Communication Training in Multidisciplinary Field: Biomedical Engineering and Symbiosis Engineering

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ABSTRACT

The biological term of "Symbiosis" is used for the situation of "living together". The internet system has made a global society with database. The global society includes many kinds of variations: culture, language, and generation. In the global society, symbiosis between systems gave us a lot of multidisciplinary topics. Multidisciplinary communication skill is necessary to handle the topics. The term of "Biomedical Engineering", on the other hand, is used for the multidisciplinary academic field combining several fields: Biology, Medicine, and Engineering. The field relates to various academic fields. In these field, many topics are picked up for collaboration among the biological systems and engineered systems. Communication is necessary not only between biological systems, but also between biological system and engineered system. Several kinds of multidisciplinary learning- programs including cross-cultural seminars have been practiced among students in the present article. The effectiveness of the multidisciplinary learning has been discussed in relation to "Biomedical Engineering" and "Symbiosis engineering".

Keywords: Multidisciplinary Field, Biomedical Engineering, Symbiosis Engineering, Communication Training and Cross-cultural Seminar.

1. INTRODUCTION

The term of "Symbiosis" is used for the situation of "living together" in close union of two dissimilar organisms. The relation between clownfish and sea anemone is one of the examples. When we look at microsystems, a biological cell collaborates with mitochondria.

The internet system has made a global society with database (Fig. 1). The global society includes many kinds of variations: culture, language, and generation [1]. In the global society, symbiosis between systems gives us a lot of multidisciplinary topics. Multidisciplinary communication skill is necessary to handle the topics.

The term of "Biomedical Engineering" is used for the multidisciplinary academic field combining several fields: Biology, Medicine, and Engineering [2, 3]. The field relates to various academic fields. In these field, many topics are picked up for collaboration among the biological systems and engineered systems. Biological cells, for example, are cultured on the engineered scaffold to make a hybrid actuator. The interface design is important in this kind of research topics. Communication is necessary not only between biological systems, but also between biological system and engineered system (Fig. 2).

Several multidisciplinary learning-programs including cross-cultural seminars have been practiced among students in the present article. The effectiveness of the multidisciplinary learning has been discussed in relation to "Biomedical Engineering" and "Symbiosis engineering".

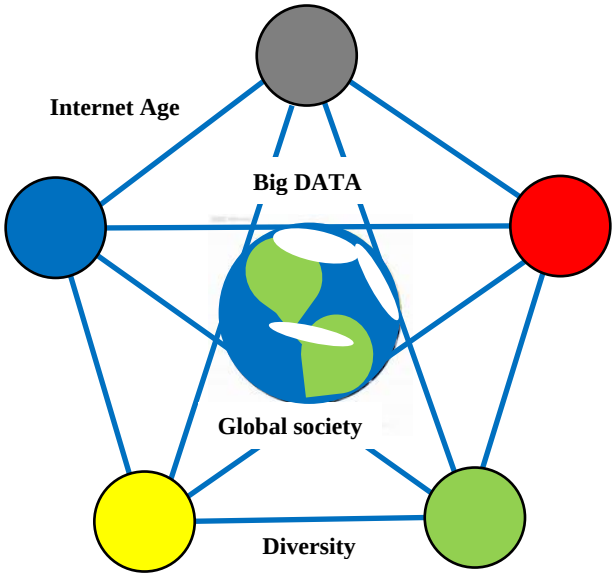

Fig. 1: Global society with internet system.

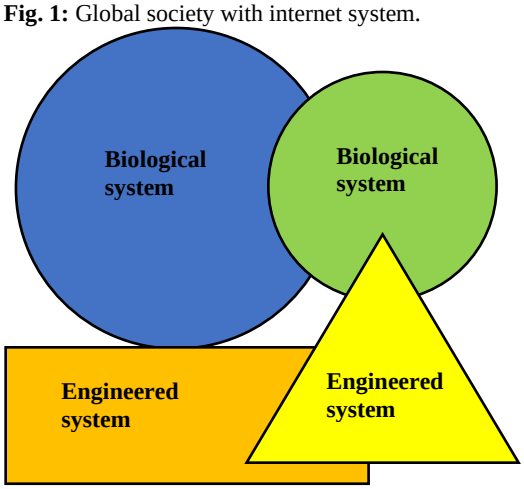

Fig. 2: Collaboration among biological systems and engineered systems.

