Human Resource Development by PBL in the Sendai National College of Technology

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Abstract

At Sendai National College of Technology (SNCT), "Cultivation of the Embedded System Engineer by PBL" project is carried out. The purpose of this project is to cultivate the group leaders and to contribute to the regional society. The targeted trainees are; 1) practical engineers in the private companies who work within 10 years from the employment or new business, 2) students of advanced engineering course in SNCT. The execution period of the project is 5 years from 2008 to 2012, and 153 trainees have been produced by 2010. Based on the investigation in 2005, the project has installed two courses to acquire knowledge and technology in terms of; 1) Embedded System, and 2) Safety and Energy Conservation. The curriculum has been composed of three phases; 1) Basic in the Engineer of Embedded System, 2) PBL Part1, and 3) PBL Part2. In this PBL system, the problem of the actual field is solved in each theme, and the cooperative education between working engineers and students is realized. In questionnaire and interviewing, needs extraction and curriculum improvement are attempted. In the succession of tacit knowledge and formal knowledge in the training period, the process of the effective knowledge creation to solve each problem can be achieved. Also the project constitutes the PDCA cycle in both of management and education. The activation of the regional industry can be expected by utilizing the skill of the trainees in the belonging enterprise. And the human network has been constructed across same and/or different business fields.

Keywords: PBL, Human Resource Development, Project Leader, Embedded System, Safety and Energy Conservation
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Introduction

Sendai National College of Technology, SNCT, formerly Miyagi National College of Technology, MNCT, have been executing the projects concerning to the promotion of human resource development, particularly for the employees who have worked within ten years in a new field and the industry in local area. The survey to the around 250 private companies in local area, Miyagi prefecture and Fukushima prefecture was executed to clarify the need of relatively small size of companies (Miyagi National College of Technology and Fukushima National College of Technology, 2006). The result indicates that they need the human development education, and 42% for the fields to apply existing technology and 17% for the high technology. The expected talent is the ability to solve the problem that occurs in the company activities, i.e. need oriented rather than seed evolving.

In 2006, in order to acquire the capability of practical management while the task should be basic level according to the participants, two colleges together have proposed the PBL (Problem/Project Based Learning) with three themes as below considering the survey and available resources of both colleges (UTSUMI et al., 2007, Miyagi Organization For Industry Promotion, 2007).

1) The performance estimation of material property,
2) The evaluation of the energy conservation equipments in building, and
3) Embedded system in machines

The project in 2006 indicated the performance for the above three themes and the discussions in the preparation phase for the next project in 2007 proposed that the group leader of several members is necessary in near future, considering the increase of the offices and
factories of the fields related to 2) and 3) in local area. In 2008, the project to promote the human resources concerning to the themes of 2) and 3) at the above was adopted as national project by Ministry of Education, Culture, Sports, Science and Technology.

This paper describes the framework, content and some example of the project in 2010 based on the above background.

**The Framework of PBL Project to Cultivate the Leader of Small Group**

The overview of the project is shown in Fig. 1. According to the previous project in 2006 and the surveys and discussions between many educational organizations that have work integrated learning system in EU, USA, China, etc., the framework can be described with five bodies (Ikeda, 2007 and Investigative Commission of Educational System of Basic Level Engineers of Miyagi National College of Technology, 2007);

1) Steering committee: The executive members from industry, local body and colleges inquire the advice and concrete plan to advisory committee. It investigates them in terms of the industrial activity, government policy, etc. and establishes the strategic basement of the project. Also it evaluates the outcome and makes suggestions to improve the project.

2) Advisory Committee: This committee is lead by a coordinator and makes the curriculum and the allocation of rooms, staff, educational materials, equipments, etc. The administrative issues are dealt by the secretary in this committee.

3) Teaching Staff: They executed the project in the lessons with students. They are from various organizations corresponding to the subject of themes and have an experience and expertise in the related fields from five to thirty years.

4) Center for enhancement and support of basic technology: Miyagi prefecture has an alliance to enhance the capability of private companies in the fields of basic technology, such as
mechanics, electronics, etc. It includes all related universities and colleges so that its human network has provided the teaching staff. In effect it established the educational project in 2007.

5) Private Companies in Miyagi Prefecture: The networks of private companies mainly focused are society for industrial technology promoting of SNCT that has supported Collaboration Technology Center of SNCT and Sennan Area Industrial Association that has exchanged information with SNCT for years.

As seen as arrows, teaching staffs have surveyed the needs in local area and advisory committee makes plans under the advises and controls of the steering committee. Private companies apply to advisory committee and will attend the educational course.

![Diagram of the Framework of the Project]

*Figure 1. The Framework of the Project*
Overview of the Executed Project

The actual project was executed with two themes listed above, and the participants and the brief content are;

1) Theme 1: Embedded System  (28 trainees)

**Scope:** The concerning field is where industrial devices and machines can be more efficient and have higher performance with implementing the control part, e.g. mobile phone.

