Bridge-Curriculum System for Multidisciplinary Courses: Application to Biomedical Engineering

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ABSTRACT

A bridge-curriculum system has been proposed for a sustained improvement of a curriculum in a multidisciplinary area. The system has been applied to the courses of "Biomedical Engineering". In the system, each course is taken by multiple teachers of variety of disciplines. A minor part, which bridges to another course, is taken by a teacher of the bridged course. Frequent communication between courses is guaranteed in the curriculum. The contents of each course are continuously reviewed by another teacher of the different discipline in the curriculum. The system is effective not only for an improvement of a curriculum but also for creation of a new discipline. The bridge-curriculum system works well to improve the courses of "Biomedical Engineering".

Keywords: Multidisciplinary Courses, Biomedical Engineering, Bridge-Curriculum and Communication between Courses

1. SEGMENTATION OF LEARNING

The academic field is divided into each field according to the subject and methodology (Fig. 1). Although reproducibility and logicality are common in every field, each field develops its own discipline. "Law" in a field cannot always be applied to study in another field.

Each field develops each discipline. Each field defines technical terms to describe research achievements. Sometimes the technical term makes communication mismatch (Fig. 2).

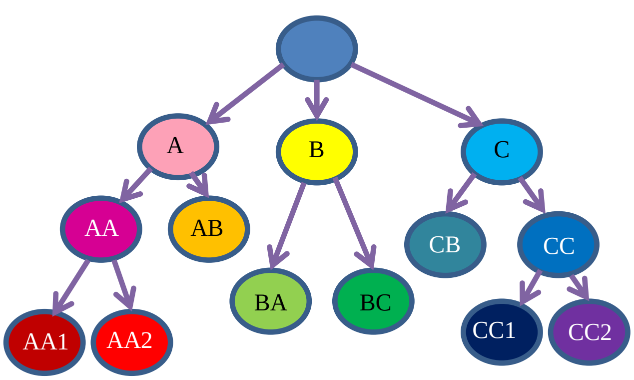

Fig. 1: Segmentation of learning.

Both "Medicine" and "Engineering" have their own technical terms. For example, "control" means comparison in medicine and regulation in engineering, respectively. "Plasma" is used for blood in medicine and for ionization in engineering.

The subject of medicine is diagnosis and treatment for disorders, where the subject of engineering is manufacturing and control of artificial materials. Although application is important both in medicine and in engineering, each field develops its own methodology.

Statistics plays an important role in medicine, because every biological specimen has individuality and changes every time. The protocol should not be changed for the statistical processing in medicine. Standardization plays an important role, on the other hand, in engineering, so that methodology and materials should be modified to minimize scattering in data (Fig. 3).

Achievement is applied in a hospital for medicine and in a factory for engineering. Clinical training in the hospital spend more than two years in a medical school, but engineering design training in the factory is not compulsory in an engineering school sometimes.

2. CURRICULUM

In a university curriculum with a credit system, each course is

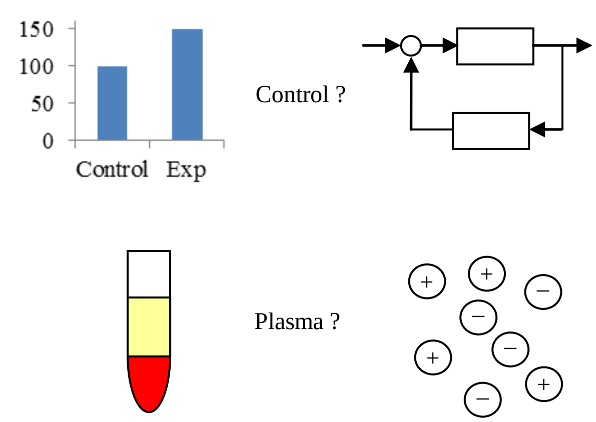

Fig. 2: Technical term makes communication mismatch.