2. METHODS

Eight kinds of learnings are introduced related to author's experiences.

1) Basic project.
2) Finding topic.
3) Finding related subjects.
4) Engineering background for biomedical engineering.
5) Proposal on biomedical engineering.
6) Cross-cultural student workshop.
7) Internship program.
8) Presentation training.

Basic Project
Students make groups for project-based learning: "designing system which has a movement". They make drawing, before collecting elements and manufacturing the system. Study fields of engineering are separated into smaller sections nowadays. Students belong to the mechanical engineering department are not good at electrical engineering. The basic discipline related to mechanical engineering as well as electrical engineering should be applied to design the system. The projects were repeated annually for eight years.

Finding Topic
Undergraduate Students make groups to find a topic on "Medicine in future". They can use the internet to collect information. Each group makes a report on following items:

1) Topic.
2) Keywords.
3) Contribution, Assessment (merit & demerit to the society).

Finding Related Subjects
Undergraduate freshman students in biomedical engineering department make groups to find the related subjects. Each group makes a short report on following items:

1) A device, which operates as a part of the human body.
2) Problems to be solved to design the device.
3) Related subjects (eg. mathematics, physics, chemistry, engineering).

Engineering Background for Biomedical Engineering
The learning has been made by the original textbook "Introduction to biomechanics", in which topics are not oriented by cases but engineering backgrounds.

1) Organism and Machine (Interdisciplinary study)
2) Unit and Measurement (Imaging)
3) Material (Hemolysis)
4) Flow (Blood circulation)
5) Energy (Oxygenator, Dialyzer)
6) Movement (Joint prosthesis)
7) Design and Machining (Artificial organs)

At the end of the course, each student should make a report on one of the topics related to biomechanics. The report must include quantitative discussion with numbers, equations, and drawings. Suitable title, which represents the content of the text must be placed.

Proposal on Biomedical Engineering
Each student makes a report of proposal on biomedical engineering for the training of multi-disciplinary design.

1) A new device, which works as a part of the human body.
2) Specifications including original drawings and numerical description.
3) The description should include following items: problem to be solved, devised methods, background, reference, expected results, contribution to the society, and references.

Cross-Cultural Student Workshop
Students make groups for the workshop on biomedical engineering or symbiosis engineering. Each group includes both Japanese and Thai students. Each group consists of students who have a variety of backgrounds of study fields. After the group activity, each group makes a presentation.

Internship Program
The international internship program is planned in the field of biomedical engineering: the student life in campus, the seminar of biomedical engineering, the lecture of biomechanics, the biomedical engineering laboratory activity, and Japanese cultural experiences.

Presentation Training
The presentation at the international seminar or at the international conference in biomedical engineering fields gives students a good opportunity not only to use foreign language, but also to learn interdisciplinary communication.

3. RESULTS

Group Work
Basic Project
Undergraduate freshman students made 13 groups to make the project-based leaning. Each group included three students. Students have studied on energy converters. They made several systems: a fan (Fig. 3), a vacuum cleaner, a linier motor car, a bell, and others. The project reminds students that a variety of bases of engineering knowledge are necessary for designing.

Finding Topic
Eleven groups made reports on the following topics:

1) Artificial Organs
2) Robotic surgery
3) Tele-robotic surgery
4) Tele-medicine
5) Medical drone
6) Orthodontic correction
7) Diagnostics by artificial intelligence (×2 groups)
8) Initial diagnostics by artificial intelligence
9) Artificial intelligence doctor
10) Artificial intelligence hospital

Most of the topics are related to keywords of robotics, tele-metrics, and artificial intelligence. Students should be more creative, because most of the topics have already been planned by someone in the world. Students get noticed that a variety of topics, which are waiting for their trial (Fig. 4).

