# INTEGRATED LEARNING FOR FEMALE STUDENTS IN ELECTRICAL AND ELECTRONIC ENGINEERING

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## ABSTRACT

This paper examines our new approach to help female students develop their integrated academic skills in the field of electronic and electrical engineering at Hiroshima Institute of Technology, Japan (HIT). There are usually few female students in engineering colleges in Japan, so now the whole country is trying to increase the number of female students who select science subjects at high school and university. To support these projects and stimulate education in engineering for female students, a year ago we created an original project for only female students: Electrys. Electrys provides female students opportunities to study and research a topic of their choice. Examples of topics include electronic and electric devices, circuits, illumination systems, and the internet of things, inside and outside the university. In addition, these events encourage students to give presentations in Japanese, English, and Chinese as their final goals in Electrys. These presentations can target workshops and domestic or international conferences as they belong to laboratories of the university. We report on the outline and significance of Electrys, introducing the first generation of students. The project has brought about the new chain reaction among students. At first, we were concerned the project might be a burden on students since it was additional work beyond regular classes. We found more success than we had expected. Furthermore, we find this a good flow to stimulate female students and our whole departments. We are continuing to tune our systematic approach to education for female students by analyzing their final data and questionnaire results.

## KEYWORDS

Electrical and Electronic Engineering, Female Students, Integrated Learning, Project-based Learning, Standards: 7

## INTRODUCTION

In Japan, there are usually few female students in engineering colleges. Compared to other developed countries in the world, the ratio of women in the workforce in Japan is extremely low, especially in the field of science and technology. So now the whole country is trying to increase the number of female students who select science subjects at high school and university. For example, Gender Equality Bureau Cabinet Office launched a project called “Rico-challenge” (Rico means engineering) across the academy, industry, and government in 2015. Some national universities, such as the University of Tokyo and Kyusyu University, have taken measures to meet the situation; they have started to support a part of board and

lodging charge for female students or give preferential treatment with a matriculation for them. Also, our university has already established an organization called JCD Center, Joshi (girls in Japanese) Career Design Center, to help female students to plan a future path through their college lives. To support these projects and stimulate education in engineering for female students, a year ago we created an original project for only female students: Electrys. Electrys is an integrated learning program for extracurricular activities, learning from CDIO Standard 7 as a guiding principle. CDIO Standard 7 is considered as one of the most effective ways to build integrated learning projects for young engineers both practically and ideally. This paper reports on the first generation of students in Electrys, with reference to CDIO principles. The outcome of the project showed positive results, as evidenced by survey feedback from students.

## DESIGN PRINCIPLE OF ELECTRYS

Electrys has three outstanding features:
1. Only for female students can participate.
2. Electronic and electrical engineering major
3. Integrated learning

In addition, the project is modeled on CDIO Standard 7, although it is not regarded as a regular course.

### *Female Only*

Owing to various kinds of policies and campaigns conducted by the academy, industry and government, female students majoring in engineering at higher education have been increasing for several decades in Japan. The percentage of female students is, however, still much lower than that of male students. For example, only ten percent of engineering at HIT are female now. For instances, 301 students enrolled in the department of electronics and computer engineering, of whom 6 are female, and 372 enrolled in the department of electrical system engineering, of whom 11 are female. In order to help female students develop both their academic skills and personal, interpersonal abilities, we have started to create a new environment as follows:

- A room for only female students (we call Joshi-room)
- A female tutor
- A tie-up with JCD Center in HIT

There are a desktop computer, printer, whiteboard, table, couch, fridge, microwave, some chairs, cushions and personal lockers in the Joshi-room. The floor is covered with a soft carpet, so they can take off their shoes there. The room is designed so that students can study, have lunch, and relax. Furthermore, a female teacher is mainly in charge of supporting them, in addition to their regular tutors. Students can consult with her about various kinds of matters, and at the same time, the teacher can get to know their situation and give encouragement. After preparing a suitable environment for their school lives, female students, about 8 students (5 first-year and 3 second-year students), began to meet, talk and study together in the Joshi-room. Then, they decided to name their group “Electrys,” a neologism expressing the plural form of electronic plus electrical, by themselves, adopting projects in the JCD Center. That is why Electrys not only represents the team-name for female students majoring in electronic and electrical engineering, but also refers to the project which supports their whole school lives. In this way, Electrys launched new activities in 2016 through both

inside and outside the university. The themes of these events include electronic and electric devices, circuits, illumination systems, and the internet of things, based on their major.

