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Formulating an Introductory Class for "Sustainability Science" Within a Global Classroom Setting

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Abstract — This article describes the development of a global classroom for Sustainability Science at Hokkaido University, Japan with emerging needs for this new discipline to solve current pressing global issues. In collaboration with five other higher education institutes across Asia and Africa, a real-time virtual classroom for sustainability science was created via an internet-based videoconference system for Introductory Sustainability Science. This effort aimed to open the door to graduate students who have been trained in traditional single disciplines to gain abilities to understand and attempt to solve current pressing global issues requiring interdisciplinary approaches. While the efforts established a solid program and attracted students from the six universities, geographical and cultural challenges among the universities (e.g., time differences, academic calendars, the stability of internet connections, sensitivities of technical terms in lectures, and biased class participation) were identified in the process of building and operating the system. In the process of further development, feedback from students and instructors has started to illuminate the path to a more solid course structure and content. This sustainability science framework enables the sharing and exchange of educational resources among the participating universities. Each university brings its research strengths and a unique cultural locality to this unified effort. This article presents the ideological background, and articulates the vision and objectives of this program. Finally, opportunities and current issues are discussed.

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1. Introduction

People the world over are searching for solutions to the issues - both global and local - that are challenging the sustainability of our society. These include: climate change, the need for alternative and renewable energy sources, poverty and hunger alleviation, dwindling natural resources, food security and economic instability. To help meet the demand for qualified professionals equipped with the tools to seek solutions, training programs for graduate students are urgently needed.

At the Center for Sustainability Science, Hokkaido University, Japan, we have assembled many of the resources necessary to develop and provide introductory courses in Sustainability Science as a part of the Special coordinated training program for Sustainability Leaders and Sustainability 'Meisters' (*StraSS*). *Sustainability Science I and II* are both provided in real-time to partner

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universities in Asian and African regions via an Internet-based remote classroom system. These courses, which give graduate students a rare opportunity to learn about issues affecting sustainability in a variety of disciplines and regional settings, may have a significant role to play in shaping sustainable future societies.

StraSS has its origins in a previous project, the Sustainability Governance Project (SGP). The SGP established the Hokkaido University Interdepartmental Graduate study in Sustainability (or HUIGS), a certificate educational course open to all graduate students at Hokkaido University, Sapporo campus. Faculty of Fisheries Sciences students, who are based in Hakodate, can attend this lecture series via the videoconference system. All students have their own special research fields, but HUIGS tries to instill in them a sustainability mindset. The term "Birds-eye view" is one of the most important keywords of the HUIGS courses, because students should not have any fixed viewpoint - their viewpoints should be flexible and capable of change when necessary. HUIGS provides seven lecture series in total, two of which - *Sustainability Science I and II* - are recognized as being both fundamental and compulsory.

In this paper we describe the evolution of *Sustainability Science I and II* from the aforementioned programs. We introduce the ideological backgrounds necessary to formulate a keystone introductory course to Sustainability Science by defining three terms, Sustainability, Sustainable Development, and Sustainability Science. Based on these definitions, we articulate our vision and propose several objectives for the introductory courses. We then describe our efforts to design class structures and our on-going efforts to create internationally shared classes via an internet-based videoconferencing system. Finally, opportunities and current issues are discussed.

2. Background: Sustainability and Sustainability Science

It is an oft-repeated theme. In the early 1980's the concepts of *Sustainability* were developed from scientific perspectives on the relationships between nature and society in order to seek solutions to core concerns (Kates et al 2001). With the subsequent rise of societal and political interests in *Sustainability*, the most frequently quoted definition of *Sustainability* was induced by the 1987 paper, *Sustainable Development* in *"Our Common Future,"* also known as the *Brundtland Report* by the *World Commission on Environment and Development* (The World Commission on Environment and Development (WCED) 1987) which stated:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

This definition implies three elements: 1) a common agenda that *Sustainability* refers to the *Sustainable Development* of society, 2) to realize *Sustainable Development* while allocating finite resources for human needs, we need to maintain the ecological services provided by the earth as conditioned by the current state of technological and social structures, and 3) *Sustainable Development* must ensure we meet present and future needs. These are the base elements of *Sustainable Development.* Therefore, *Sustainability* requires that we see society and nature as a complex integrated system; one that is both locally and globally connected; one that links current and future generations. In this paper, we accept *Sustainable Development* as a proxy for *Sustainability*.

