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Enhancing Learning by Empowering Indian Students to Solve Engineering Challenges: An Effort by SPEED and IUCEE

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Abstract:

Engineering Education (EE) has become a notable topic of discussion in India. Faculties have initiated the dialogues long back and have been working for its improvement. The student fraternity has been introduced into the discussion, when SPEED (Student Platform for Engineering Education Development) entered India in 2009. From then, SPEED has evolved to create a marked change into the field of EE through development of numerous action plans by students. Students were empowered to face, plan and solve their local EE issues. More than twenty-five workshops have been conducted by SPEED focusing on various themes, which led to a nationwide presence and collaboration with IUCEE (Indo-US Collaboration for Engineering Education). With IUCEE's immense support, the national chapter of SPEED India was created in 2013. In 2013, SPEED India formulated a general theme on EE which aided in introducing the concept in detail to the student group. With the experimentation methodologies SPEED India have used so far and in moving forward in the current year of 2014, it chose to move this dialogue and developments in EE a step forward. Involving students into questioning, addressing and solving global engineering challenges would connect the different pedagogical methods such as problem based learning, experimental learning and community based learning into the learning culture. Seven workshops have been conducted with more than 500 engineering student participants and 100 action plans created under the theme of "Grand challenges of engineering in 21st century" as created by National Academy of Engineering (NAE), three major world issues: Access to Clean Water, Economical & Sustainable Energy and Removing barriers in urban infrastructure were addressed and action plans are created. This paper discusses the impact created by addressing to solve the grand challenges in engineering and the results of SPEED India's efforts in creating a new platform to enhance EE.

Keywords: Engineering Education, Water, Infrastructure, Energy, Action Plans.

1.) SPEED India & IUCEE:

SPEED is a global, non-profit student organization that functions as an interdisciplinary network of engineering students who aspire to stimulate change and impact the development of EE and its effect on society, industry, the environment and local communities. In collaboration with academia, industry and government [1] SPEED is committed to improving EE by channeling the student voice and perspective. Through local and global initiatives SPEED empowers students and encourages the development of professional, ethical and social responsibility. Furthermore, through insight into policy, academia/industry relations and organizational structure SPEED serves to continue the professional education of its members and participants of its forums.

In June 2013, SPEED collaborated with Indo-US Collaboration for Engineering Education (IUCEE). IUCEE works to improve the quality and global relevance of EE and research in India with focus on faculty development, student development, curriculum development, as well as

improved teaching technologies and research [2]. Both the organizations joined hands to improve the EE scenario in India for the benefit of the student fraternity.

2.) Grand Challenges for Engineering:

The 20th Century proved to be the era of engineering with all the greatest innovations and grandest accomplishments. From automobiles to airplanes, computers to internet, antibiotics to medical imaging, radio and television, spacecrafts and lot more revolutionary engineering technologies was the highlights of the century. The 21st century has accomplished engineering advances at a much faster pace than the 20th century by utilizing all these primary inventions. With a modernized and technologically advanced society in place, the world also poses some formidable challenges in this century. In considering all these specific developments that has continued to show progress and is expected to continue progressing, specific challenges await engineering solutions. National Academy of Engineering convened a select, international committee to evaluate ideas on these grand challenges for engineering. The convened committee identified 14 grand challenges and opportunities for engineering. There have been various uses since the grand challenges were identified in the field of engineering. Some of them have been solving real world issues through engineering, learning engineering with a purpose, utilizing an engineer's skill sets to deal with global issues, motivating and creating a sense of responsibility among engineering graduates and engineers in the world, using grand challenges as an approach to learn engineering and more. Out of these showcasing to the engineering student community that the EE serves a purpose and possess higher levels of value has been the core ideology for SPEED India.

SPEED India and IUCEE undertook the theme of 21st century grand challenges in engineering during the year of 2014. Among the 14 grand challenges in engineering, we selected 3 grand challenges according to its adaptability in India and in reference to the diversity of engineering disciplines taught and learnt commonly in the country. The 3 challenges were provide access to clean water, restore and improve urban infrastructure and make solar energy economical. Making solar energy economical was a difficult challenge to propagate due to the inadequate research capability for solar in the country, and so the challenge was tweaked to economical and sustainable energy.

