Journal of Engineering Education Transformations,
Volume No. 37, January 2024 Special Issue, eISSN 2394-1707

Empowering Engineering Education: The Evolution and Impact of the EPICS Program in India

Santosh Madeva Naik[1] , Surendra Bandi[2], Lokeshwara Reddy[3]
[1]Assistant Professor, Hyderabad Institute of Technology and Management, Hyderabad
[2]Associate Professor CSE, Hyderabad Institute of Technology and Management, Hyderabad
[3]Professor EEE, CVR College of Engineering, Hyderabad
[1]santoshn.mech@hitam.org [2]surendra.mca@hitam.org [3]reddy.lokeshwar@gmail.com

***Abstract*— This paper chronicles the implementation of the Engineering Project in Community Service (EPICS) course within a curriculum, highlighting its journey of evolution from a Non Mandatory Course – Mandatory Course – Credit course for engineering students. The EPICS program was introduced in 2016 by one of the affiliated colleges in India, started this initiative to overcome employability issues, and for developing leadership skills, team work, problem solving skills in students. The goal was to inspire students to actively engage in real-time, community-oriented projects, shifting their focus from theoretical concepts to practical application.**

This change aimed at addressing employability concerns in India by fostering a more hands-on and service-oriented approach to engineering education. Studies the implementation of EPICS in engineering education effectively to address employability issues in India while enhancing students' technology-based learning and other skills, analyses academic performance of student whether increased after introducing the EPICS program?

The EPICS program follows a comprehensive Design Thinking process, which involves identifying real-time problems, developing ideas, generating creative solutions, prototyping, designing, seeking feedback, and ultimately delivering and maintaining the outcomes. As of now, the program has successfully completed its eighth iteration. In the first iteration, EPICS was introduced as a non-mandatory course, offering an opportunity for interested students from various disciplines to participate by registering in the course voluntarily. The EPICS program, spanning four years of engineering education, has yielded positive outcomes for its students. An analysis of the program's impact reveals that 60% of students secured placements in reputed companies, 35% pursued higher studies, and 5% ventured into their own startups. Throughout the iterations, the program has actively collected reflections from students and alumni, as well as valuable feedback from parents and industry experts. Based on the insights gathered, the course structure and delivery have undergone significant changes from the initial iteration to the current one. These refinements aim at enhancing the effectiveness of the program, ensuring a more enriching and impactful learning experience for the participating students.

Keywords*— *Assessment, Design thinking, EPICS.

Mr. Santosh Madeva Naik
Department of Mechanical Engineering, Hyderabad Institute of Technology and Management, Telangana 501401, India
santoshn.mech@hitam.org

I. INTRODUCTION

Service learning or community engagement plays very important role in engineering education research because after four years of undergraduate study students should be helpful to the society or environment. As per study by integrating service learning course in the curriculum in a proper frame work students' learning skills will improve by doing service oriented activity. If this course added in the curriculum it will boost students learning & motivation to work on service based problems (Tharakan, 2012).

The EPICS program is a well-structured community engagement course where students will learn engineering design by doing a community oriented projects. While solving the problem, team can be formed by adding a freshman with senior students or multidisciplinary students into a group. Through this multidisciplinary team's students will learn from each other's. The learning outcome of the EPICS course is mapping with ABET EC 2000 requirements (Oakes et al., 2000).

By including STEM (Science, Technology, Engineering & Mathematics) education in EPICS program, it improves students critical thinking capabilities for solving a problem. Introducing EPICS in curriculum it enhances the students learning ability and solves unemployability issues (Dutta & Mathur, 2013).

The SDSMT engineering & Oglala Lakota college taken two capstone major projects on rainwater harvesting & wastewater treatment. One of the major objectives of this project is to study the impact of service learning projects. The service learning related course should be introduced in freshman engineering to improve the students design thinking skills (Fick et al., 2013).

Interconnecting Problem Based Learning with the service learning initiative, it is a key to enhance student's teamwork and communication skills. EPICS Design thinking process it contains a step by step process how to identify a problem, how to connect with community and importance of stakeholder in the projects (Thompson & Jesiek, 2011).

