How to Learn Multidisciplinary Ideas

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ABSTRACT

The way how to learn multidisciplinary ideas has been discussed. Biomedical engineering is exemplified for a multidisciplinary field. "Biomedical Engineering" makes a multidisciplinary research area, which includes biology, medicine, engineering and others. The cross-cultural student seminars on biomedical engineering have been exemplified as the case studies. In the group fieldwork, students were divided into small groups. Each group visited the university hospital to find research topics related to biomedical engineering as the fieldwork by the cross cultural group. Students pointed out several topics related to the multidisciplinary field, which includes mechanics, informatics, and systemics. They have learned how to communicate with people, who has variety of cultural backgrounds. Through the training, students realized another way of thinking, which stands on another base of idea. The process is effective to master multidisciplinary ideas.

Keywords: Multidisciplinary Idea, Biomedical Engineering, Learning, Students and Cross-cultural Seminar.

1. INTRODUCTION

Each academic field has discipline. In the academic history, academic fields divided into small specialized fields. Although the society of the specialized field is convenient for the peer review, the fusion of the specialized fields might make innovation. Multidisciplinary ideas are important for young students to break through the boundary between academic disciplines.

The technology should contribute to the society. Recently, the number of global problems is increasing in the society. Multidisciplinary ideas are important for young students in engineering department to break through the cross cultural boundary.

Multidisciplinary ideas are important not only in the multidisciplinary field, but also in the global project.

One of the multidisciplinary fields is "Biomedical Engineering" [1-10], which includes biology, medicine, pharmacy, etc. In the field, communication is important between engineering and medicine.

In an international project, you may experience misunderstandings, which depend not only on the language, but also on the cultural background. In a research project in the interdisciplinary field, you may also experience misunderstandings, which depend on the methodological backgrounds. In this point of view, both international projects and interdisciplinary projects have the common problem. The problem supplies a good chance for communication training.

In the present study, the cross cultural multidisciplinary seminar for students has been exemplified, and the way how to learn multidisciplinary ideas has been discussed.

2. METHODS

Group Fieldwork

The annual cross-cultural student program of Biomedical Engineering between Kogakuin University and Chulalongkorn University in Thailand has been started in 2011 [8-10] (Table 1). The co-organizer of the program has been Dr. Mana Sriyudthsak. Students, who participate in the program, are divided into several groups. Each group has to make a report on the theme, and to make a presentation at the final session. Two days are available to make the report and the presentation.

The group fieldwork was selected in 2014. The students were divided into four groups. Each group includes both Thai students and Japanese students. "Visiting the King Chulalongkorn Memorial Hospital (Fig. 1)" was selected for the project. The hospital is one of the practical outputs of Biomedical Engineering. Each group visited the university hospital and tried to pick up research projects for the problems to be solved in the field of biomedical engineering. The medical staffs of hospital are busy at their daily work, but the outpatients and their sitters might have a time to answer the interview of students. Making interview to the patients is not easy for Japanese students, because patients may not speak English. Thai students can help to translate the question from English to Thai.

Presentation Training

The annual cross-cultural student program of Biomedical Engineering between Kogakuin University and Mahidol University in Thailand has also been started in 2011.

Every student made a presentation on the topic of his own research plan in English. After each presentation, students discussed on the topic in Mahidol University in Salaya: at the seminar, and at the laboratory tour.

Table 1: Numbers of students participated in the annual cross-cultural student program of Biomedical Engineering.

Year	*Number of students*
2011	3
2012	6
2013	5
2014	11

Presentation in International Research Conference
Students of "Biomedical Engineering Laboratory" have attended the annual international multidisciplinary research conference, and made presentations [8-10]. They have made the oral presentations in the World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI) since 2002.

Laboratory Visit
Several universities have special programs on biomedical engineering in the world. The author has communicated with several coordinators of the programs. Some of them supported to create a new department of biomedical engineering in Japan in 2006 [1-10]. Some of them agree to collaborate with our group. Some of them have welcomed our students, and have exchanged idea in the annual laboratory visit since 2008 [8-10]. In 2014, eleven students of Biomedical Engineering Laboratory visited two universities in Thailand (Table 1), and five students visited two universities in USA (Table 3).

