Study to Apply Project Management and Fundamental Competencies for Improvement of Project Activities in University

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***Abstract*—The present study proposes an idea for project management and fundamental competencies to improve project activities in university. Considering that students are beginners in terms of project activities and that the project term is limited, effective ideas and tools are needed for projects to succeed. In this study, Project Management Body of Knowledge Guide (PMBOK), a well-known reference in business world, is applied to improve project activities. In addition, performance is also critical for ongoing projects. To satisfy this requirement, a definition of "Fundamental Competencies for Working Person" is applied to project activities. A change of students' recognition from this perspective through the project activities is evaluated. The students felt the lack of making careful planning during their project activities. Moreover, they wish to acquire execution skill to improve their project quality. A two-dimensional map with process groups and knowledge areas defined by PMBOK and competency factors defined by "Fundamental Competencies for Working Person" is proposed to improve the prospects for project execution. This map becomes the useful tool as a procedure and the instruction guide for the project students and the teaching staff, and facilitates improvement in the quality of the project products and the process.**

***Index Terms*—project management, project activity in university, fundamental competencies for working persons, extra-curricular program**

I. Introduction

Kanazawa Institute of Technology (KIT) has a broad range of facilities and a unique environment to support project activities as extra-curricular programs. In 2019, about 80 project activities were officially recognized at KIT. The typical examples of projects undertaken for contests were manufacturing robots and hand aircrafts. KIT teaching staff is working hard to improve these project activities [1]-[4]. Similar projects and analysis are also undertaken in other universities [5], [6].

The present study proposes a project based on fundamental science and engineering, which is one of the officially recognized projects at KIT as an extra-curricular program. This study also examined how to improve the quality of both the process and the product through each project activity. Prof. Shinoda, one of the authors, moved to KIT from an electric manufacturing company in 2015. He has a vast experience in designing and manufacturing electric appliances, such as DVD player/recorder, Blu-ray player/recorder, and liquid crystal displays. He is also a certified Project Management Professional by Project Management Institute since 2007. Therefore, the present study proposes that instructing the projects based on fundamental science and engineering would improve the quality of both the product and the process of each project by applying the well-known method of project management [7]-[12]. This method was established and published as "A Guide to the Project Management Body of Knowledge," so-called PMBOK GUIDE [13]. This is practically defined as a useful methodology to guide the project activities to their goals. Therefore, we have been trying to apply this guide book to the projects planned and executed by project students.

On the one hand, in 2007, the Ministry of Economy, Trade, and Industry (METI) in Japan defined the basic abilities required for working together with various people in the workplace and in the local communities as the "Fundamental Competencies for Working Person" [14]. Three competencies were defined by a committee comprising of intellectuals in the businesses and universities. These competencies consist of 12 competency factors. These competencies are necessary for a working person to acquire at the beginning of his or her career; therefore university students should acquire them by their graduation.

The present study examines whether this definition for working person motivates the project students to pursue their project activities. The study also proposed an annual project plan format and a bi-weekly report format for project students considered by both "PMBOK GUIDE" and "Fundamental Competencies for Working Person." Using these formats, the students can reflect over their projects on the purposes, products, schedule, progress, problems, cost, and risks, among others. These factors are also crucial for the teaching staff to control the project activities to meet the goals set by the project students. Thus, this study helps in facilitate their thinking over success of their projects [7]-[12].

The present study shows how "Fundamental Competencies for Working Person" affect students' recognition through their project activities, and introduces

Manuscript received March 18, 2020; revised July 5, 2020.

doi: 10.18178/ijlt.6.3.164-169

the relationship between "PMBOK GUIDE" and "Fundamental Competencies for Working Person."

II. Brief Introduction of the Fundamental Science and Engineering Project

In the fundamental science and engineering project, the students propose project subjects individually. Next, the students and the teaching staff verify the principle of each proposed subject from the perspective of mathematics, physics, engineering, electronics, software programing, production, and so on. Subsequently, the students move on to manufacturing their products of project subjects. A typical project term is one year. Fig. 1 shows an example of products, —the experimental unit of digital audio. Project students designed and manufactured this mechanical unit by using a 3D printer. Thereafter, they assembled this electric circuit. Majority of the students had experienced using a 3D printer and soldering of electric circuit for the first time.