### *Electrical and Electronic Engineering in HIT*

In HIT, electrical and electronic engineering major consists of two departments; electronics and computer engineering, and electrical system engineering. These two departments are also divided into 6 fields as follows:

Electronics and computer engineering:
- Electronic devices
- Circuits and computers
- Information and communication

Electrical system engineering:
- Energy system
- Information and communication systems
- Computer system

One of the purposes of the project is to help students learn their own major while they take two years of courses covering engineering fundamentals and liberal arts. The project gives students opportunities to investigate research topics and potential areas of specialization earlier than other students. From November in 2016 to December 2017, Electrys carried out 5 events related to their study, selecting areas of interest.

Table 1: 5 events performed by Electrys

| | Date | Event | Task and Specialty | Purpose |
|---|---|---|---|---|
| 1 | Dec. 6, 2016 | Christmas party | How to make a candle using LED: electronic circuit and LED light | International exchange |
| 2 | June 25, 2017 | Sports event | How to make a lighting card with an AgIc circuit marker: LED light, illumination system, and handcraft | Making fun with kids |
| 3 | July 16 & Aug. 20, 2017 | Open campus | Let's take pictures in projection mappings and have experience of VR: illumination system and computer system | Introduction of departments |
| 4 | Oct. 30, 2017 | Halloween Party | How to make a kaleidoscope: handcraft and Japanese "monodzukuri" (manufacturing) | International exchange |
| 5 | Dec. 19, 2017 | Christmas party | How to make a lighting snow dome: handcraft, electronic circuit, and LED light | International exchange |

### *Integrated Learning with Project-based Learning and Workshop Style*

Table 1 describes five Electrys events. All events aim to achieve project-based learning, so students make plans for events, discuss their topics, study their specialties, exchange ideas, decide who does what, and ask teachers for advice. Except for open campus, these are held in a workshop style. The workshop format can be used to promote personal growth, teach professional skills, or create change within existing systems. Workshop provide an effective short-term training method that can be used in a wide array of settings with an infinite number of topics (Brooks-Harris et. al., 1999). Events culminate presentations. Furthermore, students used three languages, English, Chinese, and Japanese, in the Halloween and

Christmas parties. Basically, all of 5 first-year students joined in all these events from the beginning to at the end. The first event in 2016, 3 second-year students joined in. When they became third years, they were in charge of coaching positions in Electrys. In four events in 2017, 5 new-students participated in and supported seniors. These events can help reverse a decline in academic standards, help students find topics they enjoy and make new connections with peers. Through discussing these projects in the Joshi-room, planning their schedule, cross-checking results, and making their presentations, the students improve their professional knowledge, communication ability, problem-solving ability, and creativity. This is in accordance with the purposes of integrated learning reported by Helsinki Metropolia University (Karth et al., 2016). With these events, two departments cultivate these abilities and helps our graduates be more effective in their future lives. Companies nowadays expect new employees with high communication skills. Needless to say, projects like Electrys for male students to brush up both their academic and communication skills have already established in our department.

### *CDIO Standard 7*

CDIO Standard 7 explains how to implement an integrated curriculum plan. The project must be interdisciplinary and engage students' personal skills (CDIO, 2010). It is necessary for engineers to have not only professional knowledge and technical skills but also communication ability, logical thinking ability, problem-solving ability, and expressiveness. According to surveys conducted by the Japan Federation of Economic Organization, communication ability has been classified for the past 12 years as the most crucial skill for job-seekers by companies looking for new hires (JFEO, 2016). Therefore, CDIO Standard works to lead and create projects according to the following criteria, given in Table 2 below (CDIO, 2010).