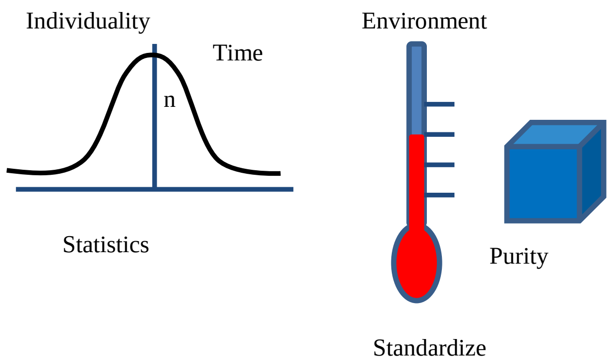

Fig. 3: Protocol should not be changed or should be modified..

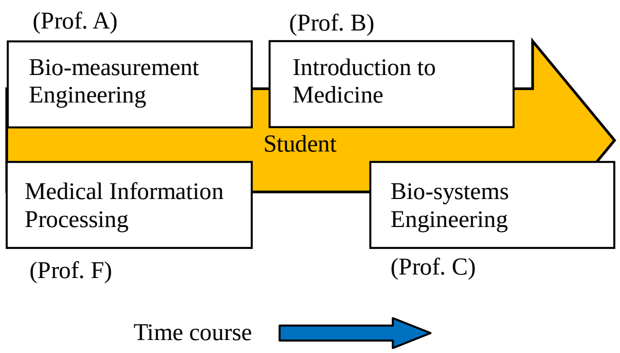

Fig. 4: Conventional curriculum.

usually handled by individual teacher alone. It is a student who should make bridges between courses (Fig. 4). Although the university teachers have their own original specialty, most of them have not trained how to make lessons. The licensed degree like a high school teacher is not necessary to be a professor in a university in Japan. In Japan, most of textbooks taken in the courses of universities have no official approval like those of high schools, either. This is convenient to offer "Place of a free doctrine". The cooperation between subjects is not enough, on the other hand, when each teacher discretely takes each class by his judgment. In a traditional field of study, every course is arranged systematically. In a new field of study, on the other hand, it is difficult for a student to understand the relation between subjects. This kind of system cannot guarantee the sustained improvement of the entire curriculum.

Recently, every university program requires a guaranteed system to improve curriculum sustainably without relying on "Student's initiative" in "Optional courses". The education program should be flexibly improved in the viewpoint not only from the program offer side but also from the student side, to extend the goals of the program.

3. MULTIDICIPLINARY COURSES

A curriculum of multidisciplinary area has a lot of chances to compare different disciplines. Contradistinction is effective not only for comprehension of a discipline, but also for creation of a new discipline.

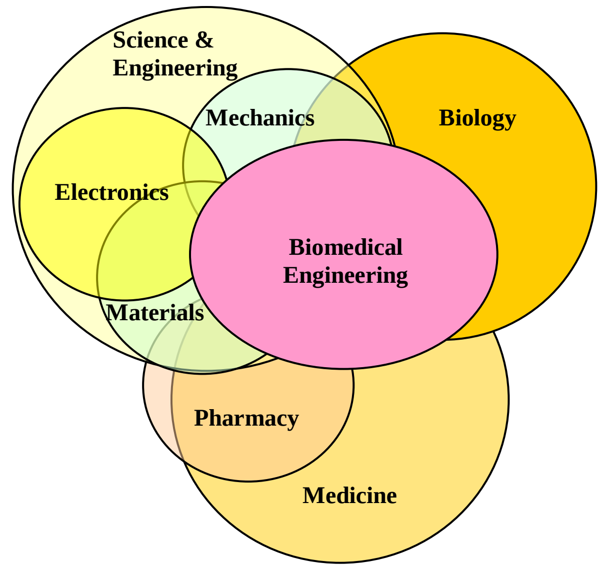

Fig. 5: Biomedical engineering field.

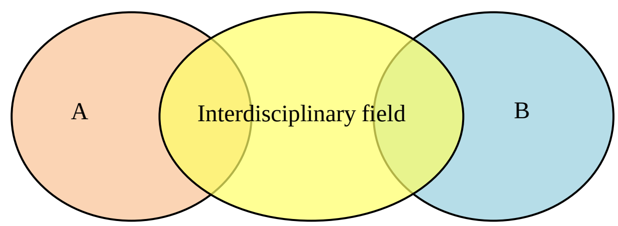

Fig. 6: Interdisciplinary field.

