Internationalization of Project-Based Learning

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Internationalization of Project Based Learning (PBL)

Abstract

The paper discusses various multi-disciplinary projects that were executed by bicultural teams of Japanese and Indian students as a part of a three-year Indo-Japanese program administered by a Japanese university and an Indian engineering college. Each year, the Japanese university selected a few students, who self-financed their travel and a weeklong stay in India, and participated in the program. Based on the background and profile of participating Japanese students, the Japanese and Indian program directors identified projects, and the Indian program director selected appropriate Indian students.

In the first year, the teams executed an Indian cultural portal and water rocket projects; in the second year, it was an augmented reality project, and in the third year, a health robot project. Typically, in December, the program directors identified projects. In January and February, students worked on their projects by interacting with their counterparts from the other country over the Skype. In late Feb and early March, the Japanese students visited India for a week and along with the Indian students completed their projects. The paper discusses experience of the Japanese students. They maintained a journal during the India trip and filled in a feedback form indicating their satisfaction with the program using the net promoter concept, expectations and learning from the program, and suggestions for future program iterations.

All three batches liked the program immensely. They felt that they could work on exciting technical projects and learn Indian culture. They always felt that they should have had more preparation time, especially to understand Indian culture and indicated their eagerness to have deeper experiences. The paper describes the program iterations in detail and analyzes feedback of the Japanese students, which could help fellow colleagues in designing and executing similar programs.

Introduction

Engineering educators, all over the globe, are training students to work in multi-cultural teams executing multi-disciplinary projects to fulfill the contemporary industry requirements. A Japanese university conceptualized a three-year Indo-Japanese program for the same reasons. This paper analyses experience of Japanese students during the program that included bicultural teams and multi-disciplinary projects such as water rocket, multi-cultural portal, an augmented reality, and a health robot. Over three years, twelve Japanese students from various engineering and social science disciplines participated in the program that included Japanese students' interactions with Indian students on the Internet and during self-financed weeklong India visits, and acquired experience of working on bi-cultural multidisciplinary projects.

The next section establishes the background of the program and the subsequent section elaborates the program. The paper then presents analysis of feedback of the Japanese students and ends with concluding remarks.

Background

The National Academy of Engineering (NAE)'s report on educating engineers for 2020 has identified the requirements of engineers working across disciplines and cultures [1]. Accreditation Board for Engineering and Technology of the Unites States (ABET) has also identified attributes of graduate engineers that include ability to function on multi-disciplinary teams, ability to communicate effectively and the broad education necessary to understand the impact of engineering solutions in a global and societal context [2]. Passow [3] has studied the ABET competencies that engineering graduates find most important at their work-place. He found the graduates of 11 engineering majors rating a top cluster of competencies (teamwork, communication, data analysis, and problem solving) significantly higher than the rest. The Royal academy of engineering has also acknowledged the importance of graduate engineers' ability to work on multidisciplinary projects in teams[4]. Male and Chapman[5] discuss Engineers Australia accreditation boards requirement of graduate engineers having attributes such as the ability to communicate effectively and the ability to function effectively in multi-disciplinary and multi-cultural teams. The Indian National accreditation board (NBA) has developed its accreditation programs requiring similar attributes[6]. The Japanese Accreditation Board for Engineering Education (JABEE) has mentioned an ability of multidimensional thinking with knowledge from global perspective and an ability to work in a team as a part of learning outcomes of all the Japanese engineering education programs [7]. Given such unequivocal need expressed by the leading policy makers, researchers have been working on various facets of cross-disciplinary and cross-cultural project-based learning (PBL) instructional strategy.

Many researchers have demonstrated the utility of the strategy and many others have analyzed and discovered finer aspects of the instructional strategy. Cheville and Bunting [8] and Smith [9] have showed that higher levels of competencies can be developed by active learning, often using teams and projects. Simpson et al. [10] advocate interdisciplinary capstone projects since that experience is more representative of what students will find in the real world. Prince and Felder [11] have found out that inductive methods like project-based learning are more effective than traditional deductive methods, for achieving a broad range of learning outcomes. Schaffer et al. [12] have concluded – based on their study of 256 students from 60 teams - that cross disciplinary team learning increases self-efficacy. Apelian [13] believes that one of the important skills for the 21st century engineer is the ability to work with anybody anywhere. He emphasizes the need to educate engineers so that they understand the societal and global context, and are innovative and creative. Michaelsen et al. are convinced that innovation and entrepreneurial competencies can be reinforced through Team Based Learning (TBL) [14]. Borrego et al. [15] reviewed research to understand negative team behaviors in student team projects and ways to minimize those behaviors using industrial and organizational psychology literature.

