

## Impact of Multi-Disciplinary International Engineering Service Learning in Instilling Global Engineer Attributes among Undergraduates

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### Abstract

International Engineering Service Learning engages multi-disciplinary and cross-cultural engineering students in experiential learning through structured community service. Through participation in this effective pedagogy approach, students is expected to gain first-hand knowledge of engineering practice, global competency, actively contribute to the community through the service they performed and develop a personal appreciation for civic responsibility. In addition, what makes service learning an activity worthy of engineering course is its reflective nature. Reflective writing is one of important component in determining value of learning experience and it gives an impact on the students. This paper aimed to investigate the impact of multidisciplinary and cross-cultural engineering service learning among undergraduates through qualitative analysis done on their reflection journals. The findings indicated that this 9-day intensive program, utilizing the concept of multi-disciplinary and multi-cultural team for engineering service learning project, can be implemented to instill global engineer attributes among students.

**Keywords:** Engineering Service Learning; Multi-disciplinary team; Multi-Cultural team; Global Engineer Attributes; Reflective Practice

### Introduction

Today's rapidly advancing technological environment and increasingly global economy has prompted a widespread call for new transformation in engineering education. As a result, engineering programs have placed greater emphasis on active, experiential, problem-based, and team-based learning. While the call for new transformation has resulted in significant changes in the manner in which engineering is taught, the literature shows that the current model for engineering education continues to fall short in preparing engineering graduates to tackle the challenges of the 21st century. Evidence suggests that engineers are particularly in need of greater developed "soft skills," which embrace communication and leadership skills as well as social, economic, and environmental sustainability awareness (Shuman et al., 2015). To address this, there have been significant efforts in recent years to incorporate community based service in teaching and learning (Coyle et al., 2005; Tsang, 2007). Service learning is a pedagogy that emphasizes experiential learning through structured community service. The partnership between

the academic institution and the community is founded on a mutually beneficial relationship that provides learning experiences for students while satisfying real needs within the community. Service learning bridges the technical and social context of engineering and therefore addresses a number of shortcomings in traditional engineering pedagogies. The extent of learning is aided by the fact that the projects are inductive and based on real-world problems. Research on problem-based learning has shown that real-world problems increase motivation and satisfaction, foster problem-solving skills, cultivate extensible and flexible knowledge bases, and promote long-term retention and motivation for life-long learning (Tsang, 2007). The service-learning projects are team-based and involve interactions between students and members of the community, which additionally promote the development of interpersonal and collaborative skills. Service learning projects can also be carried out in an international level, which adds another dimension of learning. Research has shown that international experiences in general promote cultural sensitivity, the development of a global

perspective, the development of communication skills, problem-solving skills, and the ability to adapt to unpredictable environment (Cone & Harris, 1996).

Furthermore, in the 21st Century, globalization and the growth of multinational companies throughout the world today means that the need for global workers or professionals is rising. People in different cultures may have different ways of thinking, norms, working, etc. Some language or behavior may be considered perfectly acceptable in one culture, but inappropriate in another. As such, since the end of the 20th Century, there is an increasing trend for engineers to work in multi-cultural and multi-national environments. There are several attributes reported under the brand of "Global Engineers" as early as 1997 under the Manifesto for Global Engineering Education (Hudley & Brown, 2013). The manifesto stated that global engineers not only have a good grasp of engineering knowledge and understanding but also have multidisciplinary perspective and understanding of interrelatedness of their expert area with others. They need to be able to appreciate other culture and the diversity, flexible, dynamic, have good communication and team-working skills. Later, the American Society for Engineering Education (ASEE) Corporate Member Council's Special Interest Group for International Engineering Education also listed the attributes for Global Engineer which also emphasizes on the multidisciplinary or interdisciplinary perspective as well as other attributes similar to those mentioned in 1997 (National Academy of Engineering, 2005). Chan & Fishbein (2009) listed ten attributes of a global engineer. While The ASEE Corporate Member Council's Special Interest Group for International Engineering Education came up with the following 20 outcomes of a global engineer (Hudley & Brown, 2013). In addition, engineering education research identified three such roles needed for future engineering graduates (Spinks et al., 2006). Firstly the role of engineer as specialist recognizes the continued need for engineering graduates who are technical experts of world-class standing. Secondly, the engineer as integrator reflects the need for graduates who can operate and manage across boundaries, in a complex business environment. Thirdly, the engineer as change agent highlights the critical role engineering graduates must play in providing

the creativity, innovation, and leadership needed to guide the industry to a successful future.

