COMPETENCY IMPROVEMENT THROUGH STUDENTS' INDEPENDENT ACTIVITIES AT THE DEPARTMENT OF ELECTRICAL ENGINEERING, UBE KOSEN

Masafumi Yoshida

[a] Department of Electrical Engineering, National Institute of Technology, Ube College, Ube, Japan.

Masafumi Yoshida* (yoshida-m@ube-k.ac.jp)

A group called as E-project has been supporting students working proactively in Ube KOSEN. The E-project has prepared 14 themes related to electrical engineering and applied the philosophy of servant leadership to the organization. In 2024, about a half of students, 97 members, in the Department of electrical engineering belonged to the E-project and strengthened electrical engineering knowledge as well as competency such as communication, and teamwork skills so on. Participating students themselves actively worked on themes of their own interest. Throughout the year's activities, they were successfully developed and improved various competency skills. In particular, about 60% of participants realized the developments of communication skills irrespective of years. It was also found that the skills developed was different in the themes each due to different policy and actual activities.

Keywords: *Entrepreneurial mindset, Electrical engineering, Contribution for neighbouring community, Competency*

Introduction

National Colleges of Technology are in need of proactive electrical engineers with an entrepreneurial mindset who can find new solutions to problems. In a course of the Department of Electrical Engineering (DEE) in Ube KOSEN, students are supported to proactively working as a member of the group of the E-project, which is launched in 2021. The purpose of the E-project is to strengthen not only electrical engineering knowledge but also competency such as communication skills, and teamwork skills by challenge ourselves to contests and by convention of fun learning an electrical engineering toward elementary and junior high school students. Through the activities, it is expected to be increase the number of applicants to the department of electrical engineering. Entrepreneurial mindset training was also started in 2023 with the E-project. This paper reports the recent activities undertaken as the E-Project and the effects of the competency improvement of the participating students in this project.

Table 1: History of E-project.

Year	Remarks	Number of theme
2018	PE-girls (only female) launched,.	4
2021	Male students begin to participate and E-Project is launched.	5
2022	Activities centered on female students.	5
2023	The number of participants has increased rapidly and the scale has expanded.	7
2024	Further expansion and improvement is planned.	14

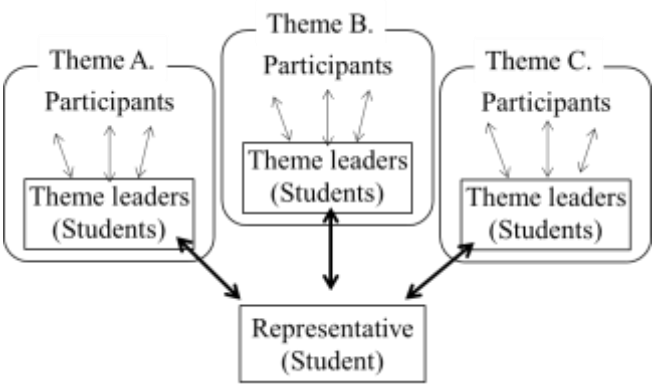


Figure 1: Management organization in E-Project.

Materials and Methods or Pedagogy

Transition or history on the E-project is summarised in table 1. The E-Project was launched by some students belong to DEE in Ube KOSEN, based on P.E.girls, in which was launched by female in DEE to improve the number of female's applicants to the DEE. The activities in the E-project continued every year and the number of the participants increased gradually, number of themes also increased. Figure 1 shows a schematic view of management organization in the E-project. The E-project is composed of some theme as for the electrical engineering, their leaders and a representative. Each theme is organized by the student's theme leaders. Based on the main purpose of the E-project, the theme leaders share the opinions of their member and decide on a policy

of each theme for a year. The E-project applies the philosophy of servant leadership, which prioritizes serving others, to the organization. The servant representative, which the student also becomes to, shares the needs of the theme leaders first, and helps them to develop and perform as highly as possible. Since some of the participates belong to different theme at the same time, the servant representative accommodates schedules of the theme activities sometimes.

All participants selected and declared skills that they wanted to develop, to consider their intention to work in the E-project before the activities. In order to evaluate effects for E-project, we compared with skills to felt to develop through the activities.

