

## **DESIGNING A CLASS TO TEACH MULTI-VIEWPOINTS**

**Seiko SHIRASAKA, Naohiko KOHTAKE**

4-1-1 Hiyoshi, Kohoku-ku, Yokohama, Kanagawa, 223-8526 Japan

### **ABSTRACT**

The Graduate School of System Design and Management of Keio University (Keio SDM) was established on April 1, 2008 to cultivate system thinkers who can lead the development and operation of large-scale complex technological and social systems. One of the indispensable capabilities of system thinker is multi-viewpoints. One of our approaches to cultivate persons who have multi-viewpoints through a class at KEIO SDM is to make good use of combination of self work and group work. Our students come from a wide variety of backgrounds. Group works with different background can cultivate multi-viewpoints as far as the students work together seriously. The student motivation is also very important for this approach. We designed the class, introduction to systems engineering, which is mandatory for all master degree students to realize the approach. We design the class to realize the multi-viewpoints. As the results of our system design of the class, we implemented the e-learning video for the class preparation and self and group consecutive work. As we mentioned above, a student motivation is also very important to make group work effective. Our approach to make student motivated is to make students feel their growth through the class. Our method to realize this approach is to ask the same question both at the beginning of class and at the end of class. This makes them participate actively in the group work by motivated. We did the questionnaires to the student at the end of each semester. According to that, the implementation of the class design works well. The combination of self work and group work makes the students feel the lesson easy. And the same question before and after lesson makes the students feel the lesson understandable and well ordered. However, there are two concerns. One concern is the time for the preparation. The students have to spend more time to prepare by watching e-learning to learn the knowledge of systems engineering. Because of this negative effect, even if the class feels more understandable, ordered well and easy to understand, the total evaluation does NOT become better. The other concern is the motivation. The same question before the lesson and after the lesson was implemented to make the students feel their growth and finally motivated. But the results of the questionnaire don't support this expectation.

Keywords: class design; multi viewpoint; motivation; e-learning

### **BACKGROUND**

A graduate school was established at Keio University in 2008 for the education of “System Design Management”, a study that integrates humanities and sciences and crosses many disciplines, with the objective of cultivating talented persons who can lead

## **Designing A Class To Teach Multi-Viewpoints**

the development and operation of large-scale complex system. The subject of the education is constructed and practically oriented so that students can acquire a capacity to design and manage large-scale complex system. For this purpose, the cultivation of multi-viewpoints is very important.

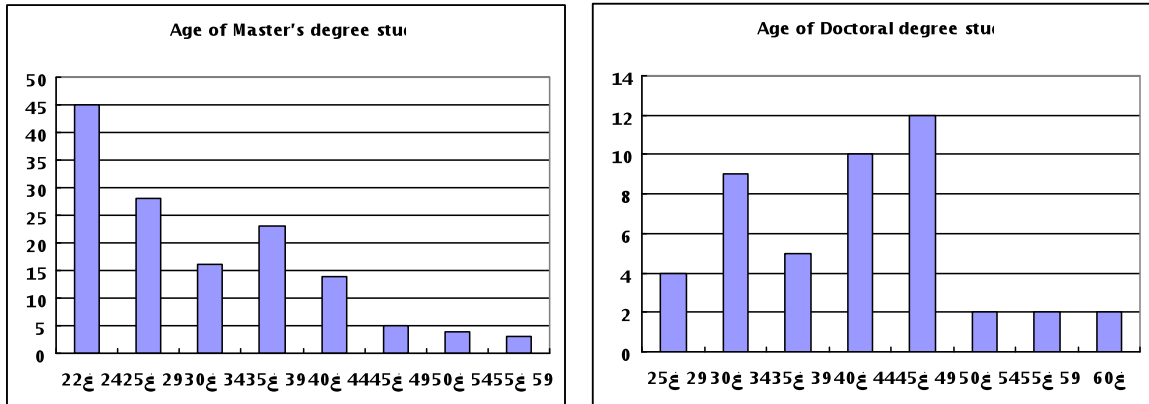
### **Demand from industries**

Education conducted at the university and graduate school level must at all times meet the demands of industry. In “Results of a questionnaire on human resources sought by corporations,” (Japan Business Federation 2004) the Japan Business Federation Committee on Educational Issues gives a list of expectations. The table lists the five most common responses in the results of a questionnaire targeted at 520 corporations to discover what sort of human resources in the engineering field they wanted from a standpoint of hiring. The results indicated that they wanted universities and graduate schools to produce human resources who can create and manage future generation systems.