Higher education institutions are using international service learning (ISL) to fulfill their mission, create opportunities for students to define skills and learning outcomes needed for effective global citizenship. (Brown, 2007). College campuses across the country are developing structures and capacity for students to expand their learning, develop themselves as civic community members and engage in meaningful partnerships through a variety of experiences, including ISL experiences. "Today's students have no choice but to be global citizens. As educators, we are challenged to provide learning „experiences that integrate how students think, feel, and relate to others, i.e., develop students to become global citizens" (Braskamp, 2008). ISL combines academic instruction, reflection and community-based service in an international context (Crabtree, 2008). Benefits from international learning experiences for students in a variety of disciplines have been noted in the literature. They include learning cultural differences, comparing health care systems, and augmenting personal development (Berry & Chisholm, 1999; Button et al. 2005; Zorn, 1996; Duffy, 2005; Sawyer & Lopopolo, 2004). Kiely & Nielsen (2002) note ISL programs facilitate "intercultural competence, language skills, appreciation of difference, tolerance of ambiguity, and experiential understanding of complex global problems related to their academic program of study." Graduates overwhelmingly support international education and described its personal and professional impact well beyond the actual experience. Sawyer & Lopopolo (2004) reported significant changes in students' abilities to focus on relevant information, to think critically, to strategize systematically, and to problem solve effectively in their provision of care. Haq et al. (2000) found multiple significant impacts on students' knowledge, attitudes, and skills gained through international health experiences, which are important for medical practice in the United States and abroad. In the past 10 years, 28% (US) of the US programs had ISL with positive effect on student personal development and the facilitation of the student's development of cross cultural competencies were found to be the greatest benefits of ISL (Pechak, 2007).

Thus, as part of the effort to develop engineers with global attributes, three nations, Korea, Indonesia and Malaysia had collaborated to conduct a global engineering service learning program at Punggai, Johor. It is a 9-day intensive program using the concept of a multi-cultural team, to instill global engineer attributes among students. This program, called the *Creativity Station*, has actually been conducted for several times (Seo et al., 2013), with the Malaysian team participating for the fourth time in 2015. Students from different countries were grouped together to identify local issues in the community. They then create and implement the solution. This paper presents the study undertaken by University Teknologi Malaysia to investigate the impact of the program, with respect to the attainment of global engineers attributes. In the study, a qualitative assessment has been conducted based on student's reflective writing about the experience in their learning process throughout this program.

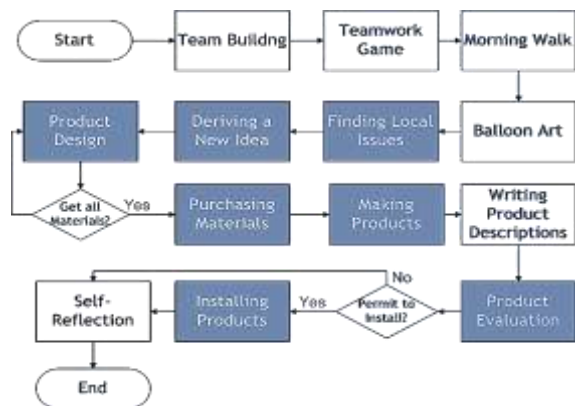
### Creativity Station 2015

The Creativity Station 2015, an innovative, community-based engineering service learning program, was held on 16-24 August 2015, at Kampung Punggai, Kota Tinggi, Johor. This international engineering service learning program, held for the first time in Malaysia, is a collaborative effort between the Centre for Engineering Education, Universiti Teknologi Malaysia (UTM) and the Pusan National University Innovative Engineering Education Hub Centre, Korea. This is the fourth time UTM have participated in Creativity Station, which was previously held in Surabaya (August 2013 and Feb 2014), and Bali (August 2014). UTM's involvement in this program is aligned to support the realization of the Higher Education Blueprint in developing holistic, innovative and high quality graduates.

Creativity Station 2015 provides an opportunity for engineering students to apply the knowledge they learned in university to solve an inter-disciplinary, local-community problem with technology based solution through activities that foster creativity and innovation. Activities in the program includes identifying problems of the community in Punggai Village, selecting a meaningful problem that is of significance to the community, sharing ideas to find the best solution to the problem, design and develop

the products invented, and finally testing and installing the products in the community.

Figure 1 shows the overall flow of activities conducted during Creativity Station 2015. The program started with team building games to help students from the different countries and universities know each other better. The participants were grouped into teams of 6 members consisting of 2 Korean students, 2 Indonesian students and 2 Malaysian students. There were a total of 10 teams, with dedicated team managers to facilitate their learning and design process. On the second day onwards, the participants begin working on their project, starting with going into the community to identify local problems, proposing engineering solutions and selecting the best possible option, and product design and fabrication to solve the identified issue, all within 5 days. In between the problem solving and design process, the teams have to prepare reports and presentations as one of the means to monitor and support their progress.