One key issue in the field of *Sustainable Development* is the competence of the match between the real world and the underlying conceptions of how science understands it. Framing solid conceptual boundaries around either natural or social systems can hamper what might be termed a more holistic understanding of the suppressed problems we are facing (Paula et al 2010). Yet, our traditional research and educational structures and practices are widely characterized by disciplinary compartmentalization.

We need to transform research and education into an entirely new interdisciplinary field by bridging between various disciplines in both science and the humanities to effectively facilitate *Sustainable Development* (Godermann 2008). This concept is driving academics to focus their attention on research and education for *Sustainable Development*. A new academic focal point, *Sustainability Science*, is emerging to more fully understand the fundamental characteristics of the social

and natural interactions that underpin *Sustainable Development* (Kates et al. 2001).

The first challenge we face to establish an education program for sustainability is the need to organize courses under a single title, essentially "*Sustainability Science*." Unfortunately this term is confusing as it implies *Sustainability Science* is an established discipline with shared conceptual frameworks and theoretical backgrounds. Instead we must portray "*Sustainability Science*" as the Science of Sustainability dependent on a notion of multiple disciplines addressing a common theme, *Sustainable Development* (National Research Council 1999). *Sustainability Science* is problem-driven, with the goal of creating and applying a cluster of interdisciplinary knowledge to support the decision-making for *Sustainability Development*.

The *Special coordinated training program for Sustainability Leaders and Sustainability 'Meisters' program (StraSS) at the* Center for Sustainability Science (CENSUS), Hokkaido University is one of two signature certificate programs at CENSUS (the other is the Hokkaido University Inter-department Graduate study in Sustainability: HUIGS). *StraSS* seeks to train graduate students to work as leaders able to resolve the issues affecting local and global sustainability by offering a certificate Sustainability program for graduate students. This program has been emerged from the needs for *Sustainability Science* - new discipline approach with multidisciplinary backgrounds to solve pressing problems we are facing in the world.

There is a critical need to accelerate our efforts to train human resources for *Sustainable Development*. Part of our vision for introductory *Sustainability Science* courses is to open the door to graduate students that have been trained in traditional single disciplines and have limited international experience - in other words to broaden their *Sustainable Development* horizons from both interdisciplinary and global perspectives. It is also our intent to provide opportunities to students outside university. Utilizing an Internet-based videoconferencing system, we can design introductory *Sustainability Science* courses that can be simultaneously shared by universities in both the global North and South so that participating students and faculty members can share the realities of local and global sustainability and exchange ideas to achieve *Sustainable Development*. For our ultimate goal, we would like to see this framework for introductory *Sustainability Science* courses become an internationally recognized benchmark. Thus, through these classes we hope to establish a common sustainability educational platform for North and South as part of an effort to make "qualitative development" a global initiative as well as fulfilling the needs for *Sustainability Science* coming from the world.

3. Objectives of the Classes

These courses are designed to provide an introduction to sustainability science to graduate students coming from diverse academic and cultural backgrounds. We assume our students do not have any prior knowledge or experience in *Sustainability* or *Sustainable Development*. Instructors are invited from different disciplines and different partner universities in Asia and Africa. Each instructor is asked to present his/her own view of *Sustainability* or *Sustainable Development* so that students can be exposed to diverse perspectives on Sustainability.

The *StraSS* alliance, which consists of six Asian and African universities, collaboratively develops and promotes an internationally shared sustainability education program for graduate students. The Alliance members are: University of Palangka Raya (UPR), Indonesia, University of Gadjah Mada (UGM), Indonesia, International Institute for Water and Environmental Engineering (2iE), Burkina Faso, Zhejiang University (ZU), China, National Cheng Kung University (NCKU), Taiwan and Hokkaido University (HU), Japan. An internet-based videoconferencing system is used to simultaneously connect classrooms at each of these institutions. This enables us to establish a "global classroom" for *Sustainability Science*.

