

# The Greening of the Information Systems Curriculum

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## Abstract

The purpose of this study is related to Green Information Technology (IT), Green Computing, and/or Sustainability (GITS) curriculum initiatives in institutions of higher education in the US and abroad. The purpose of this study is threefold; 1) to evaluate whether GITS academic programs have been initiated in higher educational organizations; 2) to analyze if GITS programs and/or courses are currently in place; and 3) to investigate the conceptual framework of GITS across campuses.

**Keywords:** Green IT, Green Computing, Sustainability, Curriculum Design, Higher Education

## 1. INTRODUCTION

According to Wheeland (2009), in the world of information technology (IT), there is a likelihood of advancement for employees who are well versed in "green" issues. Lyon,

Dorney & Sargent (2010) define the green economy as:

*...economic activity generated by companies, customers and the public sector in the form of products, services, and business models that promote economic growth, reduce*

*environmental impacts and improve social well-being* (pg. 1).

The *State of Green Business 2009 Report* notes that many college graduates and experienced professionals are looking to join organizations that combine the entrepreneurial vitality of a for-profit enterprise with the benevolence and impact of a non-profit. These green socially responsible enterprises should prosper and help develop a distinctive, emerging green workforce (Lyon, et al, 2010).

Environmental responsibility is becoming a necessary topic for information technology (IT) enterprises and their suppliers of technology. According to Mines & Davis (2007), corporate IT will go green in the coming years, "driven by a combination of cost efficiency, regulatory compliance, and corporate responsibility motivations." (pg. 1).

It is clear that corporations, governments and educators are taking note of the impact of their own resource consumption on the environment. For example:

- Twenty-five percent of the world's population is consuming 70-80% of the world's resources (ACUPCC, 2009).
- By 2050 we will have 9 billion people and economic output that is increased 4-5 times (ACUPCC, 2009).
- According to McKinsey & Company, because of the increasing need for computational power, data storage and communications, the technology footprint amounts to about 2% of global greenhouse gas emissions, and is estimated to increase to 3% by 2020 (Makower, 2010).
- The U.S. has approximately 5% of the world's population and is consuming 25% of the world's resources (Education for Sustainable Development, n.d.).

The report on *The State of Green Business 2010* revealed positive indicators for the green economy, including environmental, health and safety (EHS) spending, employment, and green product development. According to Makower (2010), eighty-three percent said their 2010 EHS spending will be equal to or greater than 2009, with nearly half (43 percent) reporting an increase in spending. The

good news is that hiring freezes are thawing. Open requisitions for environmental- and sustainability-related positions rose from 18% in mid-2009 to 23% in early 2010. Finally, investments in green product development continue to show growth, especially in companies with revenues greater than US \$1 billion.

Not only did sustainability practices not go away amid the harsh economic environment, they actually survived and thrived, according to the report on *The State of Green Business 2010* (Makower, 2010). In addition, approximately 86 percent of U.S. companies said they planned to continue to invest in green products and programs in equal amounts as they did in the year prior (Makower, 2009).

### **Sustainability and Green IT**

Not everyone agrees on what defines sustainability. Arizona State University's Global Institute of Sustainability defines a sustainable society as one that,

*...considers the interconnectedness of environmental, economic, and social systems; reconciles the planet's environmental needs with development needs over the long term; and avoids irreversible commitments that constrain future generations. (What is Sustainability, para 1).*

Lyon, et al (2010) defines sustainability after Rosenbaum (1993) and Vieira (1993) as, *...using methods, systems and materials that won't deplete resources or harm natural cycles and as a concept and attitude in development that looks at natural land, water, and energy resources as integral aspects of development; sustainability also integrates natural systems with human patterns and celebrates continuity, uniqueness and stewardship* (pg. 3).

In its most general sense, sustainability refers to the *capacity to endure*. In ecological parlance, the word describes how biological systems maintain their well being over time. More specifically, for humans it refers to the potential for long-term maintenance of well-being, which is dependent upon the well-being of the natural world and the responsible use of natural resources.

There is abundant evidence that humanity is living unsustainably. As the earth's human population has increased natural ecosystems

have declined and changes in the balance of natural cycles have had a negative impact on both humans and other living systems. Returning human use of natural resources to within sustainable limits will require a major collective effort on the part of all humanity (Adams & Jeanrenaud, 2008).

There are ways of living more sustainably and they can take many forms, such as: reorganizing living conditions (eco-villages, sustainable cities, etc); reappraising economic sectors (green building, sustainable agriculture, etc.) or work practices (sustainable architecture); using science to develop new technologies (green technologies, renewable energy, etc.); and adjusting individual lifestyles to conserve natural resources.

Green IT or green computing is a subset of sustainability. According to Lamb (2009), *"Green IT is the study and practice of using computing resources efficiently. Typically, technological systems or computing products that incorporate green computing principles take into account the so-called triple bottom line of economic viability, social responsibility, and environmental impact. This approach differs somewhat from traditional or standard business practices that focus mainly on the economic viability or economic benefits rendered by a computing solution."* (pg. xxiv).