The focus has been to introduce the grand challenges for engineering to the student community in India and utilize the grand challenges as a mode of learning engineering. The grand challenges scholars program has defined five program components such as research experience, interdisciplinary curriculum, entrepreneurship, global dimension and service learning. The workshops SPEED India offered adapted these components to be delivered to the student community.

3.) Facilitator Training:

Important aspect that SPEED India and IUCEE always had to ensure was its primary objective of mobilizing students across the country and introducing the student group about the EE community. To keep this motive alive, the best identified way was to create more leaders within the SPEED India fraternity and to take this movement across the country.

Start Time	End Time	**DAY 1: Session -** What does it take to be a facilitator?
10:00	10:05	Greetings and welcome activity
10:05	10:10	Allotting Roles - A time keeper, silence maker, schedule follower
10:10	10:15	A quick brainstorm on how the world can know what is happening right now?
10:15	10:45	Group Ice Break
10:45	11:00	Tea Break
11:00	12:00	Activity 1 - Communication activity : Draw & Describe
12:00	1:00	Activity 2 - Teaching Patience : Blind Contour
1:00	2:00	Lunch Break
2:00	3:00	Activity 3 - Turn & Talk : A debate session about utilizing technology, social media in SPEED workshops
3:00	4:00	Activity 4 - Being Creative in Engineering : Expand the frame
4:00	4:15	Tea Break
4:15	4:45	Introduction to NAE & New workshop title (21st century grand challenges)
4:45	5:30	5 part plan of K-12 grand challenges
5:30	6:00	Wrapping up Day 1
Session - What do you do as a facilitator in 2014-2015?		
10:00	10:10	Team Split - 3 Groups for 3 Challenges!!!! INFRA, ENERGY, WATER
10:10	10:15	Name yourself!!! - Think of a really cool name for your group!!
10:15	12:00	Quick Engineering!!!! - Each group gets a title to gather, learn and solve/present about it. (Energy - A closer look at oil and energy consumption, Infra – A house is a house for me, Water – Dirt in my water)
12:00	1:00	Teams present their work
1:00	2:00	Lunch Break
2:00	2:15	Guidance - Plan your Workshop!! - Participants are guided by the facilitator to plan for future SPEED workshop
2:15	4:00	Plan your workshops! - Groups – Get, Set, Go.
4:00	5:00	Present and Finalize the plan
5:00	6:00	LETS TALK!!! - A session of discussion, answering questions, feedbacks, announcements, etc and closing up...

Table 3.1 Schedule of Facilitator Training Workshop

An initial framework for the selection of facilitators with a set of skill sets required and criteria's to be met were developed. The criterion for the selection of students to be taken for facilitator training was:

1.) Students should have participated in a SPEED workshop in India or abroad
2.) Students should have developed an Action Plan and carried it forward to implementation
3.) Active members of SPEED who has been part of organizing of GSF (Global Student Forum) [2] or other SPEED activities

Students meeting up with these criteria were chosen from the existing database and evaluated for possession of necessary skill set. The skills that were expected are:

1.) Leadership quality showcased internally in SPEED or in the local university
2.) Effective communication skills (Speaking and Listening majorly)
    a. Communication skill was learnt from the feedbacks of their respective facilitators earlier and from the local university faculty advisor at the SPEED-IUCEE chapter
3.) Higher level of confidence
4.) Showcase of motivation and interest towards Engineering Education

Twenty-Five student leaders from the past IUCEE-SPEED workshops were identified, evaluated and invited to attend a facilitator training workshop. The objectives of the facilitator training program were:

1.) To find the next group of SPEED leaders for the country
2.) To effectively get them trained in the necessary skills required to conduct workshops
3.) To build confidence and interest towards Engineering Education
4.) Provide training on team work and crisis management, and
5.) Introduce them to Grand Challenges in Engineering

The workshop was organized at Hyderabad and leadership and facilitation training was provided by two eminent SPEED leaders for two consecutive days. The facilitators were also introduced to the concept of 21st Century Grand Challenges in Engineering. The facilitators were provided class room training, outbound based activities and hands on activities and made to walk through the necessities of being a facilitator. The facilitators were made to develop their own action plans on each track as part of the training, which provided the student leaders with the required technical knowledge for each track theme. These action plans were focused on acquiring the basic knowledge that is necessary while conducting the workshop for each track on Sustainable and economical energy, Restore urban infrastructure and Access to clean water. The action plan created were uploaded as Google drive documents and shared with respective team members. The members continued to update the document which were reviewed at the later stage and were appreciated with feedback.

