
Challenges of Designing, Developing and Teaching an Undergraduate Course on IT and Environment for IS, IT, CS majors and as a General Education for all Students

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Abstract

A safe, lasting green environment that is good for all species on earth can be built and sustained only with the collective efforts of every human being, societies, religions, and governments through education and involvement. Information systems and technologies (ISTs) can aid as well as hinder building and sustaining a green environment. This paper describes the processes and challenges encountered in designing, developing and teaching the course entitled, "IT and Environment" as a general education course for the students at Framingham State University. The main objective of the course is to cover various ISTs involving water, glaciers, forests, renewable energies, species, personal and household devices and systems, and recycling and management of wastes of ISTs.

Keywords: green IT education, green environment, green IT issues, green computing, recycling IT systems, waste management of IT systems, information system, information technology, general education course

1. INTRODUCTION

1.1 FSU Majors

Framingham State University (FSU) offers several four year undergraduate majors in arts, sciences and professional fields, of which three majors are directly relevant to this paper. The Computer Science (CS), and the Information Technology and Business (ITB) are two information system and technology (IST) majors. Third is an interdisciplinary major on Environmental Science (ES). The CS major has two concentrations: (1) oriented for those who want to pursue software development, and (2) oriented for those who want to pursue information system (IS). The CS major is offered by the Computer Science department. The ITB major is offered through the Economics and Business Administration department in

collaboration with the Computer Science department.

1.2 Driving Forces

The exponential increase in human population, the proportional decrease in wilderness and extinction of non-human species on earth, and the negative impacts of global warming is bringing a sense of loss in the people's heart. The destructive consumption of natural resources is increasing at a much faster rate than the rate of population growth. The projected human population increase of 50% to more than 9 billion within a few decades makes one wonder what will happen to the little that's left of nature, wilderness, rain forests, non-human species, and ultimately to the human beings who depend on nature. With passing time, the feelings for nature are growing and the

eagerness to do something about it is increasing. At the same time, around half of the United States population, which includes well educated people, believes that global warming is not a problem. Majority of the people think only about the survival of the human population and ignore or do not understand the human dependency on other species and natural resources. Educators should take the initiative to teach people about the negative impacts of what we do on nature, try to stop the destruction and help to make the earth greener and safer for the survival of all species.

Literature search on green environmental technologies has shown that several schools offer environment related degree programs and courses (Water, Forestry, Resources, Sustainability, Australia) and several books were written on environment (Withgott, & Brennan, 2010, Wright, & Boorse, 2010, Cunningham & Cunningham, 2009, Botkin & Keller, 2009). However, neither a book nor a course could be found that specifically targets at explaining the operations of several green information systems and technologies giving both positive and negative impacts of them at a freshmen undergraduate level.

These were the driving forces for the development of the IT and Environment course and offer it to FSU students.

Apart from these reasons, the author's own interest in the wilderness, in the beauty of nature, and in the multitude of non-human species on earth such as trees, plants, forests, animals and insects, as well as mountains, rivers, glaciers, and oceans is also a contributing factor in the development of this course. Growing up in a village in India with very little influence of modern technologies, he would go for a walk during the night in the open field to watch the numerous blinking fireflies floating in the gentle breeze. Occasionally, catch a firefly, hold it gently in the hand for a few seconds and then watch it fly from the hand. It is an unforgettable joyful experience. Everyone in the current and future generations should experience the joy of nature by making it greener and safer to live for all species and preserving it to last forever.

The development and offering of an IT and Environment course, which seemed simple on the surface, turned out to be challenging. The rest of this paper explains various thoughts,

process and challenges encountered in designing, developing, and teaching the course. The final result of the development has benefited from discussions with the faculty members of the Computer Science department, the Geography department and the FSU curriculum committee members. Various thought processes that occurred during the development of this course have been included throughout the paper.

2. DESIGN CHALLENGES

2.1 Type of Course

The first decision to be made was whether to design the course just for the CS, ITB, and ES majors. The major courses to be taken for the degree requirements are divided into three groups: (1) core courses, (2) upper level elective courses in the major, and (3) free elective courses. A free elective course could be any course. After the core and major electives, students could take only a couple of courses towards free elective. The departments want majors to do cooperative work or internships to gain industrial experience using the free electives. This has resulted in little room for a new course for the majors to take. Moreover, it has been felt that every student in the university should have the opportunity to take a course on green environment. Hence, the decision was made to design this course as a general education course.

