Research in Engineering Education Symposium-2024
Jan 4-6, 2024 - Hubballi, India

Enablers and Barriers for Engaging in Engineering Education Research in India

Pallavi Meshram[a], Rucha Joshi[a*], Rohit Kandakatla[b], Shreel Prasad[a], Mayanglambam Pooja Devi[a], and Ashish Agrawal[c]
Plaksha University, Mohali, Punjab, India[a], KG Reddy College of Engineering and Technology, Hyderabad, Telangana, India[b], College of Engineering Technology, Rochester Institute of Technology, Rochester, New York, USA[c]
Corresponding Author Email: rucha.joshi@plaksha.edu.in

Abstract

Context
India needs to improve its Engineering Education Research (EER) to address its unique educational requirements and align with the visionary goals set forth in the National Education Policy (NEP) 2020. To truly follow the NEP 2020 vision, we need to understand and tackle the challenges stopping us from diving deeper into EER.

Purpose or Goal
Engineering faculty in India are one of the key stakeholders as they can engage in EER in alignment with the vision of NEP 2020. However, an extremely low participation of engineering faculty in EER remains a major concern. Therefore, this work aims to systematically explore the barriers to engaging in EER in India and suggest potential directions to overcome these barriers via dialogue with stakeholders about enablers.

Methods
A qualitative approach was used in this study to gather insights and perspectives from various stakeholders regarding the barriers to engaging in EER in India and potential enablers. Semi-structured interviews were conducted with engineering education researchers, and leaders at engineering education institutes in India. Collected data was analyzed using thematic analysis and specific themes are reported.

Outcomes
This study identifies barriers and enablers to facilitate high-quality EER in India, provides recommendations for institutional and governmental policies, and motivates individuals to implement practical solutions. A few of the barriers we found include a lack of institutional support for EER, bridging research and teaching practice in academia, disciplinary silos, lack of direction, lack of recognition of EER as a field of inquiry, a small community of EER researchers, and lack of funding. Some enablers found include motivation to advance EER in India, institutional recognition, acknowledgment of EER by the engineering community, capacity building and collaborations, technology-based research, and NEP 2020.

Conclusion
This analysis provides valuable guidance for future research and policy initiatives aimed at enhancing engineering education in India. The findings can be utilized by stakeholders at both individual and systemic levels to drive positive change within the EER ecosystem in India.

Keywords— Barriers; Enablers; Challenges; Engineering education research, EER in India

I. INTRODUCTION

ENGINEERING Education Research (EER) is a multifaceted field that goes beyond traditional education and research boundaries. It encompasses reforming, implementing, and exploring interdisciplinary aspects of engineering education. EER aims to tackle worldwide issues in higher engineering education, such as attracting students, fostering skills across disciplines, and managing intricate knowledge (Borri & Maffioli, 2008). This interdisciplinary domain involves engineering, science, social science, and educational psychology researchers. By incorporating advancements in engineering education and learning sciences, EER seeks to improve teaching methods and prepare well-rounded graduates capable of making societal impacts (National Academies of Sciences, 2018).

India with its rich history of academic excellence and its burgeoning role in the global technology arena, presents a unique backdrop for EER. Performing quality EER could help the nation's academic institutions be at the forefront of producing world-class engineers. However, there are only limited systematic comparisons available for EER across various national and cultural settings. This holds true for India as well, where EER has a limited presence in both historical and global contexts. This limitation hinders its ability to be widely disseminated and recognized within the broader academic community. We realize that the journey of integrating EER into the Indian academic fabric has its own set of challenges and opportunities that need to be identified and resolved. India has taken steps towards incorporating the advancements towards

https://doi.org/10.52202/073963-0019

engineering education in the form of NEP 2020, for which the current status is now in its implementation phase. Between 2020 and 2023, the government conducted webinars and informational sessions across various institutions.

Specifically, in the domain of EER, there is a noticeable gap in discussions related to the historical foundations of the engineering profession. A limited number of individuals in this field genuinely delve into historical aspects in their research or pedagogical approaches, as noted by (Wisnioski, 2015). Previous unsuccessful initiatives in the field, which have led to a sense of caution, coupled with misunderstandings or misconceptions surrounding the concept of the Scholarship of Teaching and Learning (SoTL), can also serve as significant deterrents or obstacles that discourage individuals from engaging in EER. For a new researcher, the challenges of understanding theoretical frameworks and establishing the credibility of qualitative research remain large obstacles (Smith & McGannon, 2018). In a study conducted by (Streveler et al., 2015), which aimed to familiarize Ph.D. students with the realm of EER, the participants recognized that the most conceptually demanding elements included understanding the theoretical framework, grappling with qualitative and mixed-method approaches, and establishing the credibility of qualitative research. Despite the complexities, the students managed to navigate these challenges by leveraging their existing engineering knowledge and past experiences. They connected these insights to their educational experiences or various facets of their professional engineering roles.

