

Early Science and Engineering Education by Regional Cooperation with Traditional Craft in Fukui KOSEN

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Abstract

Fostering next-generation scientists program has been run by National Institute of Technology, Fukui College (Fukui KOSEN) since 2022. The program aims to develop the skills of young people with exceptional aptitude and interest in mathematics and science and to create future leaders in the science and technology fields. The Japan Science and Technology Agency, JST, is a sponsor of the "Fukui KOSEN type PBL for collaboration between traditional industries and digitalized generations" initiative.

PBL, or problem-based learning, is used in Fukui KOSEN to help students develop their power of execution and drive for their coursework. They watch businesses in the area around the school and analyze business issues as they study. After that, they present their ideas after deliberating on solutions in groups.

This program involves similar process for about 40 elementary and junior high school students to cultivate capacity for problem-solving and innovation for 2 years. In the first year, students of the program join workshops in traditional craft centers near Fukui KOSEN such as Echizen Japanese paper and Echizen traditional chest, and understand histories, techniques and present problems. Students also learn general and special subjects including ICT and IoT provided by Fukui KOSEN. Through the activities and some presentations about their interests, they decide the theme of sequential study.

Then 10 students who can take the second year are shortlisted among 40 students in the first year. Each student is assigned to Fukui KOSEN laboratory working on related to their own theme, and studies supported by teachers and tutors. Finally, students who have completed the course can receive certificate of "Junior Doctor".

So far, we had to change some workshops and lectures to remote operation due to COVID-19. However, we have found the validity of this program because participants made great presentation valued by external assessment committees.

In this paper, we describe the program detail even in COVID-19 situation.

Keywords: *Early education, PBL, Traditional craft, Regional cooperation, IoT, ICT*

Introduction

There are worries about a workforce shortage in several industries in Japan, where the birth rate has been decreasing recently. This is particularly apparent in regional cities, where the dropping birth rate is quickening and many local industries are starting to suffer from a severe labor shortage. Numerous traditional industries, including Echizen Washi, or Japanese handmade paper, Echizen lacquerware, Echizen pottery, Echizen traditional chests, and Echizen cutlery, are concentrated in the Tannan-area of Fukui Prefecture, where the National Institute of Technology, Fukui College (Fukui KOSEN) is situated. Additionally, the production of eyeglass frames and the textile sector have grown to be emblematic of contemporary Fukui Prefecture. There is a severe lack of successors in these established industries as well.

Increasing labor productivity is one approach to this issue. In order to do this, digital transformation is being addressed in a number of industrial areas. Additionally, the development of innovative human resources is essential for future regional revival because they can produce new value.

Japan Science and Technology Agency (JST) is conducting the Fostering Next-Generation Scientists Program, also known as "Junior Doctor Training School" in Japanese, with the goal of developing outstanding human resources. The program seeks to identify elementary and junior high school students with high motivation and outstanding abilities and to certify and support projects that support systematic development plans to further develop their abilities.

On the other side, community engagement with KOSENs is stressed. According to Kaneshige et al. (2007), local KOSEN has demonstrated cooperative efforts. In the creative subjects assigned to each of the main and major courses, Fukui KOSEN is creating Problem Based Learning (PBL) type lessons. Students participate in workshops and company visits connected

to these traditional industries in the class. They also propose solutions to issues raised during the course while hearing the viewpoints of businesses and create prototypes. We have discovered that these classes are successful since student-generated ideas have excelled in KOSEN design competitions. According to Furukawa et al. (2016), a university collaborates with a major corporation to carry out PBL. In the instance of Fukui KOSEN, it is distinguished by collaboration with small companies in education.

Fukui KOSEN has therefore been establishing Junior Doctor Training School under the name "Fukui KOSEN type PBL for collaboration between traditional industries and digitalized generations" since 2021. The project is aimed at digital native elementary and junior high school pupils. Our PBL activities give students a taste of traditional industries by applying our expertise in technological teaching. Additionally, it aspires to produce human resources that can contribute actively and creatively to the neighborhood and generate new value.

In this paper, we describe contents of the activities and valid the effects.

