e³ Program and Its Role in International Cooperation in Engineering Education

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Abstract

Hokkaido University started out in 1876 as Sapporo Agricultural College with foreign professors teaching agriculture and civil engineering to Japanese students in English. Since then HU has expanded to cover various disciplines and changed its medium of instruction to Japanese. In 2000, HU School of Engineering launched a graduate program with English as a medium of instruction. It is a complete reverse from a century ago because this time professors are Japanese while students are mainly international students from overseas. The main objective is to disseminate advanced knowledge Japan has accumulated through international students and at the same time “internationalize” our educational system.

The “English Engineering Education program” or e³ started in October 2000 with a limited number of fields. As of 2010 it has expanded to cover all fields offered by the School of Engineering. At present close to 100 graduate students from 27 countries enrolled in the program. 114 courses are offered in English, out of which 47 are regular courses, in other words, attended by both Japanese and e³ students. This paper introduces the e³ program and its practices. Its role on international cooperation in engineering education and on engineering education itself is described.

Keywords: engineering education, medium of instruction, internationalization, international cooperation

1. Brief History of Hokkaido University

Way back in 1876 when the Sapporo Agriculture College, a predecessor of Hokkaido University, was founded the medium of instruction was English. Professors were carefully recruited from overseas and students were strictly selected to pursue their study which was fully supported by the government scholarships. The four year curriculum developed by Dr William Smith Clark, founder and president of the Massachusetts Agricultural College and strictly followed by Mr William Wheeler, a young civil engineer handpicked by Dr Clark and other faculty produced graduates fluent in English, specialized in agricultural science with a focus on civil engineering subjects.

From the first enrollment of 24 students in 1876, as of 2011 Hokkaido University has close to 18,000 undergraduate and graduate students with roughly 4,000 in the School of Engineering. From an English-medium College, it is now a full fledged Japanese-medium university. Except for some fields of study, most of the research results are published in Japanese and needless to say in domestic journals. The Japanese medium of instruction restricts the number of international faculty and the regions where international students come from and as a result, limits choices of international faculty and students.

2. The English Engineering Education Program

The English Engineering Education program (e³) was first established as the English Graduate Program in Socio-Environmental Engineering (EGPSEE) in 2000 by 6 out of 15 Divisions in the Graduate School of Engineering. The aim is to attract excellent students who do not want to spend additional time studying the Japanese language. In 2006 the program expanded to include four more Divisions and in 2010 one more Division. The remaining three Divisions joined the Graduate School of Chemical Engineering and Science (Table 1).

Table 1 e³ subject group composition, 2000-present

Division	2000	2006	2010
Architectural and Structural Design	EGPSEE	e ³	e ³
Engineering and Policy for Sustainable Environment	EGPSEE	e ³	e ³
Environmental Engineering	EGPSEE	e ³	e ³
Field Engineering for Environment	EGPSEE	e ³	e ³
Human Environmental System	EGPSEE	e ³	e ³
Sustainable Resources Engineering	EGPSEE	e ³	e ³
Energy and Environmental Systems		e ³	e ³
Human Mechanical Systems and Design		e ³	e ³
Materials Science and Engineering		e ³	e ³

† 第59回年次大会国際セッションプロシーディングスより著者の了解を得て転載しました。

Mechanical and Space Engineering		e ³	e ³
Quantum Science Engineering		e ³	e ³
Applied Physics			e ³
Biotechnology and Macromolecular Chemistry			Graduate School of Chemical Science and Engineering
Chemical Process Engineering			
Materials Chemistry			

2.1 e³ Curriculum Structure

Initially all six Divisions in EGPSEE were unable to offer enough courses to stand on their own because only some professors agreed to offer courses in English. This was due to the fact that offering an additional course means an increase in the teaching load; and, for some professors, their lack of confidence in teaching in English. As a result courses were offered under seven subject groups. At present, out of twelve Divisions in e³, six offer courses on their own, the remaining Divisions are grouped into two subject groups. These six Divisions will start offering courses on their own in October 2012 (Table 2).