3. RESULTS

Group Fieldwork
In 2014, ten students from Thailand and eleven students from Japan joined in the project. Their backgrounds were mechanical engineering, material science, environmental engineering, nursing, dentist, pharmacy, and electronics. In each group, students discussed on the issue, picked up agenda, and adjusted the process to make a final report of the group. Students exchanged idea in each group.

One group made interviews to the medical staff after their work. The other groups made interviews to outpatients and sitters.

Group A: "Group A" chose "Medical instrument" for the theme. They made the interview to the medical staff in the hospital laboratory. "Radiology" (Fig. 2) is one of the famous sections in the King Chulalongkorn Memorial Hospital. The medical treatment system consists of four subsystems: a computer tomography simulator (CT-S), a magnetic resonance image simulator (MRI-S), a treatment planning system (TPS), and a linear accelerator (LA). Data from CT-S and from MRI-S are integrated to TPS, and applied to LA.

The CT-S scans the organ to mark the position and the size of the tumor. The medical staffs have pointed out three problems on the CT-S: the room humidity, the software to mark the position of a small tumor, and the easier interface for the operator. The "group A" has pointed out three projects: the humid control system, the software to mark the position of the tumor, and the simple interface for the operator.

The MRI-S scans the organ to mark the position and the size of the tumor, especially the head, the neck, the pelvic area and the prostate gland. The medical staffs have pointed out two problems on the MRI-S: heating at an electricity trouble, and the air condition in the MRI room. The "group A" has pointed out two projects: the local temperature detector, and the local air conditioning in the MRI room.

The TPS plans the treatment program to the patients, and set dose of radiation. The medical staffs have pointed out two problems on the TPS: computer hang over, and the huge expense of running. The "group A" has pointed out two projects: the up to date software, and the high specification of the computer of the lower price.

LA treats radiation at the tumor in the patient. The medical staffs have pointed out the time for processing. The "group A" has pointed out three projects: the support device to help breathing of the patient, the support device to adjust the position of the tumor to be treated at the center of the bed of the instrument, and the simple guidebook written in Thai to shorten the processing time.

Table 2: Spending time (min) for each process.

	regist	*diag*	*invest*	*pay*	*drug*	*total*
Max	360	360	120	60	120	560
Min	0	10	0	0	20	100

Regist, registration; diag, diagnosis; invest, special investigation; drug, getting drug; pay, payment; total; total time in hospital; Max, maximum spending time for each section; Min, minimum spending time for each section.

Fig. 1: King Chulalongkorn Memorial Hospital in Bangkok.

Fig. 2: Radiology in hospital.

Group B: "Group B" chose "Reducing waiting time of the outpatients in the hospital" for the theme. They asked following questions to outpatients (Fig. 3): "How long do you spend for each process: the registration (Fig. 4), the diagnosis by a medical doctor, the special investigation, the payment and the pharmacy?" Eight patients answered to the question: one male and seven females. Their ages distributed between 19 years old and 77 years old. The frequency for visiting hospital per year distributed between 1 time and 36 times. Table 2 shows the distribution (maximum and minimum) of the spending time for each section.

Some patients spend a long time for the registration. One patient complained about the loss of the patient file. Some patients complained about the insufficient number of the medical staffs. Students used internet to find the average spending time in the hospital in Japan for comparison. The "group B" has pointed out the projects of "Registration system on the web (network)". It might decrease the time for the registration at the hospital and save time of the hospital staffs, although it might spend more time for the registration at home.

Fig. 3: Interview to outpatients.

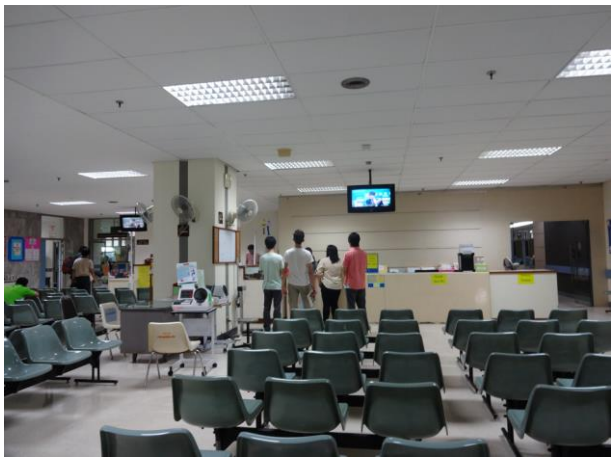

Fig. 4: Reception in hospital.