According to Ruth (2009), the "green computing" idea started in 1992 when the US Environmental Protection Agency (EPA) launched Energy Star. The term *green computing* has evolved over the past decade (Choi & Mata-Toledo, 2009). While there is no universal agreement on the definition of *green computing*, the authors consider it to encompass all aspects of computer technology that contribute to the reduction of global warming and e-waste through "alternative energy sources, power management, recycling and biodegradable materials." (pg. 1).

Andy Hopper, a professor of computer technology at the University of Cambridge defines the green computing movement as, "a multi-faceted, global effort to reduce energy consumption and promote sustainability." (Kurp, 2008, pg. 11).

Forrester Research defines green IT as, *IT suppliers and their corporate customers changing the way computing assets are*

*designed, manufactured, operated, and disposed of to gain efficiency and cost savings while reducing environmentally harmful impacts. Concerned about the environmental footprint of their companies, enterprises are constantly consolidating."* (Staten, 2008, pg. 4).

Economically, green computing strives to achieve economic viability as well as improved system performance and use while simultaneously abiding by our social and ethical responsibilities to contribute to a sustainable future. Thus, green IT must out of necessity include: the dimensions of economic sustainability; the economics of energy efficiency; and the total cost of ownership, including the cost of disposal and recycling.

Green IT is the study and practice of using computing resources efficiently across all of these dimensions. The goals of green computing include: reducing the use of hazardous materials; maximizing energy efficiency during the product's lifetime; and promoting recyclability and biodegradability of defunct products and factory waste (Murugesan, 2008).

Ruth (2009) believes that Green IT will become an integral part of the wider green movement because, "it is the largest single source of hazardous waste, or e-waste" and data center and server energy costs are substantial (pg. 78).

### **Importance to Business**

According to the 2010 report on *The State of Green Business*, what began as an ostensibly benevolent venture, green business shifted to a way to cut costs and improve corporate reputations. According to Makower (2010), "it has become a fundamental business competency, alongside accounting, finance, human resources, marketing, customer service, procurement, knowledge management and others." (pg. 4).

In November of 2009, the Wall Street Journal published a quiz, *How Well Do You Know...Green IT?* (Bulkeley, 2009). It included some interesting "fast facts" on green computing:

- Zombie servers are those that keep running even though they have nothing to

- do. These servers use a significant amount of electricity
- The consumption of electricity used by storage devices grew 191% between 2000 and 2006
  - Smart grid development efforts could create up to 280,000 jobs by 2012
  - IBM lead Greenpeace's CoolIT Challenge because of their proactive role in reducing their own emissions and broad scope of climate solutions
  - By turning off corporate computers at night, companies would save an estimated 20 million tons of carbon-dioxide emission in a year

Green IT has become a part of an elemental change in both the economy and society. According to Mines & Davis (2007), motivation for change came from government mandates, energy efficiency, product and company differentiations, and corporate social responsibility (CSR). In order for green computing and sustainability practices to work, they must be incorporated into the supply chain. Both suppliers and buyers understand that they must integrate green or sustainability practices into design, manufacturing, operation and disposal of their IT resources (Mines & Davis, 2007). Table 1 shows the evolution of sustainability practices; that is, it indicates how society currently participates in or views various sustainability issues, and how we will practice and view them in the future.

	<b>The Present</b>	<b>The Future</b>
Green regulations	Voluntary	→ Mandatory
Green consumers	Minority	→ Majority
Investor focus	Growing	→ Intense
Executive view	Leading-edge	→ Mainstream
Business initiatives	Niche projects	→ Core to business
Carbon tax	None	→ Multiple
Green IT	Interesting	→ Required

Source: Forrester Research, Inc. (2007)

Table 1: Predicted Changes in Sustainability Practices

### Importance to Education

Given the overwhelming movement toward sustainability practices and toward the incorporation of green IT into the corporate enterprise, it is incumbent upon educators to prepare students for a green workforce. According to The College Student Educators International (ACPA), "There is an urgent need for US higher education to advocate for sustainable development." (*Education for Sustainable Development*, n.d., pg. 1).

The American College & University Presidents Climate Commitment (ACUPCC) contends that higher education plays a "unique and critical role, one often overlooked, in making a healthy, just and sustainable society and a stable climate a reality." (pg. 5). The ACUPCC also believes that colleges and universities will be challenged to meet their responsibility to "provide the knowledge and educated citizenry that will lead to a thriving civil society." (ACUPCC, 2009, pg. 5).

The United Nations declared a ***Decade of Education for Sustainable Development*** (2005-2014) to "promote the local and global acceptance of principles of 'sustainable development'." (*Education for Sustainable Development*, n.d., para 1). HEASC, the Higher Education Associations Sustainability Consortium ([www.heasc.net](http://www.heasc.net)), plans to champion sustainability education throughout institutions of higher education.