Table 2 e³ curriculum structure 2011

DIVISION	SUBJECT GROUP
Applied Physics	
Engineering and Policy for Sustainable Environment	
Environmental Engineering	
Field Engineering for Environment	
Materials Science and Engineering	
Sustainable Resources Engineering	
1. Human Environmental System 2. Architectural and Structural Design	Human Environmental System, Architectural and Structural Design
1. Mechanical and Space Engineering 2. Human Mechanical Systems and Design 3. Energy and Environmental Systems 4. Quantum Science and Engineering	Mechanical and Intelligent System Engineering

2.2 Conduct of Courses

To provide Japanese students with the classroom environment that increases an opportunity for students to familiarize themselves with the English usage, instead of introducing a new e³ course or teaching their course separately, in Japanese for Japanese students and in English for e³ students, professors have been encouraged to teach their course in only English for students in both programs. At first some professors were reluctant because they were afraid that Japanese students might not understand the lectures well. Gradually it has become clear that Japanese students have no problem understanding lectures given in English. According to a survey on the impact of international students conducted among 4th year undergraduate and graduate Japanese students of the School of Engineering during January and February 2011 (314 students responded), 24% of the students who have experienced attending lectures in English said that their understanding of the lectures reduced. On the contrary, 36% of the students said that excellent international students motivated them to do better.

Fig. 1 below shows the continued increase in the number of courses offered by e³ and the number of “common” courses or courses that are meant for both international and Japanese students.

Fig. 1 Number of courses offered by e³, 2000-present

2.3 Students' Country of Origin

Before the introduction of e^3 , all international students regardless of their Japanese proficiency enrolled in the regular program where Japanese is the medium of instruction. At present 41% of all the international students or 60% of international graduate students enrolled in e^3 . The largest numbers of students, 46% overall and 33% for e^3 , come from China. The numbers of international research students, undergraduate and graduate students at the School of Engineering are shown in Table 3 below. Only graduate students enrolled in e^3 .

Table 3 Int'l students (research, undergraduate, graduate students) at School of Engineering
(as of May 2011)

Country	Total No. of students (RS + U + G)	No. of students enrolled in e^3 (G)	Country	Total No. of students (RS + U + G)	No. of students enrolled in e^3 (G)
Bangladesh	9	9	Malaysia	20	5
Bolivia	1	1	Nepal	2	1
Brazil	1	1	Nigeria	1	-
Cambodia	3	3	Pakistan	3	3
Central Africa	1	-	Philippines	6	4
China	101	30	Senegal	1	-
Colombia	2	1	Solomon Islands	1	1
Egypt	2	2	Sri Lanka	4	4
Estonia	1	-	Sweden	1	-
Ethiopia	1	1	Taiwan	1	-
France	1	-	Thailand	6	4
Guatemala	1	1	Tunisia	1	-
India	1	1	Uganda	1	1
Indonesia	10	6	USA	2	1
Iran	1	1	Vietnam	2	1
Iraq	1	-	Zambia	1	1
Jordan	1	1	Zimbabwe	1	1
Korea	27	3	TOTAL	219	88*

*does not include 7 Japanese students

2.4 Source of Funding

e^3 started with an annual allocation of 12 scholarships (6 master and 6 doctoral) from the Ministry of Education, Culture, Sports, Science and Technology or MEXT. In 2007, the number of MEXT scholarships increased by one for each degree to 14. As of May 2011, 95 students including 7 Japanese students enrolled in the program, out of which 80% of the students are scholarship recipients (Fig. 2).

Fig. 2 Source of funding of e^3 students (as of May 2011)

2.5 Graduates

As of March 2011, 132 students graduated from the program. According to the survey of graduates conducted in 2010, 41% are working or furthering their study in a third country, the remaining 59% are working in their home country.

2.6 Admission Criteria

International applicants whose qualification meets the e³ minimum admission requirement that includes a satisfactory English test score can enroll in the program without having to pass an entrance examination. e³ accepts students twice a year – in April and October. October intake has seen more students enrolled because the 14 MEXT scholarships are only available for that semester.

e³ has been keeping a record on grades students obtained from their previous universities and grades they obtained at the time of graduation from the program, and for doctoral students, their 1st and 2nd annual evaluation results. It is hope that the accumulated database can one day be used as a reliable reference when selecting students. Up to now the record includes 110 universities in 44 countries and 223 students.

