Re-envisioning engineering education in India: IIT Gandhinagar's Foundation Programme

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The Foundation Programme (FP) of the Indian Institute of Technology, Gandhinagar (IITGN) is a dynamic five-week event that strives to nurture every new batch of undergraduate B Tech students in a holistic and engaging manner. During the first five weeks after joining the institute, students participate in an engaging series of activities designed to address five major themes: (1) values and ethics, (2) creativity, (3) teamwork, (4) social awareness and (5) physical fitness. The intensive programme is thus designed to inspire students to build their sense of self-confidence, explore their creative passions, and develop their minds and bodies as well-rounded global citizens. There are no formal classes during this time and students are expected to immerse themselves in this transformative programme. The IITGN FP began at IITGN in 2011 and has been successfully conducted every year since then. Over the years, student feedback regarding the programme has been tremendous, and many have expressed that it is a powerfully engaging and transformative experience. In addition, FP functions as an active and participatory introduction to the institute's core belief that students must strive to know themselves and the world around them.

STARTING with the 2011–12 academic year, the Indian Institute of Technology Gandhinagar (IITGN) initiated a novel and innovative orientation programme for its incoming first-year B Tech students. Known as the IITGN Foundation Programme (FP), this immersive five-week event has been successfully implemented at IITGN for the past seven years, and embodies the central values and ideals of the Institute as a whole. Since its inception in 2008, IITGN has strived to emphasize the importance of contextualizing engineering education within the larger framework of societal needs and human values. The impact of this effort starts with the very first day a student enters the institute, and continues through various initiatives in each successive semester of his/her collegiate career. This first-of-its-kind programme goes beyond most freshman orientation programmes throughout the world of higher education, both in India and beyond. The focus of this article is to review the motivating philosophy, structure and impact of FP as it has evolved at IITGN over the past seven years. In addition, feedback surveys and observations from students, faculty members, resource persons and programme coordinators will be discussed to identify the strengths of FP as well as areas for improvement.

After India gained its independence as a sovereign nation in 1947, the country and its leadership were committed to developing world-class technological institutes to serve the demands of a newly industrializing nation. As early as 1945, the Sarkar Committee was formed to assess the educational landscape of the country and make recommendations based on its findings, and by 1961, the Institutes of Technology Act declared the first four IITs (Kharagpur, Bombay, Kanpur and Madras) to be 'institutes of national importance'. In addition, the Sarkar Committee stressed that 'the course of study in an institution should…be designed to provide a combination of fundamental scientific training with a broad human outlook which will afford the students the type of collegiate education endorsed by leading engineers.'[1,2]

IITGN has taken this progressive vision to heart and has developed a robust, innovative and forward-thinking undergraduate (UG) curriculum designed to nurture broad-minded engineers with the ability to think critically and apply their training to social contexts. While many recent articles have highlighted the need for a more liberal engineering education[3–8], IITGN has successfully implemented multiple new initiatives to achieve this goal, including project-based learning modules, design-based engineering courses, a wide and varied basket of elective courses, new options for minors, and an overall emphasis on humanities and social sciences (HSS) courses, including subjects like philosophy, economics, sociology and history. In fact, the current UG curriculum at IITGN

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requires a student to take a minimum of eight HSS courses (on average one per semester). By providing this kind of curricular breadth, the IITGN UG programme embodies the institute's commitment to producing well-rounded engineers with global awareness.

One critical component of this process has been the institute's development of a dynamic HSS group. With outstanding academics in various interdisciplinary fields, the HSS group, consisting of full-time faculty members as well as eminent visiting scholars, offers numerous UG core courses and electives that give context to the institute's core technological pedagogy. In addition, the HSS group supports a robust Ph D programme, and has launched a first-of-its-kind M A programme in Society and Culture in 2015. As Rukmini Nair has stated 'some of the newer IITs (Gandhinagar, Hyderabad) have groomed their HSS Departments with particular care, as have some older IITs (Kanpur, Delhi). The HSS subjects.…introduce reflexivity, an ability to argue and logically present arguments, delight in unfamiliar, independent ideas and a view of the universe not merely as a nuts-and-bolts construction, but a changeable sphere of human interaction that can be conceptualized from a variety of philosophical and civic angles'[9]. At IITGN the realization of a holistic vision of an engineering education begins with FP, an orientation programme designed to *reorient* a student's perspective on higher education.

