

Table -2

Participants' Views on the Degree Programs in which Sustainability Issues should be Included

Sustainability Issues	To be in a degree program with a major in (n= 121)		
	Computer Science & Engineering	Interdisciplinary Engineering	Science & Other
Computers for Efficient Design and manufacturing	16	97	8
Computers for Renewable energy production and use	22	83	16
Computers for simulation and efficient operation	32	84	5
Computers for modeling and Pollution free environment	22	83	22
Computers for protection of land, forest, and water	16	71	34
Computers for biodiversity and conservation of wildlife	16	71	34
Computers for transportation planning and operation	35	81	5
Computers for management of waste &environment	16	71	34
Computers for modeling and managing climate change	22	83	22
Computers for Educating the Masses	76	32	13
Computers for Poverty Elimination Economic Betterment	34	21	66
Computers for health and human welfare	25	32	64
Computers for social networking and public involvement	66	31	24
Computers for Efficient Design and manufacturing	16	97	8
Computers for Renewable energy production and use	22	83	16

With theexpressed views that the sustainability issues should be dealt with in the science or interdisciplinary engineering degree programs, the participants of the study seemed to acknowledge the real possibilities in using Artificial Intelligence and other related computer-based tools for promoting sustainability. They acknowledged that AI tools should be part of all aspects of sustainability education. Table -3 presents the survey response.

Table -3

Participants' Views on Including Aspects of Computing for Sustainability as part of Various Curricula

Computing for Sustainability Topics for Inclusion [6, 7, 8,9,10]	Participants' View on Inclusion (n= 121)		
	Should be included	May be included	No View
AI and IOT for Clean Environment	79	21	21
AI for Efficient Autonomous Vehicle	94	27	0
AI for Smart Energy Grid Management	65	31	25
AI and Data Analysis for Smart Agriculture & Food Supply	84	26	11
AI for Climate Prediction and Safety	81	18	22
AI for Development and Management of Smart Cities	91	30	0
AI and Analytics for Affordable Healthcare	95	26	0
AI and IOT for Waste Management	77	23	21
AI and Related Tools for Mass Education	121	0	0
AI for social network and public awareness	90	21	10

Table -4 presents the data on the participants preferred areas of interest in which to be trained and be ready to teach. More than two thirds of the participants identified an area of interest each to undergo a faculty development program and teach immediately. Even those who opted to undergo a faculty development program opted an area of preference.

Table -4

Preferred area of Interest and Willingness to Undergo Faculty Developmentand Teach

Preferred Area of Interest for FDP and to Teach[11,12,13,14,15,16]	Participant's Response(n=121)	
	Willing to Undergo FDP Now and Teach	Willing to Undergo FDP Later and Teach
AI and IOT for Sustainable Environment	7	3
AI for Efficient Autonomous Vehicle	12	6
AI for Smart Energy Grid Management	5	2
AI and Data Analysis for Smart Agriculture and Food Supply	17	3
AI for Climate Prediction and Safety	6	4
AI for Development and Management of Smart Cities	9	4
AI and Analytics for Affordable Healthcare	19	6
AI and IOT for Waste Management	5	3
AI and Related Tools for Mass Education	43	7
AI for social network and public awareness	13	3

6. Conclusions

Sustainability as an academic discipline has not evolved to the point of being offered as a separate degree program. However, there is a broader recognition among the faculty, especially among those with computer background, that sustainability and computing for sustainability are important aspects of education. There is a general recognition that sustainability should be part of interdisciplinary programs in science or engineering and such computer technology tools as artificial intelligence should be taught for various applications of sustainability. There is also a serious willingness and commitment on the part of the faculty to undergo faculty development programs and teach as part of the programs dealing with sustainability. The current study revealed that a larger study involving faculty from various disciplines would provide a better understanding of the status of sustainability in education and the need to prepare for it.

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