2.2 FSU General Education Model

The general education model at FSU is based on a set of goals and the outcomes from these goals satisfying the degree requirements. Each student must take a set of courses approved as general education courses satisfying all the goals and the outcomes.

Currently, the IT and Environment course has been approved by the university curriculum committee as a general education course satisfying goal 10 and its outcomes. Goal 10 has technology, sociology, geography, and forces in the United States of America as subcomponents. The outcome of this goal is that students after taking this course will have knowledge in at least three of the four subcomponents. Specific outcomes of IT and Environment course are described later.

Periodically, the general education model is reviewed. The challenge that will be faced in the future is to retain the course as a general education course every time the model is revised.

2.3 Course Objectives

The general education course is preferred to be designed such that freshmen from high school could take it without prerequisites and with no prior knowledge of ISTs and the environment.

The course was designed with the following objectives:

- expose students to environmental issues
- show how ISTs can be used to identify depletion of natural resources such as glaciers, forests, and water
- show how certain ISTs aid in creating greener ecosystems
- expose negative impacts of ISTs on the environment
- point out how students, individually as well as collectively, can contribute to make the environment greener

The main emphasis is on describing green technologies and their operations.

2.4 Course Outcomes

After taking this course, the students should have basic knowledge and understanding of the following:

- Develop ecological intelligence; understanding Life Cycle Assessment (LCA) of materials consumed by individuals and societies in the U.S.; need for full disclosure of environmental impact of all products in the U.S.
- Develop knowledge of information systems and technologies and their roles in building an eco-friendly environment.
- Understand the environmental impacts of consumption and disposal of IT system in the U.S.
- Understand geographically distributed natural resources such as water, glaciers, forests, species, wind and solar energies in the U.S. and abroad.
- Understand the need for life style change and participation in building an eco-friendly and sustainable environment at the levels of individual,

society, corporations, politics and religion in the U.S.

- Understand the impact of technological forces in the United States on the global environment.

2.5 Topics Selection

Considerable time and effort has been spent in identifying and selecting topics appropriate to the course. The list of topics chosen to be covered in the course is given below:

- Introduction to computers
- Information technologies supporting eco-friendly environment
- Virtualization, Data Centers, and Cloud Computing
- Social networks
- Sensor networks
- Role of networks in building an eco-friendly environment
- Video and audio conferencing and their environmental benefits
- Telecommuting and its environmental benefits
- Eco-friendly educational technologies
- Tracking technologies
- Imaging technologies
- Environmental contributions of electronic document management systems
- Simulation and its environmental benefits
- Life Cycle Assessment (LCA)
- Need for ecological intelligence
- Need for ecological information disclosure
- Use of ISTs in managing geographically distributed natural resources such as water, glaciers, forests in the U.S. and abroad
- Use of ISTs in studying and preservation of species
- Use of ISTs in managing renewable wind and solar energy
- Use of ISTs in a smart electrical grid
- Power management in computing systems
- Social consumption of IST products in the U.S.
- Environmentally harmful materials in IST components
- Recycling and waste disposal of IST components
- Individual roles and responsibilities including the need for life style change

- Impact of technological forces in the United States on global environment

It is not clear whether these are more or less topics to cover in one semester four credit course. Offering the course for couple of times will enable identifying the optimum number of topics that could be covered in a semester.

Associating these technologies with environmental aspects and explaining them at a level that could be easily understood by freshmen is a challenge.

2.6 Assessment

The computer science department has continuously made changes to the Computer Science curriculum, using ACM curriculum (Computer Science curriculum, 2008) as the reference, to keep the programs suitable for ABET accreditation (www.abet.org). Both ABET and FSU give significant amount of importance to assessment. Having a large number of topics results in considerable effort to assessing each and every topic. Similarly, evidence must be gathered to show the level of achievement of every outcome and having many outcomes demands more time and effort of the faculty. ABET recommends having a manageable number of important outcomes and assessing them effectively. In addition, the faculty member has to show how the course outcomes support program objectives. With tests on listed topics, it is easy to show that the course satisfies the outcomes of goal 10 and related degree outcomes.