The outcomes of the facilitator training were measured by taking feedback from the students after the completion of the workshop. The students were asked to rate the facilitator based on their knowledge of grand challenges, understanding of action plan development, communication and leadership skills. Figure 3.1 illustrates the survey results about the performance of the facilitators.

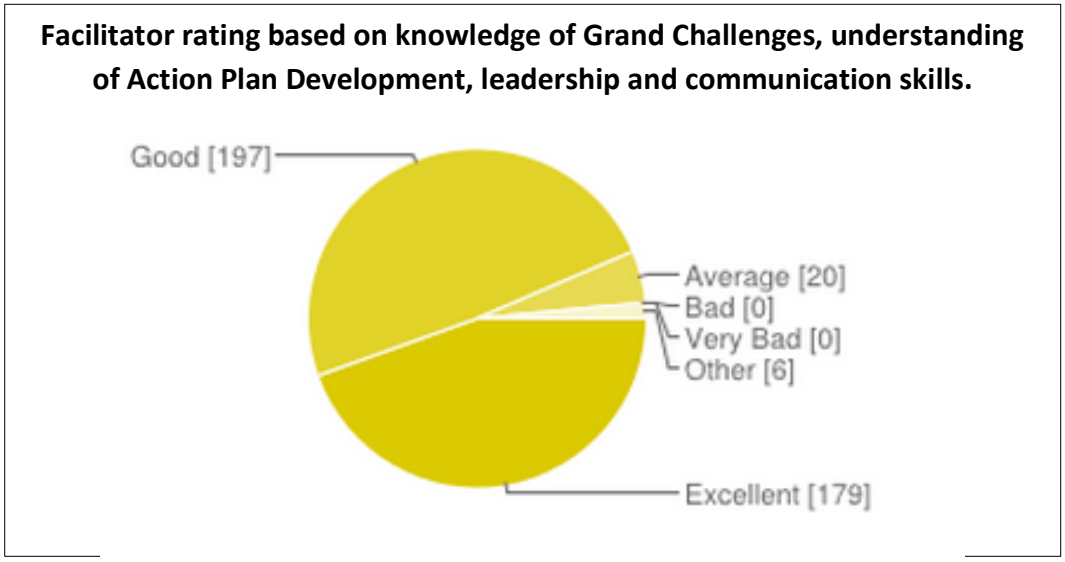

Figure 3.1

4.) Regional Workshops:

7 workshops were conducted at Bangalore, Delhi, Hyderabad, Islampur, Pimpri and Warangal. Each workshop was conducted by 3 facilitators who were chosen from the facilitator training program. Each workshop was conducted for 3 days.

The session on first day started with ice breakers. Each workshop had participants from 10 different universities located nearby the host college. The ice breaking sessions was conducted to help participants interact with each other and also come out of their comfort zone and speak out. The icebreaking session was followed by introduction to SPEED, IUCEE. The facilitators spoke about the mission and vision of both the organizations, collaboration between them and also shared information about available volunteer opportunities with both the organizations. The participants were then given an introduction to the 14 NAE grand challenges, and were explained the reason behind choosing the 3 grand challenges for the workshop. Presentation was given on how to perform effective brainstorming and the participants were then allowed to choose one of the challenge, brainstorm and list down all the related challenges they face in their communities. After lunch, participants were divided into groups and told to build a tower with newspaper and cellophane tape. Every group was instructed to make the tallest and most stable structure. The activity helped the participants bring out their creativity and also learn to work and collaborate in a group. The first day ended with a session on professional networking. Participants were provided tips to write professional emails and ways to maintain good relations with professional networks through emails and LinkedIn.

Facilitators started the second day talking about actions plans. The focus was on the need for effective action planning and their outcomes. Participants were provided with various formats available for action planning. Facilitators also presented the students about different tools helpful in action planning such as Gantt chart and SWOT analysis. Participants then divided into groups based on the challenge they chose and started developing their action plan. The action plan development continued for the complete day. The last session of the day was the critique session where each group was allowed to see the other group's action plan and provide feedback. All the groups then collected the feedback to incorporate them into their action plan.