Some researchers describe their experience with such multi-disciplinary and multi-cultural projects. Erez et al.[16] designed an on-line, 4-week virtual multicultural team project to test its effect on the development of management students' cultural intelligence, global identity, and local identity, and found significant improvement in cultural intelligence and global identity of the participating students. Jiang et al. [17] found that in multicultural and multidisciplinary teams educational specialty fault line negatively predicted task-relevant information sharing, and that nationality fault-line negatively predicted off-task social interactions.

Design of Experiment

We designed and directed a three-year Indo-Japanese program for three different cohorts to provide them bicultural and multi-disciplinary project-based learning experience. At the outset, a Japanese faculty visited India, held discussions with a few colleges, and chose a college based on its reputation and her comfort with the personnel involved. The Japanese faculty and a faculty from the Indian college proposed a program to the Japanese government. After the government approval, the Japanese faculty publicized the program along with its broad outline in her university and sought volunteer students to join the program. The outline included different program phases such as working in Japan with interactions over the Internet with Indian students, a self-financed visit to India for a week to complete their projects, and writing the final report on their learning upon returning to Japan. Once the Japanese faculty finalized students; the Japanese and Indian faculty (who assumed the roles of program directors) chose appropriate projects. Based on the projects, the Indian director selected suitable Indian students. Indian and Japanese students had online meetings to initiate the projects and scheduled various activities for the three phases - prior to India visit, during the visit, and after the visit. The Japanese teams wrote daily reports, during their India visits, to list their activities and learnings.

Table 1 provides the detailed program description for all the three years. The 2014 program had two different projects - cultural portal for non-technical students, and water rocket for technical students. The 2015 program was on augmented reality and the 2016 was on health robot. The Japanese students stayed for 8 days in India in all the three years.

Table 1 - Detailed program description for all the three years

	2014- Cultural portal	2014- Water rocket	2015	2016
Project theme	Cultural portal	Water rocket	Augmented reality for visitors	Health food robotics
Participants	3 Japanese* and 8 Indians	3 Japanese** and 10 Indians	3 Japanese, 6 Indians	3 Japanese, 4 Indians
Major of Japanese students	Regional sciences, Nursing	Mech engineering, Electronic engineering	Mech. engineering, Chemical engineering, IT	Applied science, Agriculture
Major of Indian students	Comp engineering	Instrumentation and control, comp engineering	Comp engineering	Comp engineering
Online meeting with India	Once	None	Once	Once

*The project had 7 Japanese students but only 3 travelled to India and fully participated in the program

** The project had 4 Japanese students but only 3 travelled to India and fully participated in the program

2014 Program

In 2014, we planned two projects, 'cultural portal' for regional science (social science) students and 'water rocket' for engineering students. The projects started in November with the Indian program director visiting Japan to initiate all the Japanese students into Indian culture and portal team members into software requirement development.

Cultural Portal

The portal was to facilitate Japanese tourists visiting India, which included visit-preparation, travel, and stay. Regional sciences (social sciences) and nursing students from Japan researched two cultures and derived requirements for the portal, based on which, computer engineering students from India developed the portal.

During December, the Japanese team gathered and explained requirements over a video conference to Indian team. During January, the Indian team developed the 'preparation' module and sent it over the Internet to the Japanese team members for testing. As the Japanese team was testing the module in Feb, the Indian team completed the portal. The Japanese students used to have weekly 90 minutes meeting with the Japanese program director to discuss Indian culture and the project.

Three of the seven Japanese team members travelled to India. They experienced Indian life, tested the portal, and suggested changes. The teams completed and launched the portal. Figure 1 shows the portal home page.

