Journal of Engineering Education Transformations,
Volume No 35, January 2023, Special issue, eISSN 2394-1707

10.16920/jeet/2023/v36is2/23086

Strategic approaches for DEI Implementation in Engineering Education

M. Palaninatha Raja, A. M. Abirami
Department of Information Technology, Thiagarajar College of Engineering, Tamil Nadu, India.

***Abstract*—The quality of education that one gets is directly related to his quality of life. Equity plays the vital role in offering quality education to all by addressing their issues, barriers and challenges. A fair and inclusive learning environment are the most important factors to provide equitable education. It aims to provide equal opportunities to all students for developing the successful and socially responsible engineering graduates. The education system has to be modernized with Diversity, Equity and Inclusion (DEI) principles and policies that ensure valuable and quality education for all students. This article demonstrates the strategic implementation of different DEI strategies adopted in the Engineering Institute and discussed the results obtained out of them.**

***Keywords*—Diversity, Equity, Inclusion, Engineering Educatio** ***JEET Category*—Practice**

I. INTRODUCTION

IN this 21st century, often the terms like Diversity, Equity and Inclusiveness (DEI) are spelt among different communities and in workplace environment. Diversity refers to the presence of differences in any sense; equity refers to fairness; and inclusion refers to having resources and opportunity (Leeker, 2021). Implementation of DEI policies in educational systems is much important especially in engineering programmes. Alumni of University of Washington appreciated its PEERs program (Promoting Equity in Engineering Relationships), which supported them in their workplace (Yen, 2021). PEERs is a discussion based student engagement seminar program enabled with DEI, through which students can do social science research by applying engineering principles. Few European countries such as Belgium and Denmark promote gender equality in engineering education by introducing fellowships for women. And a research study is in progress for the implementation of recommended DEI practices across the countries. The Institute has to develop practical tools for assessing the diversity in engineering education (Mitchell, 2021).

Inter-disciplinary or multi-disciplinary approach is the present trend with the application of scientific and engineering knowledge. It requires diversified personnel with talent, skill, professional ethics and inclusive mindset. Students from diverse backgrounds would have diverse opinions and different perspectives which are essential for providing strong and sustainable solutions. Berkeley Engineering strongly believes in diversity and inclusion principles in their student and faculty communities which would help them to successfully tackle complex challenges of the society. West Hartford Board of Education defined equity as high quality pedagogy, social emotional learning, cultural competence and family partnership, by which it tried to adopt Educational Equity Policy for promoting equity and anti-racism (Newton, 2021). Adopting DEI strategies like dynamic classroom by rearranging the seating of students, involving the community in different occasions to get experiences and so on.

Farrell et. al. (2021) presented different strategies like inclusive classroom environment, transparent academic culture and socially relevant examples and experimented the same for Chemical Engineering Students of Rowan University, New Jersey. McKenna et. al. (2018) identified different issues like low percentage of female students, need of inclusive pedagogies in engineering education. They recommended to have enriched curriculum with a course for system level projects exclusively for engineering students to promote diversity and inclusiveness. Secules et. al. (2020) suggested a theoretical framework like examining intersectionality, culturally responsive pedagogy and student engagement. Hess et. al. (2021) studied the connections between ethics and DEI in engineering education. They identified four predominantly used themes like cultural, global, social, and sustainable and recommended that the linkage between ethics and DEI could be promoted through these theme areas. Direto et.al. (2021) did an exploratory study on the implementation of DEI practices in European higher education institutions. Lezotte (2021) interviewed eleven participants, studied the D&I conceptualization in engineering units of United States and suggested the need for reforms.

In India, the National Education Policy (NEP) 2020 brought DEI in higher education by making it multi-disciplinary, flexible and choices. It breaks the traditional barriers of engineering programmes and make it accessible to students of any type of backgrounds like rural or urban, boy or girl, rich or poor and so on. The Indian Institute of Technology (IIT) Madras implemented DEI by introducing a new degree programme which attracted all types of learners ranging from school students to IT employees to senior citizens. In India, many private universities open their campuses in different geographical regions in other states or countries and thereby paving the way of divergence and inclusiveness. Inclusivity has occupied with certain weightages in National Institutional Ranking Framework (NIRF) as a specific parameter *'outreach and inclusivity'* for all participating institutes.