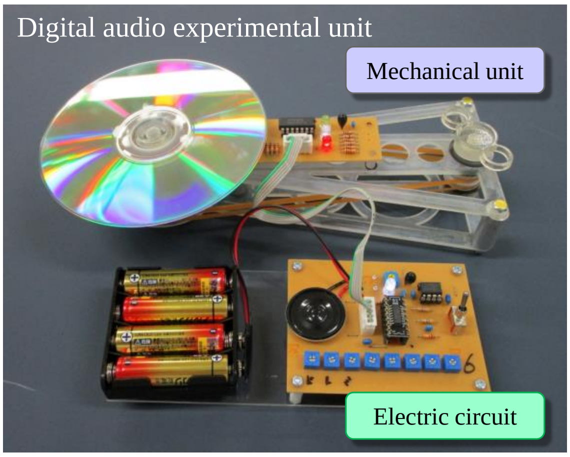


Figure 1. An example of the products, the experimental unit of digital audio, which was undertaken by the project students as the fundamental science and engineering project activity.

III. Brief Introduction of the "Project Management Body of Knowledge (PMBOK) GUIDE" and "Fundamental Competencies for Working Person"

A. *"Project Management Body of Knowledge (PMBOK) GUIDE"*

PMBOK GUIDE describes the methodology for handling projects to success, and is recognized practically as the world standard for a wide array of projects in the business world. The first edition was published in 1996 and the latest version is the sixth edition published in September, 2017. PMBOK GUIDE defines 49 processes of the project. Here, the process means a procedure or a treatment that is a necessary action in the project activities. All processes are classified into five process groups and ten knowledge areas.

The five process groups are as follows:

- Initiating process group,
- Planning process group,
- Executing process group,
- Monitoring and Controlling process group, and
- Closing process group.

The relationship among the five process groups is schematically shown in Fig. 2. The project starts according to the initiating processes; then, planned according to the planning processes and executed based on the executing processes. When a final product is completed or cancelled, the project is finalized according to the closing processes. The monitoring and controlling processes affect the other processes in terms of investigating and improving the quality of both the process and the product.

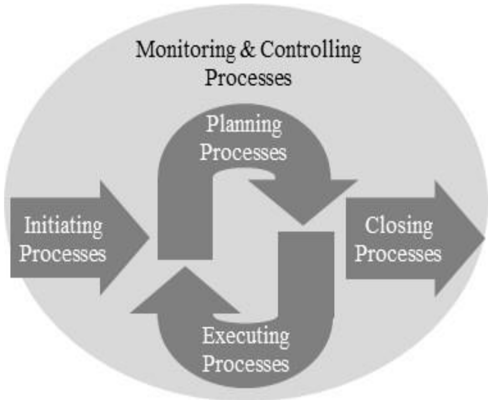


Figure 2. Schematic diagram of the relationship among the five process groups. (This figure is redrawn by the authors according to the PMBOK GUIDE.)

The knowledge areas including essential processes for project management are classified into ten management groups as follows:

- Project integration management,
- Project scope management,
- Project schedule management,
- Project cost management,
- Project quality management,
- Project resource management,
- Project communications management,
- Project risk management,
- Project procurement management, and
- Project stakeholder management.

Using these five process groups and ten knowledge areas, 49 processes are defined in the cells somewhere on a two-dimensional map, in which the process groups are placed on the horizontal rows and the knowledge areas are placed on the vertical columns as shown in Fig. 3. This study, however, does not include the contents of the 49 processes in detail.

The project activities undertaken by the students and the teaching staff were examined and the relationship between this map and project members' contributions were analyzed. The result is added on the two-dimensional map, as shown in Fig. 3 [9], [10].

Fig. 3 clearly shows that the cells on the map were filled up completely with actions by the project students and the teaching staff as follows.