Table 2: CDIO Standard 7 criteria

| | |
|---|---|
| 5 | Courses are regularly evaluated and revised regarding their integration of learning outcomes and activities. |
| 4 | There is evidence of the impact of integrated learning experience across the curriculum. |
| 3 | Integrated learning experiences are implemented in courses across the curriculum. |
| 2 | Course plans with learning outcomes and activities that integrate personal and interpersonal skills with disciplinary knowledge has been approved. |
| 1 | Course plans have been benchmarked with respect to the integrated curriculum plan. |
| 0 | There is no evidence of integrated learning of disciplines and skills. |

Learning from the criteria as a guiding principle, the project Electrys is summarized in Figure 1, as referring to integrated curriculum examples at Singapore Polytechnic (Crawly et al., 2014). Electrys functions properly to develop students' both disciplinary knowledge and personal, interpersonal skills.

In each event, students analyze results, reconsider their performances, research participants' needs, brainstorm their ideas, and co-create their solutions with teachers' advice. In addition, they learn English and Chinese. In the process, they can use competencies like questioning, critical thinking and teamwork and communication skills, as well as the skills of "conceive, design, and implement" (Crawly et al., 2014).

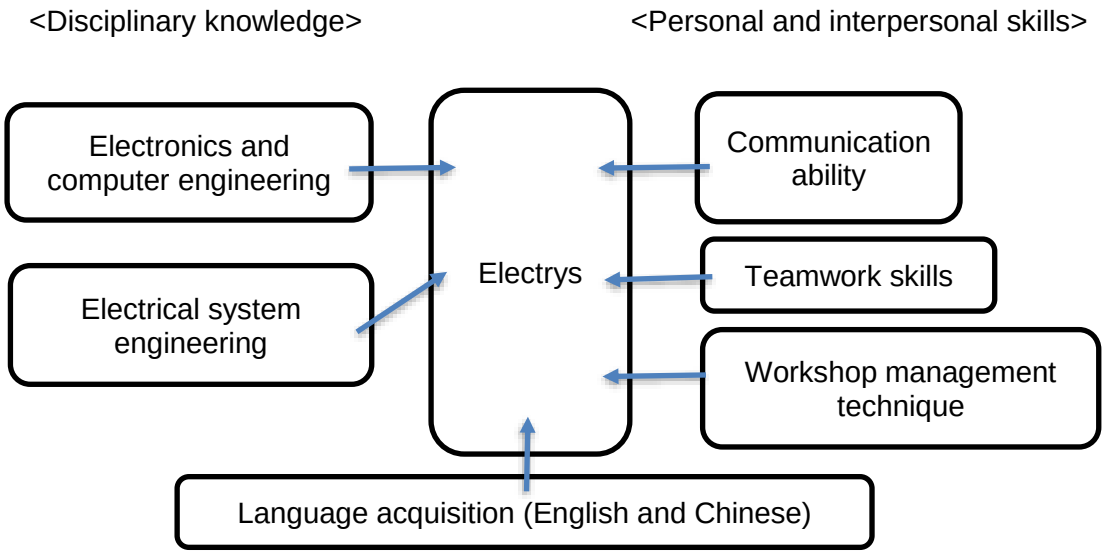


Figure 1: Cluster of integrated learning for Electrys

## RESULTS

In Table 1, there are 2 Christmas party events. At the event in 2016, students used a simple electronic circuit and LED light to make Christmas candles. Since they had learned just engineering fundamentals and liberal arts, they did not have enough knowledge of electrical and electronic engineering. In 2017, they tried to make more full-scale electronic handicrafts; attempting to use capacitors, inductors, and wireless power transmission by pursuing extensive studies. They gathered information and asked many teachers to improve their skills. Finally, they succeeded in making LED light shine inside snow domes. As a result, the number of participants in 2017 was 48, while the one in 2016 was only 22. Most of participants gave good feedback in questionnaires. Moreover, the project Electrys brought about positive feedback by the first generation of 5 students in the questionnaire's results:

- Question No. 1:
  "Do you think that the Joshi-room plays a good role for you?"
- Answers:
  Yes: 5 students, No: none

- Question No. 2:
  "Explain briefly the reason for question No. 1."
- Answers:
  Female students can relax there.
  They can find a place where they belong.
  They can promote their projects freely.
  The Joshi-room makes it easier for them to come to school. They get to like school.
  They have a place where they can go whenever they want to.