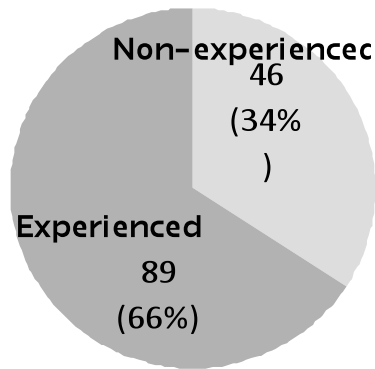
### **Feature of Students**

The university conducts student enrolment campaigns for the SDM course at academies, industries and government organizations. It requests industry to send adult students. As a result, we are now attracting students via three annual entrance examinations. The students in the program represent diverse backgrounds in age, field and nationality. In fiscal 2008 and 2009, we enrolled students both during the spring and autumn term. Master course enrolment in fiscal 2009 numbered 138 students and there were 46 doctoral course students. The age of our students range from 20 to 60 and the average age of master’s course students is 38 and 42 for doctoral course students. (Figure 1) Their original backgrounds are science, law, political science, literature, commercial science, agriculture and physical education. Many of the students possessed professional experience: 66% of master's course students and 89% of doctoral course students. (Figure 2) Students with job experience came from a wide variety of fields: manufacturing, communications, consulting, information, aerospace, finance, real estate, government and municipal offices, construction, energy, systems, medicine, mass media and publishing and the legal profession. The ratio of students with foreign nationality including students that come from overseas is now 20%. As planned, we have been able to create an environment where students with widely different job experiences can meet and associate with our diverse and talented instructor corps.

## Designing A Class To Teach Multi-Viewpoints



**Figure 1. Age of KEIO SDM Students**



**Master Course**

**Figure 2. Rate of experienced/non-experienced students**

### OBJECTIVES OF THIS PAPER

With the very special diversity of the students' backgrounds, they have a chance to cultivate their multi-viewpoints. However, the appropriate class design is required for the efficient cultivation of the multi-viewpoints. In this paper, our class design approach and the design results are shown. And the evaluation of the implementation of our design is also described.

## Designing A Class To Teach Multi-Viewpoints

### IMPORTANCE OF MULTI-VIEWPOINTS

No system can be described from only one viewpoint. To understand system requirements, stakeholders' viewpoints are required. This can be recognized from the standard. In IEEE1471-2000 "IEEE Recommended Practice for Architectural Description of Software-Intensive Systems"(IEEE, 2000) shows the conceptual model of architecture description. (Figure 3) It was conceived as a software-focused system standard, but it can be also applicable to any systems. (Maier, 2004). According to this standard, system architecture can be described by views. The view is what I see from a viewpoint. The viewpoint is where I look from. And also, the viewpoints are based on concerns which stakeholders' have. From this standard, multi-viewpoints is an indispensable capability for persons who can lead the development and operation of large-scale complex technological and social systems.