- The project integration management of the knowledge areas was undertaken by only the teaching staff, because managing these processes was critical for the purpose, significance, and rules of the project to be officially declared. In addition, it was another reason that the students involved in the project were beginners. After this integration management, each project was started by the project students.

- With regard to the planning and executing processes, the project students undertook each management process on their own, because these processes were the core actions of the projects. The students acquired various skills such as planning, executing, and manufacturing.
- With regard to the monitoring and controlling processes, the teaching staff and the students jointly carried out these processes. Since all project students were beginners, the teaching staff proposed corrective actions if there was possibility of worsening product or process quality. Based on the results of these processes, each student demonstrated the results to the planning and executing processes to improve the quality of both the process and the product.
- With regard to the project stakeholder management, in case there were some stakeholders related to the project subjects, this was managed by the teaching staff.

Consequently, the two-dimensional map shown in Fig. 3 shows the teaching staff and the students comprehend the ongoing process and the next action, respectively. They also can confirm the contribution of the project students and the teaching staff.

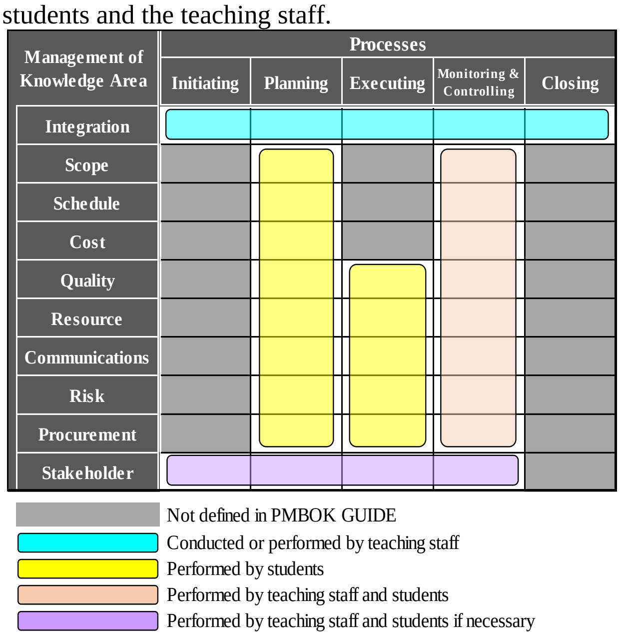


Figure 3. Contribution analysis on a two-dimensional map with process groups and knowledge areas.

B. *"Fundamental Competencies for Working Person"*

As mentioned earlier, "Fundamental Competencies for Working Person" was defined by METI in 2007 [14]. Fig. 4 explains this definition. This definition consists of three competencies, "Thinking," "Action," and "Teamwork," which are required in the business and universities. "Thinking" is the ability to question and think through, and includes three competency factors. "Action" is the ability to step forward and act persistently even if you fail, and includes three competency factors. "Teamwork" is the ability to collaborate with various people to achieve goals, and includes six competency factors.

As these competencies are necessary in a working person, university students should acquire them by the time they graduate.