**Figure 1: Flow of activities conducted during Creativity Station 2015**

To add fun to the learning environment, this program was intertwined with non-technical activities, such as balloon art session, language class, a fruit party to have a feast of local fruits and also a BBQ dinner. Besides that, participants also had a chance to visit Petronas RAPID project site office located at Tanjung Pengelih, where they were given an opportunity to see and discuss on the development of Pengerang Integrated Petroleum Complex. This visit was very meaningful to all participants, as they will become engineers in their future career. Before their final presentation, participants were given a chance to explore more about Johor's cultures, foods and attractive places

particularly in Johor Baharu. Malaysian members from each team became the tour guides, bringing their friends to local landmarks and introducing them to local foods. Though exhausted, this program indeed provided the participants with plenty of wonderful experiences. Through Creativity Station 2015, 10 engineering-solution products were invented, Push-pull Box, Fish Dryer, Fish Cart, Trash Car, Trash Picker, Multifunctional Broom, Coconut Motorbike Cart, Coconut Squeezer, Super Flies Trap and Rainwater Harvesting System.

### **Reflective Writing in Determining the Value of Learning Experience**

In this era of globalization, Creativity Station 2015 provide an international multi-culture learning environment to enable students to develop the Global Engineers attributes that are very much in demand in the 21st Century. This program further encourage the establishment of a network among researchers and engineering students with international cooperation among the three nations involved. This high impact program is expected to holistically enhance professional skills while at the same time instil a sense of responsibility towards the community, moulding them into caring professionals of the future. By the end of program, student is expected to achieve specific learning outcomes as follows:

- a. Students will be able to apply their engineering knowledge on a meaningful and challenging interdisciplinary community problem
- b. Students will be able to improve their generic skills
- c. Students will be able to demonstrate global engineer attributes
- d. Students will be able to work effectively in a multicultural team and community environment
- e. Students will be able to communicate about engineering and its importance in daily life to the society
- f. Students will be able to demonstrate a sense of care and responsible to community

In addition, what makes service learning an activity worthy of engineering course is its reflective nature. Reflective writing become one of important component in determining value of learning experience and it gives an

impact on the students. When writing a reflection, students are more aware of their attitudes and can think about engineering in broader context. The definition of service learning also highlights the importance of reflection (Cooper, 2013; Mitchell et al., 2015; Richard et al., 2016 and Huffman & Roche, 2018). Reflection is the intentional consideration of an experience in light of particular learning objectives. Reflection is central to service learning because it instills a deeper understanding of the social context of the work (Robert & Julie, 1999). The presumption is that community service does not necessarily, in and of itself, produce learning. Reflection activities provide the bridge between the community service activities and the educational content of the course. Reflection activities direct the student's attention to a new interpretations of events and provide a means through which the community service can be studied and interpreted, as much as a text is read and studied for deeper understanding (Robert & Julie, 1999). Reflections encourage students to explore their learning and understanding, implicit or explicit, in-line of their service-learning experience and assign meaning to that experience with a view to future outcomes.

Due to the importance of reflection in service learning, for this Creativity Station program we specifically devised the reflection questions that coincide with expected learning outcomes and activities conducted, as shown in Appendix. All questions were developed based on 4Cs principles of good reflection practice, as highlighted by Eyler et al. (1996) which are continuous, connected, challenging, and contextualized. The researchers concluded from their research that reflection in service learning is:

- a. **Continuous** - must be an ongoing part of the service involvement. Should include reflection before the experience, during the experience, and after the experience.
- b. **Connected** - links service to academic goals and intellectual development.
- c. **Challenging** - provides an opportunity to explore uncomfortable and unfamiliar feelings and ideas. Raises questions that may have difficult answers.
- d. **Contextualized** - reflection can occur in various forms. Activities selected correspond in a meaningful way to the service experiences.

These reflection questions have been validated by the experts, whereby they are a experienced educators from Faculty of Education which actively involved in service learning project. During the validation process, the evaluators were also been explained by the research team about the 4Cs principle used in developing those questions.

We asked the students to keep reflective journals during their time in Punggai. Writing prompts were provided to generate reflection while eliciting responses that would answer our research questions. Specifically, we sought to assess technical skills, teamwork, communication skills, global competency, and personal and professional growth. We also looked for evidence of the students being able to overcome social, cultural, and communication barriers and being able to tackle unpredictable and ill-posed engineering problems.