The Bureau of Labor statistics (2009) predicted that employment of environmental scientists was expected to grow by 25% between 2006 and 2016. Beginning in fiscal year 2010, the US Bureau of Labor Statistics (BLS) will work with other Department of Labor (DOL) agencies and key organizations to define and produce data on green jobs, <http://www.bls.gov/green>. There is also a website dedicated to Green Jobs, <http://www.greenjobs.net>.

Corporate IT organizations and their suppliers consider environmental responsibility to be an emerging critical topic in most organizations. Green IT is a fundamental ingredient of corporate social responsibility and is often a starting point for such efforts because it yields timely operational and cost benefits (McClean, 2008).

Sadly, according to the ACUPCC (2009), the vast majority of college graduates know little about the importance of climate change or sustainability. In addition, they do not have their "personal, professional and civic lives aligned with sustainability principles." (pg. 13). This is both a challenge and opportunity for higher education to move swiftly to prepare students for a green workforce. According to ACPA, higher education can change operational, curricular, and policy norms so students can become "environmentally responsible, socially responsible, economically responsible, and active citizens in a global economy." (Education for Sustainable Development, n.d.). (pg. 2).

### **Degree programs**

The demand for Green IT knowledge by those in industry has yet to make its way to the academic environment. The Association for the Advancement of Sustainability in Higher Education (AASHE) indicates that as of April 2010, 34 colleges and universities are offering academic degrees in Sustainability – 17 offering sustainability degrees at the baccalaureate level, 15 offering sustainability degrees at the masters level, and 5 offering sustainability degrees at the doctoral level.

As of this writing it appears that there are no colleges and universities offering degrees in Green IT at any level, and our survey results indicate but one Swedish university offering a minor in Green IT (though this minor could not be verified on the university web site). Almost all of the minor programs are in sustainability, and none of the minor programs in sustainability include a course in Green IT.

A sustainability curriculum framework, *Education for Sustainability*, was developed by Second Nature ([www.secondnature.org](http://www.secondnature.org)). Second Nature's mission is, "to accelerate movement toward a sustainable future by serving and supporting senior college and university leaders in making healthy, just, and sustainable living the foundation of all learning and practice in higher education." (Second Nature Mission Statement, para. 1).

There are seven critical sustainability themes within their curriculum framework, including *Technological and Economic Relationships to Sustainability*. The technology theme includes the following topical areas:

- Technical, scientific and institutional strategies that foster sustainable development
- Energy and natural resource efficiency and conservation
- Shifting from nonrenewable resources (e.g., fossil fuels) to renewable resources
- Prevention and control of pollution and waste
- Design for the environment, industrial ecology and ecologically sustainable design
- Remediation of current environmental problems and preservation of biological diversity

In the world of IT, there is plenty of potential for advancement for those who know their way around green issues. The Chief Green Officer position is one that IT professionals are ideally suited for (Wheeland, 2009).

It is no secret that there is plenty of work ahead of us in moving the U.S. and other nations to a green economy. The trouble is not in finding people who need work, but rather in finding qualified and well trained workers to take on those jobs (Terry-Cobo, 2009).

For companies facing a shortage of applicants, a promising solution is in the works: Green jobs training programs will make it easier for companies to make those hires, and federal, state and local projects are helping spread those nationwide. However, according to Terry-Cobo (2009), there is currently no concrete definition of "green-collar jobs".

## **2. METHODOLOGY**

In spring 2010, the authors sent a request for participation to the academicians in higher educational organizations. There were 89 participants who replied from the USA and eight other countries.

### **Reliability**

The survey data was analyzed with descriptive statistics, cross tabulations, and analysis of variance (ANOVA) using SPSS 17.0. To avoid research bias, ANOVA with post hoc analysis was also used to determine whether the statistically significant differences found between the independent and dependent variables were reliable (Field, 2000).

## **Instrument**

A web-based survey which was composed of twenty-seven questions included both Likert scale and open-ended question types. The questions were then grouped into three parts to analyze the following categories: (a) Part I: Demographic Information (8 questions); (b) Part II: Courses Related to GITS areas (10 questions) (see Appendix B). After we received the human subject protection approvals from each institution, an email was sent out to several universities in the USA and in other countries. The survey link was activated from the end of January to mid-March 2010.

## **Research Hypotheses**

The purpose of this study is related to Green Information Technology (IT), Green Computing, and/or Sustainability (GITS) curriculum initiatives in institutions of higher education. The purpose of this study is threefold: 1) to evaluate whether GITS academic programs have been initiated in higher educational organizations; 2) to analyze if GITS programs and/or courses are currently in place; and 3) to investigate the conceptual framework of GITS across campuses. Therefore, we proposed and tested the following hypotheses:

- H1: GITS academic programs have been initiated in more than 50% of the higher educational organizations.
- H2: GITS programs are currently in place at more than 50% of the higher educational organizations.
- H3: There will be greater GITS course content in non-US versus US countries.

