Learning Express: Transnational Collaboration in Engineering Education Based on the CDIO Framework

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Abstract

Learning Express is an immersive student exchange program that brings together students from multi-national, multi-cultural, and multi-disciplinary backgrounds to collaborate on social innovation projects in Southeast Asia. The program, conceived and spearheaded by Singapore Polytechnic, started in March 2013. Kanazawa Institute of Technology, Kanazawa Technical College, and Singapore Polytechnic together with local institutional partners, conducted the program in Yogyakarta (2013, 2014) and Malang (2015), Republic of Indonesia. The participating institutions were divided into three project groups and conducted the program with three different communities over a 14-day period. The program succeeded in providing a rich learning experience for the participants. The real world environment with real problems offered the students an in-depth look at issues faced by the communities in question and challenged the participants to solve them using the design thinking methodology. Furthermore, the program involved participants in activities that addressed local needs while developing their academic skills and commitment to the community. This report introduces this program along with its unique characteristics.

Keywords: Design Thinking, Integrative Learning Experience, Multi-cultural, Project Based Learning, Active Learning

1. Introduction

In the near future, engineers who can work across, not only disciplinary, but also national borders and cultural boundaries will be in high demand. It stands to reason that the education and development of such engineers will serve a crucial role. To foster more collaborative and global engineers, however, the practice of engineering must be changed by reforming engineering education. Not surprisingly, a considerable number of universities have realized that the subjects of communication, leadership, ethics, globalization, diversity and world cultures must be considered to be core components of engineering education, along with mathematics and physics.

The Kanazawa Institute of Technology (KIT) places emphasis on providing excellent engineering education at the undergraduate level by requiring all major students to take a common set of courses that introduces design projects, independent laboratory experimentation, effective presentation, and other fundamental non-field-specific technical abilities. However, considering the rapid progress of globalization and KIT's institutional goal—"To Foster Engineers Who can Think for Themselves, Make Wise Decisions, and Act on Them for the Benefit of Mankind"—there is a strong need to instill a mindset of global awareness and sustainable social development.

Purdue University, for one, has been providing an engineering design program, Engineering Projects in Community Service: EPICS[1] from 1995, in which teams of undergraduates design, build, and deploy real systems to solve engineering-based problems for local community service and education organizations around the world. In contrast, KIT has joined the CDIO Initiative[2] in 2011 and has contributed, together with Kanazawa Technical College (KTC) and Singapore Polytechnic (SP), to the development of an overseas version of social-innovation projects using the CDIO framework. In this paper, we will introduce the features of the program, detailing its components and underlying pedagogy.

2. Program and Pedagogy of Learning Express

Learning Express (LeX) is a global social-innovation program that provides participants from ASEAN and Japan to work together on a community project overseas using design thinking methodology. The LeX is classified as an immersive student exchange program for social-innovation projects, and is developed using the CDIO framework. LeX seeks to provide participants with an out-of-classroom learning opportunity to nurture a sense of purpose and social contribution to society, unraveling insights into their cultures and norms. It requires students to create solutions that address community needs and care for the communities they get to work with. During LeX, participants from different disciplines, different institutions, and different countries come together to collaborate on social-innovation projects. Using design thinking and the participant's domain skills, participants join hands to co-create innovative solutions that strive to meet the needs of local communities. Some challenges include access to clean water, exploration of alternative energy, food product innovation, and healthcare and social entrepreneurship initiatives. As the teams stay and work closely with the local community, they immerse themselves into its culture and lifestyle, thereby expanding their cultural quotient with
new insights and perspectives. The LeX is unique because:

- It is designed using the CDIO framework, and is based on the design thinking methodology
- Provides out-of-the-classroom learning experiences, completely organized by academics from multiple countries
- Participants are limited to students from multi-disciplinary, multi-cultural, and multi-national settings
- All activities are team-based, with non-engineering students forming an important part of the team.

<table>
<thead>
<tr>
<th>Pre-LeX</th>
<th>LeX</th>
<th>Post-LeX</th>
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<tr>
<td>4-hours of training in Kanazawa</td>
<td>13 days local immersion in ASEAN country</td>
<td>Year long projects in Kanazawa</td>
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<tr>
<td>• Basic of Design Thinking</td>
<td>• Conceiving needs</td>
<td>• Implement functional prototypes</td>
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<tr>
<td>• Preliminary Investigation</td>
<td>• Designing concepts</td>
<td>• Transfer know-how</td>
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<tr>
<td>• Safety controls</td>
<td>• Building early-prototypes</td>
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Figure 1. Three components of the Learning Express program at KIT/KTC

Figure 1 shows the three components of the LeX program. During the first component, students undergo training in design thinking, conduct a preliminary investigation, and learn safety controls, including healthcare in a developing country before they depart. These training programs are given by KIT/KTC LeX chaperones or facilitators. In addition, previous LeX participants counsel the new batch of participants with their experiences in former LeX activities.