Along with the questions in Appendix, the students were given the following guidance in keeping their reflective journals:

*“Enclosed are a series of writing prompts to be completed over the program of Creativity Station 2015. There is no specified word limit (maximum or minimum) for each question. However, it is expected that typical responses will range from 100 - 250 words per question. When answering each question, reflect on your experiences, be as specific as possible in writing the response, and try to include examples (when possible) to illustrate a point.”*

## **Methodology**

### **Participant**

About 61 engineering and technology based students from 14 universities were participated in Creativity Station 2015: 20 from Malaysia, 19 from Korea, and 22 from Indonesia. Among the universities involved are Universiti Teknologi Malaysia (UTM), Pusan National University, Chouaib Doukkali University, Gyeongnam National University of Science and Technology, Gyeongsang National University, Tongmyong University, Dongseo University, Pukyong National University, Silla University, Inje University, Handong Global University, Politeknik Elektronika Negeri Surabaya, Telkom University Surabaya, and Politeknik Negeri Bali, Indonesia. They are mainly 3<sup>rd</sup> and 4<sup>th</sup> grade students from different majors: 14 electrical engineering, 10 mechanical, 7 chemical, 5 civil, 4 electronic, 3 physics, 2 industrial, 8 computer and

telecommunication, 1 power generation, 1 nuclear, 1 robot system, 1 environmental, 2 advanced material, 1 semiconductor and 1 automobile engineering.

### **Data Collection and Analysis**

Reflection writing of students have been analyzed within a phenomenological framework (Borrego et al., 2009), which allowed common themes to be identified from the reflective journals. The analysis involved the identification of words and phrases (i.e., “individual natural units”) that corresponded to meaningful learning experiences, rereading each unit with “openness” and identifying the central theme for the unit, evaluating the data systematically in regards to the research questions, and clustering the experiences into broader (i.e., “revelatory”) themes. The themes were then examined in the context of relevant literature and the findings supported by quotes from the participating students. While our research was guided by the aforementioned research questions, we did not seek to eliminate data that did not fit within the research questions, i.e., we approached the data with “openness.” For example, while we did not explicitly seek to measure creativity as a learning outcome, data regarding creativity emerged from the students’ journals. Therefore, creativity is included here as a measured learning outcome.

### **Results and Discussion**

From the analysis of student’s reflection notes, we can classified the learning outcomes into the following themes, with respect to global engineering attributes:

1. Technical skills
2. Adaptability
3. Creativity
4. Global competency
5. Cross-cultural communication skills

### **Teamwork and interpersonal communication skills**

The broad themes are given in Table 1 along with constituent themes that were derived from individual natural unit analysis. The constituent themes of learning outcome were derived based on specific intended mission that need to be achieved in each activity conducted under this program.

**Table 1: Learning Outcomes from Thematic Analysis**

Learning Outcome	Constituent Themes
Technical skills	Engineering tolerance, keeping to a schedule, sense of scale, generate idea based on engineering solution, produce engineering drawing, understanding factors of safety, fabricate the product, using power tools, using safety equipment (gloves, google)
Adaptability	Performing engineering calculations in the field, making decisions, adapting the product design with local situation
Creativity	Group-level innovation
Global competency	Global perspective regarding local issues in remote/rural area, understanding of different culture, appreciation of and tolerance for life without modern conveniences
Cross-cultural communication skills	Communication across different languages, resolving differences in work habits
Teamwork / Interpersonal communication skills	Conflict resolution, interdependence

### **Technical skills**

As reported by Hudley & Brown (2013), technical skills are the knowledge and capabilities to perform specialized tasks such as mathematical, engineering, scientific or computer-related duties. In this program, The students gained practical experience in this *Creativity Station* project that is generally not addressed in their specific engineering coursework. When asked to summarize what they learned from the making product activity, the students reported learning “how to prioritize the main local issue need to be solved, how to transform the idea into engineering drawing, how to design practical engineering solutions, how to work with power tools to fabricate the product as well as how to modify the design for successful installation”. These tangible skills are to be expected due to the design and making product tasks that were involved.

However, we believe that the hands-on nature of the project allowed the students to develop an appreciation for scale and engineering tolerances that had not been previously developed in the classroom. The students had realizations that it is not always

possible to build to the exact dimensions specified in the drawing plan, as what they planned. This was particularly evident during purchasing materials for making the product, which material with expected size was not available. For example, one student stated that purchasing material task had taught him “that it is very difficult to get everything to the expected dimensions!”