From the literature, it has been understood that most of the European and United States universities have unique policies and procedures for promoting DEI in their premises. In India, it has been started by imposing new regulations and guidelines by the governing bodies and regulatory authorities. The

universities, autonomous institutes and other types of higher educational institutes can easily adopt these guidelines for enriching their programmes and curriculum.

Ours is an autonomous engineering institute having different processes like student admission, faculty recruitment, faculty development, academic research, national/international relations, alumni interactions, industry institute interface and suitable performance indicators. These measures are periodically monitored and analysed for continuous improvement. This paper explores these existing processes and tries to map them under three different categories Diversity, Equity and Inclusion. It would help the institute to analyse the new processes and to take corrective action for the processes which have declining trend over the period. This benchmarking activity further refines the set of processes and paves the way for sustainable growth.

II. METHODOLOGY

The Institute has to carefully design its DEI policies in alignment with its vision, mission and quality policy. The DEI processes have to be framed such that they become the part of regular academic and administrative activities. This article explains how DEI policies are integrated with the Institute's strategic objectives and how they are implemented as processes in our Institute, and it is shown in Fig. 1.

A. Diversity

Student Admission - As our Institute resides in semi-urban area, it attracts most of nearby rural school students. Every year, Engineering Exploration Camps is being organized so as to attract CBSE, ISC and State Board of students. Apart from this regular admission process, students from Northern and North-Eastern states get admitted against Government quota and its selective seats. Our Institute adopts NO capitation fee for student admission. Also, it uses single window counseling method for admitting meritorious students for management quota seats. This unique admission process attracts students of metropolitan cities and from other districts.

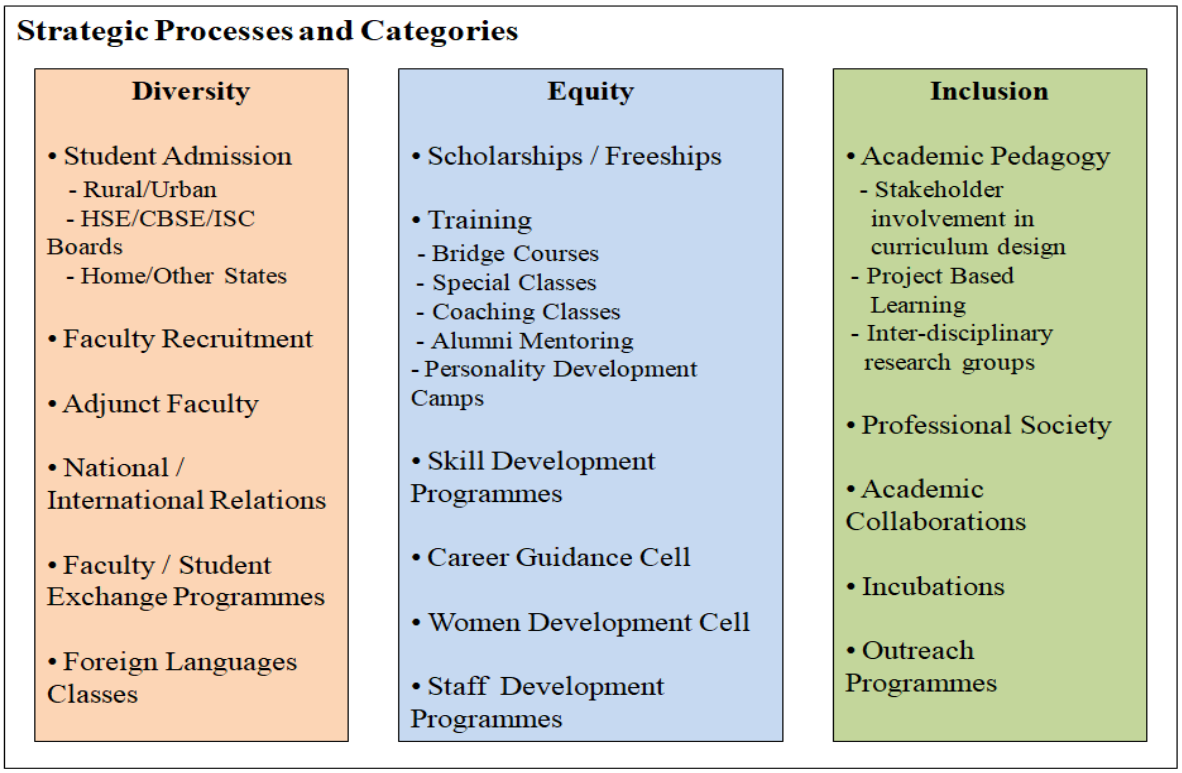


Fig.1 DEI Strategies for Engineering Education

Faculty Recruitment –This process promotes the candidates with Master's Degree and PhD qualification from IITs, NITs and other state universities. New initiative has been taken for appointing Adjunct Faculty from IITs, foreign Universities and industries, who handle the part of the syllabus and other academic engagements throughout the year.