Background

It is well known that the IIT system is the most competitive higher education system in the world[10]. By sheer number, the admission rate to the IITs in 2016 was less than 1% (~0.8%), making it seven times as competitive as Harvard (5.9%) and almost ten times as selective as MIT (7.8%). In order to gain admission to an IIT, a student must successfully compete in the Joint Entrance Exam (JEE), a notoriously challenging examination taken by well over a million students in 2016 for 10,575 seats[11]. Preparation for this exam usually begins in Class 10 and often extends beyond formal schooling into a two-year preparation period when young aspirants exclusively study for it with tenacious rigour. During these years of training, most students forego extracurricular activities, sports, arts and other creative pursuits, so that they can focus on JEE. This kind of all-encompassing preparation often diminishes, if not kills, the students' creative spirit, their ability to think critically and their aptitude for non-linear modes of reasoning.

At the October 2011 Pan IIT alumni summit in New York, USA, Infosys founder N. R. Narayana Murthy addressed this issue directly when he declared that a majority of (upwards of 4 out of 5) IIT graduates fare poorly at jobs and global institutions of higher education[12]. The root cause for this seems to be the grueling admission process which leaves most students 'mentally fatigued when they enter an IIT. Many are already burnt out and are no longer able to perform to their potential.'[13] It is from this tremendously intense training period that new students arrive at an IIT. They are in shell-shock so to speak – excited about their admission to one of the world's finest institutes, but also scared, nervous and ill-prepared to deal with the complexities of student life and the new social world around them.

FP is the first step in tackling these issues when a new student joins the institute. The programme is thus designed to help students decompress, acclimatize to their new environment, reinvigorate their passion for learning, and to induct them into the institute's spirit of free thinking and social responsibility. Essential to this process is an endeavour to revive the creative energy of each student and provide them with various perspectives to contextualize their engineering education within a global social setting. According to Umashankar Singh, a member of the FP 2016 Coordination Team: 'Foundation Program (FP) is truly a revolutionary deviation from the norm of monotonous, non-creative and unproductive engineering education. It has come as a lifeline for the engineering education in our country which has increasingly lost its purpose and relevance due to a myopic focus only on the curriculum, whilst ignoring the need to prime the students for the larger purpose of being socially relevant engineers'.

As these first five weeks at the Institute have no traditional classes, students begin to explore other facets of their life and quickly understand that they are entering an educational space with a new and progressive approach to higher education in general, and engineering education in particular. In short, FP is designed to inspire a paradigm shift in a student's thinking. In this regard, Sairam Swaroop Mallajosyula from the FP 2015 Coordination Team mentions the following: 'I felt Foundation Programme is a process of unboxing and repackaging. Students jarred with years of rote learning had to get used to critical thinking'.

The Foundation Programme

FP is an intensive five-week orientation programme that engages with five major themes: (1) values and ethics, (2) creativity, (3) teamwork, (4) social awareness and (5) physical fitness. These five themes evolved out of a series of sustained discussions amongst faculty members regarding the current needs of students and the deficiencies in their past and prospective educational trajectories. What kind of concerns were teachers having with the performance and/or engagement of their students? Also, what seems to have been the cause of such issues from the students' side of things? After a vigorous round of brainstorming sessions, a large number of salient issues were identified, ranging from a lack of reflection about ethical academic practices to a general neglect of arts and sports. Furthermore, important skill sets related to

communication, teamwork and social behaviour were all found to be insufficient in a majority of the incoming first year B Tech students. By thinking through this complex of concerns in a conceptual way, five major themes emerged as primary categories to organize and address a majority of the fundamental issues at hand.

(1) Values and ethics: Focusing on fostering a strong sense of ethical judgment and moral fortitude.

(2) Creativity: Providing channels to exhibit and develop individual creativity and self-expression through art, craft, music, singing, media, dramatics and other creative activities.

(3) Teamwork: Developing a culture of teamwork, group communication and leadership.

(4) Social awareness: Nurturing a deeper understanding of the local and global world, and our place in it as participant citizens.

(5) Physical fitness: Engaging students in sports and physical activity to ensure healthy bodily and mental growth.

Inspiration for possible solutions to these issues was drawn from the experience of a successful Civil Engineering Summer Camp conducted at IIT Kanpur for ten years (2001–2010), in which civil engineering students from across the country were inspired to be technology leaders through motivational lectures, personality development, fun-filled activities and excursions[14].

During the five weeks of FP, these five themes are realized in a multitude of ways through both structure and content of various sessions of the programme. A typical FP day may begin at 6 am with yoga and morning exercises followed by breakfast and a lecture, e.g. 'The architecture of old Ahmedabad' by Neelkanth Chhaya (former Dean of the Faculty of Architecture, CEPT). After a session of drama practice and lunch break, students might make a field visit to a nearby medieval step-well and marvel at its ornate design and important social function. Evening times are given to sports, dinner and reflections with seniors. The next day might start and end the same way with yoga and sports, but perhaps the students would have a session on ancient Indian mathematics in the morning and a neighbourhood street-cleaning outing in the afternoon. In this way, each day of FP is filled with active immersion in various academic, cultural, social and artistic activities. Thus the five themes of FP are realized everyday through active student participation in a rich variety of interactive programmes. FP students not only learn about neglected aspects of society, history and culture, they experience them in both the classroom and the field. A one-week schedule from FP 2016 is included to illustrate the structure and content of this kind of programme (Supplementary Table 1).