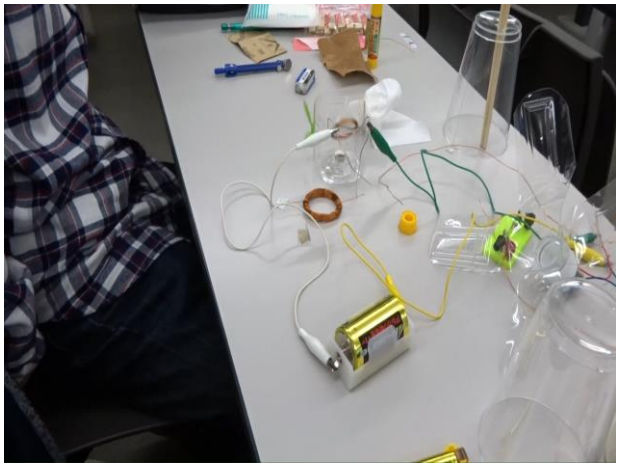

Fig. 3: "A system which has a movement".

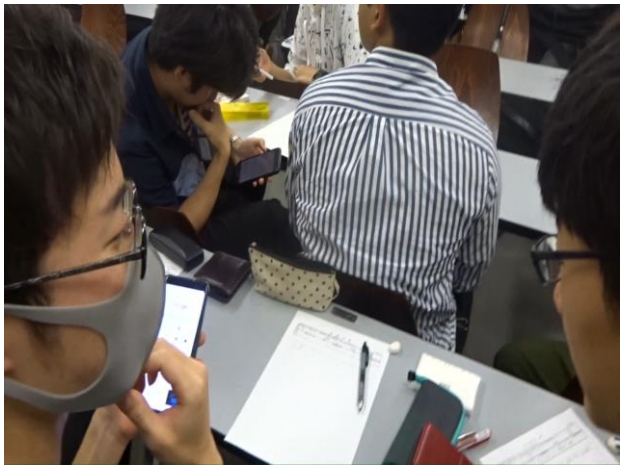

Fig. 4: Finding topic.

Finding Related Subjects

Students have found out many subjects are related to "Biomedical Engineering". After group activity, students learned about the case studies on artificial organs and on related special fields of study.

1) Artificial joint: Biomechanics (balance of force, moment, tribology)
2) Artificial blood-vessels: Biomaterials (deformation, blood compatibility)
3) Artificial heart: Biorheology (flow resistance, energy)
4) Pacemaker: Bioelectronics (electric potential of membrane, electrocardiogram)

Engineering Background for Biomedical Engineering

In total, 4500 students have been learned in the class for 25 years. They learned about "technical terms", which are sometimes defined to the different meanings. They learned that engineering has multidisciplinary communication tools for designing: units, equations, and drawings (Fig. 5).

Proposal on Biomedical Engineering

In the advanced course, 260 post graduate students (in Japan and in Thailand) made reports (Fig. 6), which are categorized into four fields (Fig. 7).

Fig. 5: Biomedical engineering course.

Fig. 6: "Your proposal on biomedical engineering" with internship students abroad.

(1) Sensor.

1) Speech aid device using acceleration sensor of oral movement.
2) Teaching machine with motion capture for optimal exercise.
3) Sensing of vital signs and body movements by smartphone.
4) Real-time HbA1c detector without needle in diabetic patients.
5) Portable infrared sensor for detection of diabetic wounds.
6) Portable burn depth measurement device.
7) Microfluidic chip coupled with magnetophoretic and dielectrophoretic forces for separating malaria-infected red blood cell.
8) Breathing dryness measuring apparatus.
9) Warning doze-off driver by using brain signals.

etc.

(2) Artificial Intelligence.

1) Artificial intelligence for communication with animal.
2) Artificial intelligence glasses to assist radiologists at lung cancer diagnosis.
3) Vision equipment to compensate for blind spots.
4) Smartwatch for diabetic patient.
5) Running suit with cooling function.

6) Design of vital sign sensing module for mobile service robots in elderly care.
7) Implantable micro-machine for diagnostics and treatment.
8) Nano-robot T-cell.
9) Archery shooting instruction using video motion capture.
10) Motion analysis and strategy planning of curling using motion capture.
11) Instruction system for runner using motion capture.

etc.