For the second component, the participants dedicate 13 continuous days in the host countries and immerse themselves into the local ecosystem to understand indigenous lifestyle, culture, and technological level in order to develop sustainable solutions. Each participant from KIT, KTC, and SP are paired with another participant from local institutional partners in the host country. For the LeX program on March 2015 in Malang, 23 SP, 6 KIT, and 6 KTC participants were divided into 3 teams. 24 participants from SP and 3 from KIT were divided into 3 teams to work on the projects in three different villages in Yogyakarta, Republic of Indonesia on September 2014. This was done so as not to disturb the local villagers’ daily routine with a large number of outsiders with their local buddies. Each team was led by at least one facilitator from SP, local institutional partners, and KIT/KTC, with one assistant from SP.

In the past projects, the teams generated several concepts for the villagers, such as more efficient jig and tools for home industry, new package design ideas to better promote local products and effective models to enhance community healthcare. The main objective of the second component is to allow the participants to experience real life in the village and to build deep empathy, and collaborate with the villagers. Consequently, the activities mainly involve discerning the needs of the local society and designing concepts to fulfill those needs. In this process, SP's design thinking framework is the main methodology during ethnographical studies to unveil hidden needs of the local community, as shown in figure 2.

For the third component, the participants are to design and implement working prototypes based on the concepts conceived in the second component. Working prototypes must be built with available resources in the host country, and
then developed and delivered to the local villages. In addition to using locally-available resources, to ensure a project’s sustainability, the local community might be trained how to build, operate, and maintain the deliverable from the projects. At KIT and KTC, Yumekobo—the metal, wood, and electric workshop—facilitates the implementation from the early prototype to working prototype. Yumekobo also offers funding support for building of working prototypes.

3. Details of Learning Express programs in Republic of Indonesia

As shown in figure 2, SP’s design thinking framework has 4 stages to unveil the needs of the local community. The stages are named, Sense and Sensibility, Empathy, Ideation, and Prototyping. The Design Thinking methodology is used as a system of overlapping spaces of Inspiration, Ideation and Implementation. Table 1 provides a comprehensive outline of LeX activities and the relationship between activities and CDIO skills.

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<tr>
<th>Schedule</th>
<th>Activities</th>
<th>Corresponding CDIO Skills</th>
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<tbody>
<tr>
<td>Day 1 Arrival in host country</td>
<td>Orientation for living environment Ice-breaking</td>
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<tr>
<td>Day 2–3 Sense and Sensibility</td>
<td>Learning local culture and language to build confidence with buddy Training for design thinking was provided for all participants. Village Orientation</td>
<td>Problem solving Teamwork Communication Active Learning</td>
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<tr>
<td>Day 4–7 Empathy</td>
<td>Staying in the local village Conducting observation and interview Understanding the issues faced by the local community</td>
<td>Conceiving system Teamwork Communication</td>
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<tr>
<td>Day 8–9 Ideation</td>
<td>Brainstorming to generate ideas Generating a feasible solution to match the needs of the local community</td>
<td>Problem solving Teamwork Communication</td>
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<tr>
<td>Day 10–11 Prototyping</td>
<td>Building early prototypes with materials that can be obtained in local area.</td>
<td>Problem solving Experimentation Designing system Implementing system</td>
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Using the design thinking framework, the participants from SP, KIT, and KTC generated ideas, developed early prototypes, and created solutions together with the villagers and participants from local universities. The use of sustainable resources that can be obtained in the local area served as a major requirement for the final ideas. This requirement is the key to the pedagogic approach of LeX, to maintain the sustainability and feasibility of the project that the participants and the local community conceive together. The hope is that the local communities would continue the development, deployment, repair, and enhancement of the project deliverables using available resources and technologies.

Owing to the second component including resource-intensive activities, funds are required. The KIT and KTC participants need to bear the cost of around 1200 USD per participant to embark on the program, and more pay for round-trip fare to a host country. However, for the LeX from 2013 to 2015, the financial support from Japanese companies reduced the financial burden of the participants to only the round-trip fare between Republic of Indonesia and Japan.

4. Conclusion

Learning Express is a transnational social innovation program that provides the participants with opportunity to immerse in multi-cultural life, obtain new multi-disciplinary skills, and make multi-national friendships through out-of-classroom experience. The main objective of Learning Express is carrying out social innovations using the design thinking methodology. Participants from various disciplines and educational institutions formed teams and collaborated to conceive innovative solutions that fulfill the needs of the local community. In addition, judging from activity on social network services like LINE and Facebook, Learning Express is contributing to establishing strong friendships between the participants in spite of linguistic and cultural differences. The Kanazawa Institute of Technology and Kanazawa Technical College will continue to collaborate in developing Learning Express with Singapore Polytechnic and educational institutes in ASEAN countries, to foster the next generation of engineers who can think for themselves, make wise decisions, and act on them for the benefit of mankind around the globe.

References

Biography
Mune-aki Sakamoto received his B.E. in Marine Engineering and also received M.E. and Ph.D. in Organic Chemistry from Kobe University of Mercantile Marine. His work experiences are Researcher in Kobe University, Lecturer (Department of Applied Chemistry) and Associate Professor (Project Education Center) in Kanazawa Institute of Technology. His current research focuses on Organometallics for energy conversion devices. Also His current pedagogic interests are designing multi-disciplinary project-based learning and building a common experiments for primary education in field of organic materials chemistry.