The objectives for all participating universities are as follows:

- To present concepts of sustainability and sustainable development issues across a wide range of contexts, disciplines and regions;
- To provide opportunities for students to identify and define "sustainability" in their own academic

disciplines and research topics;

- To share diverse realities and perspectives of sustainability by facilitating an internationally-shared classroom environment;
- To realize a mutual sharing of educational resources among participating universities.

The objectives for graduate students at Hokkaido University are as follows:

- To gain an understanding the earth systems with multi-disciplinary perspectives.
- To recognize the needs to change in our society toward *Sustainable Development*.
- To extend their international and cross-cultural knowledge and experiences;
- To experience an English-language learning environment;
- To gain international and global perspectives.

4. Structure of the Classes

The class is the product of the *StraSS* alliance university collaboration (Table 1). The official language of instruction is English. In addition to students, faculty members from each university also participate as instructors and facilitators. This requires that participants are willing to share their experiences and engage in shared dialogues. The teaching team has a shared responsibility for what this course delivers through their individual levels of expertise.

Each faculty member's underpinning beliefs and concerns about sustainability are explicitly articulated by providing an omnibus style lecture series in which each instructor is responsible for one ninety-minute session. For the first sixty minutes, the instructor addresses sustainability from the perspectives of his/her research concerns, academic discipline and regional background. The remaining class time, thirty minutes maximum, is allocated to questions for the instructor and to generate discussion among campuses. Furthermore, instructors are encouraged to assign several questions about the content of lectures as homework.

In 2011, the first year this framework was attempted, a total of 22 sessions were set and instructors were assigned to each session (Table 2). NCKU provided two sessions, 2iE provided three, ZJU and the World Bank both provided one each and HU provided 15 sessions. Although HU provides facilitators for the global classroom, each university has the responsibility to provide a faculty member to facilitate sessions in its own classrooms and to help broadcast the classes provided by their own instructors.

During the design stage, organizing faculty members carefully chose instructors from each participating university so that *Sustainability Science* could cover a wide range of up-to-date sustainability science issues and concepts, and to ensure that lectures did not overlap in content. All classes are categorized as *Sustainability I* (science-oriented) or *Sustainability II* (humanities-oriented) sessions. To evenly balance science and humanities to maintain interdisciplinary flavor, 11 classes were allocated for each category. At Hokkaido University, in addition to the 22 regular sessions, there were four discussion classes ("discussion class" in Table 2) conducted without connecting to partner institutions, followed by a set of six lectures delivered by different instructors. Over the past two decades, scientists and economists have had numerous discussions about *Sustainable Development* and *Sustainability*. Under finite ecological services and resources the word *development*

Table 1. *StraSS* Alliance Universities (Participating Universities)

Name of University	Location
University of Palangka Raya	Palangka Raya, Indonesia
University of Gadjah Mada	Yogyakarta, Indonesia
International Institute for Water and Environmental Engineering	Ouagadougou, Burkina Faso
Zeijiang University	Hangzou, China
National Cheung Kung University	Tainan, Taiwan
Hokkaido University	Sapporo and Hakodate, Japan