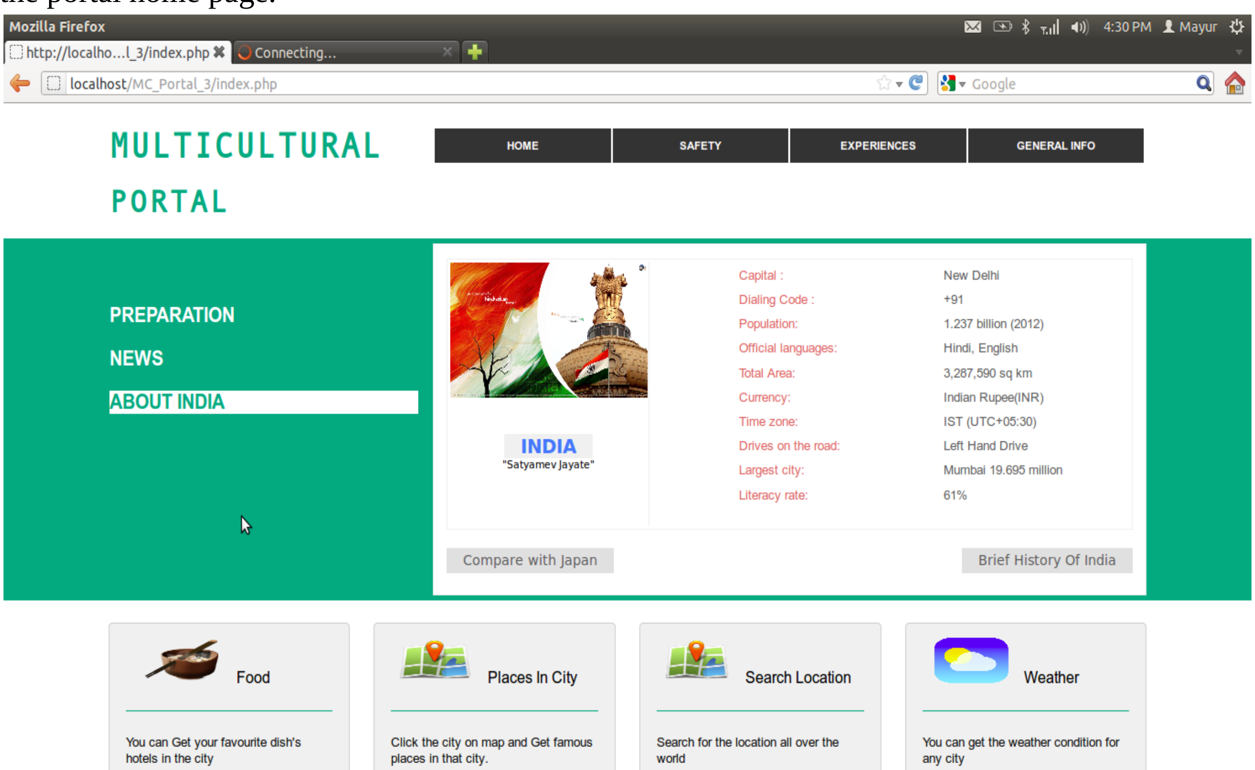

Figure 1: Home page of multi-cultural Portal

The ‘home page’ has information about ‘safety’ that includes precautions to visitors in different areas, contact information of hospitals, police stations, and embassy - along with maps. The portal allows the travelers to blog their ‘experiences’, too. It provides information on ‘preparation’ for India visits, which includes visa, luggage, vaccination rules, and tips for airport transfer. News related to travelers’ chosen areas such as international, Japan, India, sports, business, etc. can be seen in ‘News’. ‘About India’ furnishes general information about the host country. ‘Food’, ‘Places in City’, ‘Search Location’ and ‘Weather’ options are self-explanatory.

Water Rocket

This project involved four Japanese students and ten Indian students. Two Japanese students were from mechanical engineering and two from electrical and electronics engineering. Three students travelled to India. Nine Indian students were form instrumentation and control and one was from computer engineering.

A water-rocket is launched by water and air pressure. It can reach a maximum altitude of about 50 meters and has a ground range of 50-100 meters. The project designed and developed rockets and sensor modules to monitor the state of the rocket. Sensor modules consisted of an accelerometer, an atmospheric pressure sensor, a gyro sensor, a magnetic sensor, a GP (global positioning) sensor, a micro-computer, and a memory card.

During November and December of 2013, the Japanese team engineered a sensor module. In January 2014, they sent the specifications to the Indian team, who engineered another sensor module. The teams did not have any meetings prior to visiting India but communicated over emails. The Japanese team brought water rockets components to India. Both teams fabricated rockets and reviewed sensor modules of each other to revise them suitably. The teams launched many rockets successfully. They acquired and analyzed flights’ data. Figure 2 shows water rocket ready for launch and figure 3 shows a launch trajectory.

For both projects, the India stay ended with a presentation to all the stakeholders.