The challenging during making the product gave students an opportunity to learn about the factors of safety in using the power tools and the importance of using safety equipment while handling tools. In regards to this, another student stated,

*I am not a good hands-on person. I am very lacking in handling any hand tools such as saw, drill, hammer, cutter etc. During this program, I enable to learn how to drill using proper technique with the help of technical assistance. I also learn that it is very important to wear glove and safety google, even to do simple job such as to nail up something.*

### **Adaptability**

Adaptability is a critical quality that employers seek in early 21st-century employees. With rapid changes in technology, diversity and society, companies need employees who are open to new ideas, flexible enough to work through challenging issues, and generally able to cope when things don't go as planned. Demonstrating adaptability through actions can gain favor with co-workers and supervisors (National Academy of Engineering, 2005).

In addition, University of Kent Careers and Employability Service UK, listed that adaptability and flexible involved:

1. adapting successfully to changing situations & environments
  2. keeping calm in the face of difficulties
  3. planning ahead, but having alternative options in case things go wrong
  4. thinking quickly to respond to sudden changes in circumstances
  5. persisting in the face of unexpected difficulties
  6. anticipating & responding positively to changing environments
  7. ability to adapt to change positively in response to changing circumstances
  8. taking on new challenges at short notice.
  9. dealing with changing priorities/workloads
- (Source:<http://www.kent.ac.uk/careers/sk/adaptability.html>)

Throughout this program, another important aspect that the students had was confidence and ability to adapt with any situation while they need to work in with those from different cultures and different countries increased after attending the program. A student wrote:

*At beginning I become passive person, but after gone through several days, I had learnt how to adapt with the differences of working habit of my teammates. Now, I am confidence working with people from other countries.*

Another student wrote:

*I observed that Korean concern on punctuality. Thus, I always remind about myself about this too along this program.*

Due to the students had no prior engineering fieldwork experience, this was first opportunity to learn how to adapt an engineering knowledge (design) to the field/local situations. Adaptability, in the context of engineering design, requires an understanding of the constraints of the site, the ability to perform engineering calculations to justify an action, and the confidence to execute the plan. Initially the students lacked confidence in their ability to identify local issues and to come out with possible engineering solution. However, with cooperation and guided given, the students able to complete the task. One student reflected on the learning experience as follows:

*I am satisfied with what we achieved as we successfully cooperate with villagers and managed to discuss several issues with them. We also have to carefully thinking about the design of product, it must suitable with local situation. With assistance of team manager and villagers as well, we did it. The fisherman appreciate the product we made.*

### **Creativity**

Service-learning projects are valuable tools for the cultivation of ideas and creative solutions to real world problems. *Creativity Station* participants are expected to appreciate the proverb: 'think globally, act locally' and recognize that 'common humanity and shared guardianship of the planet helps to create a better and more peaceful world'. By doing real tasks that have real consequences, the *Creativity Station* framework provides everyone with the time and opportunities to benefit from experiential learning, which develops social responsibility, enhances

existing passions and interests, and raises awareness of new skills (Seo et al., 2013).

Open-ended real problem faced by students through activity of finding engineering solution for local issue gave students an opportunity to demonstrate creativity, as described by one student as follows:

*In the program, I had learned to think fast, act fast and be creative. With limited materials/resources available, we need to think out of the box how to making the product.*

To design, fabricate and successfully installed the product, students need to use critical thinking skills such as analyzing, prioritizing, categorizing, evaluating, and comparing to solve a variety of problems in real-life situations. Students use creative thinking skills to develop or invent products based on constructive ideas.

### **Global competency**

The program was carried out in an international setting and required the students to work closely with the multi-cultural team and with the locals, thus creating an environment for cultivating global competency. Global competency in engineering is defined by Downey et al. (2006), as the attainment of "knowledge, ability and predisposition to work effectively with people who define problems differently." Global competency requires an understanding of the similarities and differences of people from different countries, the ability to analyze how the value of engineering by people from countries is affected by their lives and experiences, and a predisposition to appreciate and respect the different knowledge, skills, and perspectives that people from different countries can bring to an engineering project (Downey et al., 2006).

The participants stated the program gave them the opportunity to really understand the diversity of cultures and a variety of knowledge which they have to deal with in order to be a global minded engineer. The students agree that they would not have the opportunity to experience this type of diversity if they did not participate in the program. One of the students wrote that:

*I found that the difference in styles of academic competent among three countries when we needed to draw using tools. Koreans have more experience in practical situation and Indonesian are almost similar to Koreans. I had the opportunity to learn how they work.*

Chan & Fishbein (2009) asserted that engineers should recognize their responsibility to society and align themselves to the demand of new era of globalization. The results from this research show that the outcome of incorporating engineering students from diverse engineering fields from different countries through this program, would provide the learning environment that allows students to develop the attribute of a global competency.