Considering the above-mentioned facts, this paper aims to provide a comprehensive understanding of the barriers and enablers influencing engagement in EER in present-day India. Drawing from insights by researchers, leaders, and other stakeholders, we have explored the intricate dynamics at play, offering insights that can guide future endeavors in this critical field in India.

II. LITERATURE REVIEW

While a longstanding interest has persisted in enhancing and documenting engineering education, the formal recognition of EER as a discipline-specific area within education research remains a relatively recent development compared to research in conventional engineering disciplines that have been around for many decades (Council, 2012; Johri & Olds, 2014; Lohmann & Froyd, 2010). New entrants into EER often originate from faculty roles within engineering or related domains, driven by a shared ambition to enhance educational practices (Duschl & Bybee, 2014). As a result, the field of EER has traditionally emphasized two key areas: one is centered on expanding participation, and the other concentrates on enhancing competencies (Feiman-Nemser, 1989). However, while EER has introduced innovative pedagogical methods, the intricate nature of engineering work across its various subfields demands a more nuanced perspective (Buckley et al., 2023).

Engineering education can be seen as a multilevel system comprising four main levels: the student level, the institutional personnel level, the institutional culture and industry level, and the societal level (Klein et al., 2019). As the field of engineering education evolves, researchers are increasingly emphasizing an understanding of the individual student's journey, from their initial motivations and emotions to their progression through various educational phases. However, beyond the student level, institutional dynamics play a pivotal role. The personnel involved in education, their roles, expertise, and perspectives significantly shape the education process. Moreover, the institutional culture, closely tied to industry trends and demands, greatly influences curriculum design and pedagogical approaches, shaping the directions for EER (Burbules & Torres, 2000). Navigating the newly forming EER landscape is complex because many researchers in the EER domain traditionally began as engineering faculty in conventional engineering fields like civil engineering, mechanical engineering, etc., and later shifted to research within EER (Kamp, 2020).

However, due to limited structural support on how to conduct EER and a lack of established novice-expert relationships, there's a growing need to train the new researchers to conduct research that directly impacts students and stakeholders, as current EER work is being critiqued for risks of becoming isolated and less relevant (Dart et al., 2023). To make EER more relevant to the needs of the local community, modern educational context, and changing ecosystems, barriers must be recognized and solved using an enabling ecosystem.

A. *Barriers*

Researchers typically shift to EER post-technical engineering studies, facing challenges merging their training with the distinct demands of educational research. Formal training pathways, especially in postgraduate studies, are not well-established, leading to a lack of clear standards and practices (Gardner & Willey, 2018). Further, this area of research underscores several "institutional" challenges, encompassing time limitations, inadequate institutional backing and growth prospects, insufficient funding, and a perception of undervaluation of engineering education research. These hindrances are well-documented in prior literature (Brodie et al., 2011; Haigh et al., 2011; McKinney, 2002; Wankat et al., 2002), prompting consideration of strategies to overcome these issues and stimulate increased engagement in education research among engineering academics. Another major obstacle mentioned in the literature for EER is the considerable job-related difficulties experienced by faculty members. Limited scholarship support and incentives prevent them from fully engaging in EER despite their motivation. This makes it challenging for them to effectively balance their roles as both

Proceedings of REES 2024 KLE Technological University, Hubballi, India, Copyright © Pallavi Meshram, Rucha Joshi*, Rohit Kandakatla, Shreel Prasad, Mayanglambam Pooja Devi, and Ashish Agrawal <Enablers and barriers for Engaging in Engineering Education Research in India >2024

https://doi.org/10.52202/073963-0019

educators and researchers (Ko et al., 2021). The departmental organization of universities, structured around subjects, sometimes hinders the creation of interdisciplinary teaching environments needed for holistic projects and skill enhancement. Tackling these issues is vital for advancing EER in India (Valero, 2022). It is observed that faculty at institutions with doctoral programs significantly value reduced teaching loads as an enabler for motivating research output (Chen et al., 2010). Similarly, in another study it was noted that the factors contributing to success of EER initiatives include proactive leadership support, adequate resource allocation, enthusiastic staff involvement, and access to valuable conceptual frameworks (Wenger et al., 2011). Importantly, the study emphasizes that the supportive elements outweigh the challenges, indicating a positive outlook for the advancement of EER when these factors are effectively leveraged.