## **Participants**

Participants were invited from the colleagues of professional organizations and two major international conferences: Information System Educators Conference and Science Mathematics Technology Educators. A total of 185 invitations were sent and 89 participants completed the survey; they included 25 (28.7%) from the US Northeast; 12 (13.8%) from the US Midwest; 24 (27.6%) from the US South, 5 (5.7%) from the US West, and 21 (24.1%) from a country other than the US. Of those, eight countries were included: Argentina, Britain, Germany, Hong Kong, Ireland, Malaysia, Sweden, and Taiwan. Fifty-four percent of the participants were from educational institutions that have a total student population of greater than 10,000

students. A total of 61 colleges and universities were identified in this study. Gall, Gall, and Borg (2003) stated that the minimal total sample sizes for independent samples t test with Alpha at the .05 level of significance is 64 based on the medium effect size. In this study, we collected 89 samples which met this criterion to provide a reliable analysis for a medium effect size.

## **3. FINDINGS**

The findings provided below are based on the research hypothesis in the following section.

H1: GITS academic programs have been initiated in more than 50% of the higher educational organizations.

Our survey results indicated that a very high percentage of colleges/universities did not offer a GITS minor (89%) or GITS major (84%). One institution claimed to offer a degree in Green IT, and one institution claimed to offer a degree in Green Computing, but an extensive web search could not confirm these results. Further, one institution claimed to offer a minor in Green IT, and one institution claimed to offer a minor in Green Computing, but once again an extensive web search could not confirm these results. One possible explanation for this discrepancy is perhaps those answering the survey are doing so in anticipation of forthcoming programs that have yet to be approved and/or updated on the institutions' web sites. What we did find is that almost all of the minor programs are in sustainability, and that none of the minor programs currently include a course in Green IT.

Our results indicated that 30.6% of participants expect their college or university administrators to initiate and/or promote a Green IT or Green Computing academic program on campus. On the other hand, 27.4% of participants indicated that it was unlikely that their administration would do so. When asked about the expectation for the college/university faculty to design Green IT / Green Computing courses, 28.8% of the respondents indicated that they were likely to do so, but 42.4% of responses indicated the opposite expectation. Based on the analysis, we found that GITS academic programs have not been initiated in more than 50% of the

higher educational organizations, therefore H1 was rejected.

H2: GITS academic programs are currently in place at more than 50% of the higher educational organizations.

We found that 82.7% of the responses indicated that neither Green IT nor Green Computing courses were offered by their college or university. There are only three institutions who offer the GITS course in both undergraduate (9.6%) and graduate levels (3.8%). However, there are four other institutions where a GITS course is currently under development. Within programs of the 89 respondents, only 17 (19.1%) indicated that Green IT is covered in any of their IS/IT courses. In response to a related question, 97% of those who responded cover Green IT either little or very little.

The survey results of this study indicated that 5 universities are currently offering a course in Green IT. However, a look at the courses listed on their respective web sites could not verify the survey results. At best we can conclude that these courses are currently being offered as special topics courses, that the topic of Green IT was being covered as a portion of another course, or perhaps they are still under development.

Overall, research hypothesis 2 cannot be supported. GITS programs are currently not in place in more than 50% of the higher educational organizations. Very few have them and very few spend significant time on GITS topics in their other coursework.

H3: There will be greater Green GITS course content in non-US versus US countries.

Many countries outside of the US are viewed as having higher Green initiatives. Therefore it was expected that the universities surveyed outside the US would have higher Green IT course content. A comparison of means test for difference in course content between US and other countries found the same mean for both samples as shown in Table 5 (see Appendix). Hypothesis 3 was rejected. No difference was found between the US and other countries with regard to current GITS content.

### **Summary of Findings**

Among the suggested course topical areas regarding to GITS, we found that only a very small percent (less than 13.4%) of participants have very little Green IT course content. The feedback from the participants stated a common theme that higher education administrators need to be responsible for supporting sustainability curricula. These courses will provide the necessary foundational knowledge for students as future employees who enter the workforce having an understanding of the green economy and sustainability issues. Moreover, some comments stated that the time for GITS is now. Many educated people, including faculty and students, are unaware of the importance of sustainability issues and of the impact of Green IT efforts on the environment. Therefore, "awareness and enforcement" are needed for higher education to take for the first step.

While some participants stated that they were encouraged by having the vision of implementing GITS in their college/university, a few participants expressed their concerns regarding the practices in GITS. Among the concerns is the belief that their college/university administration is not willing to support GITS because they believe that GITS is not a "front burner" issue. It is unlikely to happen unless university administrators and faculty are able to see the advantages that Green IT could bring to the community and beyond. Some participants opined that although GITS is an important topic, it does not constitute a course. Some of the participants expressed the view that a "special topics course" might be sufficient or to offer Green IT as a standing elective course. One respondent stated, "Green IT is an ascendant concept in academia and will take some time to catch on."

## **4. RESULTS**

Regarding the correlations among the participants' demographic information, courses related to GITS areas, and the sustainability initiative in the school, we summarize the following findings from this study.