### ***Cross-cultural communication skills***

Cross-cultural communication skill can be define as an ability to understand, communicate with, and effectively interact with people across cultures. "Culture" includes language, thoughts, communications, actions, customs, beliefs, values, and institutions of racial, ethnic, religious, or social groups (Ulichny, 1997). Throughout the analysis conducted, we found that language and cultural differences provided meaningful learning experiences for the students in regards to cross-cultural communication skills. Students were learnt about respecting differences and working together. They manage to building trust across cultural boundaries, as can be seen in the following quote:

*We need to gain our teammates trust; moreover we have languages and cultural barriers.*

With the challenges faced in cultural and language barriers, students were struggled to complete the task, however they successful installed the product as what they planned. For example, one student reflected as follows:

*In this program, I had learned how to convince my ideas in the language that everybody can understand. We always argue each other but at the same we understood that we need to achieve consensus. We are happy, at the end we successful made the product.*

Conflict naturally occurred amongst team members, and the students had to exercise conflict resolution skills, such as effective communication and patience, in order to achieve consensus in some instances.

### ***Teamwork and interpersonal communication skills***

Service learning involves extensive partnership between the university and community and there is a sizable literature that deals with collaboration at this level (Cherry & Shefner, 2004; Kezar, 2005). Service learning does not by definition include a team component for students; however, many service learning courses involve teamwork. Indeed, according to Eyler & Giles (1999), 40 percent of their survey respondents indicated that learning to work with people was one of the important lessons they took from their service learning experience.

Service learning courses can benefit from a team approach because service learning is intended to address real-world problems and real-world problems demand the attention of teams. Indeed, Maglaughlin and Sonnenwald (Maglaughlin & Sonnenwald, 2005) whose focus is interdisciplinary research collaboration in the natural sciences, note that complex problems require collaboration. Gronski and Pigg (Gronski & Pigg, 2000), propose that using experiential learning may help to advance students' collaborative skills. Service learning courses can provide a meaningful platform for students to practice their teamwork and collaborative skills.

Overall, in this program most students were satisfied with their team experiences and the effort expended by team members. It appears that students successfully internalized teamwork knowledge and skills. Furthermore, students generally did not point fingers at one another but seemed to appreciate that it was the responsibility of the whole group to ensure the group's success. For example, one student commented on her feedback form,

*In my team, we were from different disciplines, countries, and languages, thus I had the opportunity to learn how they think and how they work.*

The study discovered as well that students enjoyed the team working through this program, as stated by one student,

*I used to work in team before. But this time was different and I am very fortunate. They are happy go lucky persons, thus help to release a bit my stress. We are happy to get along with each other and enjoyed with all activities.*



**Table 2: Themes Classification and Samples of Sentences as written by Participants of Creativity Station 2015**

<b>Themes</b>	<b>Reflection</b>
Technical skills	"We must choose only one issue to be solved from all issues that we managed to list, and I learn how to do it"
	"As a leader, I have to keep everything done on time. Therefore, planning is very important"
	"Through this program, I learn how to use power tools and safety precaution is really matters"
	"That is very difficult to get everything to the expected dimensions"
	"This program provides platform for me to put what I learn in engineering field in practice and this also enables me to apply my engineering knowledge in solving the community's problems."
	"I have to modify the design based on available materials"
Adaptability	"I am satisfied with what we achieved as we successfully cooperate with villagers and managed to discuss several issues with them. We also have to carefully thinking about the design of product, it must suitable with local situation"
	"I had learned to respect other's idea"
	"I observed that Korean concern on punctuality. Thus, I always remind about myself about this too along this program"
	"At beginning I become passive person, but after gone through several days, I had learnt how to adapt with the differences of working habit of my teammates. Now, I am confidence working with people from other countries".
Creativity	"We really have to think out of the box to come out with possible solution for the issue"
	"To ensure the product successfully installed, we have to be creative on how to transport it safely from hall to owner's house"
	"In the program, I had learned to think fast, act fast and be creative. With limited materials/resources available, we need to think out of the box how to making the product"
Global Competency	"Since we were from three different countries, I had to work with three different personalities, and three different working attitudes."
	"Now, I have more confidence to work with people from different countries, races, and languages"
	"In this program, I had learned how to convince my ideas in the language that everybody can understand. We always argue each other but at the same we understood that we need to achieve consensus. We are happy, at the end we successful made the product."
	"I have to be open, even though we have different perspectives about the issues that we had discussed, but we managed to come out with group's decision in harmony"
	"With the experience I had in this program, I have more confidence to work abroad."
Cross-cultural communication skills	"We need to gain our teammates trust; moreover we have languages and cultural barriers."
	"I learned that to communicate with Korean, I have to explain with the support of body language and with Indonesian friends, I have to speak slowly and clearly"
	"The big challenge is how to manage different languages, understand each other to complete a product"
	"In this program, I had learned how to convince my ideas in the language that everybody can understand. We always argue each other but at the same we understood that we need to achieve consensus. We are happy, at the end we successful made the product."
	"Before the activity, I'm worried that there will be a lot of difficulties in our communication with the local people, but finally we successfully conducted interviews with locals. I become translator between local people and foreign students and we got more than 4 issues"
Teamwork and interpersonal communication skills	"Even though we were from different countries, we had to be united to produce a product."
	"I used to work in team before. But this time was different and I am very fortunate. They are happy go lucky persons, thus help to release a bit my stress. We are happy to get along with each other and enjoyed with all activities"
	"In my team, we were from different disciplines, countries, and languages, thus I had the opportunity to learn how they think and how they work."
	"At first, I think it is impossible to complete the product, but in this program I realized that with team working everything is possible"