(3) Prosthesis.

1) Contact lenses for color-blindness.
2) Artificial larynx.
3) Artificial vision.
4) Soft-robotic glove to improve hand function with EEG.
5) Somatosensory feedback for hand prosthesis device.
6) Glasses with additional function.
7) Navigation device for the visually impaired.
8) Braking pedal with left foot.
9) Vision expander.

etc.

(4) Human engineering, Human interface.

1) Human engineering on backrest.
2) Pad for force distribution and ventilation during sleeping.
3) New driving pedal system using both foots.
4) Bioelectric current watch.
5) Device with augmented reality for prohibiting smartphone usage while walking.
6) Softener with cooling micro-capsules.

etc.

Cross-Cultural Student Workshop

For 8 years, 55 students joined in the workshop. Each group consisted of students who had a variety of backgrounds of study fields: mechanical engineering, electric engineering, material engineering, control engineering, informatics, medicine, nursing, dentistry, biology, and veterinary science. Themes were as follows: "Find a project to be solved in biomedical engineering field", "Oil spill cleanup from the surface of the sea", "Visiting the hospital", "Magnesium", "Innovation for the aging society", and "Research topics for collaboration". The program gave students a good opportunity to communicate with a person who has a different background.

Internship Program

In total, five Thai students participated in three months program to Kogakuin University since 2017 (Fig. 8). Each student stayed in the university guest house, took a campus life, attended the lecture, and joined in the laboratory activity. Each student experienced not only study in Japan, but also Japanese culture. The experience gave them a great shock, which would be converted to a basic skill for an interdisciplinarian.

In the domestic program, six students of the electric engineering course (before the bachelor course) participated in two weeks program in the mechanical engineering department. They experienced not only the bachelor course program, but also another discipline, which extends their communication skill.

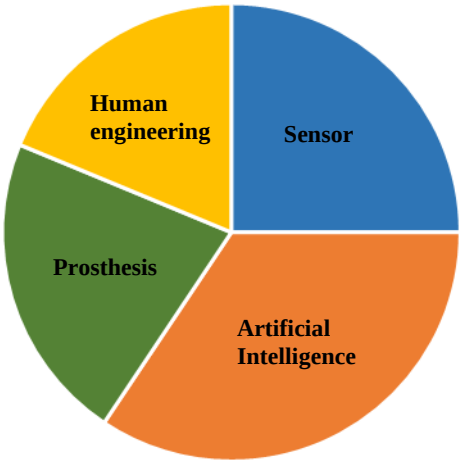

Fig. 7: Proposal on biomedical engineering.

Fig. 8: International internship in laboratory.

Presentation Training

For six years, 15 students joined in the annual cross-cultural seminar for students on biomedical engineering in University of Illinois Chicago. For 7 years, 52 students joined in the annual international biomedical engineering student's seminar in Mahidol University.

The cumulative total number of participating students in the "World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI)" is 61 from 2002 to 2019. The topics of presentation in 2019 are as follows:

a) Effect of Couette type of shear stress field with axial shear slope on deformation and migration of cell: comparison between C2C12 and HUVEC.
b) Alignment and deformation of MC3T3-E1 cultured on micro striped pattern after stimulation of tangential force field.
c) Cell deformation passing through slit between micro-machined surfaces in vitro: comparison among cell types.
d) Cell migration in shear field: comparative study between MC3T3-E1 and 3T3-L1.

e) Design of flow channel with surface electrodes to detect dielectrophoretic movement of floating myoblast.
f) Sorting of cells with flow channel: movement of flowing myoblast cell at oblique micro grooves.

The annual conference of WMSCI includes participants from many countries: from 27 to 52. The number is rather large compared with the other international conferences on the specialized fields. It is good stimulation for young students to join in the multi-society. WMSCI supplies the multidisciplinary society and the cross-cultural society, simultaneously.

Students prepared slides with figures to compensate their English ability. The experience gave motivation to brush up their skill for communication. Both interdisciplinary discussion and cross-cultural discussion compensate peer reviewing.