The results for our proposed hypotheses are stated as that follows:

H1 was rejected. The GITS academic programs have not been initiated in more than 50% of higher educational organizations collected from this study.

H2 was rejected. The GITS academic programs are not currently in place at more than 50% of the higher educational organizations collected from this study.

H6 was rejected. There was no difference between US vs. non-US countries in amount of GITS coverage.

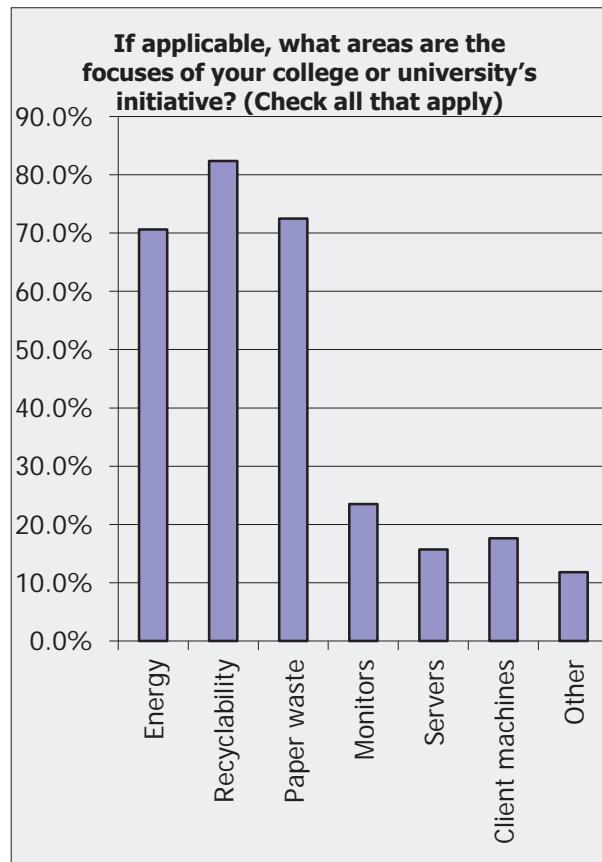


Figure 1. GITS Focuses

When asked what areas their respective college or university focused on with relation to GITS, we found the top three items that stood out were: Recyclability, Energy, and Paper Waste (see Figure 2). Overall, 56.7% of the respondents expect that Green IT/Green Computing courses will benefit environmental sustainability issues in the long run, but 17.9% expressed an unlikely expectation. To carry on the concern of the environmental sustainability

issues, 55.2% of participants would be willing to assist with implementing Green IT/Green Computing courses in their department or college. Only 13.5% responded that they are unlikely to assist in this area; however, 31.3% were neutral.

Among the suggested GITS course topical areas, the respondents suggested the following areas, as indicated in Table 2, from the most to the least important:

Table 2. Suggested GITS course topical areas

GITS Topical Area	Frequencies
Recyclability	8
Energy	6
Paper Waste	6
Sustainability Studies	6
Operations and Infrastructure	5
Energy Management Systems	5
Budget Management	4
Client Machines	4
Data Center Energy Consumption	3
Server Virtualization and Consolidation	3
Servers	3
Monitors	1

Table 3. GITS topical areas currently taught in other courses

Topics Taught in other Courses	Frequencies
Energy Management Systems	9
Energy	7
Data Center Energy Consumption	7
Operations and Infrastructure	7
Recyclability	7
Server Virtualization & Consolidation	7
Client Machines	6
Paper Waste	6
Budget Management	5
Sustainability Studies	5
Servers	4
Monitors	2
Other—Environmental Management	1

Twenty-five percent of those responding answered that they covered GITS topics in the courses that they are currently teaching. The respondents indicated that the following topics, as indicated in Table 3, were covered in their

courses from the most to the least popular. We also verified that 86.6% of the participants spent very little time on coursework that encompasses Green IT. GITS academic programs have not been initiated in more than 50% of higher educational institutions that participated in this study.

## 5. RECOMMENDATIONS

This study concluded that while there is an interest by higher education academicians in Green IT and Sustainability studies, very few institutions have incorporated Green IT into their curriculum. Based on the survey findings and a content analysis of several Green IT and sustainability books that are currently on the market (see Appendix A), we have recommended topical areas for a first course in Green IT (see Table 4). Interestingly, many of these areas mapped to the topical areas that many of the respondents have already incorporated into other classes in their IS/IT curriculum, or areas that the respondents perceived as notable.

While there are no textbooks in Green IT on the market to-date, Appendix A provides a list of Green IT and sustainability books (listed by publication date), websites, newsletters, and certification sites that one could utilize as resources and references in the Green IT course. Some of the books, e.g. *Greening through IT: Information Technology for Environmental Sustainability* and *Green IT for Dummies*, provide an overview of many of the areas listed in Table 3, while others, e.g., *The Shortcut Guide to Data Center Energy Efficiency*, provide information on very specific topical areas. In addition, one can find information on sustainability throughout in books such as, *Hot, Flat, and Crowded 2.0: Why We Need a Green Revolution--and How It Can Renew America*.