Introducing a service learning project for first year engineering students, they will learn the technical concepts by self-learning method to solve community problems. While comparing the data of senior course project with a freshman student's SL projects, the technicality is improved in freshman students (Lee et al., 2019).

A curriculum was designed with a combination of environmental course with SL (Service Learning). A group of 20 students from fourth year environmental course took four real time problems which are related to displaying of location of health clinic centers for the local communities. Through informal feedback with local communities' students have understood the importance of problem faced by the communities. The challenges faced is maintaining of connection with community partner for longer time and delivering of solution in a shorter duration of time. By facing of this challenges students learnings has improved enormously (Kulkarni, 2014).

Outreach program on Mechanical engineering introductory course was introduced for freshman engineering students. The impact of this course is students' communication skills have enhanced and also students have solved the community partner problems. Due to this students are able to understand the importance of service learning in engineering (Bailey et al., 2005).

The future of engineering education is through integrating EPICS and service learning it solves the unemployability issues and it enhances the student's technical knowledge and other skills (Coyle et al., 2006).

Integration of engineering, community engagement and entrepreneurship in engineering education students will develop society oriented innovations. This will lead to a developing of eco-friendly society and due to community interactions the ability of understanding and communication skills enhance students performances (Ravel et al., 2015).

The main challenge of community engagement course in engineering is logistics, community partner interaction and time. There are only few researches done on community engagement , interaction and community feedback (Natarajarathinam et al., 2021).

By following this literature there are few challenges. Among them one is to maintain long term communication with the stakeholders. From the study it is observed that the EPICS course enhances students learning, communication, teamwork, presentation skills, technical skills, leadership skill and teamwork etc.

II. METHODOLOGY

A. EPICS (Engineering Project in Community Service)

The EPICS design thinking process shown in figure.1 followed for implementation of EPICS course in curriculum.

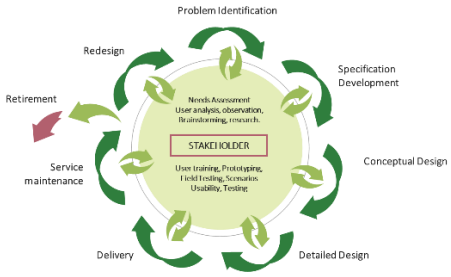

Fig. 1 Design Process

The transition of EPICS course a non credit – mandatory – credit course shown in figure.2. In 2016 EPICS was first introduced as an extracurricular activity. At an initial level 25 Male students & 15 female students of multidisciplinary branches enrolled in EPICS. After seeing the impact of program and students' feedback, 2018-2020 it was introduced for all engineering students who are interested to work on community related problems, those students are enrolled, due to affiliated system it is not introduced as a credit course. In the transition period2016-2020, the instructor learnt how to communicate with a community partner, how to conduct

an activity to identify a problem and how much time should be given for design process stages.

After getting autonomous status in 2021 the course was introduced as a mandatory course for freshman engineering students. After seeing the impact of the course on the students finally in 2022 it is introduced as a credit based course for freshman engineering students.