Planning of Collaboration

To collaborate traditional crafts around Fukui KOSEN, we had searched alliance partner. Then, we found a workshop event in traditional craft studios for sustainable community by an organization called "RENEW." Fortunately, the undergraduate student in Fukui KOSEN was helping with this RENEW event, and we were able to meet with the chairman of the RENEW. Since 2015, RENEW has been holding events such as studio tours, hands-on workshops, craftsperson symposium, focusing on traditional crafts every year. Nearly 100 workshops and companies exhibited, and a total of more than 30,000 people, including those from inside and outside the prefecture, visited to events. We consulted whether it would be possible to conduct an attractive studio experience-type workshop that has been held at RENEW event in the Junior Doctor Training School. We received a reply that RENEW would like to be involved in the "education" part, and we were able to obtain cooperation with many traditional craft studios for the project through RENEW.

Contents of the Course

The institute of Junior Doctor Training School must prepare fostering program in 2 divided stages. We have planned that students take classes in Fukui KOSEN and have workshops in traditional craft studios as the first stage. We also planned that each student is assigned to Fukui KOSEN laboratory working on related to their own theme, and studies supported by teachers and tutors as second stage.

The program in first stage is shown in Table 1. The number of classes is greater than other institutions conducting Junior Doctor Training School. Many classes are reconfigured for elementary and junior high school students with reflection of experience and knowledge of previous extension lectures.

The requirements for completing the first stage are to take all compulsory courses and 7 elective courses out of the 30 courses mainly implemented by Fukui KOSEN.

Table 1. Title of courses in the 1st stage

Title of course	Type	Max No. accepted
Research Ethics	Compulsory	40
Thinking Method	Compulsory	40
Various Tools and Roles	Compulsory	41
Machine Training Factory Tour	Compulsory	41
Digital Manufacturing	Elective Compulsory	20
Model Plane Making with Laser Cutter	Elective Compulsory	20
Campus Tour	Free	41
Programming for Beginner	Compulsory	41
What's ICT? What's IoT?	Compulsory	41
Math and Technology in Egg Drop	Elective	25
How-to 3D CAD	Elective	25
Making Toy Powered by Thermal Energy	Elective	20
Electronic Circuit with Block 1	Elective	12
Electronic Circuit with Block 2	Elective	12
Electronic Circuit with Breadboard	Elective	15
Data and Error	Elective	20
Measurement and Control by IchigoJam	Elective	20
Web Design and Web Game Application	Elective	41
Making Original Bookmark	Elective	10
Let's study Surfactant	Elective	20
Pigment Synthesis	Elective	20
Drone Flight and 3D Model Creation	Elective	20
Architecture with MR	Elective	10
Science by Construction	Elective	20
Wonder of Numbers	Elective	20
Sports Data Science	Elective	10
Let's look at Sound	Elective	15
Traditional Industry from SDGs	Elective	10
Dialect Description by Interview	Elective	20

After elective courses, students must submit report. At the same time, students must join at least 2 traditional craft workshops and 2 presentations at the middle and the final. If student achieve the requirements, they can receive the certificate “Junior Master of Fukui KOSEN.”

We have given students guidance on the presentation theme which means research title in the second stage. The guidance policy is merger the knowledge from the coursed in Fukui KOSEN and interest in the workshops.

Students who achieve excellent grades in the first stage can proceed to the second stage in the next year. In the stage, students are assigned to laboratories of Fukui KOSEN according to the research theme of each student. They come to Fukui KOSEN on weekend and after school to carry out their research, and are supported by teachers and student tutors.

Progress and Validation

In first year, 2021, we have held only first stage. After document screening of 68 applicants, 4firststudents were accepted. Figure 1 shows the situation of the workshop in Echizen lacquerware studio. Many students had taken a note and ask their questions religiously.

Table 2 shows a part of the title of the middle presentation held face-to-face in Dec. 4th, 2021. Many titles are vague in this stage yet. After the middle presentation, the course related to thinking method was held as one of the compulsory courses. Table 2 also shows a part of the title of the last presentation in March 2first, 2021. The final presentation had been conducted with remote conference system by considering the COVID-19 infection despite the plan of face-to-face with posters in our school gym. So, students who can prepare prototypes and handmade poster might have regretted. Figure 2 shows the situation of final presentation.