Incorporating the GreenBiz.com newsletters, *Greener Computing News* and *GreenBuzz*, into the Green IT course, will provide the students with up-to-date contemporary issues for discussion and research. While some sample videos were provided in Appendix A, it is recommended that faculty and students search YouTube at least once per semester for specific topical areas, e.g. e-waste, for access to current videos.

If the course does not have another sustainability course as a pre-requisite, we recommend that the Green IT course begins with an overview of sustainability concepts, followed by an overview of Green IT concepts. We recommend no specific order in which to present the other topical areas. While other subject areas were presented in the GITS books that were reviewed, the twelve recommended topics below were presented in two or more books. This list should provide the instructor a strong foundational course in Green Information Technology.

Table 4. Content analysis of Green IT publications: GITS topical areas

GITS Topical Areas	Frequency Ranking
Virtualization	1
Virtual Servers	
Desktop Virtualization	
Server ROI & Implementation	
Energy Use	2
Carbon/Environmental Footprint	
Metrics	
Power Savings	
Energy Resource Efficiency	
Technology Infrastructure	3
Resource Management	
Green Hardware	
Green Data Center	4
Cooling	
Data replication	
Efficiency	
Design	
Human Factors	5
Employees/Virtual Workers	
Customers	
Creating a Green Culture	
Document and Data Storage	6
Management	
Green IT Checklist	7
Planning, Policies, Strategies	
Problems/Pitfalls	
IT Asset Disposal & Recycling	8
e-Waste	
Green Computing & Sustainability	9
Basics	
Legal/Government Standards	10
Paperless	11
Green Supply Chain	12

## 6. CONCLUSIONS

The demand for Green IT knowledge by those in industry has yet to make its way to the

academic environment. The Association for the Advancement of Sustainability in Higher Education (AASHE) indicates that as of April 2010, thirty-four colleges and universities are offering academic degrees in Sustainability – 17 offering sustainability degrees at the baccalaureate level, 15 offering sustainability degrees at the masters level, and 5 offering sustainability degrees at the doctoral level.

As of this writing it appears that there are no colleges and universities offering degrees in Green IT at any level, and our survey results indicate but one Swedish university offering a minor in Green IT (though this minor could not be verified on the university web site). Almost all of the minor programs are in sustainability, and none of the minor programs in sustainability include a course in Green IT.

Our survey results indicated that five universities are currently offering a course in Green IT. However, a look at the courses listed on their respective web sites could not verify the survey results. At best we can conclude that these courses are currently being offered as special topics courses, or that the topic of Green IT was being covered as a portion of another course.

EDUCAUSE concluded that engagement of most institutions of higher education in sustainability practices is "more optimistic than systemic." (Sheehan & Smith, 2010, pg. 18). Cameron (2009) stated, "As IT professionals, educators, and researchers, we share a responsibility to identify key contributors to energy and environmental waste in our field. But simply identifying problems is not enough; we also have the responsibility to act." Survey respondents shared similar expectations toward environmental sustainability issues.

According to Jucker (2003), "Sustainability is achieved when all people on Earth can live well without compromising the quality of life for future generations." (pg. 85). Institutions of higher learning should therefore strive to explore the value of Green IT & Sustainability initiatives through academic programs to fulfill a common goal as digital citizens.

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**Editor's Note:**

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## Appendices and Annexure

Table 5. Descriptive—Green IT Course Content in US vs. non-US Countries

GI Covered

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for	Minimum	Maximum
					Mean		
US	52	1.75	.437	.061	1.63	1.87	1
Other Country	16	1.75	.447	.112	1.51	1.99	1
Total	68	1.75	.436	.053	1.64	1.86	2

## Appendix A

### Green IT and Sustainability Resources

#### BOOKS

#### **Greening through IT: Information Technology for Environmental Sustainability**

Bill Tomlinson

Hardcover: 216 pages

Publisher: The MIT Press (May 3, 2010)

ISBN-10: 0262013932

ISBN-13: 978-0262013932

#### **The Shortcut Guide to Data Center Energy Efficiency**

David Chernicoff

Published April 28, 2010

Format: Kindle Edition

File Size: 1169 KB

 Publisher: Realtime Publishers (March 1, 2010) ASIN: B003M68XP8

<http://www.greenbiz.com/business/research/bookstore/2010/04/27/shortcut-guide-data-center-energy-efficiency#ixzz0qS38NALP>

**CompTIA Strata - Green IT Certification Exam Preparation Course in a Book**

William Manning

Paperback: 188 pages

Publisher: Emereo Pty Ltd (January 15, 2010)

ISBN-10: 1742442463

ISBN-13: 978-1742442464

**Hot, Flat, and Crowded 2.0: Why We Need a Green Revolution--and How It Can Renew America**

Thomas L. Friedman

Paperback: 528 pages

Publisher: Picador; Exp Upd edition (November 24, 2009)