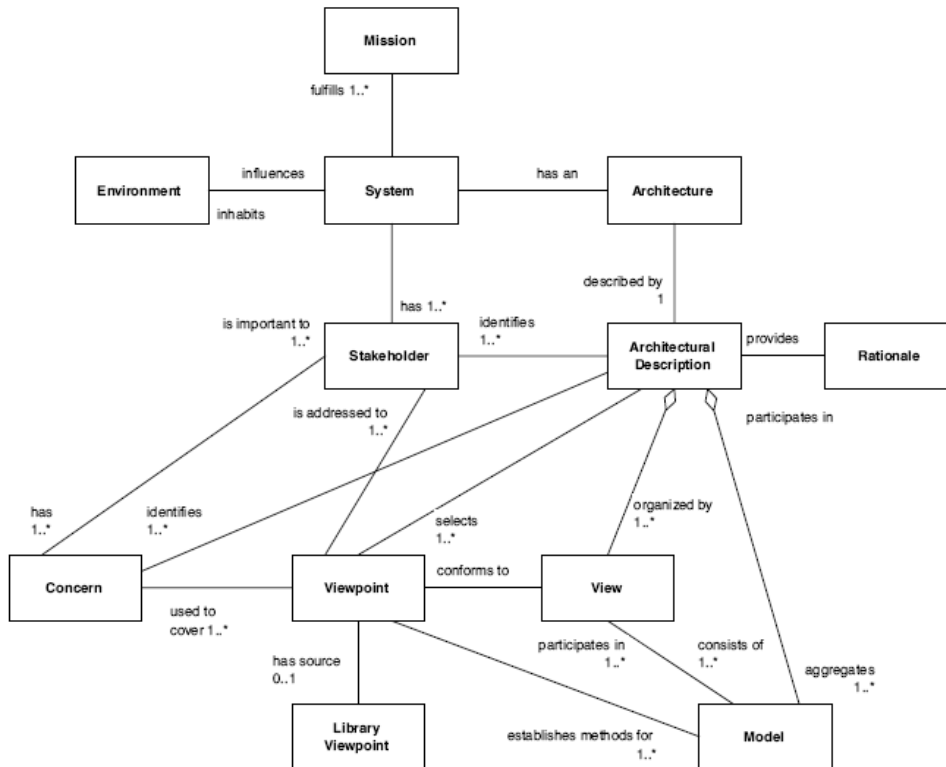


Figure 3. Conceptual model of architectural description in IEEE1471-2000

## Designing A Class To Teach Multi-Viewpoints

### CLASS DESIGN

There are four mandatory classes for all master's degree students. The introduction of systems engineering is one of them. This class teaches very basic knowledge of system thinking and systems engineering. There are several objectives of this class, but one of the most important objectives is to cultivate a capability to see a system from multi-viewpoints. To design the class and class operation, system approach is used.

#### Design Approach

In the systems engineering approach, system architecture is designed by three steps according to the traditional systems engineering standards. For example, in ISO/IEC15288 "Systems and software engineering — System life cycle processes", there are three steps to define architecture. (ISO/IEC, 2008)

- Step1: Define appropriate logical architectural designs
- Step2: Partition the system functions and allocate them to elements of system architecture
- Step3: Define and document the interfaces between system elements and at the system boundary with external systems.

When we think a class as a system, we can follow these steps to design steps.

#### Step1: Logical Architectural Design

Step1 is "Define appropriate logical architectural designs". One of the most important goals is to cultivate a capability to see a system from multi-viewpoints. A capability to see a system from multi-viewpoints means that students have their own viewpoints and understand other students' viewpoints, too.

#### Step2: Class Operation Design

Step2 is a partitioning functions and an allocation of the partitioned function to system elements. Partitioning of the functions come from the results of the logical architectural design. Two functions are required to satisfy logical architecture design. One function is to let students have their own viewpoints. The other function is to let them understand other students' viewpoints.

We have to define the system elements of the class in order to allocate functions to them. Here, we select a "workshop" is a system element. However, one element is not enough to allocate two functions. We partitioned one workshop into two. The function of the first workshop is to let students have their own viewpoint. This means that at the first workshop students have to work by themselves. The function of the second workshop is to let them to understand other students' viewpoints. This means that at the second

## Designing A Class To Teach Multi-Viewpoints

workshop students have to work together with other students and understand other students opinions to know their viewpoints.

### Step3: Define the interfaces

Generally the interfaces between elements are very important. This is the same as our case. The interfaces between the first workshop and second workshop are important. Their interfaces are the sequence and the subject. They have to have the correct sequence. Of course, the self work has to be prior to the group work. If the order of two workshop is incorrect, some of the students may not be able to have their own viewpoint because they know other students' viewpoints at the group work. And also the same subject should be used for these two workshops to know and understand other students' viewpoints to recognize the differences of their viewpoints.

The result of Design is shown in Figure 4.

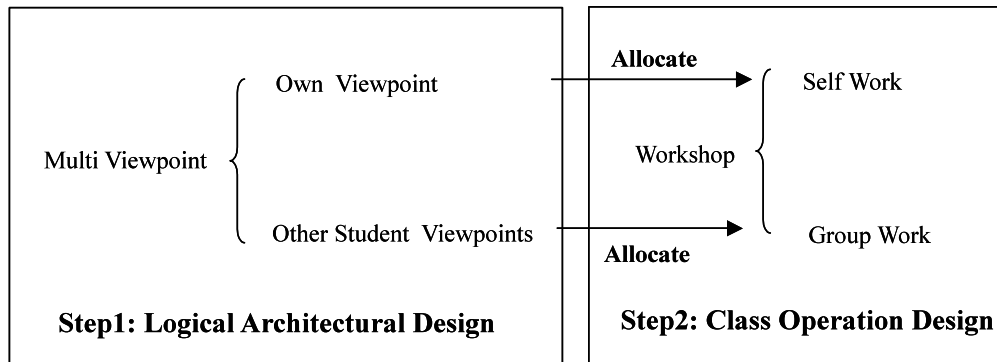


Figure 4. The Result of Class Design

### Additional concerns

When we designed the class described above, we had two concerns. The concerns were motivation and time. The first concern was motivation. To understand other students' viewpoints, the students have to do group work actively. If the students don't do group work actively, they will not try to understand other students' viewpoints. The second concern was time to conduct workshop twice for the same subject. One works was self work and the other one was the group work. This means that we need more time than we do only one workshop. Followings are additional class design to solve these concerns. The design approach is same as the previous approach which is described above.