Results and Discussion

Table 2 shows lists of the participants in 2024. One-second of students in the DEE, where 40 people in each year belong, participated active across all years and genders. A main member including the theme leader was students in 3rd year. The past representatives were also student in 3rd year actually. The 4th and 5th year participants supported the 1st ~ 3rd year students in terms of competency as well as electrical engineering knowledge. In 2024, about half of participants actively repeated and worked as shown in figure 2. These participants who gained experience in the E-project in last year remains to improve further skills and help new participants to strength skills through the activities. These alignments and connections between the participants are an advantage for helps of successive activities in E-project.

Table 3 shows theme lists and its participants in 2024. As for the electrical engineering, these themes were categorized to five; power electronics, device, control, information network and spread of fun learning electrical engineering. In the theme of video production, videos that were easy to understand about power electronics and to interest it for common people was planned to be produced. In the railway research, materials were produced to convey the appeal of power electronics and electrical engineering that can be learned from railways. The theme of EV miniature car improved a EV miniature car and challenge to a race competition. The theme of Robot for decommissioning manufactured for a robot competition. The theme of BSO counter produced a new BSO counter, which was used in baseball games. The theme of a sea turtle-shaped robot for cleaning beaches manufactured an auto robot that cleaned beaches polluted by microplastic materials. The theme of pitching machine manufactured a pitching machine to use practice of batting in baseball. The theme of illumination exhibits produced the illumination exhibits for TOKIWA fantasia festival, which was held in Ube city in winter season. The theme of application development for electrical engineering proposed education systems to help students to learn the electronic engineering. The theme of virtual reality created school buildings of Ube KOSEN in virtual reality by using Blender and Unity applications. The theme of craft class planned classes as the electric engineering for elementary and junior high school students. The theme of development of teaching materials developed and proposed teaching materials to learn electric engineering. The theme of business plan proposed plans to solve social problems and produced systems and/or products, and entered it into various business plan competitions. The theme of public relations appealed our activities and DEE by using SNS, so on. All participants selected themselves to actively work on themes of their own interest. Here is an introduction describing typical activities of VR, craft class, TOKIWA fantasia festival and EV miniature car on E-project, firstly. Next, we summarized survey results for developments and improvements of the various skills after the activities and discussed them.

In the theme of VR, it was considered to check present skills of the members to create the school building of Ube KOSEN in VR. Then, the theme leaders

Table 2: Composition of the member in 2024.

Year	Number of member	Participation rate [%]
1st	20	48.7
2nd	24	55.6
3rd	23	57.5
4th	20	45.5
5th	10	25.6
total	97	

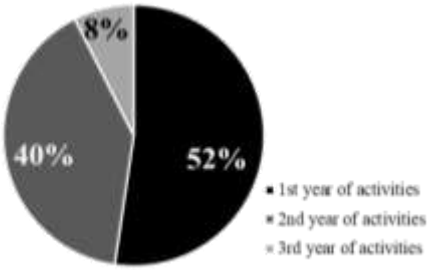


Figure 2: Number of years of activities in E-Project.

Table 3: Theme lists and its participants in 2024.

Category	Name of theme	Participants	Since
Power electronics	Video production	17	2021
	Railway research	8	2021
	EV miniature car	24	2024
	Decommissioning	7	2024
Device	BSO counter	13	2024
Control	Cleaning on beaches	23	2023
	Pitching machines	16	2024
	TOKIWA fantasia festival	18	2024
Information network	Applications	15	2024
	Virtual Reality (VR)	28	2024
Spread of fun learning electrical engineering	Craft class	19	2021
	Teaching Materials	12	2021
	Business Plan	9	2023
	Public relations (PR)	4	2023

Figure 3: Seminar held by VR theme.