Group C: "Group C" chose "Device to improve the quality of life of the patient" for the theme. They made the interview to the outpatients.

Case 1: a male patient of 60 years old in rehabilitation has an osteoporosis. The "group C" pointed out the project of "The wheelchair, which transforms into the bed".

Case 2: a female patient of 13 years old in orthopedic surgery has a congenital shortening of the Achilles tendon, as the result of the abnormal structure. She cannot keep symmetry during walking. The "group C" pointed out the project of "Artificial heel to support her foot: adjustment of the length of her leg".

Case 3: a male patient of 55 years old in orthopedic surgery fell down from a height, and has been suffering with the low back pain. The "group C" pointed out the project of "Damper (Supporter) to decrease the pain during the ventilation".

Case 4: a female patient of 60 years old in orthopedic surgery had a benign tumor at her knee joint. She was going to accept operation. The "group C" pointed out the project of "Walking stick with alarm against falling down".

Case 5: a female patient of 55 years old in orthopedic surgery had a tumor in the brain, and lost eyesight. The first operation led her to paralysis. She could not move the lower half of her body. After the second operation, she became to be able to walk. The group C pointed out the project of "Supporter for getting up from bed".

Group D: "Group D" chose "Device for a patient with a cardiac problem" for the theme. They tried to make a report on artificial organs. They made the interview to the outpatients. The "group D" pointed out the project of "Warning device for cardiac problems".

Each group got data from the survey, extracted information, found the key information, set the topic for the research. Each group made a presentation (Fig. 5). The "group C" made a drawing, which is easy for communication.

Fig. 5: Presentation of the group fieldwork.

Fig. 6: Presentation of the topic of research.

Presentation Training
The topics of the presentation in Mahidol University in Thailand in 2014 were as follows (Fig. 6):

1) Simulation of Ridge Formation in Cortical Bone near the Anterior Cruciate Ligament Insertion: Bone Remodeling Due to Interstitial Fluid Flow.
2) Effect of Centrifugal Force on Cell Culture.
3) Effect of Ultrasonic Vibration on Proliferation of Myoblast.
4) Culture of Myoblast on Gold Film Sputtered on Polydimethylsiloxane Disk.
5) Effect of Flow Stimulation on Myoblasts at Parallel Plates Channel.
6) Effect of Centrifugal Force and Electrical Stimulation on Myoblasts.
7) Evaluation of Cell Adhesion Strength on Micro-pattern Using Ultrasonic Vibration.
8) Deformation of Cell Passing through Micro Slit.
9) Regulate Differentiation of 3T3-L1 and Hypertrophy of Differentiated 3T3-L1 by Electrical Stimulation.
10) Effect of Mechanical Stimulation on Mesenchymal Stem Cells.
11) Culture of Carcinoma Cells in Serum-Free Medium.
12) The Synthesis of ZnO Nanorods on Silica Glass Substrate for Homocysteine Optical Biosensor.
13) Development of Virtual Reality System for Rehabilitation Treatment Program.
14) Real Time Calcium Ion Detection on Cell Manipulation System.
15) Antibacterial Nanoparticles for Catheter Coating

It was the first experience for Japanese students to make a group activity in English. The evaluation to their English was not very good, but the presentation of every Japanese student was understandable to Thai students. The figures in the slides might help for Thai students to understand the outline. The presentation is good training for the students to explain contents in the logical order.

The presentation also gave a Japanese student a good opportunity to express himself to the person at the first meeting. After the seminar, communication among students continues to the sightseeing in the traditional places. Some students keep in touch with the participants by e-mail.

Interview to Students
Every student has positive impression after the participation of the seminar. Every student wanted to join the seminar again. The seminar has given a heavy shock to their brain. The seminar has given motivation to change their mind and brush up their skill.