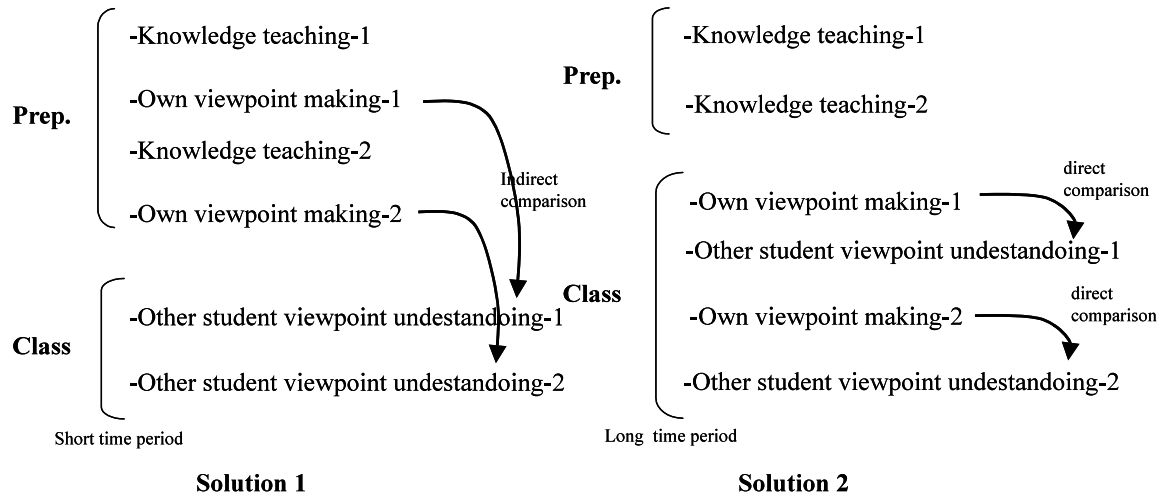
### Step1': Logical Architectural Design

Step1 is "Define appropriate logical architectural designs". The goals are to motivate the students and to make time for two workshops.

## Designing A Class To Teach Multi-Viewpoints

The first concern is motivation. What makes students positive to do group work actively? Our idea is to make students feel their own growth by comparing current their own skills with previous their own skills. This idea was implemented before the two workshops for multi-viewpoints were implemented.

The other concern is time. One lesson time is 90 minutes. This is the introduction course of Systems Engineering. Most of the students have no knowledge of systems engineering when they take this class. Usually we teach the knowledge first, and then do some workshops to deepen the understandings of the lesson. And also homework after the lesson helps the students deepen the understandings of the lesson. When we implement two-workshop style, we have to follow the different sequence. Usually we teach two or three topics within one lesson. To know other student viewpoints, students have to gather. But students do not necessarily gather for knowledge teaching and own viewpoint making. There are two solutions for this concern. One solution is that students study knowledge, make own viewpoint at home before lesson and understand other student viewpoints at a class. The other solution is that students study knowledge at home before lesson and make own viewpoint and understand other student viewpoints at a class. From time point of view, the first solution is better because we can have more time at a class. However, when we consider the motivation concern, the result is opposite. To make students feel their differences of skill level between before learn a lesson and after learn a lesson, direct comparison within the short period is easier to feel the differences. Figure 5 shows the features of two solutions.



**Figure 5. The Result of Class Design**

## **Designing A Class To Teach Multi-Viewpoints**

### **Step2': Class Operation Design**

Step2 is a partitioning functions and an allocation of the partitioned function to system elements. Partitioning of the functions come from the results of the logical architectural design. In addition to the two functions which are identified Step2, three more functions are required to satisfy the logical architecture design (Step1'). The first function is to teach knowledge of systems engineering. The second function is to confirm the skill before the class. The last function is to confirm the skill after the class.

We have to define the system elements of the class in order to allocate functions to them. In addition to the workshop including self-work and group work, we need E-learning and questions to confirm the students' skill. However, one "question" element is not enough to allocate two functions. We need two questions. The function of the first question is to confirm the skill before the class. The function of the second question is to confirm the skill after the class. This means that at the first question students can confirm the skill before they study class. The function of the second question is to confirm the skill after they study the class.