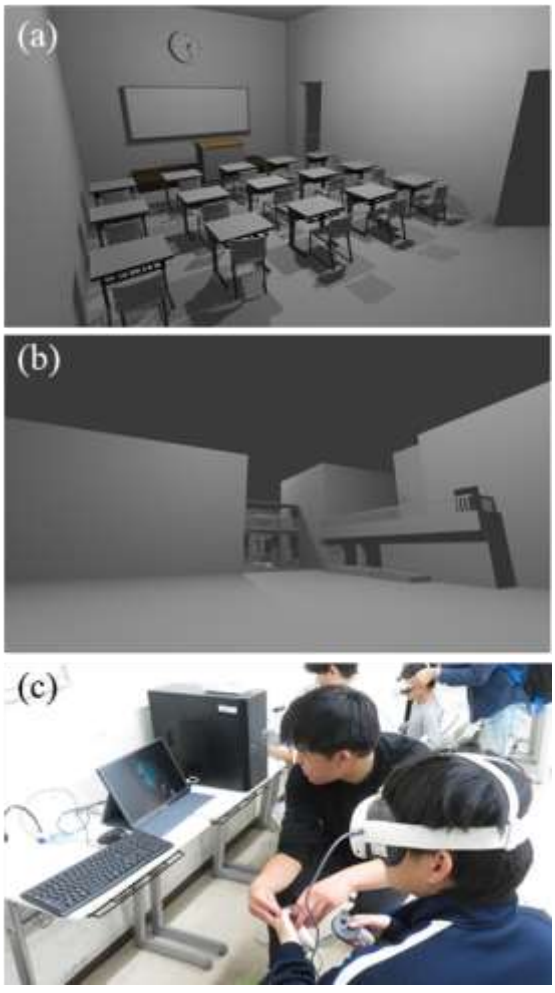


Figure 4: (a) Creation of classroom inside building, (b) appearances of the building in VR Ube KOSEN by using Blender application, and (c) experiences in 61st Kosen-sai festival in 2024. [1]

surveyed the skills and experiences to use Blender application, which is one of tools of modelling of the materials. As a result, it was found that 90% of participants was no experience to use the applications. So, the leaders planed and held on seminars how to use the Blender applications as shown in figure 3. At the same time, they required the member to submit reports about items, which was installed in the school, modelling by the application. The member actually modelled some items; pencils, clock, white board, chair, desks and storage case,

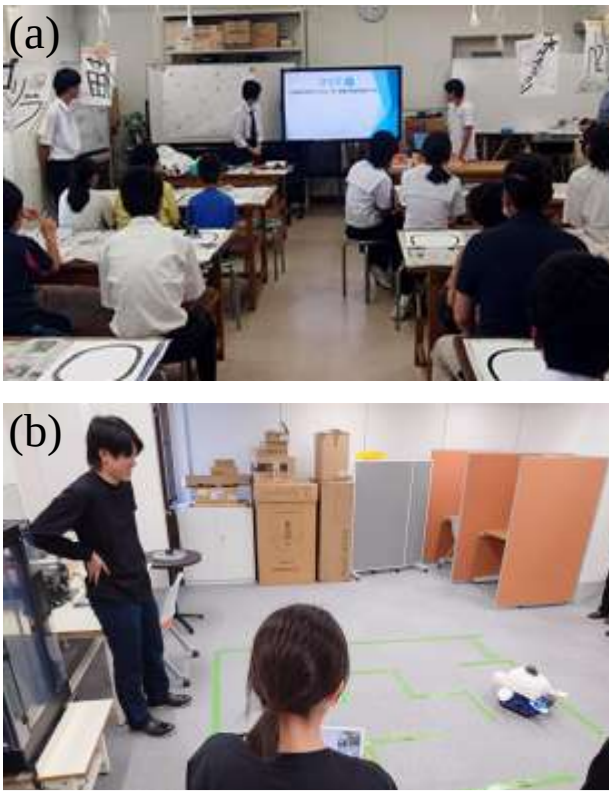


Figure 5: Craft class planned for 2024; (a) line tracer mobile, (b) experience of control of a turtle shaped-robot for clean beaches.

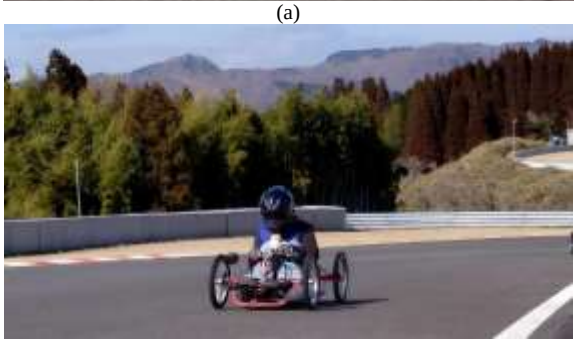
so on. Figure 4 shows the views of (a) a typical classroom and (b) a school building in Ube KOSEN modeled by the members. Most of the items in the classroom were modeled by members who attended the seminars. Ube KOSEN created by VR was experienced in 61st Kosen-sai festival in 2024 by its visitors as shown in figure 4 (c). Details were referred as ref. 1.