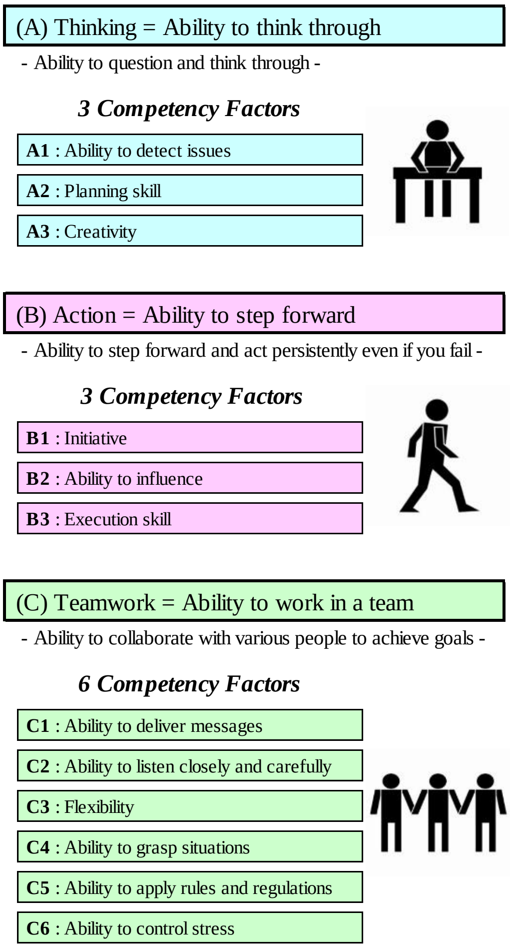


Figure 4. "Fundamental Competencies for Working Person" defined by the Ministry of Economy, Trade, and Industry (METI) in Japan in 2007. (This figure is redrawn by the authors according to METI's website.)

IV. Students' Impressions and Recognition through Questionaire

The study gathered project students' impressions about the project activities, and students' recognitions for "Fundamental Competencies" through a questionnaire at the end of one year of the project term.

A. *"Fundamental Competencies for Working Person"*

The following questions about the project activities were put forth.

- Question #1: Was your project activity executed as planned?
- Question #2: What level was your project product?

Figs. 5 and 6 show the result of questions #1 and #2, respectively. Fig. 5 showed that 62% of students recognized that their project activities were nearly successful as initially planned. On the other hand, Fig. 6 showed that 84% of students felt that completion of their products was lower than expected. These two results appear contradictory. The students appeared highly satisfied to continue working on their project activities for one year than to complete their project products.

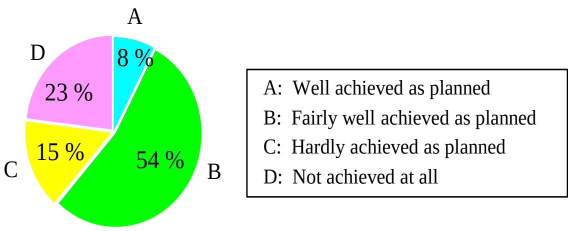


Figure 5. Result of question #1: Was your project activity executed as planned?

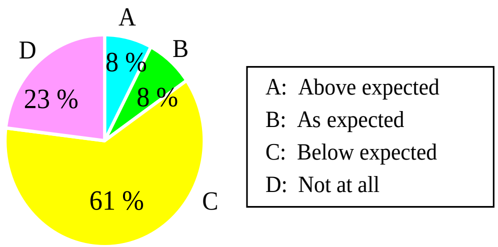


Figure 6. Result of question #2: What level was your project product?

Given that majority of the products were substandard, we asked the following questions.

- Question #3: Why was your project product incomplete? (multiple answers allowed)
- Question #4: What was your satisfaction level?

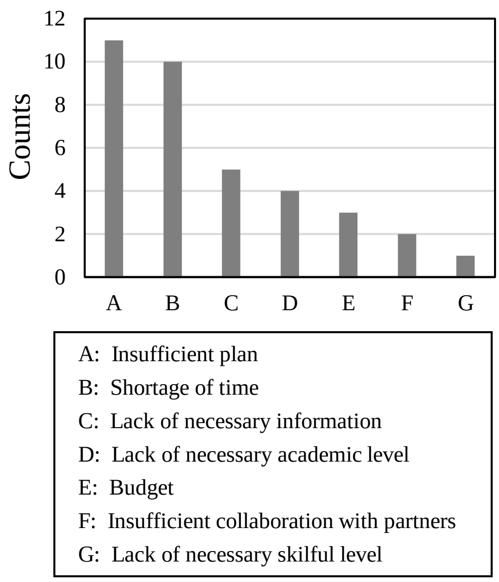


Figure 7. Result of question #3: What was the cause of the incomplete project product? (multiple answers allowed)

Fig. 7 shows the result of question #3. The most frequent cause was "Insufficient plan" and the second most frequent was "Shortage of time." The project students did not have enough "Planning skill" and "Execution skill" to complete their project activities because they were beginners. Both the causes were related to "Planning skill." It appeared that the project students focused on the plan rather than academic knowledge and skill. Here, "Planning skill" is the competency factor of "Thinking" competency and "Execution skill" is the competency factor of "Action" competency in "Fundamental Competencies for Working Person."

