

# Multidisciplinary Learning Extends Communication Skill, and Helps Cross Cultural Understandings: Biomedical Engineering

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## ABSTRACT

The effects of multidisciplinary learning on extension of communication skill and on cross-cultural understandings have been discussed. “Biomedical engineering” is exemplified for the multidisciplinary field, which includes biology, medicine, engineering, and others. Several multidisciplinary learning programs have been practiced in the biomedical engineering field: in Japan, in Thailand, and in USA. Some of them are cross-cultural student-seminars on biomedical engineering. In the group work, students are divided into the small cross-cultural groups. Each group finds a problem, methods to solve the problem, and contribution to the society in relation to Biomedical Engineering. Presentations are made with slides in reference to information in the internet. They have learned how to communicate with students, who has not only a variety of studying backgrounds but also a variety of cultural backgrounds. The training awakes students to several points: thinking from a different point of view, and using various communication tools. The process extends the communication skill, and helps cross-cultural understandings.

**Keywords:** Multidisciplinary Learning, Biomedical Engineering, Communication and Cross-cultural Understanding.

## 1. INTRODUCTION

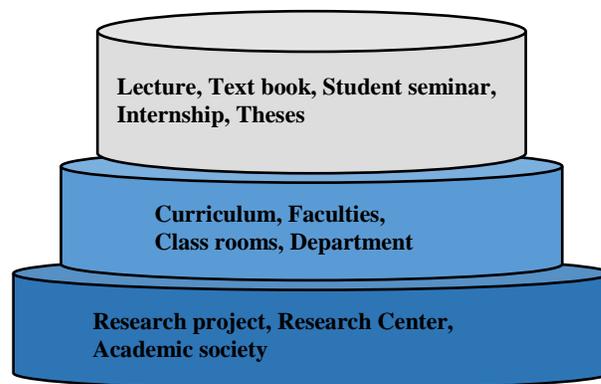
Japanese proverb tells us “Harmonize, but not agree”. One of professors taught the author, “Not agree, but harmonize”. The present article is based on experiences in the author’s personal history: cross cultural experiences, and multidisciplinary experiences (Table 1). The author’s first motivation is artificial organs, which is based on multidisciplinary science and technology. The topic is “device coexists with human”. This article hopefully could help next generation to extend multidisciplinary world.

What is multidisciplinary learning (Fig. 1)? Multidisciplinary learning includes several elements: multidisciplinary lectures, multidisciplinary text books, multidisciplinary student seminars, multidisciplinary internships, and multidisciplinary theses. These elements are supported by several bases: multidisciplinary curriculums, multidisciplinary faculties, multidisciplinary class rooms, and multidisciplinary departments. These bases are supported by several backgrounds: research projects, research centers, and academic societies.

Biomedical engineering makes collaboration with many medical departments on many research projects: cardiovascular surgery on the artificial heart, orthopedics on the artificial joint, plastic surgery on the artificial vessel, neuro surgery on the shunt, and anesthesiology on the laryngoscope. The medical engineering research center supports a variety of research projects, which are related to biomechanics, bio-rheology, bioelectronics, biomaterials, bio-systems, bioinformatics, bio-measurements, and biosensor. The author attended two Japanese multidisciplinary academic societies established in 1978: Biomaterials, and Bio-rheology. In biomedical engineering field, a living body inspires bio-mimic systems. An engineered device, on the other hand, is designed for the prosthesis of the living body.

**Table 1:** Cross-cultural experiences, and multi-disciplinary experiences (year).

	Cross-cultural	Multi-disciplinary
Student seminar	1975-	1975-, 1981-
Internship	1975-, 1977	1975-, 1977
Academic society	1983-	1978-
Research project		1979-
Lecture	2008-, 2016-	1981-, 2016-
Affiliation (Faculty)		1981, 1994, 2011
Thesis		1987, 1990, 2010
Text book	2017	1996, 2000, 2013
New department	2004	2006
Research center		2005



**Fig. 1:** Multidisciplinary learning.

Many interviews gave a variety of information to create the new department of “Biomedical Engineering”. Creating the first department of “Biomedical Engineering (including bachelor, master, and PhD courses)” in Japan was a big challenge. A lot of pioneers in the world (Case Western Reserve University, Northwestern, UIC, UC Berkley, Boston, MIT, and UNSW) helped the author to make the new discipline [1].