National / International Relations – This is a unique process in the Institute to promote this national and international relations by having different collaborative activities like webinars, remote or virtual student research internships, and joint teaching programmes. New initiative has been taken for student and faculty exchange programmes based on the collaborative MoUs signed.

Foreign / Other Languages - Career Guidance Cell has taken the initiative to teach German and Japanese languages for the interested students after their class hours. Students and staff members are given opportunity to learn Hindi language.

B. Equity

Socio-Economic Equity - There are well defined Tutor Ward System for identifying the needy students who need academic and financial support. Various training programmes like bridge courses, special classes for vernacular medium students, mentoring and personality development camps are being organized with the support of faculty members and alumni.

Placement cell and Entrepreneurship Development Cell in association with NASSCOM organizes various skill development programmes for improving employability among students in the future skill technologies. Career Guidance Cell organizes GATE coaching, Cambridge English Certifications for the students who have higher studies aspirations in NITs/IITs and other foreign universities.

The Faculty Development Process ensures that all faculty members are getting training and upgraded their knowledge in emerging technologies by giving financial assistance to attend various national and international programs.

Scholarships/Freeships are given to the economically poor students under merit cum means basis for their tuition and examination fees.

Gender Equity – Student Support Center facilitates the participation of both boys and girls in all types of co-curricular and extra-curricular activities. Their achievements are recognized in the College Annual Day functions and given awards like Medal of Excellence (Boy), Medal of Excellence (Girl), Best Outgoing Student (Boy) and Best Outgoing Student (Girl). Also, the College management makes senior women faculty members in the administrative positions. Apart from this, Women Development Cell (WDC) organizes awareness and promotional programmes regularly and takes care of all students and staff members. Student council includes boy/girl class representatives, hostel/day scholars and NCC/NSS/Sports/Clubs representatives of all Departments. The Institute is extending a support to the students indiscriminately and facilitate them in participating in national and international level competitions held at various places.
Racial Equity – Secularism is ensured among all stakeholders; no disparity or bias exists in the names of caste, community or color.

C. Inclusion

Academic Pedagogy – The curriculum development process includes different stakeholders like academic council members, board of studies members, students, alumni, industry experts and parents. The Institute started developing MOOCs so that any type of engineering student can learn other courses in his/her own pace.

Project Based Learning – The latest curriculum has courses like Design Thinking, System Thinking, Engineering Design

Project for all engineering disciplines students in which they take problem statements related to Sustainable Development Goals (SDGs). Students from different disciplines form project teams and try to provide solutions. These type of inter-disciplinary projects would bring in DEI culture among students. Apart from these projects, the students of different disciplines jointly participate in hackathons, design contests, sports, cultural, NCC and NSS activities.

Academic Collaborations – This process includes joint teaching programs from other higher learning institutions or foreign universities, mentoring other institutes for implementing Outcome Based Education (OBE) and for sharing best practices, faculty/student exchange programmes, and collaborative research projects.

Incubations – DST sponsored Technology Based Incubations are set up in the campus for promoting new start-ups companies. The identified students are encouraged to compete with other University students to equip them through National Entrepreneurship Network (NEN) courses to promote the startup culture among students.

Outreach Programmes – Every year engineering explorations camps, cultural programmes, technical workshops, technical contests are being organized for school and other College students. This increases the visibility and adds brand value to the Institute.

