Development of the International PBL and Suggestion of the Evaluation Method

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***Abstract*— We propose Global Engineering PBL which consist of elemental technic in industrial field. So we proposed on the theme of sequential control which is the mainstream in the industrial field. Therefore we have developed the Global Engineering PBL of sequential control for the effect. And the validity of Global Engineering PBL is confirmed by cooperation with KMITL. We employ two methods as an investigation of the effect of Global Engineering PBL. One is the subjective value by the questionnaire before and after PBL implementation. Another is the objective value by PROG.**

***Keywords*— Global Engineering PBL; International Corporation; Active Learning; Generic Skill ;Sequence control kit**

I. INTRODUCTION

Society is in need of human resources who possess skills relevant to the 21st century and who can learn and operate higher educational facilities. Students should have advanced knowledge and ability to solve social issues, both regionally and globally, in an autonomous, collaborative and constructive way [1]. A student is requesting the practicing ability. The ability to find a problem and settle a problem actively by oneself in particular is wished for. PBL is introduced in the education for an effective method and many papers were published about its effect. But some papers are reported about the learning technique of the PBL(Project/Problem Based Learning) , and the thinking method in the internationalism PBL.

We research the paper that Global PBL implement the follow report in Japan, the group member consist of the global, held the PBL in foreign country. Now a day, the Internet technique provide some application, so we are possible to new education without the distance and time. For example, LMS, Open Web Contents, TV meeting system, SNS and so on.

Usually, we ask for a wide opinion as a solution of those problems (Environmental issue). In these case, important things are below: propose, communicate, cooperate and agree. After the PBL, we measure the effect of the PBL. Usually we use the ex post fact questionnaire. This result is low objectivity because this evaluation will be the subjectivity value of the student. And it's difficult that we understand improvement of the ability of the student objectively. NIT of Sendai College had introduced PROG (Progress Report on Generic Skill) into the value of the student's generic skill. That's confirming that student's skill can be estimated objectively [2]. A match of international PBL is also performed at a Japanese university. That's general and widely PBL problem. It's because students of the wide field are gathered. It's to make it easy to put into effect.

In this paper, we restricted a theme of PBL to engineering. We aimed at a sequence control as a PBL problem in it. The sequence control technology is used in many electric appliances and industrial machines. Therefore, Sequence control is important knowledge for students of the engineering.

We propose utilizing those for the preliminary class of Global PBL and learning basic knowledge, and compose a group by students with the same basic knowledge and work on a problem in Global PBL. We put emphasis on that a solution is easy as a theme of PBL and that it's driven by the spirit of competition. Because we imaged the Global PBL goal is special knowledge of one engineering filed.

Therefor, the PROG test, which has some improvable elements [3], was carried out to evaluate the educational benefits of the A3 Learning System. In addition, this method is discussed as a method of evaluating 'literacy', leading to the practical resolution of problems and 'competency', which is the skill used to forge good relationships with the surrounding environment. NIT of Sendai College.

So we develop necessary development of an experimental kit and learning contents for Global engineering PBL implementation. And we consider how to visualize student's generic skill changes by participation in Global PBL about a visualized way.

II. DEVELOPMENT OF A SEQUENCE EXPERIMENTAL KIT

First we thought about a problem for Global Engineering PBL. We propose a PBL theme which consists very easily for engineering field students. That's the theme to which a student can propose a solution. A solution isn't inarticulate for that. It's like an environmental issue and business improvement. It's composed of PBL put into effect in PBL of the project type, not the problem solving type.

So we made the sequence control a subject. Our college cooperates with France (IUT:Institus Universitaire de Technologie), Finland (HMUAS: Helsinki Metropolia University of Applied Sciences, TUAS: Turku University of Applied Sciences) and Thailand (KMITL: King Mongkut's Institute of Technology). Those universities are experimenting on a sequence control. Student are experiencing a sequence control by some experiments. They understood these contents, so we selected the Global engineering PBL theme which is the sequence control of a positioning control.

Students learn a sequence control with a part of the basic knowledge (fixed knowledge type) and a part of confirmation by an experiment (experiment knowledge type). The basic knowledge support the active learning which are e-learning, flipped classroom and so on. We suggest the Global Engineering PBL which consist of three part. 1st is Basic knowledge (Relay Sequence), 2nd is Regular knowledge (Sequence Control, PLC), last is Application knowledge (PLC, Sensor).

A. Basic knowledge (Relay Sequece)

Several Kosen has a FA Basic kit which contributed from Omron Corporation. It shows the figure1. This kit can learn basic relay sequence. The students were learned by experiments using by this kit and text.

The FA Basic kit include of the some sensors (reflection, penetration, scattering, touch and magnetic), belt comber (position control), 7seg LED, switches (toggle, push, NC, NO and rotary) and some color light.