The core curriculum has been designed with project based experiments, which gives a chance to inspire students to learn multidisciplinary ideas. The learning atmosphere for students is important. The training room for undergraduate students located next to the research laboratory stimulates motivation of students. Biomedical Engineering is one of the multidisciplinary fields, which have connections to a lot of disciplines: mechanics, electronics, materials, biology, medicine, pharmacy, economics, sociology, ethics, religion, etc. The variation of courses demands the guide for students. The author created a new concept for the interdisciplinary department, which includes the “Bridge Curriculum [2-7]”. In the multidisciplinary department, the professor himself should be a multi-disciplinarian with the multiple academic backgrounds. The bridge made by a professor between courses is effective for students to understand the relation between courses [7].

The internship-abroad of biomedical engineering provides the cross cultural experience to students. The internship program in the institute of the artificial heart in Free University Berlin in 1977 gave the author both cross cultural and interdisciplinary senses, simultaneously: collaboration between engineering and medicine. The author experienced reviews of two kinds of PhD theses: medicine, and engineering. Each discipline has its own reviewing process. Biology keeps statistic evaluation related to individuality and to time-dependency. Engineering demands sophisticated methodology related to standardize.

The author also found different disciplines, when the affiliation changed: mechanical engineering, school of medicine, electronics, biomedical engineering, and the second term of mechanical engineering (Fig. 2). Each special field of study develops own discipline including the style of education. Each discipline has one’s own technical terms. For example, “control” means “comparison” in medicine, although it means “regulation” in engineering.

In the present article, multidisciplinary learning has been discussed in relation to cross-cultural understandings.

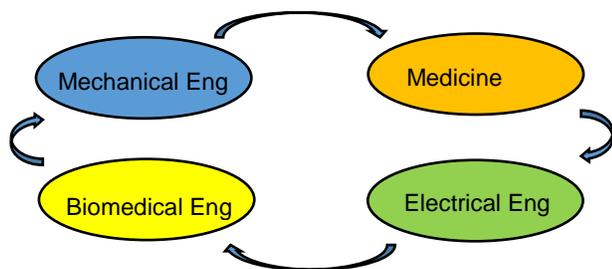


Fig. 2: Changing affiliations.

## 2. METHODS

### Group Work

The annual cross-cultural student program of Biomedical Engineering between Kogakuin University and Chulalongkorn University in Thailand has been started in 2011 (Table 2) [8-12]. Students, who participate in the program, divided into several groups (Fig. 3). Each group includes Thai students and Japanese students. The backgrounds of students have variations: pharmacology, nanotechnology, medicine, mechanical engineering, computer engineering, biology, material science, and biomedical engineering. Each group has to make a report, and to make a presentation at the final session. Two days are available to make the report and the presentation.

### Your Proposal

Each student made a report for the training of multi-disciplinary design in the course of “Fundamental of Biomedical Engineering” (Fig. 4). The title is “Design a new system related to biomedical engineering”. Each report should describe the specifications, including drawings and numerical description within one page of A4 paper. The description should include following items: problem to be solved, background, devised methods, expected results, contribution to the society, and reference. If the reference is Uniform Resource Locator (URL), the reference date should be written.

Table 2: Annual cross cultural seminar for students on biomedical engineering in Chulalongkorn University.

Year	Number of Students
2011	3
2012	6
2013	5
2014	10
2015	11
2016	6
2017	11

### Laboratory Visit

Several universities in the world have programs on biomedical engineering. The author has communicated with several coordinators of the programs: Stanford, UC-Berkeley, Harvard, Caltech, TU-Vienna, Keel, NTU-Athens, Chulalongkorn, and Mahidol. They supported to create a new department of biomedical engineering in Japan in 2006 [1-10]. Some of them have welcomed Japanese students for the laboratory visit since 2006 [8-12]. In 2016, six students of “Biomedical Engineering Laboratory” visited two universities in Thailand, and five students visited three universities in USA. In 2017, Kogakuin University accepts the first generation of internship students from Thai Universities. One student visits Kogakuin from Chulalongkorn, and one student visits Kogakuin from Mahidol, respectively (Fig. 5).