2015 Program

This project - Augmented Reality (AR) - involved three Japanese and six Indian students. The Japanese students were from mechanical engineering, information technology, and chemical engineering, each and had built a prototype of the proposed AR application, before coming to India. The Japanese students also used to have weekly 90 minutes meeting with the Japanese program director to discuss Indian culture and the project. All Indian students were from computer engineering.

The India visit started with a two-day workshop on Design Thinking,[18] wherein students interviewed each other to analysis user requirements. The students followed agile process to develop prototypes. Japanese students also developed a route recommendation system, which suggested not only the shortest route but also appropriate breaks in the journey (figure 4). Indian students developed sightseeing application, wherein users could take a picture and get more information on the artefacts in the picture.

Figure 2: Water rocket ready for launch

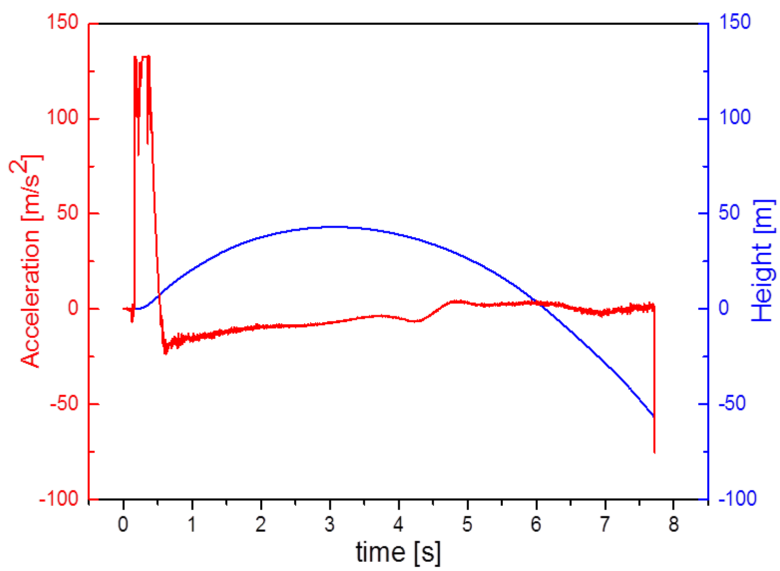

Figure 3: Water rocket launch trajectory

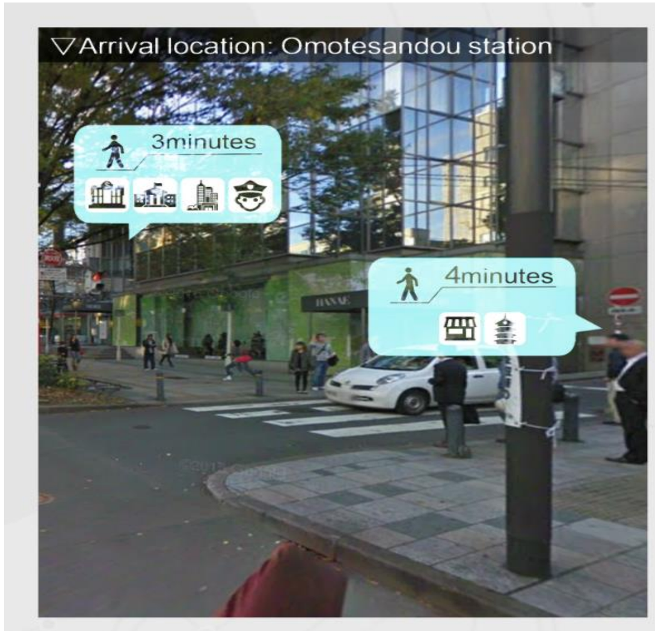

Figure 4: A screenshot of a rout recommendation system

2016 Program

This project - Health Food Robot - involved three Japanese students and four Indian students. A Japanese student was from agriculture, who had developed a robot before this program, and two students were from applied science. All Indian students were from Computer engineering.

The project developed a robot to guide on food intake such as alerting on high intake of meat. Students decided the rules and developed the robot. Figure 5 and 6 show the schematic of the robot and a sample screenshot, respectively. The project used Arduino board for control, android tablet for interface, and wood for the robot body.

Students did not have much time to prepare for their India visit and did not have meetings with the Japanese program director, who had moved to another university. The directors formed mixed team of Indian and Japanese students for various modules of the project.