III. Results and Discussions

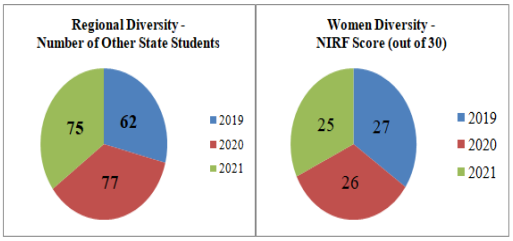
The Institute has implemented its DEI strategies under various processes and kept monitoring the strategic goals periodically. The Institute has become the consortium member of CDIO since 2017 and adopted its curricular framework for producing the next generation of engineers by conceiving and designing the solutions for real time systems and products. The academic regulations ensure that Project Based Learning (PBL) is adopted in courses like Design Thinking, System Thinking, Engineering Design and Capstone projects. The Institute encourages the teachers to adapt their teaching styles using different ICT tools and pedagogical activities based on the learning capabilities of students so as to support all types of learners. The Institute has well defined process for organizing Parent-Teachers meetings and Alumni reunions every year which in turn improves the rapport between the Institute and them. These *inclusive* strategies in academic and other aspects brought good vicinity for the Institute globally. Table 1 shows the results of these strategic objectives in various categories.

TABLE II
DEI KEY PERFORMANCE INDICATORS

S.No	DEI Key Performance Indicators	2021	2020	2019
Diversity				
1.	Regional Diversity *(as in NIRF score)*	1.63	1.63	1.27
2.	Percent of Women Diversity *(as in NIRF score)*	85.5	88.6	90.7
3.	Number of Joint Teaching Programmes	3	1	-
4.	Number of Adjunct Faculty appointed	11	2	-
Equity				
5.	Percent of Boys, Girls (UG)	63, 37	60, 40	59, 41
6.	Percent of Boys, Girls (PG)	44, 56	44, 56	42, 58
7.	Percent of students benefited from Scholarship	26	37	39
8.	Percent of Faculty given Financial assistance under FDPs for upgrading their knowledge	30	57	36
Inclusion				
9.	Outreach and Inclusivity *(as in NIRF score)*	48.59	50.99	51.54
10.	Number of MoUs signed and active	16	12	8
11.	Number of Incubations in the campus	25	20	-
12.	Number of programs organized under National/International Relations	46	41	29
13.	Number of Industries involved in the Academic Support *(industry supported courses)*	18	16	20
14.	Number of Field Projects/Internships *(National/International Institutes and Industries)*	333	423	589
15.	Number of Alumni Reunions per year	5	5	5
16.	Number of extension and collaborative activities	28	18	16
17.	Number of MOOCs developed by the Institute, number of students benefited	11, 925	-	-

A. Discussions - Diversity

Regional Diversity includes the number of students admitted from other states or countries whereas Women Diversity includes the number of girl students, female faculty members and female leadership members. Fig. 2 shows the increasing trend of these metrics, however there was a very small dip in the year 2021.



Fig, 2 Regional and Women Diversity

B. Discussions - Equity

Fig. 3 and 4 show the number of UG/PG students for the period of three years 2019, 2020 and 2021. It is seen that girls dominate in PG programmes in all three years, whereas there was a drop in UG girls count. This might be due to Covid-19 pandemic which impacted all processes globally.

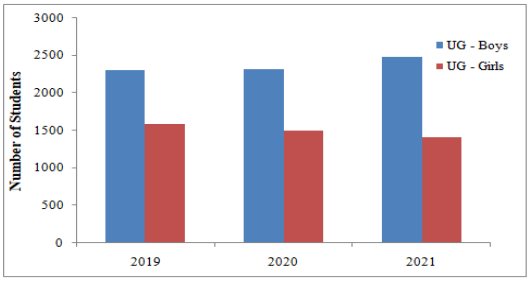


Fig. 3 Gender Equity – UG Students

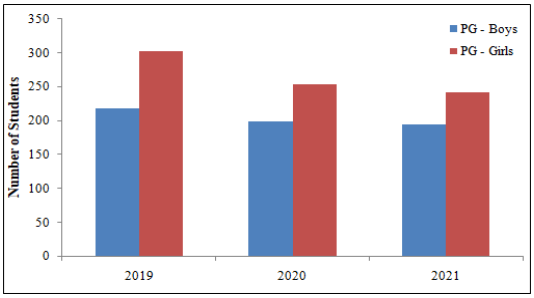


Fig. 4 Gender Equity – PG Students

Fig. 5 explains the number of students benefited by various scholarship provided by State/Central Government, from Institution funds and from private bodies.