2.7 Course Evaluation

Since its establishment in 2000, e³ has been asking its students to provide feedback on the course contents and the teaching method. Student feedback was then forwarded to the concerned course instructors. The practice has helped improve the course content as well as the way courses are conducted.

2.8 Supervision and Graduation

Unlike most Japanese universities, every doctoral student is subject to evaluation by and at the same time receives guidance from not only his supervisor but his program committee at the end of his 1st and 2nd year. In order to graduate, he/she must have at least two refereed journal papers, one of which is published in an international journal or his/her dissertation must be reviewed by an external examiner.

2.9 Student Organization

e³ extra-curricular activities are organized by the Student Organization run by representatives elected by students. Students pay a membership fee once a semester. The fact that e³ is a combination of twelve Divisions without extra-curricular activities students will simply disperse into different laboratories. Furthermore since their fields of study are different, they may or may not have any chance to meet each other even in the classroom. As a result SO plays an important role in uniting students from different disciplines together enabling them to form a unique network across the fields during and after their study at HU.

2.10 Alumni Network

At a Seminar on Coping with Globalization which was held to celebrate the 10th anniversary of e³ on 16-17 September 2010, e³ alumni from various countries agreed to set up an alumni association. At present e³ office maintains a mailing list with a group address that enables students and alumni to exchange information.

3. e³ Role in International Cooperation in Engineering Education

Throughout the history of Japanese education the government has had a strong role in shaping up the engineering education. The country has embarked on implementing the Science and Technology Basic Law that establishes a broad and ambitious plan for changing government support of science and technology in Japan. The framework for internationalization of higher education drawn up by the government is on the national level, it is however up to each university to adjust itself in order to be globally competitive.

3.1. Student Mobility and Network

HU School of Engineering signed an agreement for academic and educational exchanges and cooperation with 30 universities in 13 countries (Table 4).

Table 4: Agreements with overseas universities
(as of May 2011)

Country	University	Country	University
Burkina Faso	Int'l Institute for Water and Environment, 2010	Korea (cont.)	Chungnam National U, 2001
Canada	U of Alberta, 1977		Kangwon National U, 2003
China	Shenyang U of Technology, 1985		Dong-eui U, 2008
	Shanghai Jiao Tong U, 1992		Hankyong National U, 2009
	Zhejiang U, 2002	Poland	AGH U of Science and Technology, 2007
	U of Science and Technology Beijing, 2006	Spain	The Polytechnic U of Valencia, 2006
	Hebei Polytechnic U, 2008	Sweden	Linkoping U, 2000
Denmark	Royal Danish Academy of Fine Arts, 2010		KTH Royal Institute of Technology, 2010
Finland	U of Oulu, 2006	Thailand	Sirindhorn Int'l Inst of Technology, 2007
Hungary	Budapest U of Tech. and Economics, 2004		Asian Institute of Technology, 2008
Indonesia	Institute of Technology Bandung, 2000		Chulalongkorn U, 2008
	U of Palalangka Raya, 2006		Rajamangala U of Science and Tech, 2008

Korea	Seoul National U, 1997	U.K.	U of Warwick, 2000
	Chonbuk National U, 2000	U.S.A.	U of Wisconsin, 1987
	Yeungnam U, 2000		Lamar U, 2008

Agreement among universities is believed to be the best tool to start or increase student mobility. According to MEXT, about 90% of the international students who study in Japan are from China, Korea and the other countries of East Asia and 40% of Japan's 67,000 study abroad students are studying in East Asia thanks to the closely interrelated in terms of economic activities. However to be fully international, cultural diversity is crucial. As you can see from Table 3, a majority of students from other parts of the world are e^3 students. This is due to the fact that e^3 medium of instruction is English and most of the engineering students regardless of where they come from are familiar with English since it is the most commonly used language in science and engineering fields.