ISBN-10: 0312428928

ISBN-13: 978-0312428921

**The Green Collar Economy: How One Solution Can Fix Our Two Biggest Problems**

Van Jones

Paperback: 272 pages

Publisher: HarperOne (September 29, 2009)

ISBN-10: 0061650765

ASIN: B003GAN3FK

**Grow a Greener Data Center**

Douglas Alger

Paperback: 336 pages

Publisher: Cisco Press; 1 edition (August 27, 2009)

ISBN-10: 1587058138

ISBN-13: 978-1587058134

**Foundations of Green IT: Consolidation, Virtualization, Efficiency, and ROI in the Data Center**

Marty Poniatowski

Paperback: 352 pages

Publisher: Prentice Hall; 1 edition (August 21, 2009)

ISBN-10: 0137043759

ISBN-13: 978-0137043750

**Green Recovery: Get Lean, Get Smart, and Emerge from the Downturn on Top**

Andrew Winston

Hardcover: 200 pages

Publisher: Harvard Business Press (August 1, 2009)

ISBN-10: 1422166546

ISBN-13: 978-1422166543

**Green Tech: How to Plan and Implement Sustainable IT Solutions**

Lawrence Webber, Michael Wallace

Hardcover: 292 pages

Publisher: AMACOM; 1 edition (July 28, 2009)

ISBN-10: 081441446X

ISBN-13: 978-0814414460

**The Greening of IT: How Companies Can Make a Difference for the Environment**

John Lamb

Paperback: 352 pages

Publisher: IBM Press; 1 edition (May 7, 2009)

ISBN-10: 0137150830

ISBN-13: 978-0137150830

**The Green IT Pocket Pack**

By View Site

Published April 28, 2009

The complete set includes:

The Green Agenda: A Business Guide (Softcover)

The Green Office: A Business Guide (Softcover)

Compliance for Green IT: Pocket Guide (Softcover)

<http://www.greenbiz.com/business/research/bookstore/2009/04/28/green-it-pocket-pack#ixzz0qS54nvEV>**Green IT For Dummies**

Carol Baroudi, Jeffrey Hill, Arnold Reinhold, Jhana Senxian

Paperback: 364 pages

Publisher: For Dummies (April 27, 2009)

ISBN-10: 0470386886

ISBN-13: 978-0470386880

**Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage**

Daniel Esty, Andrew Winston

Paperback: 408 pages

Publisher: Wiley; Rev Upd edition (January 9, 2009)

ISBN-10: 0470393742

ISBN-13: 978-0470393741

**The Green and Virtual Data Center**

Greg Schulz

Hardcover: 396 pages

Publisher: CRC/Auerbach Publications; 1 edition (January 26, 2009)

ISBN-10: 1420086669

ISBN-13: 978-1420086669

**Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line**

Toby Velte, Anthony Velte, Robert Elsenpeter

Paperback: 308 pages

Publisher: McGraw-Hill Osborne Media; 1 edition (September 8, 2008)  
ISBN-10: 0071599231  
ISBN-13: 978-0071599238

**75 Green Businesses You Can Start to Make Money and Make A Difference**

Glenn Croston  
Paperback: 328 pages  
Publisher: Entrepreneur Press; 1 edition (August 1, 2008)  
ISBN-10: 1599181800  
ISBN-13: 978-1599181806

**ENCYCLOPEDIAS****Green Business: An A-to-Z Guide**

Nevin Cohen, general editor/Paul Robbins, series editor  
Electronic ISBN 978-1-4129-7379-3  
2010 by SAGE Publications, Inc.

**CERTIFICATION****Green IT Certification**

Global Knowledge  
<http://www.globalknowledge.com/training/course.asp?pageid=9&courseid=13290>

**Tonex Green IT Boot Camp**

<http://www.tonex.com/Courses/100103/>

**CompTIA Strata Green IT Certificate**

<http://www.comptia.org/certifications/strata/greenit.aspx>

**MSP Alliance Green IT Certification**

<https://www.mspalliance.com/why-mspa/green-it-certification-program>

**CISCO Green IT Certification**

[https://learningnetwork.cisco.com/community/learning\\_center/green\\_it](https://learningnetwork.cisco.com/community/learning_center/green_it)

**VIDEOS****Green Recovery: Emerge from the Downturn on Top**

[http://www.youtube.com/watch?v=WLX\\_hKT3JTY](http://www.youtube.com/watch?v=WLX_hKT3JTY)

**HarvardBusiness** — August 25, 2009 — Andrew Winston, founder of Winston Eco-Strategies, explains how to get lean, get smart, and emerge from the downturn on top. 12 min

**Green Recovery: Get Lean, Get Smart, and Emerge from the Downturn on Top**

[http://www.youtube.com/watch?v=EC\\_I6TdCS14](http://www.youtube.com/watch?v=EC_I6TdCS14)