As a general education course, when students with varying background take this course, and multiple sections are taught by several instructors, the management of assessment becomes more difficult.

2.7 Catalog Description

The following is the catalog description of the approved course:

"This course is a study of how information technologies can support and affect a clean and sustainable environment. Technologies such as virtualization, data centers, cloud computing, smart grid, tracking, imaging, simulation, document management, social networks, sensors, analog/digital devices, telecommuting, and teleconferencing will be discussed. We will cover use of these information technologies in

the U.S. by examining geographically distributed resources such as water, glaciers, forests, species, and renewable wind and solar energies. Environmental impacts of social consumption, recycling, and improper disposal of IT systems will be addressed. The impact of technological forces in the United States on global environment will also be examined."

3. DEVELOPING CHALLENGES

3.1 Textbook Challenge

One of the FSU requirements in getting a course approved is that the syllabus that must be submitted should include textbook(s) for the course. Few books relevant to the course were found by searching bookstores, amazon.com, and publisher sites. Al Gore's book (Gore, 2009) gives an excellent description of the various environmental issues, but it does not describe the technologies to be covered in the course except for a very brief mention of a few of them in the last chapter. The need for life cycle analysis (LCA) and disclosure is described at length by Daniel Goleman in his *Ecological Intelligence* book (Goleman, 2010). The negative impact of computing systems on the environment is covered in detail by (Kuer, & William, 2003). The issue with this book is that the book was published in 2003 and hence the data is not current. References (Espio, 2008, Grossman, 2006, Slade, 2007, Johri, 2008, Hester & Harrison, 2009) cover waste management topics. The importance of teaching environmental literacy across campus and across the curriculum is addressed in (Reynolds, Brondizio, & Robinson, 2010) with a collection of articles. However, it does not cover ISTs and their operation needed for this course. Soon it became clear that currently no textbook covers all the topics in this course. Also, the books do not describe the operation of appropriate information systems and technologies in building a green environment. This is particularly true for natural resources such as water, glaciers, forests, and power generation and management.

This means that the instructor has to create a manuscript before offering this course, which is at most challenging and time consuming task.

3.2 Instructor Materials

Most instructors are not interested in writing a textbook, particularly a book that will become outdated fast. Nor do they have the time needed

to write a book and get it published. One possible way to solve the textbook problem is to search the resources available on the Internet, blogs, conference proceedings and journals, and transferring the information into a Word document giving proper references to the sources and make it as a manuscript. It turned out that most of the information needed is not available on the Internet, particularly, materials that describe how a specific information system and technology aids in making the environment green. Most journal and conference papers (Green IT, 2010, Spagnolli, Corradi, Gamberini, Hoggan, Jacucci, Katzeff, Broms, Jonson, 2011, Ranganathan, & Chang, 2011) are not at an introductory level suitable for freshmen with no prior knowledge of ISTs. Online blogs have both exciting (Lavitan, 2011) and disappointingly unrealized technology (Fairley, 2011) information stated very briefly. These blogs are bits and pieces of information and may not fit to present a topic coherently. In the end, it has become clear that the instructor has to collect as much available information as possible from various sources, attend seminars, and then write the manuscript for the course. If multiple instructors are going to teach the course and need the same manuscript, this effort has to be supported at the departmental or institutional level so that it can be shared. A computer science faculty creating the document must acquire adequate knowledge on environment; otherwise accurate writing becomes a tough task. Collaborating with another faculty member knowledgeable on environment is an alternative.

Another dilemma is as the information is collected should they be sorted according to the technologies or according to the environmental topics as shown in Table 1. Currently, the information is scattered between the two categories. For coherent and consistent presentation adopting only one method seems good. Personally, the environment method looks better than the technology method. Will this push technology to the sidelines and create the impression that it is less important? It is not clear which method will be more attractive to the students and be easier to follow. Will a hybrid method be equally good?