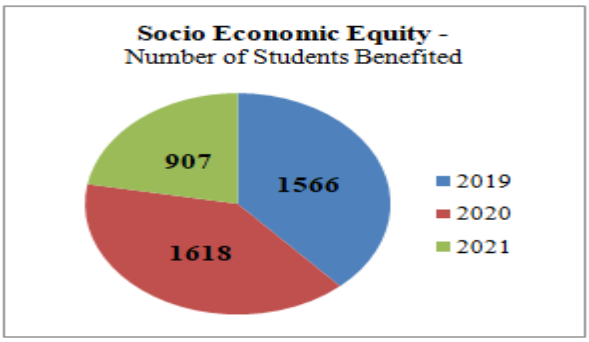


Fig. 5 Socio-Economic Equity

The number of beneficiaries low during the year 2021, due to the process delay in Government scholarships whereas the other two schemes (institutions and private bodies) identified the really needy students and supported financially for their tuition, examination and hostel fees.

C. Discussions - Inclusiveness

The National/International process owner explored the various opportunities like joint teaching programs, student/faculty exchange programs, joint hackathons and so on. These activities promoted the students to interact with those Professors and industry experts, which in turn paved the way for remote internships, collaborative projects, joint participation of technical contests, and mentoring.

The Institute has established positive relationships with IITs/IIITs/NITs. Professors from these higher learning institutions take part in the review process of academic projects, research council, joint teaching programs, collaborative projects and publications. Industry experts and Alumni involve in Board of Studies meeting, Webinars and so on. Fig. 6 shows the number of collaborative activities by academic partners and industry experts. During the pandemic period, these processes were well utilized and established various collaborations with academic institutes and industries for promoting research and industry institute interactions.

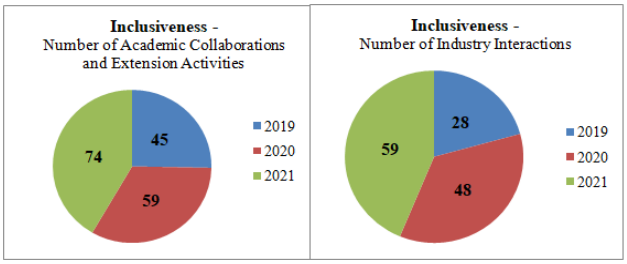


Fig. 6 Inclusiveness

D. Implications

The institute was recognized with *Katral Award 2022* from the State Higher Education Minister for the specific reason that the Institute plays a phenomenon role in uplifting the rural female students by affording valuable engineering degree with employment in the corresponding domain.

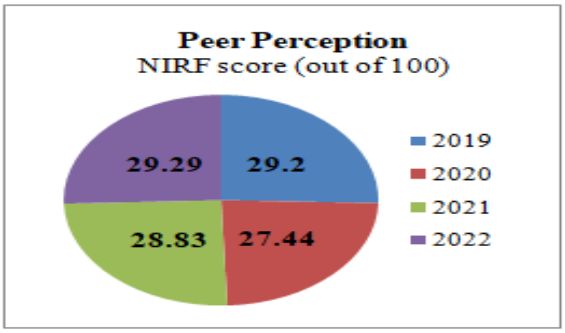


Fig. 7 Results of DEI Strategies - Peer Perception

These DEI strategies and the processes bring fruitful results to the institute in Peer Perception criteria of NIRF ranking. Fig. 7 shows the increasing trend in the perception, which in turn improves the branding of the Institute.

IV. CONCLUSIONS

The educational institute has to create opportunity for underprivileged students to get their education at the

affordable cost. All students should be granted access for all resources irrespective of their race, gender, community, economical status and so on. The institute has to connect to its stakeholders in its processes and have inclusive environment.

This article described different DEI policies and their strategic implementations in the engineering Institute and their corresponding outcomes. These strategies were appreciated by the mentee institutes and jointly developed many collaborative activities. The process owners understood their responsibilities and created the better platform for the participation from all stakeholders. The periodic monitoring of all metrics and the rigorous follow-ups improved almost all the processes, which in turn resulted in better accreditation and rankings. This explorative study on the strategic processes and their implementation paved the way for benchmarking exercise and supported the quality team to improve the target values and redefine some processes.

ACKNOWLEDGMENT

We acknowledge our Institute Thiagarajar College of Engineering for supporting this work.

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