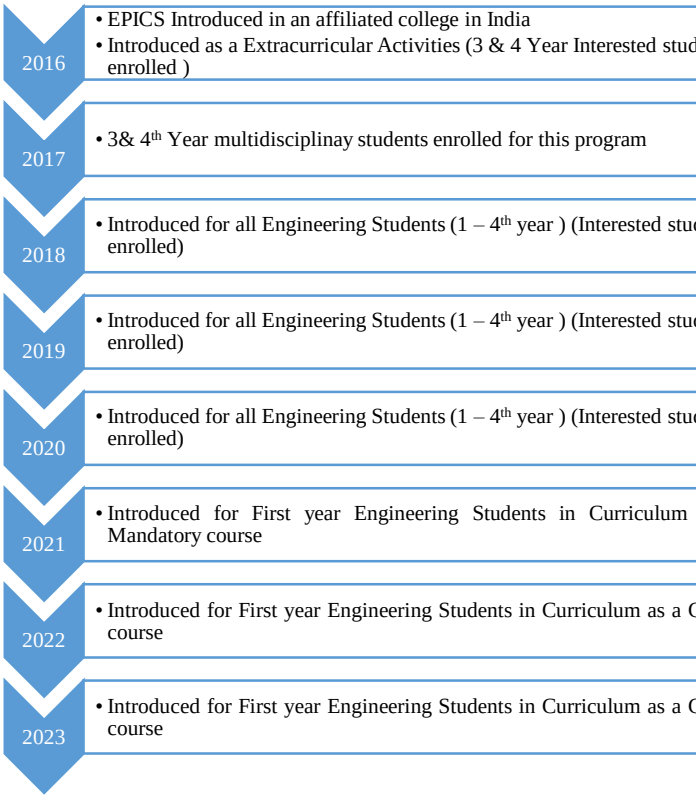

Fig.2 Evolving from Non Credit – Credit Course

B. Course plan

Through this transitions many challenges were faced, to address these challenges some of the changes were made in delivering of the module.

- Assigning Engineers Without Border (EWB) senior Students Mentor for freshman engineering sections
- Problem Identification Stage Connecting Every Problem with SDG themes
- Moodle Implementation for EPICS lab – Assignment Submission & Evaluation
- Recording each & every interaction of community partner

To understand the process of problem identification wallet activity is conducted. One member will act as a community partner and one more will be a student. In this process students understand how to identify a problem. The figure.3 shows problem identification phase module.

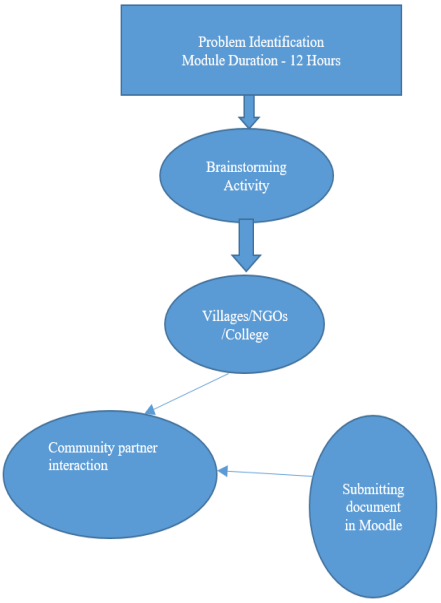

Fig. 3 Problem Identification

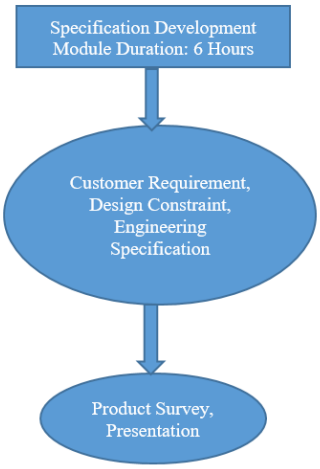

Fig.4. Specification Development

Moodle tool is used for submission of assignment and project documents. The specification development stage shown in figure.4. In this stage student's teams will take the customer requirement for solving a problem and the team will do the product survey to know what are the existing solutions or products available for existing problem.

Fig.5 Conceptual Design

In conceptual design process shown in figure.5. Students will prepare the decision matrix for 4-5 multiple solution for a one problem, depends on criteria and requirement best solution will be selected though decision matrix table. A persona interview will be conducted to understand a solution will address the requirement stake holder or not.

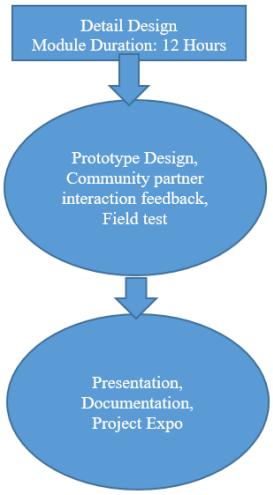

Fig. 6 Detail Design

The detail design shown in figure.6. in this teams prepare the working prototype and will take the feedback from the community partner. Depends on field testing and community partner feedback the working prototype will be converted into a product after the multiple testing's. For the valuation purpose and motivating the students project expo will be organized to showcase the student's social innovations.