Because “Biomedical Engineering” is a multidisciplinary area [1], it has variations not only in teachers’ special fields but also in study backgrounds of students. The relation among courses might be hard to understand in the curriculum, when it consists of disorderly aggregated subjects taken by each teacher from variety of the study field. A fusion of various systems and backgrounds of study, on the other hand, creates a new field of study in a multidisciplinary area such as “Biomedical Engineering” (Fig. 5).

An interdisciplinary field is not a mere mixture of specialized fields. When several fields that extend to another area are connected to each other, they represent the academic value as an interdisciplinary field (Fig. 6). Aggregation of professors from various special fields cannot make a multidisciplinary education program. Every professor should experience multidiscipline, and should have ability to fuse special fields. In the present study, a challenging bridge-curriculum has been applied for a sustained improvement of a curriculum in a multidisciplinary area of “Biomedical Engineering”.

4. BRIDGE BETWEEN COURSES

The design of courses in the bridge curriculum (Fig. 7) is as follows:

1) Two or more professors take charge in every course at an omnibus style. A student meets two or more teachers in any class.
2) A key professor is in charge to arrange the entire syllabus and to decide the evaluation method to give a student a credit for the subject, collecting the contents from the related professors.
3) Through the communication between courses by class inspection and by discussion between professors, each professor proposes the content of the contribution part to the key professor.
4) A professor takes charge of the part, which should be bridged to another subject (Fig. 8). For example, the professor "B" of "Introduction to Medicine" takes charge of a statistics part of "Medical Information Processing" and the electrocardiogram part of "Bio-measurement Engineering".
5) Each lecturer takes charge of an experimental project. The contents of the experimental project relates to that of the lecture (Fig. 9).
6) Each experimental project includes many elements of learning: planning, designing, instrumentation, teamwork, analyzing, modeling, explanation, and presentation.
7) The experimental project provides a good opportunity to touch materials and to meet with application of fundamental subjects, which have been learned in the lecture.

5. DISCUSSION

Interviews to students, to their parents and to industry show the following advantages and disadvantages of the bridge-curriculum system.

Advantages:
1) The system gives a chance to refresh and inspire students from one object to another. Compatibility between a student and the content of the subject can be distinguished from that between a student and the professor individuality. Students can select professor, when they complain to the contents of the subject. Professor can collect opinion from students about the contents charged by another professor.
2) The bridging-charge system guarantees the daily discussion among subjects.
3) A constant exchange between subjects is guaranteed. Cooperation with other subjects can be considered at any time. Scheduled lecture is requested.
4) A discussion on the level of student's achievement among related subjects is guaranteed. A self-righteous evaluation to students can be prevented with the check by another professor.
5) The bias, which depends on professor individuality, can be compensated by another professor. The improvement of the content of the subject can be distinguished from that of the professor ability.
6) Because every professor takes part in the class of multi semesters, he can always check students' achievement according to their learning history.
7) Because two or more professors recognize the outline of the class, a lecturer at any class can be easily replaced by another professor in a case of an accident. The lesson schedule becomes flexible independent of teacher's convenience.

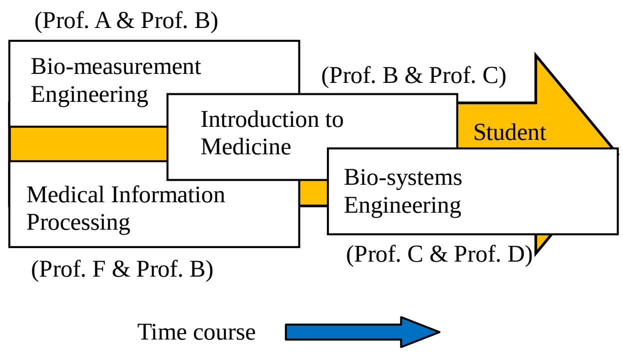

Fig. 7: Bridge curriculum.