In the theme of craft class, classes to get students interested in electric engineering was planned by themselves. The theme leader shared the interests in the members and decided first subject the line trace mobiles for 40 minutes' class. To understand how to move the mobiles and to get interested the electricity, class managements and slides were improved by members. Advertisements of the craft class were also prepared themselves. 20 elementary and junior high school students were totally attended in the craft class for the line trace mobiles in summer as shown in figure 5 (a). With a support of the member, the students attended successfully learned principle of movements of its mobiles while actually moving. According to questionnaire after the class, all students answered that it was enjoyed during the class, and interested not only the electricity but also education in DEE of Ube KOSEN. In recent march, another craft class of robot control and lecture of environment on microplastic trash was held as shown in figure 5 (b).

In the theme of TOKIWA fantasia festival, the illumination exhibit for TOKIWA fantasia festival, which was held in Ube city, was manufactured. Figure 6 shows a photo of the exhibit, which was a bench created

Figure 6: Illumination exhibit for TOKIWA fantasia festival 2024 in Ube city by the theme of TOKIWA fantasia festival. [2]

(a)



(b)

Figure 7: Photos of (a) coordinating their machine and (b) running in EV miniature car race competitions by the theme of EV miniature car.

by combining dynamic illumination using matrixLEDs and static illumination using ribbonLEDs [2]. Students worked on all ideas, design, purchase of goods, scheduling and production of the production. The exhibit was lit without problems throughout the festival, much to the delight of visitors.

Figure 7 shows photos of the activities in the theme of EV miniature car. In the theme, a single-seat miniature electric car equipped with an outer-rotor motor, batteries and an inverter was tuned for race competition, which was held at SPA Naonyu in Kyushu in march 2025, for the first time. The students proactively learned about the structure of motors and the basics of inverters, in addition to the content of the electrical engineering class. In the race competition, their EV ran trouble-free for 30 minutes and placed 7th out of 14 teams.

After the activity, a reflection was conducted. The skills of choice were typical competency items; “Initiative”, “Communication”, “Listen attentively”, “Teamwork”, “Team management”, “Flexibility”, “Self-management”, “Perseverance”, “Identifying problems”, “Planning solutions”, “Implementing solutions”, “Problem solving” and “Presentation”. In the reflection, participants selected about their skills before the activities, the skills they improved, and the skills they would like to develop in the future. The number of responses from each year was 14, 4, 4, 5, and 3 respectively. The total number of responses accounted for 30% of the 97 individuals. Figure 8 shows the response rates for skills by years. After the activities, the proportion of various skills has increased. Although many students with initiative and communication skills originally participated, they also felt their communication skills have improved more after the activities. In particular, approximately 60% of the 1st year students indicated that their communication skills had improved. This can be attributed mainly to the fact that they worked not only with their classmates but also with upperclassmen. Furthermore, many students answered a growth in their listening skills and teamwork abilities. Also, all 4th year students who responded felt a growth in their ability to identify problems. It could be inferred that they had many experiences discovering challenges towards achieving their goals while supporting the advancement of the themes.

Figure 9 shows the response rates for skills by theme, to compare the effectiveness of skill development in four typical themes. It was confirmed that communication skills could be cultivated in the four themes. More than half of the students who participated in illumination exhibit felt an improvement in their listening skills and flexibility. This was largely due to the sequential changes in direction made as the project progressed step by step from adjustments that were discovered during post-design production and on-site meetings at the venue. In the theme of EV miniature car, perseverance and presentation skills appeared to have improved. This can be attributed to the ability to coordinate their machines for the race competition, and to their experience in preparing presentation materials for their report on the theme of this year's activities. Many of the participants who participated in craft class mainly realized their

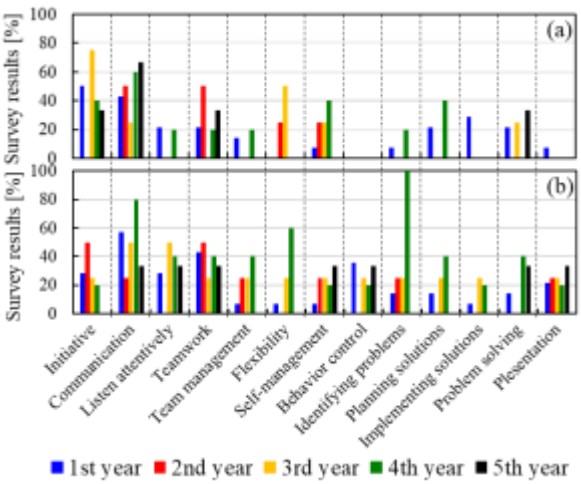


Figure 8: Survey results for each year, (a) before activities and (b) after activities.