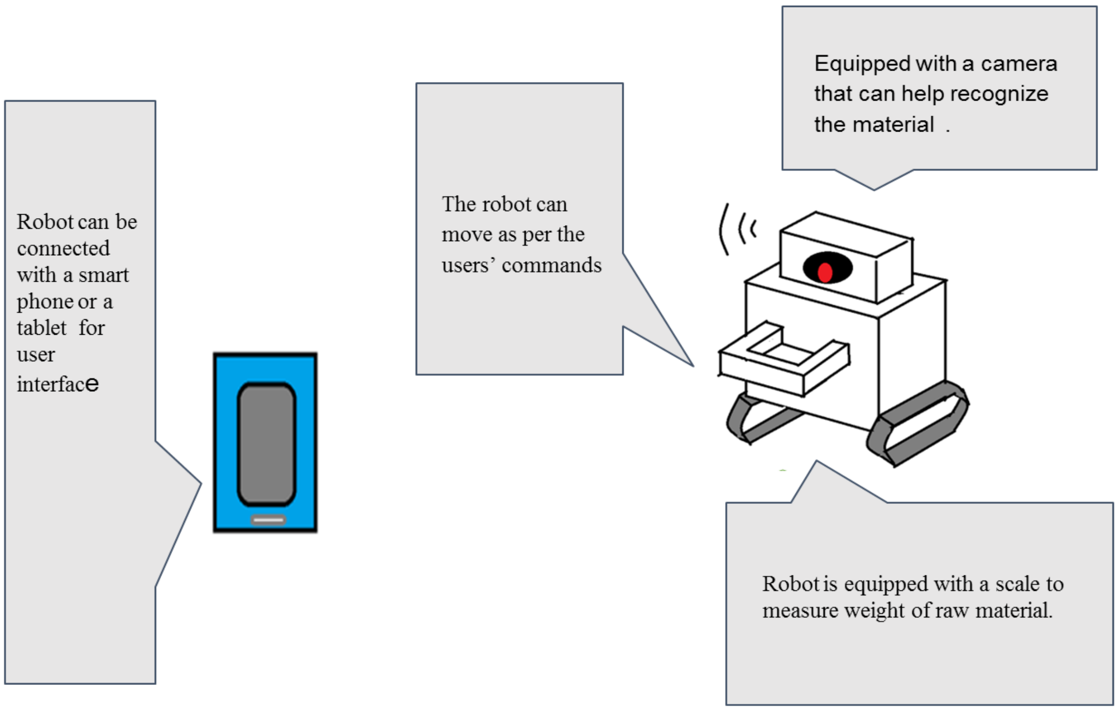

Figure 5: The schematic of health robot

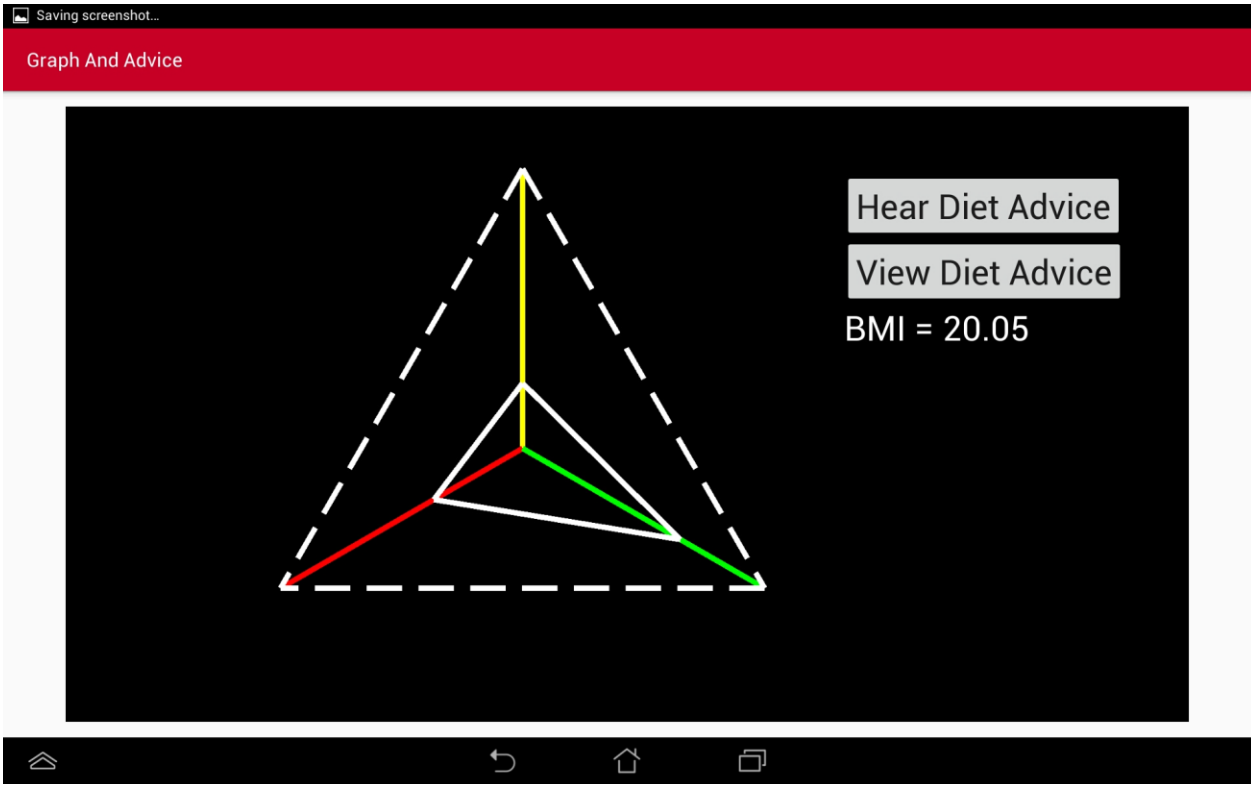

Figure 6: A sample screenshot of health robot

Results

We sought overall feedback based on Reichheld's net promoter score concept [19]. The counts for each promoter category are indicated in Table 2. We also sought qualitative inputs such as expectations, learning, and suggestions from students of all the three cohorts. The section presents results of the feedback.

Table 2: Overall Feedback – count of students by promoter category and project

Promoter category	2014 – CP*	2014 –WR**	2015	2016
Proactive positive recommendation	3	1	3	1
Positive recommendation	0	2	0	2
Neutral	0	0	0	0
Negative recommendation and proactive negative recommendation	0	0	0	0

*CP – Cultural Portal, **WR – Water Rocket

The Japanese students liked the program in all the three years, with a slight decline in the last year and in case of 2014 water rocket project. The 2016 decline may be due to poor rapport between the students and the Japanese director, who had moved to another university. Further, the director had taught 2014 and 2015 students prior to the program, and had regular interactions with them during the 'prior-to-India' visit phase of the program. The 2016 cohort stayed in a hostel (and not with the director, unlike 2014 and 2015), during India visit, and missed guidance of the program director. The 2014 water rocket team was guided by a different faculty member. The team, perhaps, did not enjoy the same level of rapport with the faculty, who was looking after only the technical aspects of the project.

Table 3: Expectations – count of students by expectations and projects

Area	**2014-CP**	**2014-WR**	**2015**	**2016**
Technical skill / knowledge	-	3	2	2
International exposure	3		3	2
Understanding new culture	-	2	-	1
Cross-disciplinary	2	-	1	2
English skill / communication	-	2	-	1
*Others	-	-	1	1

* "Others" included "innovation" in 2015 and "test one's English proficiency" in 2016.

Tables 3,4, and 5 and figures 7, 8, and 9 provide expectations, learning and suggestions from the Japanese students on the program.