### **Step3': Define the interface**

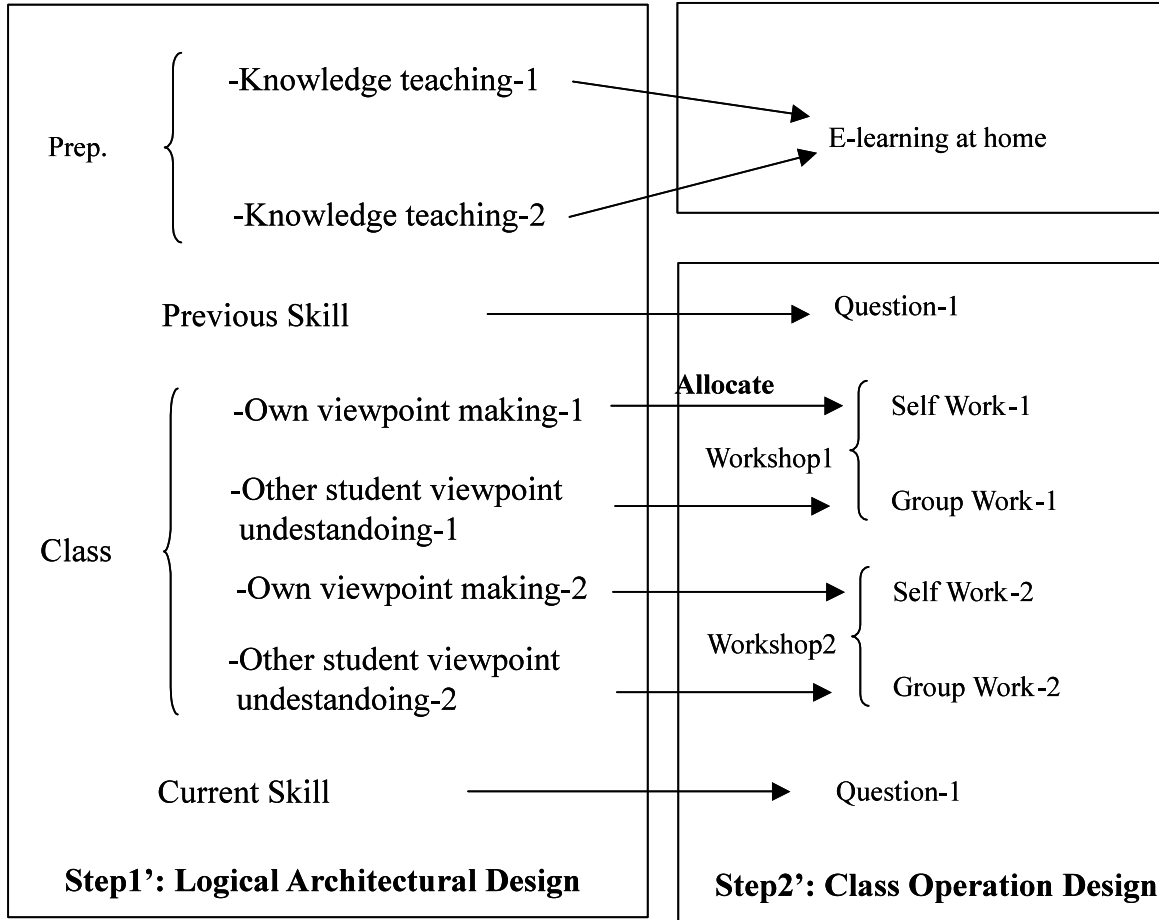
The interfaces between the first question and second question are important. Their interfaces are the sequence and the subject. They have to have the correct sequence. Of course, the first question has to be prior to the workshop. And also the same subject should be used for these two questions to know the difference of the skill between before the workshop and after the workshop.

The e-learning is used for teaching knowledge. Because it does not require that students come together at the same room.

The result of Design is shown in Figure 6.



## Designing A Class To Teach Multi-Viewpoints

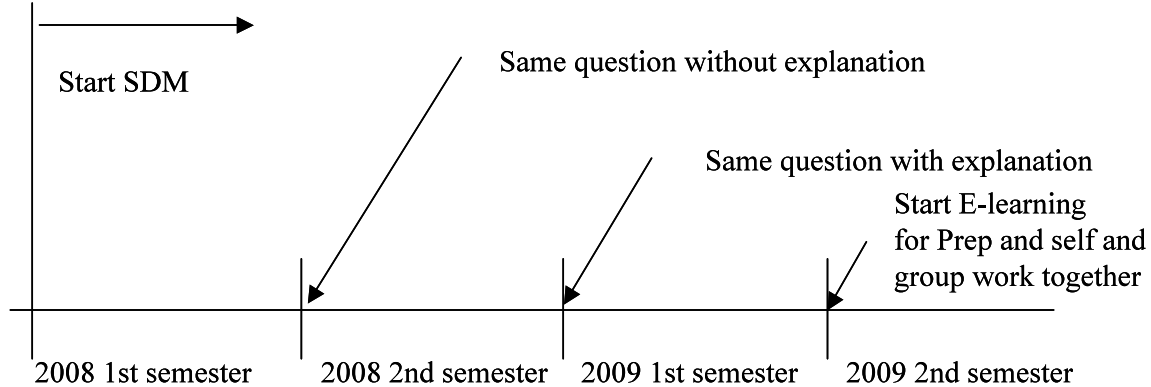


**Figure 6. The Result of 2nd Class Design**

### IMPLEMENTATION

We implemented the class operation design which is described above step-by-step. KEIO SDM started in 2008. At the first semester of 2008, the class was very normal. Most of the time, students sat at the seats. There were some self work, but not group work. At the second semester of 2008, we started to ask the same questions before and after class to motivate students without explanation. At the first semester of 2009, we did the same thing, but we explained why we did the same question before and after class. At the second semester of 2009, we started to use E-learning system for preparation and perform self and group work together. (Figure 7)