August 28, 2009 — Andrew Winston is interviewed by Harvard Business Publishing on Green Recovery. 4:11 mins

**Explaining Green Computing**

<http://www.youtube.com/watch?v=350Rb2sOc3U>

August 22, 2008 — When it comes to being green, computing is both part of the problem and part of the solution. This video therefore looks at the environmental aspects of computing, and is presented by Christopher Barnatt, author of ExplainingComputers.com, and Associate Professor of Computing and Organizations in Nottingham University Business School. 7:18 mins

**5 Green Computing Tips**

<http://www.youtube.com/watch?v=SdxPgjfQ9yk>

March 17, 2008 — InformationWeek Green Computing blogger Cora Nucci offers advice to make your data center more eco-friendly, and economical, too. 2:29 mins

**The definitive guide to green computing**

<http://wwwcomputing.co.uk/computing/video/2224462/ctg-def-guide-green>

Jul 10, 2008 - Rising energy costs mean going *green* makes business sense - we look at the latest trends. 6 min

**Earth Week Green Computing Solutions Series**

e.g., Earth Week: Green Computing Solutions #2 - Top Green Web Sites

<http://www.watchdoit.com/how-to-videos/Earth-Week-Green-Computing-Solutions-2-Top-Green-Web-Sites-36946.aspx>

**WEBSITES & NEWSLETTERS****Greener Computing News and GreenBuzz e-newsletters**

[www.greenbiz.com](http://www.greenbiz.com)

Newsletter comes once per week, includes links to blogs and podcasts

**Greener Design**

[www.greenerdesign.com](http://www.greenerdesign.com)

**Green Life**

[www.thegreenlife.org](http://www.thegreenlife.org)

**Second Nature**

[www.secondnature.org](http://www.secondnature.org)

**Sustainability**

[www.sustainability.com](http://www.sustainability.com)

**Village Earth**

[www.villageearth.org](http://www.villageearth.org)

## Appendix B

### Survey

**Part I: Demographics**

1. What is the total student population of your college or university (your location only)?  
Less than 1000  
1000-2000  
2000-5000  
5000-10000  
+10000
  
2. Where is your school located?  
US Northeast  
US MidWest  
US South  
US West  
Other country \_\_\_\_\_
  
3. What type of IT degree do you offer?  
CS  
IS  
IT  
MIS  
None  
Other \_\_\_\_\_
  
4. What is the gender type of your IT students?  
< 10% Female  
10-25% Female  
25-50% Female  
More than 50% Female
  
5. What is your gender?  
Female  
Male  
Prefer not to answer
  
6. What is your age range?  
18-25  
25-35  
35-50  
50+  
Prefer not to answer
  
7. What is your academic rank?  
Adjunct  
Instructor  
Assistant Professor  
Associate Professor  
Professor  
Other \_\_\_\_\_
  
8. What is the name of your university? (This information will be kept in the strictest confidence and will not be used in the report manuscript)

9. What is the name of your department? (This information will be kept in the strictest confidence and will not be used in the report manuscript)

**Part II: Green IT / Green Computing courses**

1. Does your university offer a Green IT, Green Computing or Sustainability major? (Check all that apply)

- Green IT
- Green Computing
- Sustainability
- None of the above
- Currently under development
- Other \_\_\_\_\_

2. Does your university offer a Green IT, Green Computing or Sustainability minor? (Check all that apply)

- Green IT
- Green Computing
- Sustainability
- None of the above
- Currently under development
- Other \_\_\_\_\_

3. Does your university offer a Green IT or Green Computing course? (Check all that apply)

- Green IT
- Green Computing
- Both
- Neither
- Currently under development
- Other \_\_\_\_\_

4. If so, which topical areas are included or proposed? (Check all that apply)

- Budget Management
- Client machines
- Data Center Energy Consumption
- Operations and infrastructure
- Energy
- Energy Management System
- Monitors
- Paper waste
- Recyclability
- Server virtualization and Consolidation
- Servers
- Sustainability Study
- None
- Other \_\_\_\_\_

5. If so, at which academic level? (Check all that apply)

- Undergraduate
- Graduate
- Both UG and Grad
- Do not offer

6. Do you personally offer this course?

- Yes
- No, another colleague teaches this course
- Do not offer

7. If your university offers neither a Green IT nor a Green Computing course, are Green IT, Green Computing, or Sustainability covered in any of your IS/IT courses?

Yes

No

8. If so, which topic areas are covered? (Check all that apply)I

Budget Management

Client machines

Data Center Energy Consumption

Operations and infrastructure

Energy

Energy Management System

Monitors

Paper waste

Recyclability

Server virtualization and Consolidation

Servers

Sustainability Study

None

Other \_\_\_\_\_

9. If so, would you mind sharing a copy of your syllabus with us?

Yes

No

If yes, what is your email address so that we might contact you:

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10. On a scale of 1 to 5 (1-very little, 5- a great deal), how much of your coursework deals with Green IT?