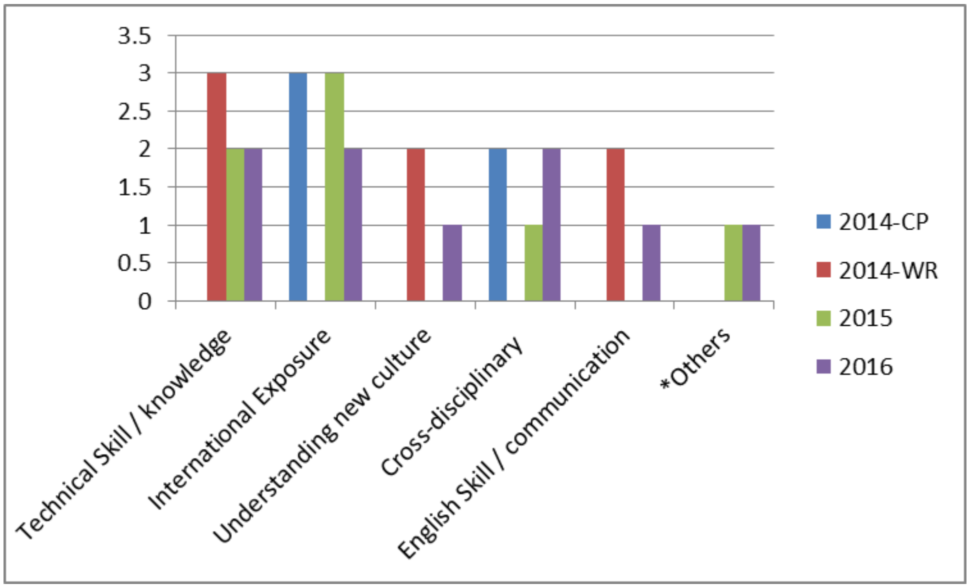

Figure 7: Expectations

Table 4: Learning - – count of students by learning and project

Area	**2014-CP**	**2014-WR**	**2015**	**2016**
Technical skill / knowledge	-	-	1	1
International exposure	3	-	3	2
Understanding new culture	-	3	-	1
Cross-disciplinary project	2	2	2	1
English skill / communication	-	2	1	-
Future work	-	-	1	2
Discover Oneself	-	-	-	2

The international exposure appeared to be the main objective of the program, the main expectation from the students, and the main learning from the program, in all the three years. The water rocket team, an engineering team, seemed to have segregated understanding new culture from international exposure, expected that understanding from the program, and were satisfied on that account. In all three years, students were expecting to work on cross-disciplinary project and did enjoy that experience. The students were also eager to develop their English communication skills and did benefit on that account. All the teams (except the cultural portal team) were technical and wanted to develop technical skills and did not give better rating for this learning. Perhaps, the cultural learning may have overshadowed technical learning. We also saw higher-level learning such as 'future work' and 'discovering oneself' in the latter years.

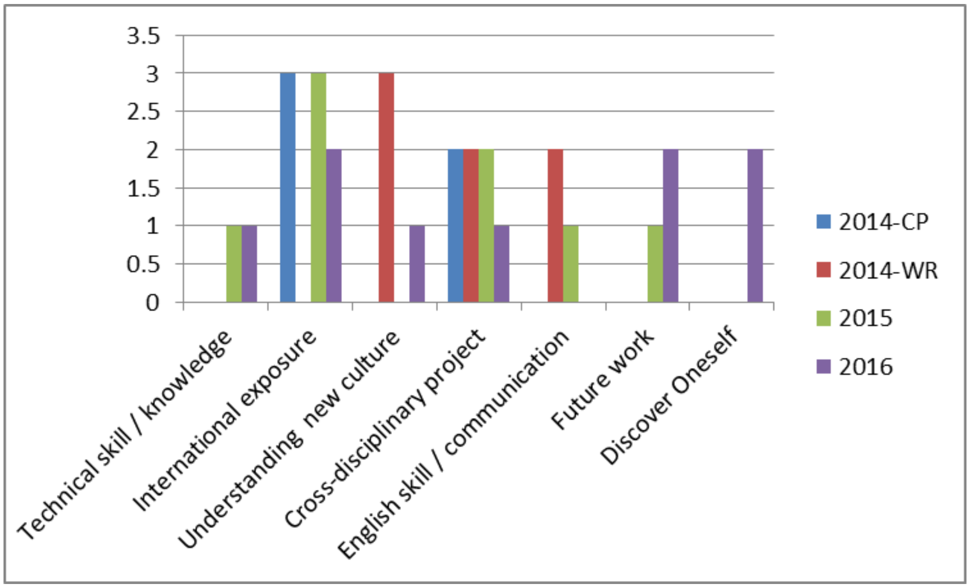

Figure 8: Learning

Table 5: Suggestions - – count of students by area and project

	2014-CP	2014-WR	2015	2016
More communication / preparation before visits	3	-	3	1
Better planning and execution	1	3	2	-
Overcome language barrier	1	-	1	-
Extensions - staying at homes, other countries	1	-	-	1
Scholarship	-	-	2	-
Evaluation criteria	-	-	1	-
Focus on research	-	-	-	1

The main suggestion was more communication and preparation before the visits. In all the three years, the Japanese director made her students aware of the criticality of such pre-visit activity but did not see sufficient interest from students, perhaps due to their other academic commitments. Some students wanted to have better plans and their executions. The execution suggestion came from the cultural portal team and the planning suggestion came from the water portal and the augmented reality teams. In 2016, the suggestions did not stem from such operational areas but higher level areas such as research activities. Some students suggested steps to overcome language barriers, and extensions such as staying at Indian homes and expanding the program to other countries. The suggestions about staying at home came from the non-technical cultural portal team. That was implemented in 2016 but resulted in poor rapport between the Japanese program director and students. Since the program expected students to pay for their international expenses, a couple of them suggested providing scholarships to enable participation of financially weaker students. A student wanted evaluation criteria to include English and communication skills, which was critical for their experience in India. He thought that the inclusion would encourage students to intensify their efforts to develop the language skills.