Fieldwork:
1) Though the presentation was serious, the discussion was interesting. I got a lot of information from students.
2) I do not forget the study and the play with you.
3) I have never experienced field works in a hospital. It was a very valuable experience. I will come here again next year.
4) I had a precious experience. Visiting the hospital is a good memory.
5) Activity with students was very exciting to me. Visiting the University Hospital was very helpful.
6) Participating in the trip of "Biomedical Engineering Seminar in Thailand" is third time for me. It gives us power. We must study hard like you. I worried about travel to Thailand before, but I am looking forward to coming to Thailand the next year now.
7) It was a very meaningful experience for me. I am very thankful that we were able to collaborate with everyone. Biomedical Engineering contributes as the technology between patients and medicine.
8) I learned a lot of things from extracurricular lessons.
9) It was a very good experience, which stimulates me to study English.
10) It was a lot of fun talking with the many students.

Laboratory Visit:
1) I came to the Mahidol University and learned various things.
2) I thank you for discussion and introduction of your laboratory. I was surprised to your advanced technologies. I won't forget your passion as a researcher. I will work hard for my study. Communication is not easy between people of different cultural backgrounds.
3) The laboratory tour shows important studies. Because I am a mechanical engineer, I am interested in every field.
4) I appreciate your support and great help at the university. Thank you for showing the laboratory.
5) Activities with you were very exciting to me. Visiting the various laboratories was very informative.
6) We are very glad to come to the university again. It makes us stronger. In the laboratory visiting, we saw very high level researches, which stimulate us to continue our researches.
7) It was a very meaningful experience for me. I learned a lot of things from the laboratory tour: essential expressions, and effective presentations.
8) I learned a lot of things from the laboratory tour for three days.
9) I want to study English and to study more about Biomedical Engineering.
10) Thank you for the comments on my research. Dinner on the last day was very enjoyable. Language is not the only tool for communication.

Presentation Training in Seminar
Five students from Japan joined in the joint seminar between Kogakuin University and University of Illinois at Chicago

(UIC) in UIC in 2014. The titles of presentations in the seminar were as follows.

a) Effect of Flow Stimulation on Cultured Osteoblast.
b) Effect of Ultrasonic Vibration on Proliferation of Myoblast.
c) Simulation of Ridge Formation in Cortical Bone near the Anterior Cruciate Ligament Insertion: Bone Remodeling Due to Interstitial Fluid Flow.
d) Culture of Myoblast on Sputtered Gold Film on Polydimethylsiloxane Disk.
e) Effect of Centrifugal Force on Cell Culture.
f) Dimensionality Reduced Connectomes in CAVE2.
g) New Pulse Sequence Combining Diffusion MRI and MR Elastography (dMRE).

It was not easy for Japanese students to understand the lecture in English. Several research projects in biomedical engineering were introduced to Japanese students. The topic was familiar to Japanese students, because they knew the instruments. Students exchanged ideas about the experimental system.

Presentation in International Research Conference

Students of "Biomedical Engineering Laboratory" have made presentations in WMSCI from 2002. Table 3 shows the numbers of students, who participated in the session as the speaker.

Five students made oral presentations in 2014. The topics are as follows (Fig. 7):

1) Effect of Flow Stimulation on Cultured Osteoblast.
2) Effect of Ultrasonic Vibration on Culture of Myoblast.
3) Behavior of Cell Passing through Micro Slit.
4) Micro Hole for Trapping Flowing Cell.
5) Simulation of Ridge Formation in Cortical Bone near the Anterior Cruciate Ligament Insertion: Bone Remodeling Due to Interstitial Fluid Flow.
6) Culture of Myoblast on Gold Film Sputtered on Polydimethylsiloxane Disk.
7) Effect of Micro Ridges on Orientation of Cultured Cell.
8) Effect of Centrifugal Force on Cell Culture.
9) Myotube Cultured on Micro Coil Spring.

Fig. 7: Presentation in WMSCI2014.

Table 3: Numbers of participated students for presentation in WMSCI.

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

Table 4: Numbers of countries of papers in the proceedings of WMSCI.

Year	*Number of countries*
2008	51
2009	46
2010	52
2011	40
2012	35
2013	27
2014	27
2015	39

4. DISCUSSION

The World Multi-Conference on Systemcs, Cybernetics and Informatics (WMSCI) gives good opportunity to learn multidisciplinary idea, because it welcomes researchers not only from variety of special fields of study, but also from variety of cultural backgrounds (Table 4).

Many academic conferences are concentrated into a special field so that the number of participating countries is limited. Although the specialized group is convenient for a peer review, it is not almighty for the global society. The global society consists of variety of elements. The single discipline is not enough for the application to the global society. A multidisciplinary idea breaks through the global problem, and creates innovation.