Table 1. Methods of presenting Instructor Materials

Environment based	Technology based
Water	Tracking

Glaciers	Imaging
Iceberg	VPN
Forest	RFID
Power	Virtualization
Transportation	Data center
Religion	Cloud computing
Government and laws	Social Networks
Education	Sensor devices and networks
Population	System design
Biological system - Species	Audio and video conferencing
Recycling and waste disposal	Satellite technology
Personal and Home	Document Management systems

4. TEACHING CHALLENGES

4.1 Faculty Background

The list of topics mentioned earlier covers diverse disciplines such as computer science, computer engineering, electrical engineering, material science, manufacturing, reliability engineering, environment and others. Apart from the faculty creating the manuscript, every instructor teaching the course must have at least basic, if not expert, knowledge about these topics and be able to explain how these technologies operate and connect them to green environment. It is fairly easy to find an instructor with general knowledge in one area. However, finding a qualified instructor knowledgeable in both areas with emphasis on the list of green technologies mentioned earlier is a challenge.

4.2 Student background

There are no prerequisites for this course. Students from high school should be able to take this course. Some of the students do not have much mathematics background. Some of the continuing education students who have taken introductory college mathematics such as college algebra and precalculus have forgotten them. Hence, the materials to be covered should not require much mathematics. In addition, students should not be expected to have knowledge of computing technologies other than usage of personal computers and mobile computing devices such as smart phones. Therefore all of the information systems and

technologies including RFID, VPN, networking, sensor network, image processing, tracking systems, audio and video conferencing, etc., must be explained at an elementary level to illustrate how these technologies help in reducing pollution, global warming and in protecting natural resources.

4.3 Presentation Challenge

One way to deliver this course is to give lectures and have homework and quizzes. However, a traditional method like this will not be effective given the fact that almost half the population of United States, which includes well educated people, do not believe in global warming, pollution and unsustainable level of consumption of natural resources. Hence, it is important that this course includes a substantial amount of class discussion on the topics facilitating exchange of views and opinions with instructor as the moderator. Students should be encouraged to read the materials ahead of class time and come to class prepared for discussion. Making students read book(s) ahead of class time seems difficult nowadays when they spend more and more time on texting and social networking. Effective class discussion becomes challenging and time consuming when the course is offered as an online course without face-to-face contact using systems such as blackboard and Internet.

5. PROGRESS

The work on the course started only near the end of January 2011. The first version of the course proposal was submitted to the department curriculum committee for review. It was discussed and revised a few times. Then, the proposal was submitted to the university curriculum committee for review and approval during March 2011. The subcommittee responsible for computer science courses reviewed it first and suggested minor changes. After incorporating the changes, it was sent to the university curriculum committee for final approval. Towards the end of the spring semester, the course was finally approved. By this time the fall 2011 schedule was already finalized, published, advising for full-time day students and fall registration were completed. There was not much time to prepare the course materials during the spring semester to offer the course during fall 2011.

Currently, the author is working on creating the course materials including the manuscript with the objective of offering the course during 2012. In order to acquire knowledge and to collect information, he has attended several seminars and presentations offered by the Massachusetts Green High Performance Computing, Boston chapters of IEEE societies such as the Power and Energy Society, the Computer Society, the Reliability Society, the Communications Society, and others. Continued participation is expected in the future.

6. CONCLUSION

Human population is growing exponentially, and the rate of consumption and destruction of natural resources is increasing even steeper. Non-renewable resources are decreasing rapidly, pollution is increasing and climate changes are happening affecting every species on earth. These effects necessitate that everyone learn about the environment and technologies that can help as well as hinder in keeping a green environment.

The course entitled, "IT and Environment" got approved by the university curriculum committee as a general education course under goal 10 during the spring 2011 semester. It was also approved that environmental science students could take this course to satisfy one of their major requirements.

The hurdles in offering this course include identifying sources of information, making the instructor acquire adequate knowledge in diversified fields, and creating the needed manuscript for the students. With full-time teaching load during the fall and spring semesters, only little time is left to spend on preparation for the course. Being on a nine months contract, there is no incentive to spend summer months on the course. Development of assessment materials such as exams, homework, project(s), etc., is in progress.

Due to these challenges, the course is not yet offered even though a quick offering is desired. However, efforts are underway in preparing the manuscript and other teaching materials so that the course could be offered in 2012. Experience gained from offering the course will help in revising the course including the list of topics and the manuscript. It is anticipated that the course will be well received by the students and become popular.

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