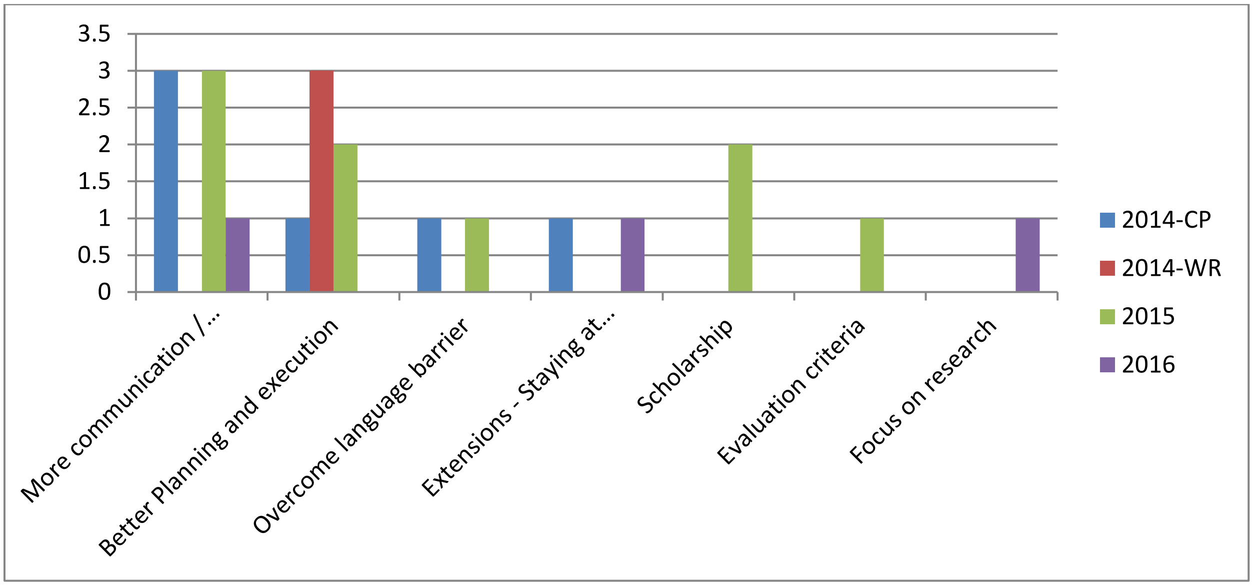

Figure 9: Suggestions

Concluding Remarks

Many researchers and educators have found that Project-based learning (PBL) is like a panacea for contemporary engineering education [11, 12]. Researchers and educators are using its variations such as multi-disciplinary and multi-cultural PBL in line with the present-day professional environment, which are no longer limited to a culture, or a discipline. In this paper, we present our experience of directing a three-year Indo- Japanese program that consisted of many bicultural and multi-disciplinary projects. Overall the program was successful as indicated by the feedback of the participants and as seen in the informal interactions between the two teams during India visits.

The participants highly valued international exposure and opportunities to work on multi-disciplinary projects. The students were also eager to develop their English communication skills and did benefit on that account. The technical teams wanted to develop technical skills and many team members did not mention that as their learning. The cultural learning may have overshadowed the technical learning. The participants suggested more preparation for the visits in terms of learning other language / culture and more pre-visit communication. It seemed that cross-cultural experience was more prominent than cross-disciplinary. This could be due to inadequate engagement prior to India visits, shorter India visits, and higher syntactical divergence (difference in food, language) and higher semantic convergence (similarities in values, relationships) between two cultures. Such program requires deep involvement of faculty members, especially of faculty member from the visiting country and excellent rapport between faculty members from either country.

Such a joint Indo-Japanese program appears to be the first of its kind, though on a smaller scale. The positive feedback can help enroll more students and faculty to sustain the program. The interaction can be longer than a semester and visits can be longer than a week. The plan could start with a visit by students from a culture, followed by project work at their respective locations, and could end with a reverse visit i.e. by students from the other culture. Experience of individuals in such multi-disciplinary, bicultural environment depends on many factors such as, prior experience, team composition, and task complexity; and requires to be analyzed on those parameters to maximize learning for everyone. We require analyzing experience of Indian students, too.

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