Firstly the students learn the relay sequence. Relay sequence control is the basic control system of the sequence control. An order of the learning. First, the students learn the basic knowledge. For example, input/output device, control device, the sequence circuit and ladder diagram and so on. Lastly, the students learn ladder diagram in order to learn the PLC sequence.

Omron had the original Web contents about this kit. But we developed original Web learning contents for the basic relay sequence. Because we considered the self-learning system for the students. It shows the figure.2 .They try to experiments and check and search the Web contents. They found the keyword Web contents and they learned by themselves. The contents are very fundamental knowledge (AND, OR, NOT and Self hold by Relay). These contents were expressed in Japanese and English. And it includes the CBT contents. Students can check the understanding levels by themselves.

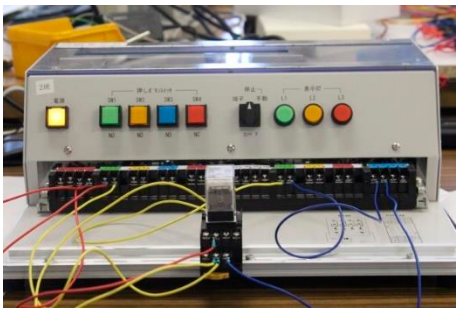

Fig 1. Relay sequence circuit using the "Basic FA learning kit"

Fig 2. Development of web page of the contents

B. Regular knowledge (B.PLC sequence control)

We suggest for students to learn from basic skill to expert skill which mean from the relay sequence to PLC sequence control. The program of PLC designed by the ladder program. The students learn by the e-learning and CBT, they got the some knowledge. The students use the FA Basic kit too. It include of the PLC. The students can learn the PCL sequence control. But it's very simple and fundamental experiments. So the students learn the input devices which are some kind of sensor and the output device which is motor controller.

Students can create a complicated circuit using a program on the PC. Example of a simple ladder program is show in figure.3. Students can easily create a program by simply using the input and output symbol. In addition, there is something called a FB (Function Block) in the output symbol. We can issue various commands to the device by using the FB. In this research, we prepared an experiment of positioning control as a basic experiment of PCL sequence using this kit. The positioning control system is a fundamental system. Usually the students learn the positioning control system which control the motor to adjust the actual position. They got the skill of ladder programing technique and Input/Output device of PLC. And they changed some parameter to get optimal control though repeat the experiment. Students control the positioning using the FB. FB to use in positioning control is show in figure.4. We can change the speed and position of the positioning control. In the experiments, the Input data is a target positon, after the table move to the target position smoothly, quickly, fast without vibration. They can got the skill how to get the best control parameters.

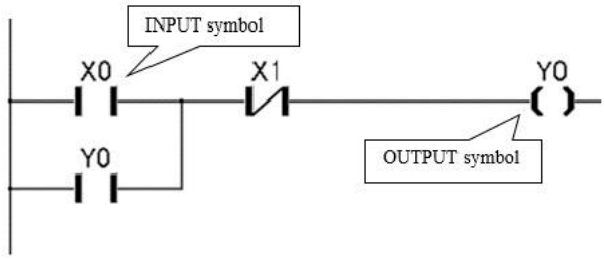

Fig 3. Example of a simple ladder program

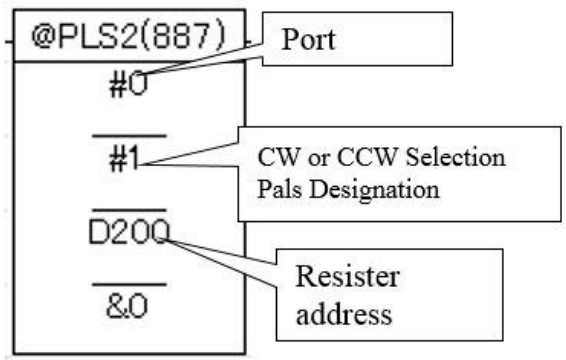

Fig 4. FB (Function Block) to use in positioning control

C. Application knowledge(PLC,Sensor)

The students have skill the positioning control system and develop the program. So this section they learn the Project Based Learning. After we write detail about Global PLB, his section we write about developed the experimental kit for the sequence control kit. It shows the figure.5 . This kit consist of 3 part. One of the board on which balls are lying, other are the motor part where I move the box and the box in which a ball is caught, and positioning control by PLC.

This kit can choose the used sensor and also choose location of the sensor freely. It shows the figure.6 . Therefor they research and learn how to use the sensors. After they design the circuit and program to achieve the goal.

The problem is very simple. They move a box to the position where the lying ball is caught. A destination in this PBL is to catch many balls. But several restriction is held by the process which settles a problem, Restriction time of the play, the number of the ball which can be used and the sensor, the kind of balls and movement after a catch.