In addition to activities related directly to the five FP themes, several important one-on-one sessions are included in the first few days of the programme that are designed to address the specific, individual needs of each student. In this way each new student is personally welcomed to the institute and treated as an individual with unique needs and challenges, rather than as a depersonalized roll number. These sessions, which include a private medical health checkup, a one-on-one counselling meeting, a personalized financial assessment, an English language proficiency evaluation and a 16PF psychometric questionnaire, are all included to help understand the overall well-being of each individual student, and thereby provide each one of them with the best, most personalized assistance and support wherever it may be needed.

Two challenges faced in organizing and managing such a long and intense programme such as FP are timing and coordination. Immediately after the IIT admissions are finalized, incoming students are invited to join IITGN, usually a full one or two weeks ahead of the commencement of the regular semester. In this way the five-week programme extends for three or four weeks into the regular semester. While fellow IITians at other institutes are already having quizzes and homework assignments, first-year B Tech students at IITGN are still busy with engaging FP activities. Indeed, their first semester is shortened a bit but FP is recognized as a full-semester, four-credit course in and of itself. The remainder of the semester is reformatted accordingly, so that the full range of basic first-year cores is seamlessly integrated into the UG curriculum.

The second challenge of coordinating such an intensive programme with multiple sessions and several visiting resource persons is addressed by a select and dedicated coordination team. We began with two faculty coordinators in 2011, and currently the coordination team consists of five faculty members. One strategy to deal with the increasing student body strength has been to divide the class into smaller breakout groups, thereby helping to ease logistical issues and also allow for more intimate interactions. For example, the schedule for a large class divided into four groups would be organized such that each group would rotate through four parallel sessions (e.g. theater workshop, metal sculpture, creative thinking and juggling; see Supplementary Table 1). The increasing student strength will continue to be a challenge as the institute grows in numbers, but we are confident that a robust coordination, team, increased small group sessions and a well-organized, interlocking schedule will be able to address these demands.

One of the key features of the five-week programme is extended exposure to, and interaction with, some of the brightest and most innovative thought leaders in the world. During FP 2014 for example, Kailash Satyarthi spent a day at the institute and conducted a session entitled 'Engineers can fight social injustice better – a personal story', just a few months before he was awarded the 2014 Nobel Peace Prize. The coordinating team works diligently to develop a rich set of sessions with artists, thinkers, writers, activists and other leaders from various domains to embody the five FP themes.

It has been crucial to balance all the sessions so that no theme is underrepresented, and although creativity and physical fitness account for a majority of the time allocation of the programme, the other three themes are given due importance through a variety of focused sessions (Figure 1). For example, a session on corporate ethics by K. Subramaniam (Motorola India) might be followed by an interactive theater workshop with Brian Brophy (Director of Theater Arts at CalTech, USA). In this way students engage with a wide range of socio-economic and cultural issues through a rich series of sessions with a diverse set of resource persons. Supplementary Table 2 provides a full list of the FP 2016 sessions along with student ratings for them.

Feedback and insights

How has FP influenced our first-year students, and what changes have we seen in the overall development of the institute's academic ethos? Indeed it is difficult to quantify a transformation that is essentially qualitative in nature, but continued student feedback and response have helped us understand the immense impact of this programme. An anonymous FP 2013 student stated: 'My overall experience of Foundation Programme was really awesome. I got to learn so many new things in the course of FP. I rediscovered the hidden talents in me!! FP was superb, outstanding, incredible, highly engaging…I am quite sure that it is going to be an unforgettable everlasting memory!!' Another student recollected on his/her first experience with dance: 'My experience was amazing. For an example I never danced before FP but here I danced first time in my life. Such many things happened with me, which was totally unexpected. So it was a good start for our college life.' Indeed this is typical of the enthusiastic response that most students have expressed over the years. Although many students initially grumble about the long hours and extended length of the programme, most reflect back on it with a great sense of joy and gratitude. Of particular interest is the student response to morning and evening sports sessions, which most of them complain about initially because they find them difficult to get used to. However, by the time they are into their fourth or fifth week, students actually start enjoying these sports sessions, which are highly rated at 4.5/5 in the end.
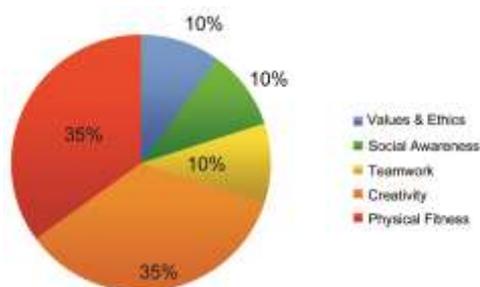
A comparison of student feedback statistics from FP 2014 and FP 2016 reveals that students are consistently receptive to and enthusiastic about non-lecture based, activity-oriented programmes. For example, the neighbourhood street cleaning session in 2014 and the Kalupur Railway Station cleaning session in 2016 both ranked as one of the most meaningful and memorable experiences of the programme in the respective year. We have also noticed that the buzz about FP is out. Incoming students now learn about FP from their seniors and arrive at the institute excited, perhaps a bit anxious, but always highly energized to participate in this uniquely engaging programme.