International students from diverse backgrounds enrich the environment in term of cultural, education and research while they are here and after graduation serve as a bridge between HU and their home institution. Excluding those who are doing a Ph.D. at HU or other universities, as of 2011, 42% of e^3 graduates work at the research and educational institutions in various countries (Table 5). Some have continued their research activities or co-hosted international conference/workshop with their former supervisor, some act as e^3 representative in their respective country. e^3 has provided a platform for international cooperation and network in engineering education not only between former students and HU but among graduates themselves who are now residing in various parts of the world.

e^3 international environment enables professors to accept short- and long-term exchange students. In recent years the number of exchange and internship students has continued to rise. HU civil engineering group is preparing an international undergraduate program, which will be integrated with the graduate program in e^3 , in order to enhance student international mobility.

Table 5: Countries and number of e^3 graduates working at research and educational institutions
(as of May 2011)

Country	No. of alumni	Country	No. of alumni
Australia	1	Japan	7
Bangladesh	1	Korea	2
Cambodia	1	Nepal	1
Canada	1	New Zealand	1
China	1	Pakistan	1
Colombia	1	Philippines	3
Egypt	4	Sri Lanka	2
Ethiopia	1	Thailand	7
Germany	1	USA	1
Indonesia	10	Vietnam	1

3.2 Human Resource Development through International Organization

Exchanges on both faculty and student levels under the ASEAN University Network (AUN)/Southeast Asia Engineering Education Development Network (SEED-Net) which started in 2003 have been active and successful.

AUN/SEED-Net is mainly supported by the Japanese Government through the Japan International Cooperation Agency (JICA), and partially supported by the ASEAN Foundation and the respective ASEAN countries. It aims at promoting human resource development in engineering in ASEAN by supporting faculty members from member universities in Cambodia, Laos and Myanmar to obtain a master's degree at a host university in Indonesia, Malaysia, Philippines, Singapore and Thailand and either remain there to complete their Ph.D. study that includes spending 8 months at a Japanese host university (sandwich program) or spending a full 3-year at a Japanese host university. Thanks to e^3 , HU is able to act as one of the Japanese host universities.

The number of faculty members from ASEAN universities who were supported by AUN/SEED-Net are shown in Table 6. HU was a host to 47 out of 87 Ph.D. graduates.

Table 6 AUN/SEED-Net alumni
(as of March 2011)

Fiscal Year of Graduation	Master's	PhD Sandwich	PhD in Japan	PhD in Singapore	Total
	331	45	42	2	420
2003	9	0	0	0	9
2004	13	0	0	0	13

2005	51	0	1	0	52
2006	53	0	4	0	57
2007	63	12	8	0	83
2008	41	8	8	0	57
2009	56	14	11	1	82
2010	45	11	10	1	67

Source: AUN/SEED-Net website

JICA is launching another project to enhance the infrastructure, agricultural and rural development in Afghanistan through human resource development by the scholarship program in Japan. HU will again act as one of the host universities where Afghan government employees will enroll in e^3 to obtain a master's degree.

3.3 Double-degree Program

HU has recently started one double-degree (master's degree) program in the field of transportation engineering with the Asian Institute of Technology and another (Ph.D) in the field of material sciences with AGH University of Science and Technology. HU regulation requires that to graduate, a master's student must earn at least 30 credits from coursework and successfully pass a thesis defense. Needless to say that e^3 plays a major role for HU to start such program.

4. Conclusion

e^3 has opened the door for internationalization and international cooperation to Hokkaido University. e^3 makes it possible for international students from various parts of the world to come to further their study without having to spend additional time mastering the Japanese language. At the same time it creates opportunities for Japanese students to experience cultural diversity, different and more active teaching and learning atmosphere, and improve their English proficiency. Feedbacks from e^3 students who come from various educational backgrounds help guide the program and the school as a whole to a more in line with international standards. Participating in international cooperation has become simple and as a result professors who otherwise are active domestically have become active internationally.

About the authors

Dr Werawan Manakul worked at the Asian Institute of Technology, Thailand before joining Hokkaido University in 1999 to oversee the newly established English-medium graduate program in engineering. Transforming the way engineering education in Japan is conducted into a more international one still remains a challenge for her. Dr Werawan is e^3 program coordinator.

Professor Tamon Ueda specializes in structural engineering. He worked at the University of Tokyo before joining Hokkaido University in 1991. He was one of the four founding members of EGPSEE/ e^3 the first English-medium graduate program at HU School of Engineering. Professor Ueda is currently e^3 program head.