Each group was allowed to present their action plan to a group of judges which included the dean, head of departments and faculty from the host university. The judges were provided with a rubric for judging on a scale of 1 to 5 with 5 being the highest. The rubric contained the following criteria's:

1. Creativity and Originality
2. Sustainability
3. Thoroughness
4. Social Impact
5. Presentation

All the participants received constructive feedback from the judges which was positive and a moral boost for all the groups. The regional workshops ended with positive feedback from the participants. The workshops helped them think innovatively, research and also appreciate service learning.

More than 500 students participated in the 7 workshops from 70 different universities. The workshops also helped participants broaden their professional network across different parts of India. A survey was conducted to understand the feedback of the student participants for such workshops. 437 student participants responded to the survey.

5.) GC Video Contest:

A grand challenges video contest was conducted after the regional workshops. Each group was allowed to submit a 3 minute video about the challenge they are addressing and also the solution. Each group was given the leverage to shoot the video with any production technique and genre such as drama, animation, documentary, experimental or artist video, and hybrid work. The participants were given 30 days to submit their videos. The videos were rated on a scale of 1-10 with 10 being the highest for the following criteria's:

1. Creativity, entertainment and overall appeal,
2. Effectiveness in highlighting engineering research *towards solutions of* the grand challenges they have chosen,
3. Incorporating global perspectives,
4. Integrating interdisciplinary learning,
5. Engaging the community into their solution through service-learning and
6. Including ideas about entrepreneurship that relates to the engineering solution.

64 videos were submitted for the video contest. The videos were judged by IUCEE Faculty across U.S.A. The judges were informed to rate the video on a scale of 1 - 10 (10 being the best). 10 videos were chosen as winners. The winners were provided free registration and transport to attend the 2nd Indian Student Forum which was held at BMS College of Engineering in Bangalore. The video contest motivated the students to improve their action plan by including the various aspects of the judging criteria.

6.) Indian Student Forum 2015:

Learning is an evolving process. It's important to keep checkpoints during the process of engineering a work and obtain feedbacks throughout the process. Incorporating the feedbacks will help in carrying out sustainable and quicker actions. Indian Student Forum (ISF) is a platform created to assist in providing a checkpoint to all the action plans framed and being implemented through regional workshops [3]. Whereas we do face the challenge of more students who would like to take part in the sessions of SPEED India and IUCEE. In order to satisfy the needs of students, to create and spread the awareness all together around the nation SPEED India conducted a tuned model of 3 day action plan workshop on January 4-6, 2015 at B.M.S College of Engineering, Bangalore. 160 student participants attended the forum from more than 20 engineering institutes in India.

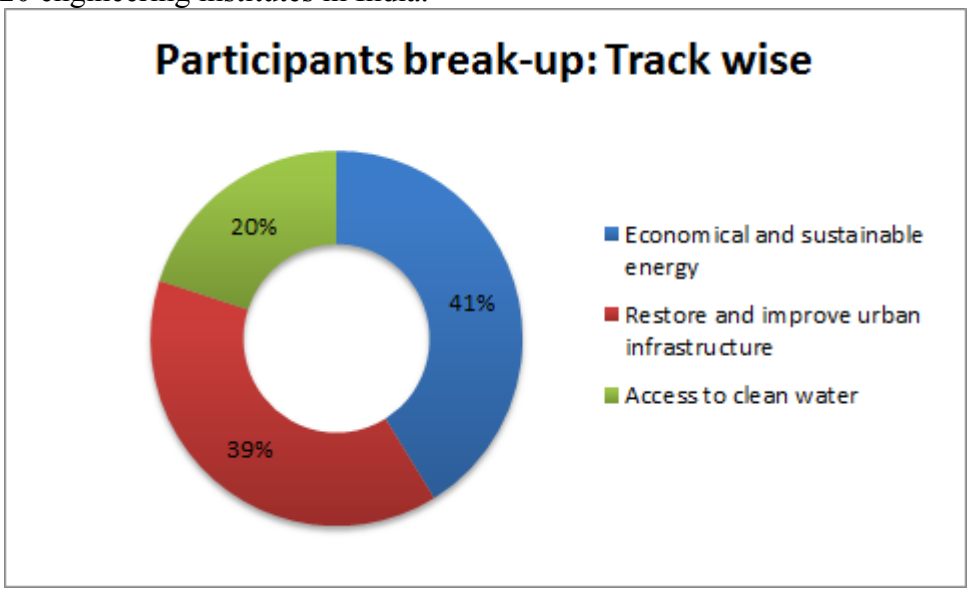

Figure.6.1

All the three tracks had eminent industrial, SPEED and IUCEE experts. The industrial experts were proficient and well knowledge professionals in the field of each track theme. International and Indian SPEED experts were also present in each track. Both SPEED and Industrial experts provided the perfect blend of assisting the students and supporting them in creating concrete action plans.