C. Assessment

Total two assessments will be conducted in this course, Total marks is 100 (Internal Marks – 40 M, External Marks – 60 M).

Table.1 Internal Assessment

Assessment Parameter		Good	Average	Poor
Problem Identification (20 M)	Community Interaction (10 M)	Documentation & stakeholder interaction (10 M)	Oral Stakeholder interaction (5 M)	No proper documentation (1 M)
	Problem identification (10 M)	Identification of problem & matching with SDG (10 M)	Problem identified but not matched with SDG (5 M)	No clarity on problem identified (1 M)
Specification Development (20 M)	Requirements (5 M)	Identifying of minimum 6-5 measurable requirements (5 M)	Identifying of minimum 3-2 measurable requirements (3 M)	1 measurable requirement (1 M)
	Existing solutions (5 M)	Finding the existing solutions for identified problems with documentation (5 M)	Finding the existing solutions for identified problems with documentation (3M).	No clear existing solutions (1 M)
	Gaps Identified (5 M)	Gap identified in existing solution With analysis & documentation	Gap identified in existing solution Without analysis &	No proper gaps identified (1 M)

		(5 M)	documentation (3 M)	
	Demo of Poster (5 M)	Poster Presentation with animation (5 M)	Poster Presentation (2 M)	Oral presentation (1 M)

Table.2 External Assessment

Assessment Parameter		Good	Average	Poor
Conceptual Design (20 M)	Decision Matrix (10 M)	Minimum 5 solutions for one problem with sketches (10 M)	Minimum 2 solutions for one problem (5 M)	No Solutions (1 M)
	Community Partner Feedback (10 M)	Prototype testing & feedback (10 M)	No testing but taken feedback (5 M)	Not Taken (1 M)
Working Prototype & Documentation (40 M)	Prototype demonstration (30 M)	Working Prototype (30 M)	No prototype demonstration only working animation video (5 M)	Oral Demonstration (1M)
	Final Report Submission (10 M)	Report with Design thinking process and design (10 M)	Partially submitted report (3 M)	No Report (1 M)

The internal assessment rubrics for 40 Marks shown in table.1, and external assessment for 60 Marks shown in table.2. For the external assessment it will be evaluated by external experts. The external assessment conducted as a project expo to showcase the innovation done by the student teams.

III. RESULTS AND DISCUSSION

The number of students enrolled from 2016-2023 shown in table.3. The quality of the project has gradually increased and students have learnt the pertinent technical skills, leadership skills, team work & problem solving skills. After getting a credit to EPICS course lot of student's time is saved and they are motivated towards solving of community problems. Students & faculty participated in many competitions & also presented research papers in international conferences. This course has given an identity to students as well to faculty.

Table. 3 Number of students enrolled

Sl.No	Year	No. of Students Impacted
1	2016-2017	65
2	2017-2018	400
3	2018-2019	350
4	2019-2020	370
5	2020-2021	272
6	2021-2022	450
7	2022-2023	466