It is the multi-society that creates the multidisciplinary idea. Multi-society consists of various elements of cultural and of academic backgrounds. It is good stimulation for young students to join in the multi-society. WMSCI supplies the multidisciplinary society and the cross-cultural society, simultaneously.

The hospital is the place, where many kinds of specialists are joining to accomplish the medical treatments and the health care. Because the university hospital is very big and has a complicated system, it is not easy for patients to find a way to receive better consultations. Visiting the hospital might be a good experience for students to get multidisciplinary ideas.
In the society of one's own native language, communication is easier. A large amount of vocabulary can be used. In the

native language, people feels nuance. The same background allows using abbreviations. In the multi-society, on the other hand, you have to be careful at symbols, which have different meanings according to the backgrounds. Each field has the rule for using technical terms. Misunderstanding often occurs in a multidisciplinary research area, because each area has its own background of thinking. At the beginning, students tend to pay attention to the language itself. After the seminar, students found that "It is easy to find the rule, but difficult to understand the background".

The multidisciplinary field makes students learn several things: logical thinking, and flexibility without prejudice. The shocking experience of the cross cultural seminar makes students notice that "It is important to understand the background of thinking to learn the multidisciplinary field of study".

When I was a student, I experienced a technical internship in the institute of artificial heart in Free University Berlin. The research project of the artificial heart had been supported by collaboration between engineering and medicine. The experience gave me international sense and interdisciplinary sense, simultaneously.

I myself joined the cross cultural student camp every year, since I was nineteen years old. I experienced a lot of difficulties to communicate with students of different fields of study, and of different backgrounds of culture.

I found different disciplines, when I took examinations for multiple PhD theses: the one for medicine and the other for engineering. The research in the field of biology is based on the individuality and the time dependency, so that the statistical processing is indispensable. The research in the field of engineering is based on homogenization, so that the experimental condition should be controlled. The referee of medicine requested numbers of experiment with keeping the protocol, although the referee of engineering requested the sophisticated condition of the experiment.

I also found different disciplines, when my affiliation changed: school of medicine, electronics, biomedical engineering, and mechanical engineering. Each special field of study has developed own discipline including the style of education. Each discipline has its own technical terms. For example, "control" means "comparison" in medicine, although it means "regulation" in engineering.

Creating the first department of "Biomedical Engineering (including bachelor, master, and PhD courses)" in Japan was a big challenge. I created a new concept for the multidisciplinary department, which includes the "Bridge Curriculum" [1-7]. In the multidisciplinary department, the professor himself should be multidisciplinary with the multiple academic backgrounds. Education by multiple professors is effective for multidisciplinary education. In several cases, the evaluation score depends not on professor, but on subject [7].

The view from another side is important in biomedical engineering. In the view of mechanical engineering, cells may tilt along the stream line (the passive reaction). In the view of biology, cells may tilt perpendicular to the stream line to minimize the internal stress (the active reaction) [11].

The experience in the cross-cultural student seminars on biomedical engineering helps students not only understand new idea in the laboratory visit, but also make a presentation in the international research conference.

A common base is necessary for communication. Similar experiences develop the common base. When the common rules are defined, the communication becomes easier. That is the reason why you learn language, mathematics, SI unit, etc.

The information should be available to everyone, and attributed to the society. For universal communication, mathematics is useful. An international unit has been developed. Description should be logical.

When a student of engineering goes abroad, he founds that he has many tools for communication besides language: mathematics, drawings, and figures. Kogakuin University recommends students to go abroad to take lectures in the campus abroad even in Japanese. The lecture system is named as "Hybrid Overseas Education".

Mr. Hiromoto Watanabe, who is the first president (1886-1890) of Imperial University of Japan, made variety of societies to make communication among multidisciplinary fields. He established Kogakuin University, which is one of the societies for education of engineering.

5. CONCLUSION

The cross cultural multidisciplinary seminar for students has been exemplified, and the way how to learn multidisciplinary ideas has been discussed. Students from a variety of backgrounds of research area and culture have joined in the program. Through the training, students realized another way of thinking, which stands on another base of idea. The process is effective to educate multidisciplinary concept.

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