Teamwork involves individuals working collaboratively toward a common goal. Drake et al. (2006) provide a useful discussion of the term teamwork and how it can be distinguished from group work. They propose that teamwork has behavioural, cognitive, and emotional elements: teamwork involves a group working together but also involves alliance with and commitment to the team purpose. Teamwork requires effective communication and negotiation skills; it involves professionalism and responsibility as well as vision, focus, and discipline. Teamwork is an important component of higher education today (Pfaff & Huddleston, 2003). It is a skill that is highly valued in future career.

The experience that students gained through the natural process of trying to solve an engineering problem within a multicultural team created a learning environment that led them to develop a teamwork and interpersonal communication skills. In addition, Table 2 shows other sample vignettes that they written in the reflection notes corresponding to the respective themes classifications of learning outcomes attained through Creativity Station 2015.

The outcomes with high impact obtained through the Creativity Station 2015 are mostly those that can be attained only through multicultural participation in engineering service learning. The experience that students gained through the natural process of trying to solve an engineering problem within a multicultural team created a learning environment that led them to develop the Global Engineer attributes. This is essential in tackling the challenges of the 21st Century, as put forth in various engineering education reports (National Academy of Engineering, 2005, Spinks et al., 2006). Therefore, the finding indicates that this 9-day intensive program, using the concept of a multicultural team for engineering service learning, can be implemented to attain the global engineer attributes among students.

## Conclusion

In this era of globalization, Creativity Station 2015 provide an international multicultural learning environment to enable students to develop the Global Engineers attributes that are very much in demand in the 21st Century. Based on qualitative analysis of daily reflection notes, it was indicated that the program provided an impactful platform for the students to develop a range of technical

and non-technical skills that are not fully addressed in classroom. The research finding support the notions that international experiences strengthen global competency and communication, real-problem engineering projects improve competency of technical skills as well as interpersonal communication skills, and service learning instills a greater understanding of the social context of engineering field. Given positive effect on the students, the effort that goes into organizing such program is definitely worth it.

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## Appendix

Days	Activity	Reflection Question	Expected Learning Outcomes
Day -1 (am)	Team-Building	<ol style="list-style-type: none"> <li>1. What is your opinion about the activity? What did you feel before, during and after going through the activity? Why?</li> <li>2. What did you learn from the team building activity? Is there anything useful that you have discovered from the activity to help you during the creativity station or when you work as an engineer?</li> <li>3. As you go through the activity, what did you discover about yourself in working together with team mates from other cultures? How do you communicate and handle the differences?</li> <li>4. If you were to go through this activity again, can anything be done to improve the experience?</li> </ol>	<ul style="list-style-type: none"> <li>• Work effectively in a multicultural team</li> </ul>
Day-1 (pm)	Lecture - Social Entrepreneurship & Design Education	<ol style="list-style-type: none"> <li>1. What did you learn in these classes? Please highlight points that you find interesting or useful.</li> <li>2. How can you apply the knowledge from the lectures for Creativity Station?</li> <li>3. How do you think these knowledge would be useful for you in your future career?</li> </ol>	<ul style="list-style-type: none"> <li>• Improve generic skills</li> <li>• Communicate about engineering and its importance in daily life to the society</li> </ul>
Day-2	Finding Local Issues	<ol style="list-style-type: none"> <li>1. How did you and team mates prepare before going out to find the local issues? What was the strategy that your team took to identify the different issues?</li> <li>2. What did you feel before, during and after the activity? Are you satisfied with the quality of achievement of the activity in your team?</li> <li>3. What are the difficulties that you faced in identifying the local issues?</li> <li>4. How did you contribute in identifying the issues? What was your contribution?</li> <li>5. As a future engineer or professional, what is your opinion on your responsibility towards the community?</li> <li>6. How different is the local issues in the community compared to the problem that you faced in the classroom in the university?</li> </ol>	<ul style="list-style-type: none"> <li>• Improve generic skills</li> <li>• Work effectively in a multicultural team and community environment</li> <li>• Demonstrate a sense of care and responsible to community</li> </ul>
Day-3 (am)	Derive Idea and Product Design	<ol style="list-style-type: none"> <li>1. How did you and team mates get to the idea for the solution or product? How did you and your team mates decide which idea to choose for product design?</li> <li>2. What did you feel before, during and after the activity? Are you satisfied with the quality of achievement of the activity in your team?</li> <li>3. What are the difficulties that you faced in deriving the idea and designing the product?</li> <li>4. How did you contribute in deriving the idea for product design? What was your contribution?</li> <li>5. If you were to go through this activity again, can anything be done to improve the experience?</li> </ol>	<ul style="list-style-type: none"> <li>• Apply their engineering knowledge on a meaningful and challenging interdisciplinary community problem</li> <li>• Improve generic skills</li> <li>• Demonstrate global engineer attributes</li> <li>• Work effectively in a multicultural team and community environment</li> </ul>
Day-3 (pm)	Technical Visit to RAPID project	<ol style="list-style-type: none"> <li>1. What did you learn from this visit? Please highlight points that you find interesting or useful.</li> <li>2. How can you apply the knowledge from the visit for Creativity Station?</li> <li>3. How do you think the knowledge from this visit would be useful for you in your future career?</li> </ol>	<ul style="list-style-type: none"> <li>• Demonstrate global engineer attributes</li> </ul>