Fig. 8 shows the result of question #4. Almost half of students were satisfied with their project activities in spite of incompletion of their products. They seemed to be satisfied with the experience of one year of project activities.

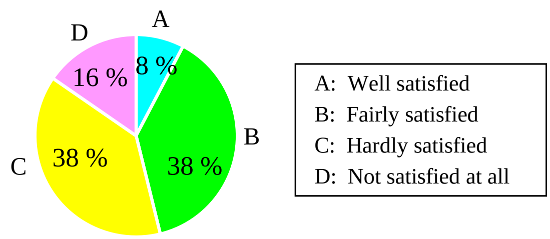


Figure 8. Result of question #4: What was your satisfaction level?

B. *Students' Actual Recognitions for "Fundamental Competencies"*

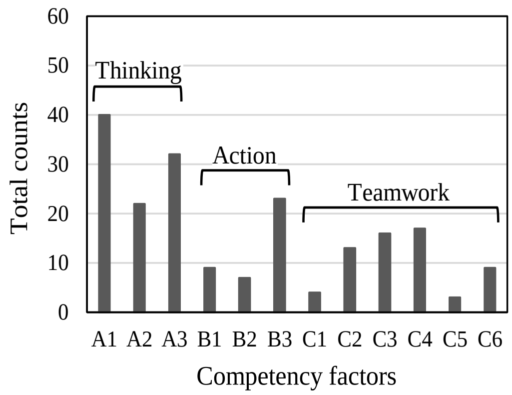
The students' actual recognition for "Fundamental Competencies" was evaluated through the project activities.

- Question #5: Choose the best five competency factors that you acquired through the project activity from the top.
- Question #6: Choose the best five factors that you want to acquire in the near future from the last project experience from the top.

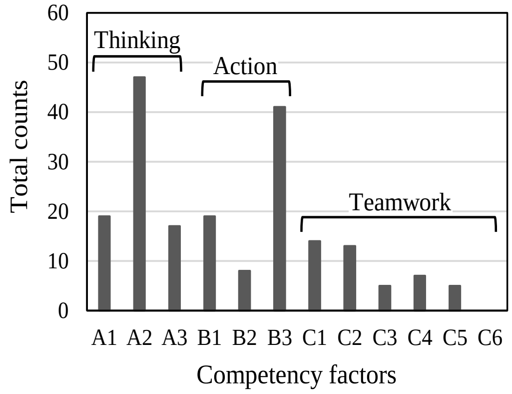
Figs. 9 (a) and (b) are the result of questions #5 and #6, respectively. Best competency factor is weighted with 5 point, the second best factor is weighted with 4 point, and similarly, fifth best factor is weighted with 1 point. The vertical number indicates total counts.

From Fig. 9 (a), "(A1) Ability to detect issues," "(A3) Creativity," and "(B3) Execution skill" acquired high counts. These factors appear to be the main interests for the project students. On the other hand, "(B1) Initiative" and "(B2) Ability to influence" did not acquire high counts. These results indicate that the students' activities during project activities seem to lack a positive attitude. With regard to competency categories, "Teamwork" acquired smaller counts than "Thinking" and "Action." "(B1) Initiative" and "(B2) Ability to influence" are closely related to "Teamwork." In fact, most of project activities were undertaken by single student. Therefore, the competencies related to "Teamwork" were not the driving force to enhance the students' recognition to carry out the project activities.

From Fig. 9 (b), "(A2) Planning skill" and "(B3) Execution skill" overwhelmingly acquired high counts. These factors appear to be the main skills required to manufacture the product.



(a) Result of question #5: Best five factors that the project students acquired through the project activity.



(b) Result of question #6: Best five factors that the project students want to acquire in the near future from the last project experience.

[Symbols of the horizontal axes]

A1 : Ability to detect issues
A2 : Planning skill
A3 : Creativity
B1 : Initiative
B2 : Ability to influence
B3 : Execution skill
C1 : Ability to deliver message
C2 : Ability to listen closely and carefully
C3 : Flexibility
C4 : Ability to grasp situation
C5 : Ability to apply rules and regulations
C6 : Ability to control stress

Figure 9. Change of students' recognition for "Fundamental Competencies" through the project activities.