7.) Survey results and analysis:

In order to analyze the outcomes of the year's work and in particular the success of Indian Student Forum (ISF)'2015, we conducted a survey poll post the event. Three major parameters which were behind the objectives of the year's work were framed. They were

1.) Awareness to grand challenges,
2.) Understanding of grand challenges
3.) Addressing the grand challenges.

82 student participants responded to the poll.The poll results and the impact are provided in the graphs and discussions below.

SPEED India and IUCEE was the first organization to take up the grand challenges to the engineering students in the country. Among the student participants who attended ISF, 55% of the participants were from previous regional student workshops. The figure 7.1 showcases that among the awareness created 57% were through the IUCEE-SPEED workshops and 37% who polled NO became aware of Grand Challenges after ISF. All together 96% of the student participants were introduced to Grand Challenges only through the efforts of SPEED India and IUCEE.

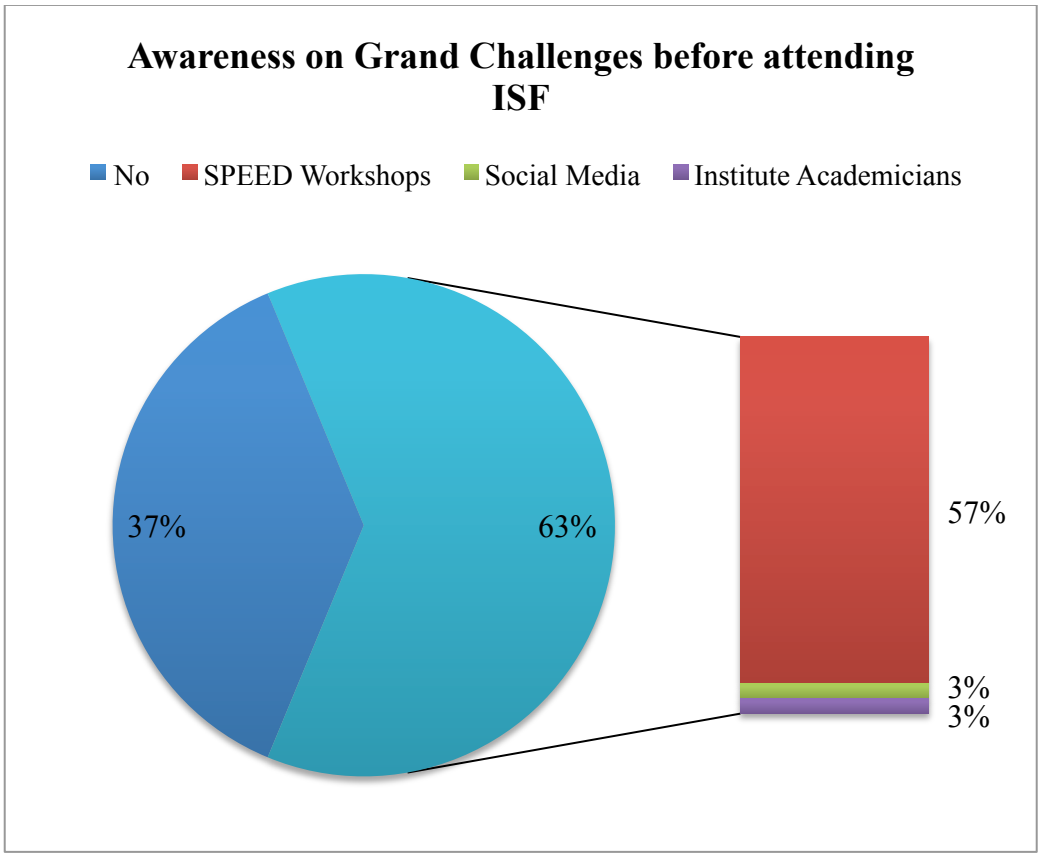

Figure 7.1

The most important understanding from the student participants was to learn if they believe that the Grand Challenges (GC) listed are engineering challenges or not. 97% of the students believed all the grand challenges are engineering challenges and 100% students trust that engineers can address and bring up solutions to these challenges.