Beyond the immediately palpable impact on first-year students, FP integrates the entire institute as it welcomes each batch of new students. For example, the evening interaction sessions with seniors have consistently proven to be a critical component of the programme. This is a perfect chance for new students to speak casually and interact with their seniors in a healthy, informal and inclusive setting. We have clearly witnessed how this kind of early engagement creates a supportive and well-integrated student community.

Apart from the students, faculty members have also commented on how FP has been a transformative experience for them as well. Pratik Mutha from the FP 2015 Coordination Team remarked: 'I believe FP has been transformative for both, the students and the faculty coordinators. Apart from all the learning in the formal sessions, it has enabled students to forge bonds so strong that they will be cherished for a lifetime.' Coordinating the five-week FP is no small task; it requires a great deal of dedication, sustained engagement and passion from the faculty coordinators. Every year, young faculty members, who in many cases are new to the institute themselves, are carefully chosen to coordinate the upcoming FP. In this way, new faculty members are also inducted into the institute's vision, operations and campus ethos. According to Dilip Sundaram, a member of FP 2016 Coordination Team who joined the institute in 2015: 'It was an amazing experience, one of the most enriching learning experiences in my career. I was also fortunate to be a part of an amazing team, who put their heart and soul into this programme. Frankly, this is also a foundation programme for the new faculty'. Thus in many ways, FP which embodies the spirit of the institute's core values, has developed into a flagship programme that has had an immense intellectual, social and cultural impact on everyone at the IITGN campus.

Concluding remarks

The success of the Foundation Programme at IITGN has inspired several other institutes in the country to undertake similar programmes for their first year students. NIT

Figure 1. Typical time allocation of the five FP themes.

Trichy was the first to follow up on the IITGN experience by starting a three-week induction programme in 2013. A committee of IIT Directors (Rajeev Sangal of IIT BHU, Gautam Biswas of IIT Guwahati, Timothy Gonsalvez of IIT Mandi and Pushpak Bhattacharya of IIT Patna), in a report on 'Motivating UG students towards studies' presented at the 153rd meeting of the IIT Directors, endorsed IITGN's initiatives and recommended a five-week long orientation programme for new UG students in the IIT system. This recommendation was followed by three IITs (IIT Patna, IIT Mandi and IIT BHU) who each started a three-week induction programme in 2016. A presentation was made on the Induction Programme in the 50th meeting of the Council of the IITs held in August 2016 by Prof Rajeev Sangal, Director IIT BHU, acknowledging the programme as having been originally started at IITGN. Several more IITs have started similar programmes in 2017. Further, the All India Council for Technical Education (AICTE) has now recommended a three-week induction programme at the beginning of their undergraduate programme[15]. These programmes were inspired by IITGN's successful FP model, and they illustrate how bold and innovative academic initiatives at one institute can spread and influence the educational ethos of the entire country.

As Arnab Dutta from the 2015 FP Coordination Team observed: 'This programme signifies the importance of a multidimensional teaching technique for engineering studies. In the near future, FP or its variants may emerge as an essential part of engineering curricula all over India.' In the years to come we are confident that the innovative changes implemented through FP (and other novel programmes at IITGN) will help to transform the outlook, design and vision of engineering education in India. In fact we have already begun to see the long-range impact of such progressive initiatives.

Vikram Rao remarked that 'the IITGN Foundation Programme is truly a base camp for the assault to come of what most consider the pinnacle of engineering learning. These students will be better pre-pared than those at other IITs; of this I have little doubt… All engineering institutes would be well served to study and emulate the IITGN innovation… MIT is credited with being highly influential in the formation and content of the IITs. Their adoption of a version of this program would be fair turnabout'[16].

And so perhaps the IIT Gandhinagar Foundation Program will be one part of India's global contribution to the world of higher education, a successful model for inspiring creative, compassionate and socially aware engineers for the future.

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