The teacher becomes possible to design PBL of various degree of difficulty. The students can understand a goal clearly, too. The system that one has developed it by a demonstration, it becomes possible to estimate objectively.

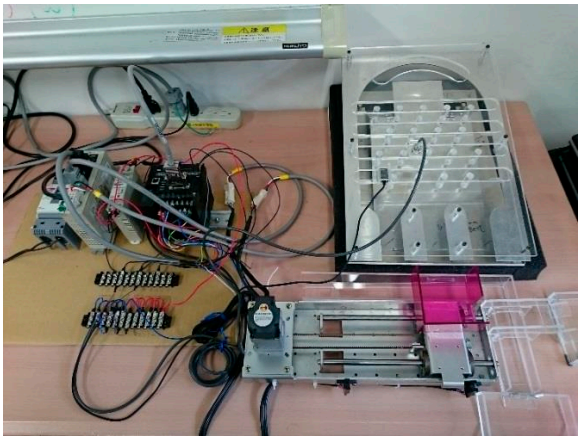

Fig 5. Development of the sequence learning Kit

Fig 6. Select the Sensor

III. GLOBAL PBL

A. Design

We're planning to put Global PBL into effect with KMITL in faculty of engineering. Our students and KIMTL students collaborate with this project. We'd like to visualize growth of student's skill by this project. So we estimate student's skill before this project in PROG. And after this project we estimate student's skill again. It's possible to confirm the growth of the student's skill which isn't obtained by domestic lecture. And it's possible to confirm the grown-up field of the skill by the different environment. It's possible to be being to measure these data continually and be arranging for problem setting of Global PBL.

This year is first year, we will design Global PBL follow schedule.

1st day:

Acquisition of Basic and Regular basic knowledge is learned separately in the respective environment (Japan and Thailand). Application knowledge mixes a student and composes a group. A student learns basic knowledge of a sensor and a PLC by a group. After that a report meeting of a learning outcome is put into effect. Finally the students know the contents of PBL.

2nd day:

The students design a circuit to yesterday's PBL problem by the respective groups. They investigate by the internet and library. They design a pre circuit using a kit and check the operation. They exhibit the circuit they do some degree movement of before an end.

3rd day:

The students redesign and reorganize for the last presentation from the evening (athletic meeting). The presentation put into effect in the evening estimates a design concept and originality. The students compete for

the acquisition score in an athletic meeting. It's estimated even between the student as well as the teacher.

We're planning to put Global PBL into effect by the above mentioned schedule. The student who participated in this project will receive PROG once again about 3 months later. It's possible to confirm which degree a generic skill improves by this. We have been developing an evaluation seat of a skill for experimental implementation. The student is the value of the skill by himself, and this evaluation sheet puts it into effect to get correlation with objective evaluation.

B. Implementation

We think PBL have two kind of meanings, one of the Problem Based Learning, other is Project Based Learning. Usually its implement one of them, but we blended both method in Global PBL. Students carry out independently by a group to make a project succeed. They settle a problem using the PDCA cycle.

We have to establish a problem so that a student can concentrate. After I pay attention to the following point. They can imagine a goal. A problem is good complication exactly. They can have a competitive spirit. Students can maintain a motivation of problem solving by these.

Therefore we have developed the learning kit described by a preceding chapter. This kit isn't a problem of the positioning control to catch an easy ball. We adopt competition during a group as the final presentation. Students devise improvement of a system by this to get a high score.

IV. MEASUREMENT OF A SKILL

A. Generic Skill

In February, 2006, the Ministry of Economy, Trade and Industry defined the basic abilities required in working together with various people in the workplace and in the local communities as "Fundamental Competencies for Working Persons" which consist of the following three competencies (12 competency factors) at a committee comprising of intellectuals in the businesses and universities[1]. It's consist of 3 Competencies and 12 Competency Factors. It shows the figure.5. Fundamental Competencies for Working Persons. And the skill think about figure.7.

The necessary knowledge utilization ability is called a generic skill to live by society and go in recent years. An expectation of generic skill upbringing through university education is rising as member of society basic skills and the university graduate power. An expectation of generic skill upbringing through university education is rising as member of society basic skills and the university graduate power. An evaluation test of the skill which is indicated on figure.8 as the ability grade of the student different from results as well as introduction of active learning is performed at United States and Europe. It's a related figure of time for test implementation and the cost on table.1.