### Presentation Training

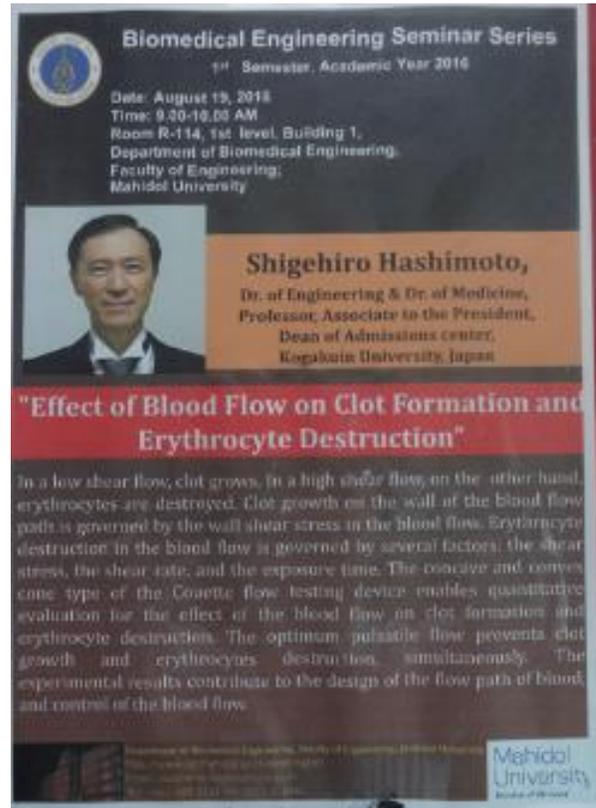
The annual cross-cultural student program of Biomedical Engineering between Kogakuin University and Mahidol University in Thailand has been started in 2012. Every student made a presentation on the topic of his own research plan in English. After each presentation, students discuss on the topic at the seminar and at the laboratory tour in Mahidol University in Salaya. Several students also made presentations at the symposium in UIC.



**Fig. 3:** Social welfare development center for older persons (upper), group work in Chulalongkorn University (lower).



**Fig. 4a:** Lecture in Mahidol University in January 2017.



**Fig. 4b:** Seminar “Effect of Blood Flow on Clot Formation and Erythrocyte Destruction” in Mahidol University in August 2016.



**Fig. 5:** Internship in Kogakuin in 2017.

**Presentation in International Research Conference**

Students of “Biomedical Engineering Laboratory” attended the annual international multidisciplinary research conference, and made presentations [8-12]. They made the oral presentations in the World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI) since 2002.

### 3. RESULTS

#### Group Work

Every year, a theme was set: “Find a project to be solved in biomedical engineering field (2012)”, “Oil spill cleanup from the surface of sea (2013)”, “Visiting the hospital (2014)”, and “Magnesium (2015)”.

In 2016, “Innovation for aging society” was selected for the theme of the group work. Students visited “Social Welfare Development Center for Older Persons” in Bangkok. Students were divided into three groups (Fig. 3). Each group selected the following topic and discussed on the role of engineers in the aging society.

- 1) Device to enhance exercise motivation for old people.
- 2) Game application for old people.
- 3) Traction device for human skeletal system at home.

The impressions of the students after the group work were as follows:

- 1) Equations are universal.
- 2) Figures and animations are effective for communication.
- 3) It is difficult to express my original idea.
- 4) It is difficult to listen precisely to the opinions of neighbors.
- 5) The same background helps understandings.
- 6) I have made a friend abroad.
- 7) Excess concentration to one’s own thoughts disturbs taking ideas of others.
- 8) I have found different background of thinking.
- 9) I have made a communication network between international students.
- 10) Team activity is not easy, not only between inter-national members, but also intra-national members.

#### Your Proposal

Each student made a report on the following topic.