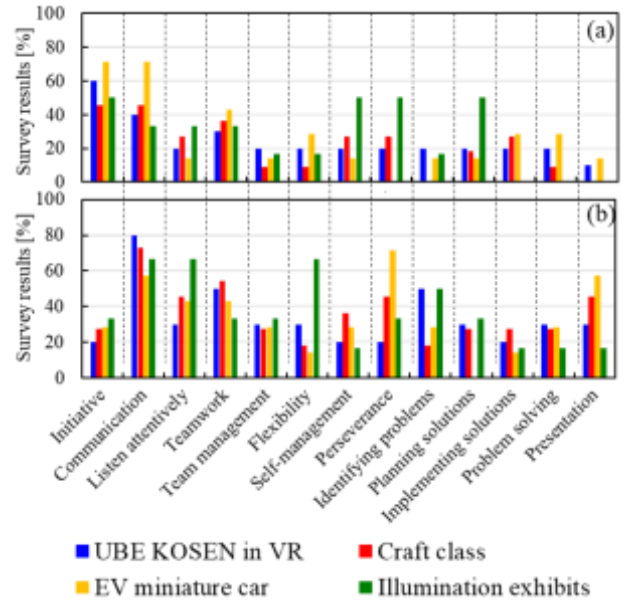


Figure 9: Survey results for typical theme, (a) before activities and (b) after activities.

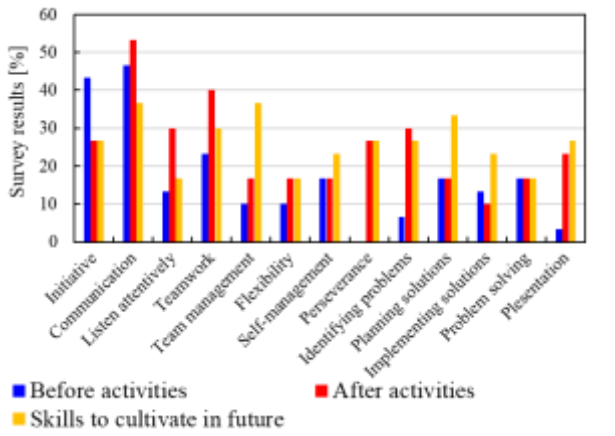


Figure 10: Summary of survey results for skills for participants answered.

teamwork, perseverance, and presentation skills. It is suggested that each skill have been cultivated as the members worked together to organize and plan the craft class and prepare class materials. From these results, it was found that skill improvement was expected to be effectively achieved by selecting a theme in the same electrical engineering field according to the skills that the students want to develop.

Figure 10 shows summary of survey results for skills for all participants answered. It was found that E-project activities are expected to greatly improve communication, listen attentively, and teamwork skills, as the participants work as a team regardless of years or genders. In addition, through team activities, it is also possible to develop new skills such as perseverance and presentation skills. In the future, we plan to introduce other-self evaluation to visualize the improvement of students' skills from multiple perspectives and to stimulate their activities. Through these activities, we would like to increase the number of students interested in electrical engineering.

Conclusions

In order to improve student's competency, their independent activities is supported at Ube KOSEN. In the department of electrical engineering in Ube KOSEN, E-project is launched in 2019. The number of participants has increased from the last year, and we have gotten many opportunities to collaborate between all years and genders. In 2024, by creating many ideas and starting new activities, the scope of their activities has expanded. It was found that the participating students improved various competency skills, in particular communication, listen attentively, and teamwork skills. In addition, student's skill improvement can be effectively achieved by selecting a theme according to the skills that they want to develop. In the future, we plan to introduce other-self evaluation to visualize the improvement of students' skills and to stimulate their activities. Finally, through various activities, we would like to increase the number of students who are interested in electrical engineering.

References

[1] Naoya, F. *at al*. (2025). Activities for the Modeling of UBE Kosen into VR in 2024. *Research report of Ube Technical College*, 71, 7-13.

[2] Hibiki, K. *at al*. (2025). The potential of matrixLEDs as an educational tool. *Research report of Ube Technical College*, 71, 1-6.