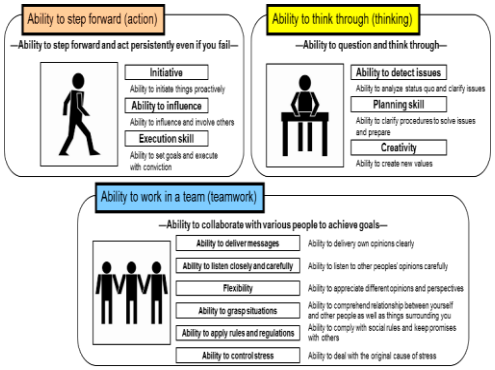

Fig 7. Fundamental Competencies for Working Persons

TABLE I
KIND OF THE GENERIC SKILL TEST

Country	Name of test	Implementing agency	method	
USA	**CLA** The Collegiate Learning Assessment	CAE	Narrative form	3h
	MAPP Measure of Academic Proficiency and Progress	ETS	Multiple-choice narrative form	8h
	CAAP Collegiate Assessment of Academic Profiiciency	ACT	Multiple-choice narrative form	4h
Australia	**GSA** Graduate Skill Assessment	ACER	Multiple-choice narrative form	3h
Japan	**PROG** Progress Report on Generic Skill	KRT	Multiple-choice (a part of narrative form)	1.5h

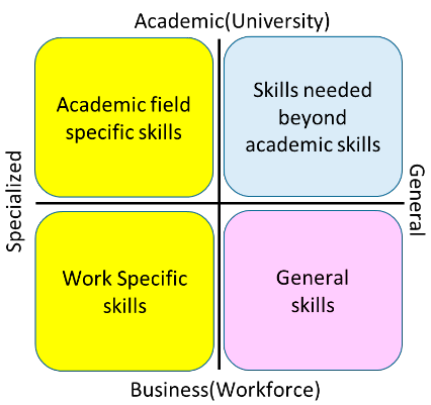

Fig.8 Generic Skill

The PROG has the following advantage, it's possible to estimate student's skill objectively which can balance a cost with time. So we made students who are Sendai college students took a PROG [2].

The figure.9 shows the result of 2015 of NIT of Sendai and KMITL. PROG has 2 sides of generic skills, Literacy and Competency. Literacy evaluate the learning knowledge. A broken line is an average of the Japanese science system frosh. Red circle indicates student's data of an engineering department electric family of KMITL.A green square indicates the 4th grader's data in Sendai. PROG can analyze a student literacy and the competency more in detail. PROG can classify the plan drafting ability, executive ability and the cooperativeness into 12 kinds of competency and 6 kinds of literacy altogether.

Sendai student have the literacy ability more excellent than an average of the college student. They have the equal competency. These mean that they are equal to student of the science system of the same age. On the other hand the literacy is low, but a student of KMITL has the excellent competency. This equals the ability of the member of society in Japan.

We aren't implementing student's PROG test enough to analyze details into effect. I'll also continue and put measurement by PROG into effect from now on.

It's comparison of student's generic skill in KMITL and Sendai College by the current state. The respective students are visualization of a change by implementation of global PBL for our purpose. PROG visualizes student's generic skill objectively.

We're planning to implement global PBL with KMITL and Sendai students this year. We measure how student's skill changes by Global PBL.

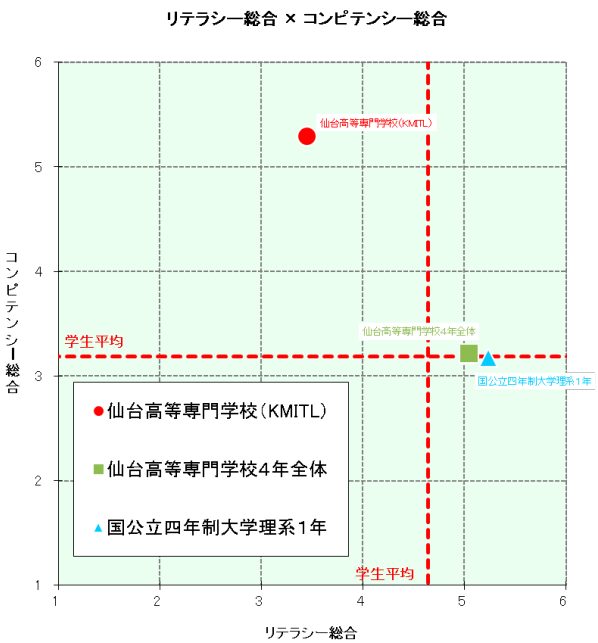

Fig.9 Average values of the total scores of literacy and competency of the students

V. CONCLUSIONS

We proposed Global PBL which a goal is clear by a technological problem. Students do a group work though they learn the basic knowledge before PBL implementation. They use the internet systems. Students can aim at the goal which is special from student's aspiration by a joint experiment. We have developed an experimental kit and learning contents in order to carry out such Global PBL. We proposed estimating growth of student's skill as well as implementation of Global PBL objectively. We're planning to do grown-up visualization and evaluation of student's skill by this project by future's experiment

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