- 1) Virtual electrode by two-dimensional current steering in retinal prostheses.
- 2) Seat for sitting evaluation in children with disabilities.
- 3) Micro-sensor implanted in brain for detection of unconsciousness.
- 4) Virtual reality devices for diabetic retinopathy patients.
- 5) Device of gas exchanger by engineered tissue as artificial alveolar to extend life.
- 6) Functional eye prosthesis for a blind person.
- 7) Innovation of internal monologue for a deafness person.
- 8) Design of foot collision alarm device for a diabetic peripheral neuropathy patient.
- 9) Biomechanics on wheelchair rugby.
- 10) Humanoid robot for a bioreactor.
- 11) Flapping type compact aircraft.
- 12) Manufacture of organ by three dimensional printing technology.
- 13) Application of synthetic jet for a ventilator.
- 14) Prosthetic leg robot for quadriplegia and paraplegia.
- 15) Needle inspired by mosquito mouth.
- 16) Application of double network gel to damper for prosthesis.
- 17) Artificial joint using pure titanium strengthened by strong strain processing and heat treatment.
- 18) Architecture control system inspired by insects.
- 19) Reduction of resistance of artificial blood vessel by micro

dimples.

- 20) Control of air conditioning equipment using neural network.
- 21) Transportation robot inspired by fish school.
- 22) Application of carbon nanotube to artificial organs.
- 23) Application of dolphin skin to multi-copter.
- 24) Non-reflective film inspired by moth eye.
- 25) Cancer treatment by needleless syringe with cavitation.
- 26) Application of carbon fiber to nerve system.
- 27) Counter measurements against bird hazards using ornithopter.
- 28) Application of bat’s echo system to real-time 3D space modeling.
- 29) Navigation for micromanipulation on cell.
- 30) Artificial arm based on foot structure of gecko.
- 31) Control of itching using flexible thermoelectric element.
- 32) Intelligent key of car with heart rate monitor.
- 33) Stent for coronary artery disease.
- 34) Application of bone structure to metal mold.

Although it was not easy for student to find originality, the report gave students opportunity for multidisciplinary learning.

#### Laboratory Visit:

Students joined in the laboratory tour (Fig. 6a), and gave comments as follows:

- 1) Listening is difficult without understanding the background.
- 2) Understand the universal goal helps discussion with another topic of research.
- 3) Checking another research project extends application of my own research.
- 4) Language is not the only tool for communication.
- 5) The similar topic inspired me new idea.
- 6) Laboratory tour reminds me that biomedical engineering includes a variety of research topics.

#### Presentation Training 1

In 2016 (Fig. 6b), the topics of presentation in Mahidol University in Thailand were as follows:

- 1) Effect of aspect ratio of checkered (Ichimatsu) convexo-concave micro-pattern on orientation of cultured cells.
- 2) Effect of surface morphology of scaffold with lines of micro ridges on deformation of cells.
- 3) Observation of cell by flow channel with micro-pattern.
- 4) Effect of hyper-gravitational force on Neuro2a.
- 5) Di-electrophoresis of myoblasts with micro-coil of electrode.
- 6) Comparison of cell’s deformability using cylindrical pattern.
- 7) Glucose-installed PEG-b-PCL micelles nanoscale drug delivery system for cancer targeting.
- 8) Lactate measurement by colorimetric reaction on Origami Paper-based biosensor.
- 9) Brain-computer interface and brain-machine interface.
- 10) Real time calcium ion detection on cell manipulation system.

The presentation also gave a Japanese student a good opportunity to express himself to the person at the first meeting. Students prepared slides with figures with animation to compensate their English ability. Students feel that more preparation is necessary to accept good questions.



**Fig. 6a:** Laboratory visit in Mahidol University.



**Fig. 6b:** Presentation in Mahidol University.

Interdisciplinary discussion helps understanding peer reviewing. Cross cultural discussion also helps understanding peer reviewing. After the seminar, communication among students continued to the sightseeing in the traditional places. Some students keep in touch with the participants by e-mail.

### Presentation Training 2

Five Japanese students participated in the joint seminar between Kogakuin University and University of Illinois at Chicago (UIC) in 2017 (Table 3).