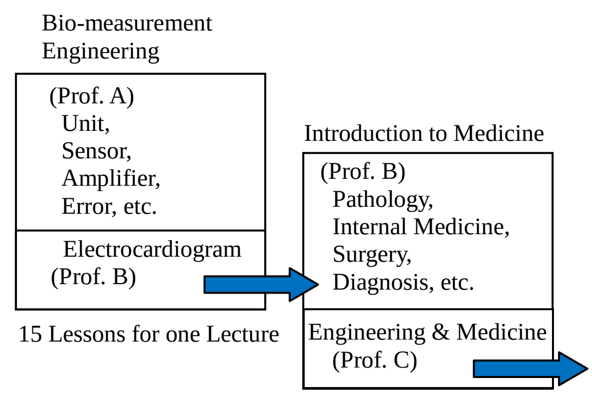

Fig. 8: Bridge (arrow) content between courses.

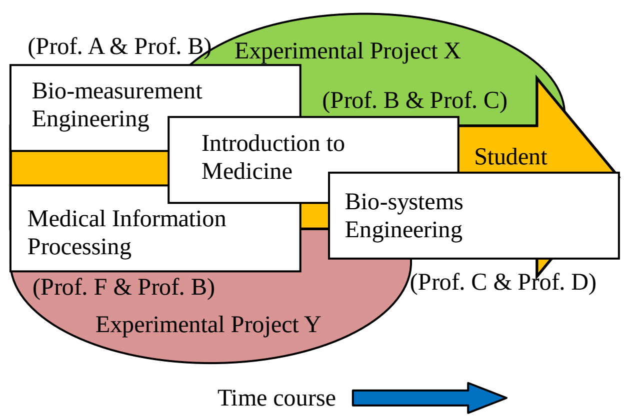

Fig. 9: Bridge curriculum with experimental projects.

8) The system breaks the wall between subjects, and enhances the exchange of the contents between them.
9) The system reforms the traditional style of "one teacher on one subject".
10) The system creates a new curriculum system, as well as a new academic system.

Disadvantages:
1) Interrupt the story of each course.
2) Students have to follow the change of the lecture style during one course.

3) Scheduled lecture is requested.
4) The management of the class schedule becomes complicated for faculties.
5) The class schedule becomes complicated for professors.
6) Alternation of professors might make it difficult for student to understand the continuousness of the content in a course.

The “Plan, Do, Check, Action (PDCA)” cycle to improve a curriculum works with the inspection of the class and with the meeting on the content of the course among faculties. The regular meeting, however, is not enough to support the cycle. The daily discussion among faculties is preferred to support the cycle. Before introduction of the system, the inspection of the class and the meeting on the content tended to be skipped.

Although it is the best way for students to select one from two or more classes prepared for each subject, a department does not have allowance to prepare such a huge amount of classes: neither enough space, nor enough professors. Students tend to select not the contents but professor’s individuality. The subject does not depend too much on individuality of one professor in the bridging-charge system. Before introduction of the system, the improvement of the content of the subject could hardly be distinguished from that of the professor’s ability. Monotonous contents of the basic subject can be changed to exciting contents by variation of professors’ specialty. It is easy for a professor to take cooperation with another university under flexible class schedule in the system. Cooperation between universities is important especially in a multidisciplinary field.

The contents have been continuously reviewed with the designed system. Following the students’ opinion about the weakness of the area in biology and in life science, fields on the cell technology and on the gene technology have been added to the curriculum [2-5]. The curriculum has serial subjects of small group activity in “Seminars” and in “Rotational Experimental Projects” from first semester to last semester. They enable polishing the ability of design, communication, presentation, and teamwork, as well as supplying the advisory system for students’ learning. The bridging-charge system works well to improve the curriculum of “Biomedical Engineering".

6. CONCLUSION

A bridge-curriculum has been proposed for a sustained improvement of a curriculum in a multidisciplinary area. The curriculum has been applied to “Biomedical Engineering” courses. The curriculum works well to improve the curriculum of a multidisciplinary area.

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