**Targeted level:** This theme deals with software but also the combination with hardware, while the recent evolvement of FPGA/CPLD (field programmable gate array/complex programmable logic device) enables mounting hardware on the product.

**Resulted talent and its role in practice:** The capability of using software (micro computer) and hardware (FPGA/CPLD) to design the embedded system corresponding to the usage in practice is inquired.

1) Theme 2: Safety and Energy Conservation (49 trainees)

**Scope:** The development, operation and management of the machines and equipments in factory and building needs the knowledge of the fields of mechanical engineering, architectural engineering, etc.

**Targeted level:** The productivity in the industry is based on the safety, high efficiency and energy conservation of machines and equipments. It is necessary for the engineers to achieve them in practical field.

**Resulted talent and its role in practice:** The capability of the analysis of required performance of the working and/or inhabitant space.
The Procedures and Results in the Executed Courses

As there are different backgrounds among the trainees and many knowledge and requisite as for the engineer, the procedure consists of three phases shown in Fig.2:

1) Stage I: The knowledge required as a member of the society and an engineer is learned, therefore, all trainees attend. Subjects are engineering ethics, intellectual properties and global environment. Also to acquire the capability as the leader, the subject on MOT, Management Of Technology was added.

2) Stage II: This stage is subdivided into two sub-stages according to the themes as below.

(II-1) Basic knowledge necessary in each theme is provided.
(II-2) PBL is executed in each theme and there is a variety of learning methods.

This is essential part of the course that all the knowledge learned until this stage is summarized and used to solve the problem brought by the trainee and/or the teacher. There are questionnaires before and after the each lesson, and all members including teachers discusses about the questions and comments at each lesson for mutual understanding.

The curriculum was developed from 2008 and the principle is “less period for basic expertise and longer period for the PBL learning”. The course started in 2010 September and finished in 2011 March. Stage I takes two months and stage II takes six months. Subsequent period is interactive communication between trainees and teachers for the discussion, summarizing the report, preparing the presentation, etc. It enables us to transfer the formal and tacit knowledge to trainees during the dialogues among the members, where the discussions of the trainees’ job site are very useful.

After the execution of two themes the meetings including the employer are held and the questionnaire is applied in order to evaluate the effect of the project. The results show; 1) The trainees have started to ask the supervisor about the principle of the practical fields in their company, that is, they started to think about the management and the steering system. 2) The trainees succeeded to make the plan and the execution of the project in this project including the presentation.

**Discussion**

According to the response of trainees and belonging companies, it is likely to approve the effectiveness of this project. And the points to be improved including the project in 2010 would be;
1) The number of trainees: The number of trainees of 10 for one concrete theme seems to be the maximum when the PBL is applied, according to the available equipments and teaching staffs. And the role of the leader should be shared in the practical working time in return.

2) The questionnaires and interviews done at the application phase and each lessons allow the careful survey of participant’s and employer’s demand and support the understanding between teaching staffs and trainees. For example the teacher can provide the expertise and future direction based on each trainee’s need and capability at the lesson.

3) MOT lectures: They are newly introduced in this project adding to the previous one and are effective to acquire the capability as a leader of the group of several members. The trainee’s scope was extended to the upstream activity such as the meaning of the facing task and also to the downstream activity, e.g. the influence of the task achievement.

4) PBL Structure: The reason that this project can achieve the purpose can be explained with SECI model (NONAKA, 1995) shown in Fig.3 with comments provided here and corresponding stage in the project. In this project the cycle starts at the combination and ends at externalization. The combination is done by the lectures with textbooks and presentation slides, and through internalization and socialization processes, the knowledge and expertise are externalized in the form of report and presentation by the trainees. The cycle is rotated only once basically, however, some trainees may rotate a few times because the report was written at each class and the final report and presentation materials has been checked several times in some cases.
5) The effect of the whole project may depend on the capability of the teachers and staffs:

The discussions among teachers show that the teacher should be able to answer the student’s question within a few days since the will to study tends to decrease after days because of daily business (Miyagi Organization For Industry Promotion, 2008). It means the teacher should have the broad expertise and the links of knowledge. The books and the introducing many related organization were helpful, and well prepared materials may help about that situation in the next project.
Conclusion

The PBL (Problem/Project Based Learning) project to cultivate a leader of small number of engineers was executed in the framework of professional education and it has two themes according to the survey performed in advance. The procedure has three stages and the first stage is for the literacy for an engineer. The second stage is for study of professional knowledge and PBL in a group, while the structure is similar to the previous project until 2007.

As the conclusion, this new PBL procedure is effective to make professional education approved by participants and employers. The several trainees in a group are the maximum to execute the project and the capability of teachers is essential. The lectures of MOT allow the trainee’s scope to be wider and the longer period of PBL seem to be better to transfer the knowledge. All the activities may be explained by the SECI model.

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