The titles of presentations in the seminar were as follows:

- Deformation of cell passing through micro slit between micro ridges fabricated by photolithography technique.
- Effect of flow on cultured cell at micro-pattern of ridge lines.
- Effect of mechanical property of scaffold surface with micro hybrid striped pattern on cell migration.
- Effect of Couette type of shear flow by rotating disk on migration of cell.
- Cell behavior after stimulation of excess gravity.

After the seminar, students made the following comments:

- High level researches stimulate me to continue the research.

- I learned essential expression, and effective presentation.
- Topic on common background is easy to understand.

### Presentation in International Research Conference

The cumulative total number of participating students in WMSCI (World Multi-Conference on Systemics, Cybernetics and Informatics) is 58 from 2002 to 2017 (Table 4). Five students made oral presentation in 2017 (Fig. 7). The topics are as follows:

- Deformation of cell passing through micro slit between micro ridges fabricated by photolithography technique.
- Effect of flow on cultured cell at micro-pattern of ridge lines.
- Effect of aspect ratio of checkered convexo-concave micro-pattern on orientation of cultured single cell.
- Effect of Couette type of shear flow by rotating disk on migration of cell.
- Cell behavior after stimulation of excess gravity.

The presentation experience has given motivation to change their mind and brush up their skill for communication.

**Table 3:** Annual cross cultural seminar for students on biomedical engineering in UIC.

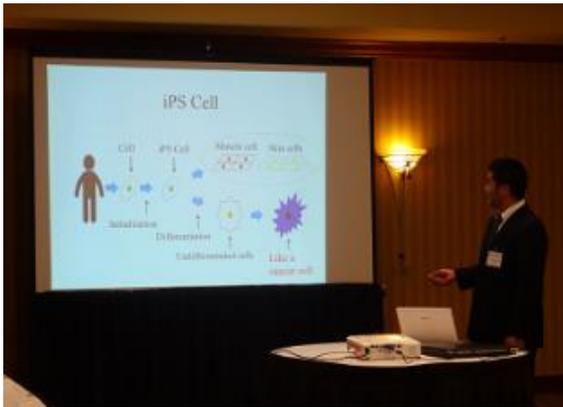
Year	Number of students
2013	4
2014	5
2015	6
2016	5
2017	5

**Table 4:** Presentations in World Multi-conference on Systemics Cybernetics and Informatics.

Year	Number of students
2002	1
2004	3
2005	5
2006	3
2007	4
2008	5
2009	4
2010	5
2011	2
2012	1
2013	4
2014	5
2015	6
2016	5
2017	5

## 4. DISCUSSION

Every year, the United Nations counts rankings on the "happiness degree" of each country in the world by using indicators: GDP (gross domestic product) per citizen, healthy lifespan, degree of freedom, and tolerance to others. The score of "tolerance to others" is very low in Japan.



**Fig. 7:** Presentation in WMSCI.

Both project-based learning and presentation training are effective in multi-disciplinary field of biomedical engineering. Biomedical engineering demands multi-disciplinary text books: “Introduction to Biomechanical Engineering [13-14]”, “Introduction to Biomedical Measurement Engineering”, and “Introduction to Biosystems Engineering”. The text book should describe not collection of topics but describe relation between topics under multidisciplinary view point (Fig. 8).

For the workshop of biomedical engineering, you can pick up many interdisciplinary topics: a hospital, a nursing home, and a prosthesis. The hospital, for example, is supported by a variety of specialists, and accepts patients form a variety of backgrounds.

The multidisciplinary learning extends the communication skill. Curiosity can be motivation for communication. Language is not the only tool for communication. Drawings, figures, or equations can be global communication tools. The terms of technology are basically global.

Changing way of thinking is effective to make communication between disciplines as well as cultures. A person looks at oneself with the opposite side image by a mirror in the everyday life (Fig. 9).