Table 2. Schedule and Classes Provided by Participating Universities

Date		Class title	Lecturer / Facilitator	Date		Class title	Lecturer / Facilitator
				Apr	7	Orientation	Prof. Noriyuki Tanaka (CENSUS, HU)
Apr	11	Earth history and global sustainability	Prof. Noriyuki Tanaka (CENSUS, HU)	Apr	14	Introduction to land change science	Prof. Ademola Braimoh (World Bank)
Apr	18	Land ecosystem and agricultural activities: Is it sustainable?	Prof. Mitsuru Osaki (Agriculture, HU)	Apr	21	Marine ecosystems and sustainable marine resources	Dr. John Bower (Fisheries Science, HU)
Apr	25	Societal applications in fisheries & acuaculture using remotely-sensed imagery and marine-GIS	Prof. Seiichi Saito (Fisheries Science, HU)	Apr	28	Ecological Agriculture: a holistic approach to sustainable agriculture	Dr. Xujun Ye (ZJU)
May	2	Class discussion		May	5	No class	
May	9	Systems thinking for sustainability	Dr. Yasuhiro Fukushima (NCKU)	May	12	Rethinking of resources	Prof. Noriyuki Tanaka (CENSUS, HU)
May	16	The commons without tragedy	Dr. Gakushi Ishimura (CENSUS, HU)	May	19	Ethics for sustainable society	Dr. Shunzo Majima (Letters, HU)
May	23	Sustainable and cyclical economy of Asia	Prof. Fumikazu Yoshida (Public Policy School, HU)	May	26	An introduction to carbon credits	Ms. Nathalie Weisman (2iE)
May	30	Solar thermal power plants: CSP technologies	Dr. Yao Azoumah (2iE)	Jun	2	No class	
Jun	6	Class discussion		Jun	9	An introduction on Industrial Ecology and Sustainable Engineering	Prof. Didier Lecomte (2iE)
Jun	13	Emerging contaminants in aquatic environment	Prof. Pei-Hsin Chou (NCKU)	Jun	16	Introduction to sustainability science lecture on cleaner production	Prof. Naoyuki Funamizu (Engineering, HU)
Jun	20	TBD	Prof. Hidehiko Tamashiro (Medicine, HU)	Jun	23	Food security	Dr. Anthony Chittenden (CENSUS, HU)
Jun	27	Class discussion		Jun	30	Market, capitalism and industry	Prof. Takao Sasaki (CENSUS, HU)
Jul	4	Environmental citizen participation and deliberation	Prof. Nobuo Kurata (Letters, HU)	Jul	7	Environmental policy of EU	Dr. Kazuto Suzuki (Law, HU)
Jul	11	Low Carbon Society	Dr. Masahiko Fujii (Environmental Science, HU)	Jul	14	Class discussion	
Jul	18	No class		Jul	21	Examination	
Jul	25	Examination		Jul	28	Reserved day	

connotes the economic growth of a society rather than a steady state - which would accelerate the consumption of finite resources and lead to immoderate utilization of ecological services. Economic growth and the use of limited resources should be mutually reinforcing, but in reality they are often in conflict. Moreover, economic growth in the physical sense can have negative impacts on our society; while excessive growth may include negative costs to society (e.g., pollution and global warming) that increase much faster than any benefits (Daly 1996). Although it has a limitation on available faculties from participating universities, a structure of the classes are carefully chosen reflecting to this fact and current topics in sustainability.

Evaluation of student performance is the responsibility of each university rather than the *StraSS* alliance. This approach was adopted to avoid merging dissimilar academic calendars and evaluation methods among the universities. At Hokkaido University, a final written exam is conducted to evaluate students. Organizing faculty members at Hokkaido University set questions carefully to cover all the topics to which the students were exposed.

5. Discussion

Sustainability Science enables students to broaden the horizons of their knowledge and experience, making them more interdisciplinary and global. At the graduate program level, students are usually required to focus on narrow topics within their discipline. For students, the motivation to study in an alternative interdisciplinary environment included enhancing their ability to adjust to shifting job markets, to develop new career paths, to sense the relevance of their subjects and to develop more flexible skills (Paula et al. 2010).

Spared the need to travel long distances or pay high costs, students benefited from our global classroom experience. In our classroom, instructors from five overseas universities provide classes via an Internet-based videoconferencing system and students from different campuses (thus, countries) can ask the instructors stimulating questions based on their varied regional, academic and cultural backgrounds.

Our *Sustainability Science* framework enables us to share and exchange educational resources among the participating universities. Each university brings its research strengths and a unique cultural locality. With the keen participation of students and faculty members, we can share educational resources that enhance the capacities of all participating universities.

This is an on-going effort and the course is still evolving. However, several issues have been identified:

1) *Time differences among Asian and African regions:* While the time difference across Indonesia, Taiwan, China and Japan is just three hours, the difference between Japan and Burkina Faso is nine hours. By setting the classes to start at 18:30 JST, 2iE can adopt this course as the first morning class. When considering the work hours for staff and faculty members at each university, nine hours should be the maximum acceptable time difference in this global campus framework.
2) *Academic calendar and national holidays:* Academic calendars and holidays differ among universities and countries. Regular communication and coordination between member institutions is a key to success.
3) *Stability of Internet connections:* Stable Internet connections are essential. In developing nations like Indonesia and Burkina Faso, securing and maintaining Internet stability has proven to be a challenge. The success of our global classroom efforts under the present framework is heavily dependent on the presence of stable Internet connections.
4) *Sensitivity to technical terms:* Instructors must be aware of the need to provide clear definitions of technical terms related to sustainability (e.g., climate, global, and resources). Without an instructor providing clear unified definitions of such terms, we noticed that students in different countries often have different understandings of the same term. One solution could be to develop a *Wiki* type web-based glossary for important technical terms. In addition to being easy to use, wiki's can be updated with new terms as necessary by any *StraSS*-affiliated instructor. Students could also add their own terms and definitions.
5) *Biased classroom participations:* At Hokkaido University international students have consistently comprised over 80% of the total student enrollment in *Sustainability Science*, despite the program being widely advertised in English and in Japanese throughout the university. This may reflect that; 1) The number of alternative English-language classes available to international students at Hokkaido University is very limited, and/or 2) classes requiring English communication skills intimidate Japanese students at Hokkaido University. Then again it may simply reflect that foreign students have a greater interest in sustainability issues. Offering more classes in Japanese may shed more light on this issue.

While the development of the *Sustainability Science I and II* courses was ongoing, a survey was conducted to get feedback from students taking the classes. This feedback has started to illuminate the path to a more solid course structure and content. Of the thirteen students from different partner institutions that participated in the initial survey, most were graduate students (69. 2% Master students and 23. 1% Doctoral students) from diverse cultural backgrounds. Twelve students selected this course as it matched well with their interests. All students expressed overall satisfaction with the courses and most of them (84.6%) found that the courses met their expectations. Unfortunately, nearly 40% of the students found that the time allocated for discussion too

Table 3. Comments from students who participated in the classes

	Comments
Student A	Courses were alright, but some of them were not that easy to understand and relevant to the title of that specific lecture
Student B	All instructors show clearly by thinking the sustainability precaution should be taken regarding environmental, economical and social aspects.
Student C	There was some hints about what is "sustainability" but no real definition or demonstration, in my point of view.
Student D	these courses between many universities are a good initiative
Student E	To make it easier for students to full lectures it is better for instructors to state clearly the connection of their lectures with sustainability at the beginning of the classes.
Student F	all aspect related to our resources, how can we managed them for a long lasting time.
Student G	Discussion parts are one of the best, because it is another way to go through the new topic and new ideas.
Student H	I really like the courses on sustainable agriculture because these courses give to me essential way to rethink agriculture practices in my country
Student I	I think there should be more discussion time, and time limitation for some lecturers who speak all way 80 minutes without giving a chance to ask questions
Student J	Union and communication among both, students-professors and students
Student K	The fact that we could argue in class over topics that are completely irrelevant in our lives. It truly was amazing to see the selfishness and the ideals of students from third world and developing countries. It actually opened my eyes to see why these countries are where they are in terms of advancements today.
Student L	had discussion with students from other countries,
Student M	The aspect of the course that I really liked was the question and discussion section as well as the presentation of what has being discussed. This is because it helped me to think and provide solutions to some critical issues and questions and also helped me to be able to lead and speak in public.
Student N	Cross cultural discussion was a great experience for me.

limited. Moreover, a few students thought that several instructors did not clearly define any sustainability concepts in their lectures. Some of the comments from students who participated in the survey are shown (Table 3). Following this survey, several important course improvements were decided and implemented in the following year's program. These measures included the preparation of lecture guideline materials that need to be followed by all instructors. This guideline stresses to lecturers that their lectures need to be designed in such a way that takes into account the diverse backgrounds and cultures of the students. Also, each lecture should start with a clear definition of the sustainability concepts the lecturer is attempting to address. Moreover, we strongly recommend instructors to allow a thirty-minute discussion session at the end of each lecture to encourage interaction among students. This is in addition to the normal discussion classes that regularly take place after each group of five to six lectures.

6. Conclusions

StraSS program will be closed in 2015 due to the luck of financial support. However, gained experiences during the process of establishing and operating will remain valuable for students and people associated with. It should be noted that our efforts to formulate an introductory Sustainability Science course with a global campus are well underway. This was our attempt to build a standardized international educational platform for *Sustainability Science*. We aimed to challenge *North-South* inequality in educational opportunities by developing a truly interactive global classroom, which can

provide both real-time international and cross-cultural experiences to universities in both developed and developing nations. For universities, this framework enabled us to enrich and diversify educational resources available to remotely separated institutions.

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