Finally, 39 students out of 41 could receive the certificate “Junior Master of Fukui KOSEN,” and 29 students except 9th grade students who cannot be a subject wanted to advance the second stage in next year.

In second year, 2022, we have held first stage for new 4firststudent and second stage for 10 students shortlisted among 4firststudents in the first stage.

The 10 lines from the top of Table 2 shows all themes of the final presentations by the students in the second stage. The theme proposed by the students in the last of the first stage was the basic theme, but the final theme also took into consideration the specialties of the teachers. At the time of the presentation, prototypes and system productions were carried out for all themes, and it was observed that the high motivation of the students continued and the growth of their abilities was seen. In particular, two researches, “Collaboration with Washi industry using pH-responsive pigment extracted from *Trifolium pratense*” and “Disseminating Information on Traditional Crafts Considering Individual Preferences”, received awards for excellent study at the "Science Conference," an event attended by representatives of Junior Doctor Training Schools nationwide. Both themes were the fusion of young points of view unique to students and the specialized knowledge and skills of Fukui KOSEN, and research content unique to this



Fig. 1 Workshop in Echizen lacquerware studio



Fig. 2 Final presentation in first stage

project. We find that this result shows the high effectiveness of this project.

Conclusions

We think that we were able to develop problem-solving skills linked to traditional industries in elementary and junior high school students by implementing Junior Doctor Training School that applied Fukui KOSEN PBL.

Continued activities are required in the future because this project can receive support for 5 years from JST. However, the number of applicants for the second year decreased from the first year to 41, and all of them passed the selection process and proceeded to the first stage. Among them, only 1 first student wished to proceed to the second stage, which was also less than in the first year. In order to secure highly motivated students, it is necessary to consider not only securing the number of applicants but also improving the training program to make it more attractive.

Students in Fukui KOSEN are participating in this project as tutors. It is thought that teaching elementary and junior high school students will lead to their own growth.

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Table 2. The title of presentations and studies

Grade	Title of the middle presentation in 1st stage	Title of the last presentation in 1st stage	Title of study in 2nd stage	Department of Adviser
8	Artisanship and Modern Technique	Antibiotic and Hygroscopic Washi	Development Washi using research of Nostoc commune	Chemistry and Biology
8	Traditional Craft & English	Deliver Traditional craft in Tannan in English	Study on Disseminating Information on Traditional Crafts Considering Individual Preferences	Electronics and Information Engineering
8	Lacquer & Bridge	Bridge Build-up with Lacquer	Study on Crack Repair of Concrete by Kintsugi Technology Using Lacquer	Civil Engineering
8	Coloring Titanium Plate & Knife	Fancy Knife & Cooking Skill Up	Research on corrosion of colorful kitchen knife	Chemistry and Biology
7	Echizen Chest & Echizen Cutlery	Echizen chest & Echizen cutlery	Kitchen Knife Stand incorporating the design concept of Echizen chests of drawers	Mechanical Engineering
7	Surfactant & Washi	Insoluble Portable Washi Soap	Making Portable Soap Made of Echizen Washi and Evaluation	Chemistry and Biology
7	MR & Echizen Chest	Fukui traditional craft by VR	Development of Teaching Materials for Inheritance of Fukui Traditional Crafts Using Mixed Reality	Civil Engineering
7	Cutlery & Pigment Synthesis	Cutlery for Health and Environment	Collaboration with Washi industry using pH-responsive pigment extracted from Trifolium pratense	Chemistry and Biology
6	Echizen Washi & Programming	Japanese Traditional Crafts from Fukui to the Future	Metaverse development to disseminate traditional crafts in Fukui	Electronics and Information Engineering
6	Making Toy Powered by Thermal Energy & Knife Village	Big Pop Pop Boat by Thermal Energy	Larger Pop Pop Boat for My Ride	Electrical and Electronic Engineering
9	Sports Data & Eyeglass	Sports Data & Eyeglass	(Not applicable)	-
5	Lacquerware & IoT	Food and Health Problem Solution by Echizen Lacquerware	(Unsuccessful)	-
4	Echizen Cutlery & Laser	Stronger and Lighter Echizen Cutlery	(Unsuccessful)	-