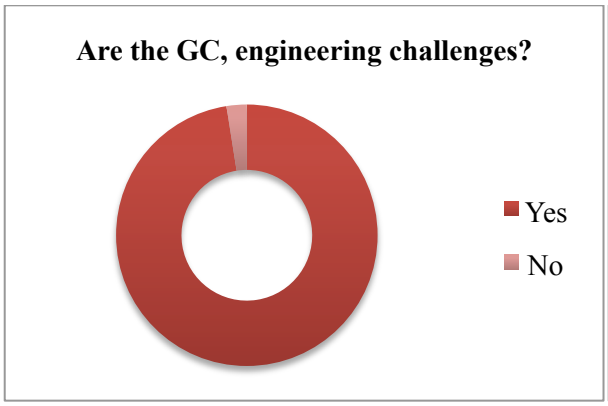

Figure 7.2

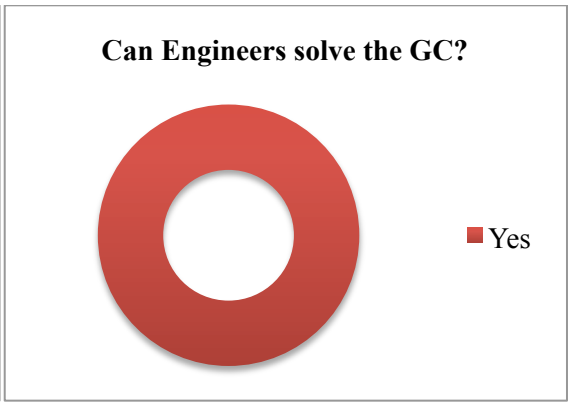

Figure 7.3

SPEED India and IUCEE being EE organizations, utilizes the opportunity of every theme to relate it with the way EE can progress. Every engineering student can choose to strengthen their engineering skills by working on the action plans developed to address the GC. During the AP development, students undertook the needed research to develop a solution for the grand challenges being addressed. In this process, the students were able to relate and bring many of the concepts which they learnt in their classrooms into an application. While doing so, the students started to appreciate engineering better as they realized the importance of learning engineering. The survey were focused with questions like, if they feel they would learn engineering better if they have hands on experience of addressing grand challenges and if it was part of their curriculum, their answers were positive. This particular understanding has been evaluated and presented in the below figures 7.4 and 7.5.