4. DISCUSSION

An engineering school of Kogakuin University has been established as one of the societies to make communication among multidisciplinary fields. Kogakuin University has a group on biomedical engineering, which includes the following fields.

1) Nano/Microsystems
2) Cellular mechanics
3) Biomechanics
4) Biomaterials and simulation
5) Medical robotics
6) Medical systems
7) Biomedical informatics
8) Bio-control engineering
9) Bio-measurement

Both the internet communication and the database make the global society. That is supported by several technologies. Among the database, statistics is applied frequently (Fig. 9) [4]. "Significant difference" depends on the number of samples. Probability is not almighty for decision making.

Imaging technique has been progressed and support database (Fig. 10). You can use data compression technique to save the data size. You can use data recovery technique, on the other hand, to get higher resolution of the image. In the medical images, for example, enough resolution is necessary for diagnostics [4]. You should be careful about the filter and threshold value. Is that prediction, or fake?

On the background of these technologies, young people must fight with multidisciplinary topics. Symbiosis Engineering is the key to solve multidisciplinary problem in the global society. For example, biodegradable materials are preferable to keep the global environment. Multidisciplinary education is necessary for young generation.

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 [3]. A multidisciplinary textbook should describe not collection of topics, but relationships between topics under a multidisciplinary viewpoint [4–11].

If you can access to every medical data, for example, it might be possible for you to pick up answer to take care of your own health. You do not have to listen to the second opinion from another medical doctor. From the data base, you can pick up the best solution according to the statistics. These systems should be extended to health care system of the society. You can access to the system every moment, which helps registration before the change of condition. People might prefer input personal data to the system rather than declare to a medical doctor. In front of the medical doctor, it might be not easy for a patient to maintain daily conditions.

Cross cultural experience inspires students multidisciplinary learning: Biomedical Engineering, and Symbiosis Engineering [12–14]. I myself experienced internship program abroad in Biomedical engineering field when I was an undergraduate student [15]. The experience gave me a great shock: not only about the interdisciplinary field, but also about the cross-cultural experience.

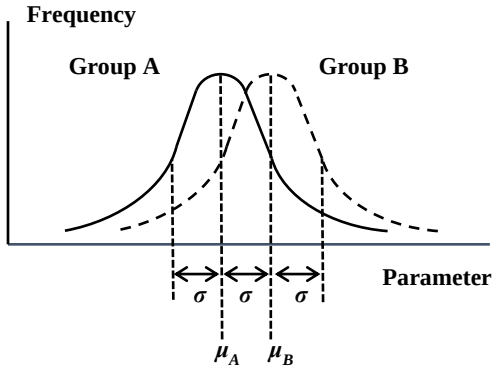

Fig. 9: Test of mean difference: μ, mean; σ, standard deviation.

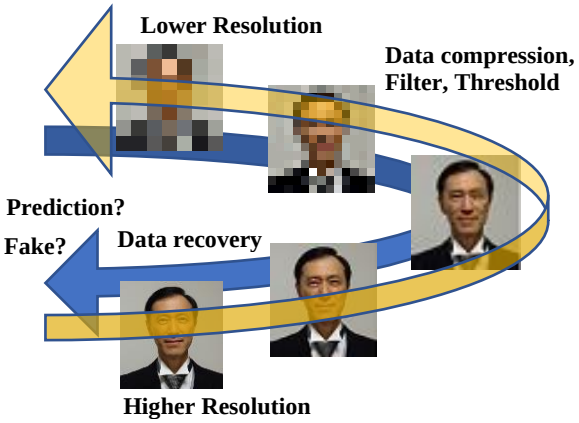

Fig. 10: Imaging technology.

5. CONCLUSION

Several kinds of multidisciplinary learning-programs including cross-cultural programs have been practiced among students. The effectiveness of the multidisciplinary communication training has been discussed in relation to "Biomedical Engineering" and "Symbiosis engineering". The global society includes many kinds of variations: culture, language, and generation. In the global society, symbiosis between systems gave us a lot of multidisciplinary topics. Multidisciplinary communication skill is necessary to handle the topics.

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