## Designing A Class To Teach Multi-Viewpoints



**Figure 7. Implementation**

### RESULTS

One of the main objectives of the class design is to cultivate multi-viewpoints. However, it is not directory evaluate whether the students have it or not. In stead of that, we had the feedback from the students at the end of every semester using an unsigned questionnaire for the evaluation. This is a standard questionnaire for class evaluation at KEIO SDM. There are 18 items in the questionnaire, but we pick up six which are related to our class design.

First three questionnaires are picked up to evaluate the same question method which is described above.

- Degree of Understandable Level
- Class Sequence Correctness
- Motivation

Next two questionnaires are picked up to evaluate the e-learning utilization for preparation which is described above.

- Difficulty
- Prep./Review Time

Last questionnaire is to evaluate the class design totally.

- Total Evaluation

## Designing A Class To Teach Multi-Viewpoints

### Degree of Understandable Level

This is the item to check how well the students feel they understand the class. The bigger number means that they understand better. From the results of questionnaire, the students' feelings of understanding level have obviously increased from the second semester of 2008 when we introduced the same questions method without explanation. (Figure 8)

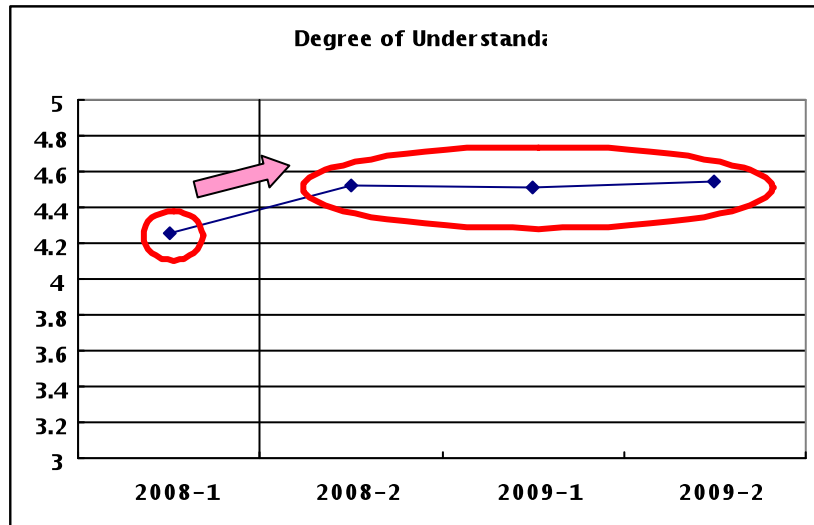


Figure 8. Degree of Understandable Level

### Class Sequence Correctness

This is the item to check how well the students feel the class sequence is good. The bigger number means that they feel it better. From the results of questionnaire, the students' feelings of class sequence correctness have obviously increased from the first semester of 2009 when we used the same questions method with explanation. (Figure 9) The difference between the second semester of 2008 and the first semester of 2009 was whether we explicitly explained our same question method or not. From these results, this method is effective even if we did not explicitly explain the reason. But the students feel better when we explicitly explained it.

## Designing A Class To Teach Multi-Viewpoints

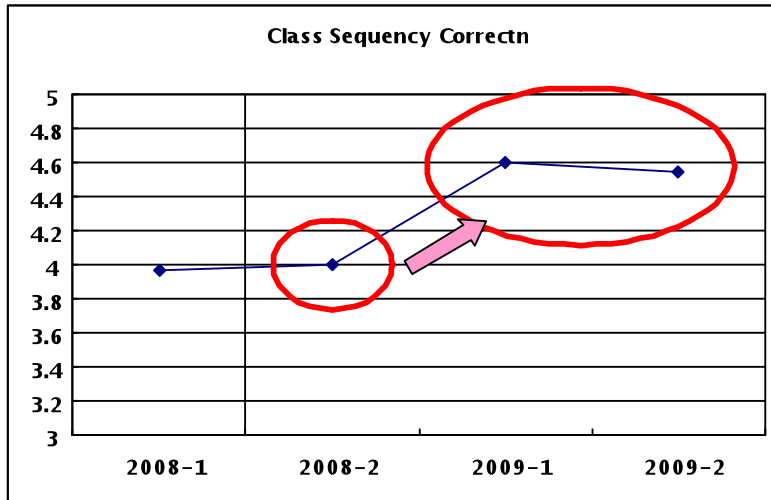


Figure 9. Class Sequence Correctness

### Motivation

This is the item to check how big the students have motivation. The bigger number means that they have more motivation. From the results of questionnaire, the students' feelings of their motivation have not changed for two years. (Figure 10) From the results of understandable level, class sequence correctness and motivation, the same question method can make students to understand the lesson better, but not motivate them.