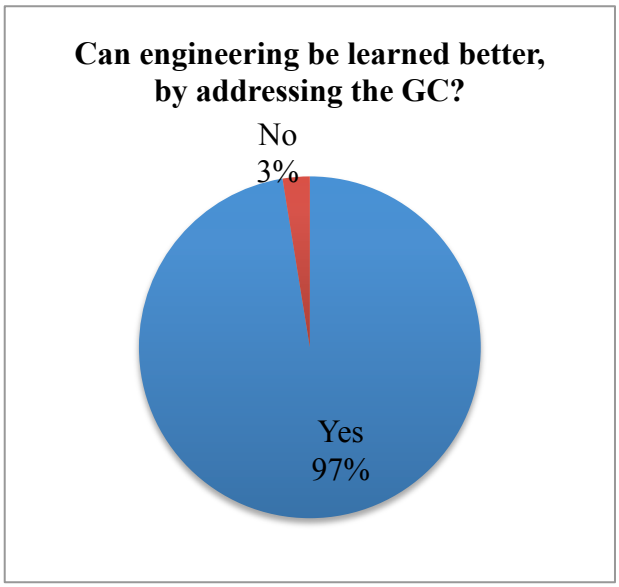

Figure 7.4

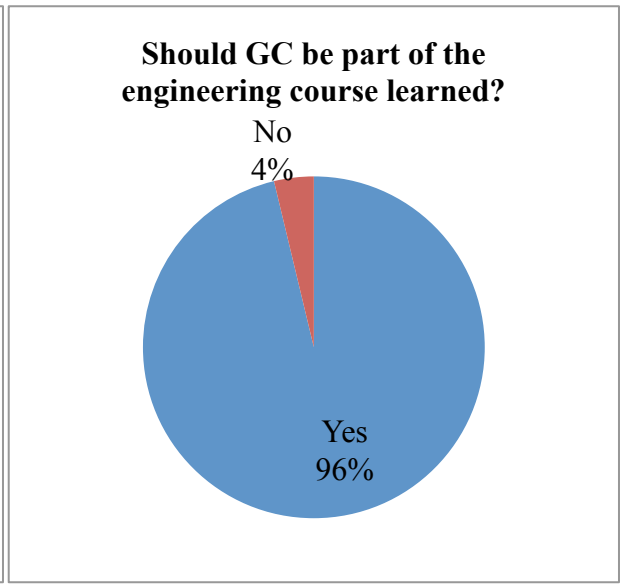

Figure 7.5

The 3rd major objective of addressing the GC determines the success of a year's work of SPEED India and also ISF. At the moment the success has been determined basically through the survey poll and interest of students to implement their action plans. Actual success will be determined

after the 4 month Action Plan implementation competition. In the process of addressing grand challenges, the students understood that engineers have a very important role in the community as they are the key to overcoming the 21st century grand challenges of engineering. The current understanding of success are projected in this paper through the below figure 7.6 and 7.7.

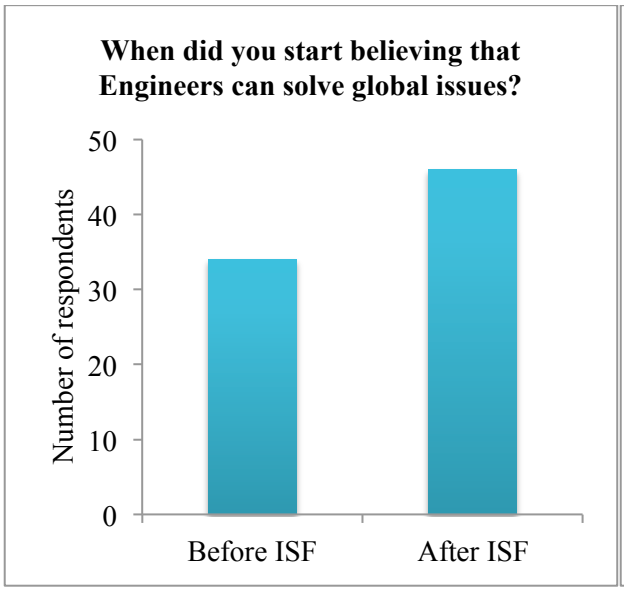

Figure 7.6

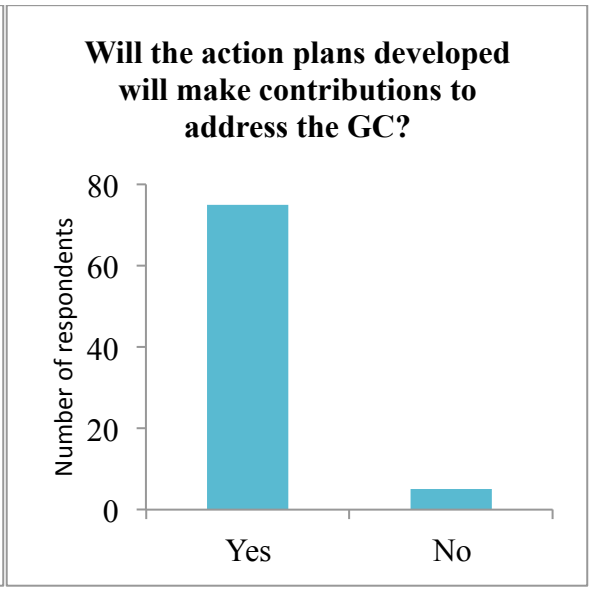

Figure 7.7

Conclusion:

SPEED India and IUCEE has been profound in bringing Indian engineering students into the dialogues of EE for the past two years [3, 4]. In this particular year of having taken the theme of grand challenges in engineering, SPEED India and IUCEE has been exceptional in causing the awareness of global issues, preparing students to become global engineers by taking part in international discussions. "Plan the work and Work the Plan" has been the mantra behind the organizations efforts. The results from the survey of workshops and ISF showcases that the students have found it important to contribute to grand challenges being engineers. More concrete results in terms of actual contributions from each action plan developed will be showcased and measured through the implementation competition devised to happen in 4 months. More importantly the survey results has made shown clearly that the students would find it interesting and beneficial to have these existing global engineering challenges as part of their course curriculum. Efforts of SPEED India and IUCEE with respect to grand challenges will be continuously monitored and measured.

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