- Question No. 3:
  "Do you think that the project Electrys plays a good role for you?"
- Answers:
  Yes: 5 students, No: none

- Question No. 4:
  "Do you think that what 'Electrys' is for you?"
- Answers:
  A friendly group with which they can do whatever they want to do, seriously and happily, with responsibility, using PDCA circle by themselves.
  The group that made electronic handcarts reported close friendship.
  They can enjoy electronic things.

- Question No. 5:
  "What do you want to try in Electrys?"
- Answers:
  To have study tours and collaborate with companies.
  To introduce Japanese "monodzukuri" to foreigners in English.
  To hold events outside universities more.
  To try business projects.
  To make research presentations in domestic or international conferences.

- Question No. 6:
  "Do you think that you acquired disciplinary knowledge on your specialty through Electrys?" "What was the most useful thing your learned?"
- Answers:
  How to create an enjoyable workshop efficiently within their budget through discussion.
  They could practice the knowledge they learned in regular classes.
  How to put into organize a project.
  They reviewed what they learned in their courses, especially the basic theory for electronic circuits. Also, they applied the knowledge they had learned for two years to workshops.
  Abilities to negotiate with others and plan carefully through proposing projects and carrying out workshops.
  Before negotiating, they discuss thoroughly, such as how big the place they need, how many people they need, and what and when they should prepare. They repeated these processes several times.
  Abilities to plan something and put it into practice.
  They really understood what they learned in regular courses by means of putting into practice their basic knowledge of "monodzukuri."
  Each of them played their roles with responsibility. As a result, the whole group showed what they could do in their own sphere.

- Question No. 7:
  "Please give your ideas on how to improve the Electrys project."
- Answers:
  Because the joshi-room is a relaxing place to be, they just enjoy talking and staying together without seriously discussing workshops. They want to try make a habit of holding serious meetings in other places.
  To manage their costs more efficiently.
  To study methods to make more formal materials and presentations that can pass muster in the business world. They want to attain business-level ability.

As these questionnaire's results indicate, students are really satisfied with the project Electrys; they put the knowledge they learned in regular classes into practice in events and

tried to find more efficient ways to improve projects. In addition, they attained communication ability, logical thinking ability, problem-solving ability, and expressiveness through managing the teamwork.

## CONCLUSION

Referring to CDIO Standard 7, Electrys can be successful for both students and our departments, although it is not a regular course. The level 2 of the criteria can be achieved in Electrys. The project involves three teaching skills: integrated learning, project-based learning, and workshops. It has brought about the new chain reaction among students. At first, we were concerned the project might be a burden on students since it was additional work beyond regular classes. We found more success than we had expected; they enjoy the project, developing personal and interpersonal skills with disciplinary knowledge. We find this a good flow to stimulate female students and our whole departments. We are continuing to tune our systematic approach to education for female students.

## REFERENCES


Brooks-Harris, Jeff E. and Susan R. Stock-Ward. *Workshops*. Thousand Oaks: SAGE Publications (1999).

CDIO Knowledge Library, "CDIO Standards v 2.0", (2010). URL: http://cdio.org. Accessed 2016-03-31.

Crawley, Edward F., Johan Malmqvist, Sören Östlund, Doris R. Brodeur and Kristina Edström. *Rethinking Engineering Education: the CDIO Approach*. 2nd ed. New York: Springer (2014).

The Japan Federation of Economic Organization (JFEO), "Questionnaire Result about Graduate Recruitment in 2015", (2016). URL: http://www.keidanren.or.jp. Accessed 2016-04-10.

Karth, Markku, Kaisa Väänänen, and Yue Fu. (2016). Integrated Learning through an Intensive Course on User Experience. *Proceedings of CDIO '16*, Turku. URL: http://cdio.org. Accessed 2017-11-01.


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