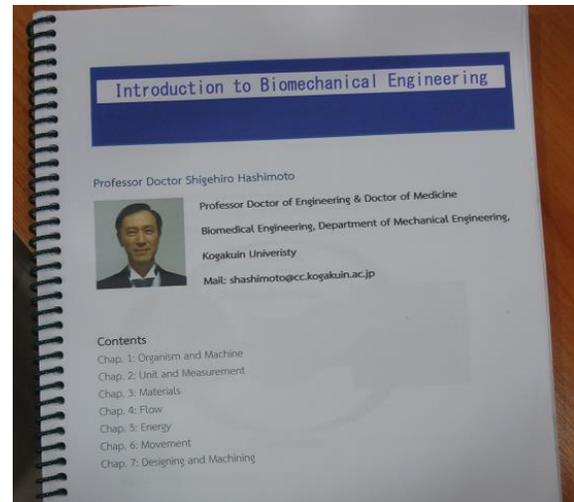
How do you make a team? Do you make a fusion of elements? Do you want to make uniformity (Fig. 10)? Do you want to keep variations of elements? Do you collect elements and make a checkered pattern (harmony) (Fig. 11)? How do you think of the human society in the world? Fusion or assembly? Global or intercultural? Universal or multidisciplinary?

International language or native language? Peer review, universal review, or interdisciplinary review? Students of the next generation should learn the active method to use the internet as a communication tool. Communication first. Making friend is not always easy. Understanding is difficult. Keep communication. Respect your neighbor.

## 5. CONCLUSION

Multidisciplinary learning has been discussed in relation to cross-cultural understandings. “Biomedical engineering” is exemplified for the multidisciplinary field. Students have

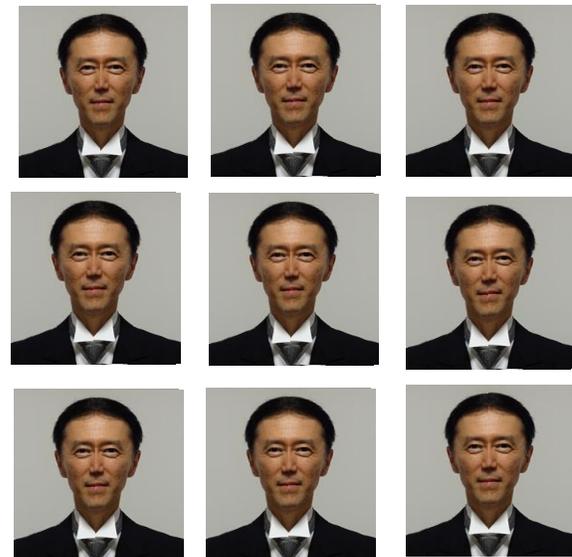
learned how to communicate with students, who have not only a variety of studying backgrounds but also a variety of cultural backgrounds. The training awakes students to several points: thinking from a different point of view, and using various communication tools. The process extends the communication skill, and helps cross-cultural understandings.



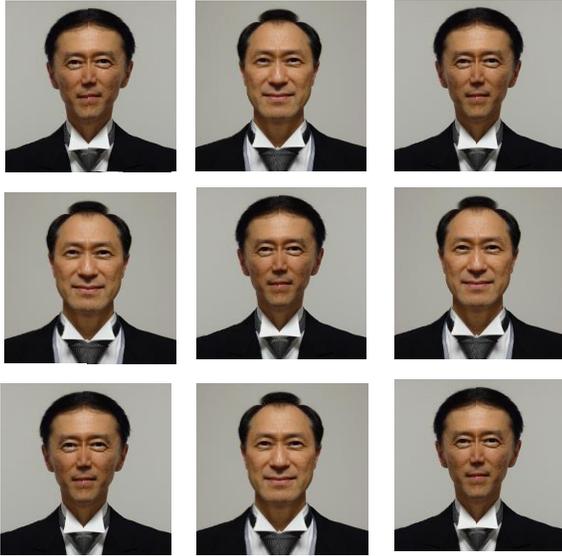
**Fig. 8:** Text book for “Biomechanical Engineering”.



**Fig. 9:** Image from outside (left), mirrored image (right).



**Fig. 10:** Uniformity consists of fused elements.



**Fig. 11:** Checked collaboration; variation between fused elements is maintained.

## 6. ACKNOWLEDGMENT

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