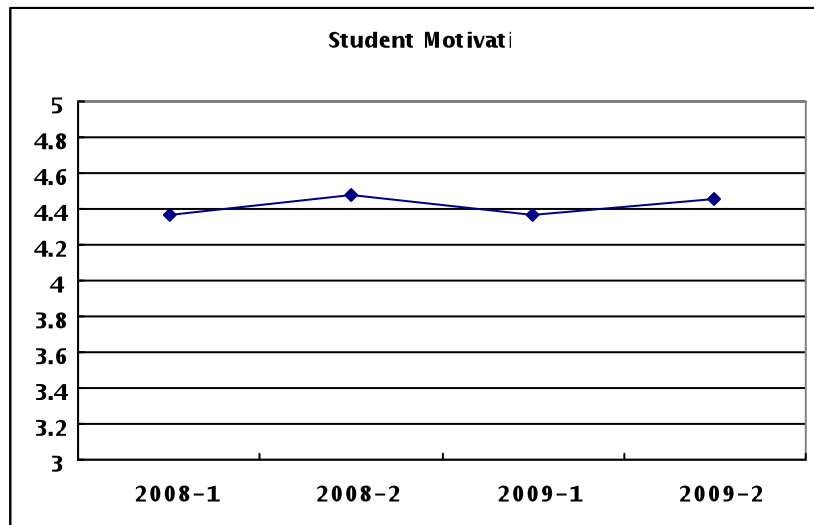


Figure 10. Class Sequence Correctness

## Designing A Class To Teach Multi-Viewpoints

### Difficulty

This is the item to check how difficult for the students to understand the class. The bigger number means more difficult. Number three is appropriate. Less than three means too easy. From the results of questionnaire, the students' feelings of difficulty have obviously changed from the first semester of 2009 when we used the e-learning for preparation. (Figure 11) From this result, the e-learning for preparation and self and group work is effective for student to learn.

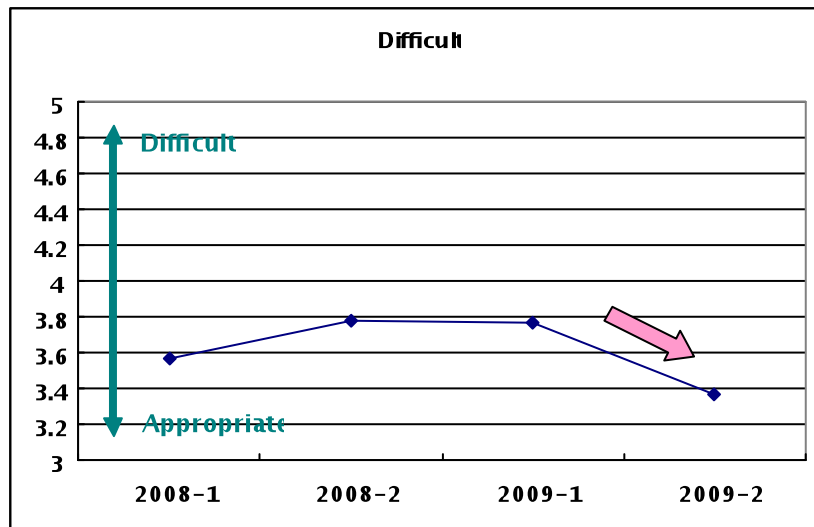


Figure 11. Difficulty

### Prep./Review Time

This is the item to check how many hours the students spend for the preparation and review. The unit of Y axis is hours. From the results of questionnaire, the required time has obviously changed from the first semester of 2009 when we used the e-learning for preparation. (Figure 12) This result is understandable because the students have to spend several hours as the preparation to learn knowledge before the class.