From these results, the project students recognized the lack of careful planning during their project activities. In addition, they strongly desired to acquire execution skill to improve their products with respect to quality. Nearly all the students recognized that their execution skills were not enough at the beginning of the project, because all of them were beginners for project activities. However, after the project, they recognized certain improvement in execution skills. Each student struggled how to plan a schedule, how to manufacture a product, how to evaluate it, and so on, for the first time during the project activities.

V. Discussion

From the result of question #6, the relationship between "PMBOK GUIDE" and "Fundamental Competencies" can be illustrated in Fig. 10. "(A2) Planning skill" and "(B3) Execution skill" are the competency factors that the students would wish to acquire in the near future. "Planning skill" competency factor is strongly related to "Schedule" knowledge area in PMBOK GUIDE. Similarly, "Execution skill" competency factor is strongly related to "Quality" knowledge area. Therefore, the project students should manage their own project activities by making schedules using "Planning skill" in planning process and improving quality of project products using "Execution skill" in both planning and executing processes. The teaching staff also should monitor the students' activities and make suggestion when rescheduling or re-designing is needed to meet the project goals proposed by the students.

Fig. 10 combines both "PMBOK GUIDE," as the methodology of project management, and "Fundamental Competencies," as an awareness of achieving projects. This map serves as a useful tool for the project students and the teaching staff and also serves as an instruction guide for the teaching staff to improve the quality of process of project activities as well as that of project products.

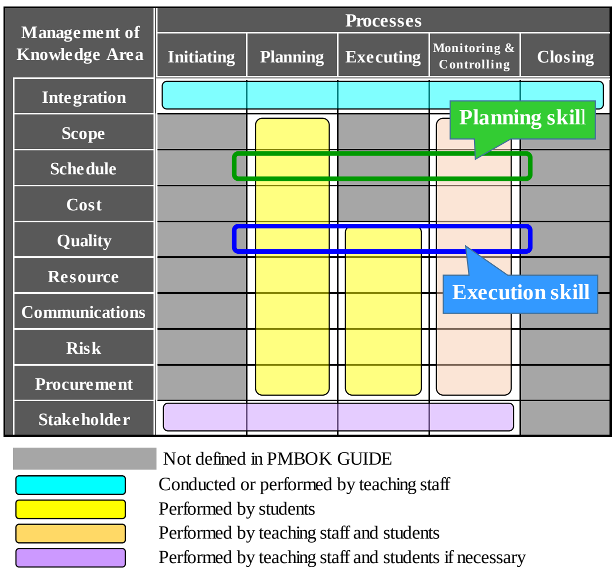


Figure 10. Map combined with both PMBOK GUIDE and "Fundamental Competencies."

VI. Conclusion

The project was undertaken based on fundamental science and engineering. In this project, we tried to improve the quality of both the process and the product using a two-dimensional map defined in "PMBOK GUIDE." From our earlier studies, this map appeared to be an effective tool as a practical methodology to understand how to proceed with projects and confirm the contribution of the project students and the teaching staff.

To succeed in projects, however, it was recognized that abilities to manage the processes of the projects were also indispensable. We found that "Fundamental Competencies for Working Person" defined by METI was a suitable idea to satisfy these abilities.

The results of questionnaire survey on the project students at the end of the project term showed that "Fundamental Competencies for Working Person" meaningfully enhanced students' recognition during their project activities. The students particularly experienced the importance of "Ability to detect issues," "Creativity," and "Execution skill" through their project activities. The students also desired to acquire "Planning skill" and "Execution skill" in the near future to improve both the product and the process of the project activities. In other words, they recognized the lack of these skills to complete their project activities. Such recognition would motivate them to challenge their future project activities.

Further research would include increasing project samples.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Masahisa Shinoda conducted the research and wrote the paper; Keita Nishioka supported the research; all authors had approved the final version.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number 19K03176.

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