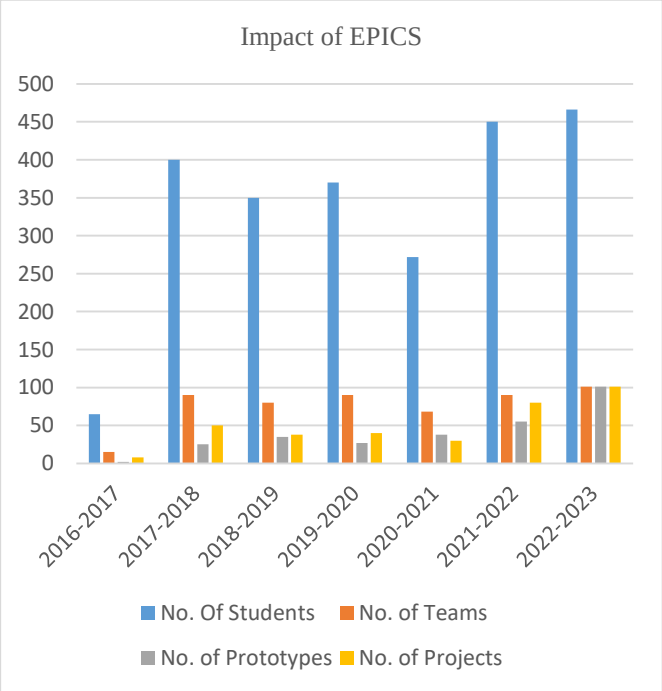

Fig.7. Impact of EPICS course

The course is started with 65 students and they developed 8 projects, now the student strength is 466 and done 101

working prototypes. The outcome of this course is mapped with all attributes. This course has given a platform for students to showcase their talents, skills in terms of building projects and connecting with people, impact EPICS course shown in figure.7.

A. Does the implementation of EPICS in engineering education effectively address employability issues in India?

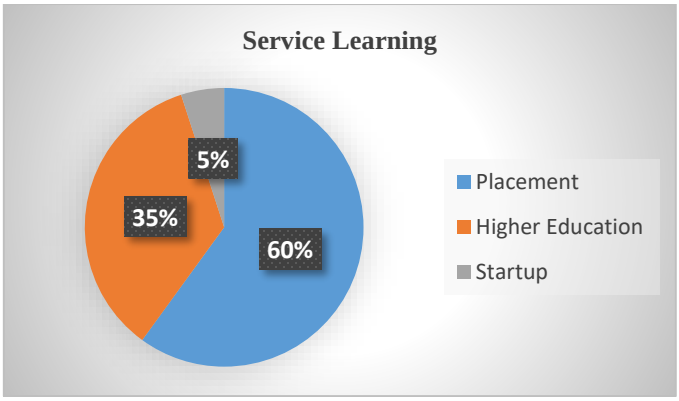

Fig. 8. Students data

The student's teams who have done real time projects related to service learning with a multidisciplinary content 60 % of the students have secured seats in good Universities for higher education because of PB – SL (Problem Based – Service Learning) and 35% student's got placed in the companies of their choice.

B. Feedback of students

A Student: EPICS has helped a lot to me personally for building my project solving skills. It has helped me in developing my expertise in problem solving and developing my project also helped me to prepare my research paper based on this project. It helps a lot in problem identification, solving it and presenting it in front of many dignitaries. Overall my experience regarding EPICS program was fascinating and helped a lot in exploration.

B Student: I am writing to express my heartfelt gratitude for the invaluable role that the EPICS program played in shaping my educational and professional journey. As a successful graduate, I cannot emphasize enough the profound impact EPICS had on my personal and professional growth.

C Student: EPICS has been a game-changer in my life, providing me with a unique platform to apply my academic knowledge to real-world challenges. The hands-on, project-based approach taught me not only technical skills but also crucial soft skills like teamwork, communication, and problem-solving, Practical Experience, Networking Opportunities, Social Responsibilities. These skills have been instrumental in my career and personal life.

D Student: EPICS has not only equipped me with the technical and soft skills needed to excel in my profession but has also shaped me into a socially conscious, responsible, and adaptable individual. I am proud to be a part of this, and I carry the values and experiences gained through the EPICS with me every day.

Introducing EPICS Program or Service learning course in a curriculum the biggest challenge is logistics supports (Natarajarathinam et al., 2021). This issues can be addressed by before commencing of semester the logistics requirement should be planned depends on student's enrollment.

IV. CONCLUSION

EPICS course is a well-structured design thinking process where it is followed universally for service learning implementation. This course enhances students learning skills and it addresses unemployability issues. After survey students have given a very good feedback on this course and also students expressed how this course helped in enhancing technical skills.

Still after introducing into freshman engineering courses there are some advantages as well as disadvantages. Limitation is that due to shortage duration student's teams are not able to convert prototype into a product. If this course continued for 2nd, 3rd & 4th years of engineering with an industry connected curriculum related to service learning it will enhance student's skills and also students' teams can become successful entrepreneurs.

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