Day-4	Purchasing Materials	<ol style="list-style-type: none"> <li>1. What is your opinion about the activity? What did you feel before, during and after going through the activity? Why?</li> <li>2. What are the difficulties that you faced in this activity?</li> <li>3. How did you contribute in purchasing the material? What was your contribution?</li> </ol>	<ul style="list-style-type: none"> <li>• Apply their engineering knowledge on a meaningful and challenging interdisciplinary community problem</li> <li>• Improve their generic skills</li> <li>• Demonstrate global engineer attributes</li> <li>• Work effectively in a multicultural team and community environment</li> </ul>
Day-5, Day-6	Making Product	<ol style="list-style-type: none"> <li>1. What was the strategy taken by your team for making the product? What do you think about the strategy?</li> <li>2. What did you feel before, during and after the activity? Are you satisfied with the quality of achievement of the activity in your team?</li> <li>3. What are the difficulties that you faced in making the product?</li> <li>4. How did you contribute in making the product? What was your contribution?</li> <li>5. If you were to go through this activity again, can anything be done to improve the experience?</li> </ol>	<ul style="list-style-type: none"> <li>• Apply their engineering knowledge on a meaningful and challenging interdisciplinary community problem</li> <li>• Improve their generic skills</li> <li>• Demonstrate global engineer attributes</li> <li>• Work effectively in a multicultural team and community environment</li> </ul>
Day-7	Product Testing, Installation and Final Check	<ol style="list-style-type: none"> <li>1. How do you think your team perform during product testing and installation?</li> <li>2. Are you satisfied with the quality of achievement of the activity in your team?</li> <li>3. If you were to go through this activity again, can anything be done to improve the experience?</li> </ol>	<ul style="list-style-type: none"> <li>• Improve their generic skills</li> <li>• Demonstrate global engineer attributes</li> <li>• Work effectively in a multicultural team and community environment</li> <li>• Communicate about engineering and its importance in daily life to the society</li> <li>• Demonstrate a sense of care and responsible to community</li> </ul>
Day-8	Finding Engineering in Culture	<ol style="list-style-type: none"> <li>1. What have you learned in today's activity?</li> <li>2. How did you feel about the activity?</li> <li>3. What knowledge or skills did you learn from this experience that you will apply in the future?</li> <li>4. How is this activity connected to your life? What connections do you find between the experiences (engineering vs culture)?</li> </ol>	<ul style="list-style-type: none"> <li>• Work effectively in a multicultural team and community environment</li> </ul>
Day-9	Reflection	<ol style="list-style-type: none"> <li>1. How did you contribute in this presentation activity? What was your contribution?</li> <li>2. How did you feel about the activity?</li> <li>3. Are you satisfied with the quality of achievement of the presentation by your team?</li> <li>4. If you were to go through this presentation again, can anything be done to improve the experience?</li> </ol>	<ul style="list-style-type: none"> <li>• Improve their generic skills</li> <li>• Demonstrate global engineer attributes</li> <li>• Work effectively in a multicultural team</li> </ul>