## Designing A Class To Teach Multi-Viewpoints

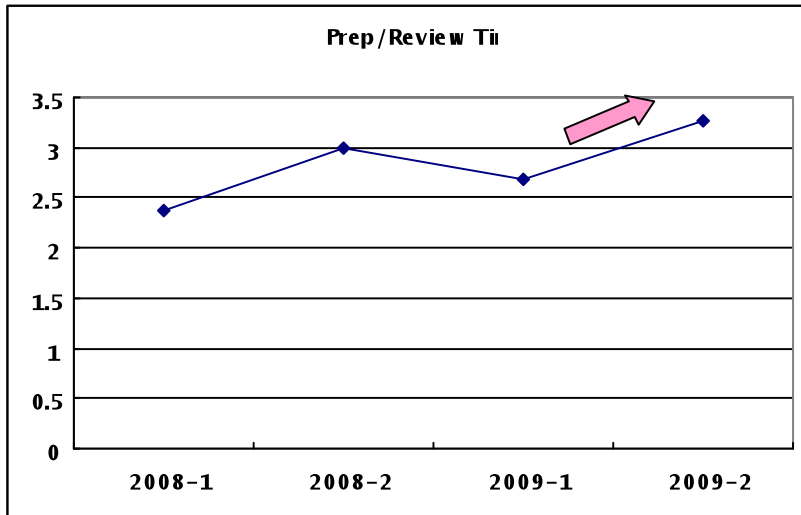


Figure 12. Prep/Review Time

### Total Evaluation

This is the item to check how well the students feel the class totally. The bigger number means better. From the results of questionnaire, the students' feelings of total evaluation have not changed for two years. Or little bit worse at the second semester of 2009. (Figure 13) To understand this situation, we did the interview to the student at the second semester of 2009. Most of their complaint was too much time they need for preparation.

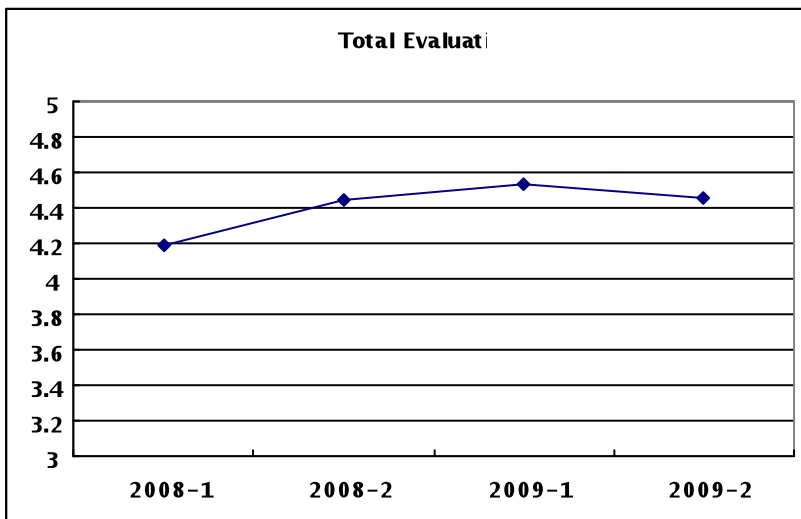


Figure 13. Total Evaluation

## **Designing A Class To Teach Multi-Viewpoints**

### **CONCLUSION**

One of the main objectives of the class design is to cultivate multi-viewpoints. However, it is not directory evaluate whether the students have it or not. In stead of that, we use the standard class evaluation questionnaire. According to that, the implementation of the class design works well. The combination of self work and group work makes the students feel the lesson easy. And the same question before and after lesson makes the students feel the lesson understandable and well ordered. However, there are two concerns. One concern is the time for the preparation. The students have to spend more time to prepare by watching e-learning to learn the knowledge of systems engineering. Because of this negative effect, even if the class feels more understandable, ordered well and easy to understand, the total evaluation does NOT become better. The other concern is the motivation. The same question before the lesson and after the lesson was implemented to make the students feel their growth and finally motivated. But the results of the questionnaire don't support this expectation.

### **FUTURE WORK**

The biggest concern is the time for preparation. We have to make some solution to make the time for preparation shorter. The current e-learning is the video which was recorded during the first semester of 2009 class. And also we need some solution to motivate the students.

### **ACKNOWLEDGEMENTS**

Part of this research was carried out with the support of the Global COE Program "Center for Education and Research of Symbiotic, Safe and Secure System Design" by the Ministry of Education, Culture, Sports, Science and Technology, Japan. We wish to note and express their appreciation.

### **REFERENCES**

- IEEE (2000). IEEE1471-2000 IEEE Recommended Practice for Architectural Description of Software-Intensive Systems, IEEE
- ISO/IEC(2008), ISO/IEC 15288 Systems and software engineering — System life cycle processes, ISO/IEC
- Jain, R., Sheppard, K., Elisabeth, M. and Bernard, G. (2008), Promoting systems thinking in engineering and pre-engineering students', ASEE Conference Proceedings, Zone 1 Conference held at the US Military Academy at West Point
- Maier, M., Emery, D. & Hilliard, R. (2004). ANSI/IEEE 1471 and systems engineering, Systems Engineering, 7(3), 257-270
- Sage, A.(2000), "Systems Engineering Education", IEEE Transactions on System, Man, and Cybernetics, Vol. 30, No. 2

## **Designing A Class To Teach Multi-Viewpoints**

W. Fabrycky and E. McCrae (2005), Systems Engineering Degree Programs in the United States. Proceedings of the 15 INCOSE International Symposium