B. Enablers

Researchers (Borrego & Bernhard, 2011) (Beddoes et al., 2010) identify the significance of global research collaborations and how it is equally important to adapt EER to local contexts. Researchers and educators should make their work understandable across various institutions and countries, considering cultural and educational differences (Jesiek, Borrego, & Beddoes, 2010). However, it's crucial to understand that not all findings can apply everywhere due to cultural and educational differences (Beddoes et al., 2010). It is important for EER researchers to show impact for gaining traction in the field (Mehta & Berdanier, 2019), review the need for incorporation of EER in the educational landscape, and emphasize the need for curriculum adjustments to address the implementation challenges. It brings out the necessity of integrating EER to tackle emerging issues in curriculum design, teaching methods, expertise development, and diversity for Additive Manufacturing context.

Various research articles have delved into the assessment and progression of EER as an independent field (Borrego & Bernhard, 2011; Jesiek et al., 2009) (Borrego and Bernhard, 2011; Jesiek, Newswander, and Borrego, 2009). Numerous studies have explored the evolution of EER within diverse settings, encompassing the U.S.A. (Lohmann & Froyd, 2010) (Froyd and Lohmann, 2014), Portugal (van Hattum-Janssen et al., 2015) (Sorby et al., 2014; van Hattum-Janssen, Williams, and Nunes de Oliveira, 2015), Ireland (Sorby et al., 2014), Australia and New Zealand (Godfrey & Hadgraft, 2009) (Godfrey and Hadgraft, 2009), Europe (Bernhard, 2018) (Bernhard, 2018), and three Nordic countries (Edström et al., 2018) (Edström et al., 2016). Additionally, research has analyzed EER in a global context (Streveler & Smith, 2010) (Jesiek, Borrego, and Beddoes, 2010a, 2010b; Streveler and Smith, 2010). However, there remains a gap in terms of investigating EER within the Indian context, especially with respect to enabling and hindering factors.

The absence of such studies in India leaves an information gap regarding the barriers, recognition, institutional support, funding, and career pathways for EER researchers in the country. This dearth underscores the need for targeted research initiatives in India to better understand and address the challenges and potential solutions related to the advancement of EER in the Indian engineering education.

III. METHODS

The literature review serves as the foundation for developing the interview protocol by providing a comprehensive understanding of the historical context, key concepts, emerging trends, and challenges in EER. Here, we systematically investigated data obtained from interviews in India by following Braun et al. thematic analysis (Braun & Clarke, 2006). Initially, we carefully selected our stakeholders, comprising key figures in engineering education, including the Deans, Vice-chancellors, Teaching and learning center heads, EER researchers, and Practitioners. To guide our interviews with these stakeholders, we crafted a questionnaire that probed their views on “Evolution of Engineering Education in India in terms of their impressions of current state, factors shaping it, and most pressing challenges”; “Engineering Education in India next two decades, including factors driving it, and role of NEP”, and “Potential Directions for EER in India”. The detailed questionnaire is given in (Appendix I). Subsequently, we invited participants (India-over) who possessed relevant experience within the Indian engineering education context or had engaged in research related to it. Ultimately, we conducted semi-structured interviews with a total of 18 participants from institutes across India, including 6 institutional leaders, 8 EER researchers, 2 practitioners, and 2 heads of teaching-learning centres. Interviewees consisted in total of 4 female participants and 14 male participants. Interviews were transcribed using the transcription tool available in Microsoft Teams application. Our analysis utilized an exploratory coding method, as advocated by Creswell (Cresswell et al., 2012), to systematically uncover significant themes and patterns within the transcripts. These themes included barriers and enablers for EER in India, providing valuable insights into the challenges and opportunities within the field. Throughout the analysis, we maintained the credibility and trustworthiness of our findings through continuous dialogue and resolution of disagreements among the authors. This comprehensive methodology allowed us to gather structured insights from the stakeholders and perform a rigorous analysis of the interview data, contributing to a deeper understanding of EER in the Indian context. Overall, 7 themes emerged in barriers and 6 themes emerged in enablers. Illustrative quotes are given for themes, with the pseudonyms in place to protect privacy of stakeholders.

IV. RESULTS

The analysis of transcripts revealed the key themes that act as barriers and enablers for EER in India. Participants talked of

Proceedings of REES 2024 KLE Technological University, Hubballi, India, Copyright © Pallavi Meshram, Rucha Joshi*, Rohit Kandakatla, Shreel Prasad, Mayanglambam Pooja Devi, and Ashish Agrawal <Enablers and barriers for Engaging in Engineering Education Research in India >2024

many problems including lack of institutional support, people not recognizing EER as a field of inquiry, teaching overload, shortage of time, lack of training, lack of working opportunities, lack of funding, lack of proper research questions framing, challenges in ecosystem, lack of opportunities, lack of practice, absence of dedicated centre, etc. However, some participants talked positively of motivation for educational research, and how factors such as connecting with different researchers, having people acknowledge significance of EER, conferences and appropriate platforms to disseminate findings, technology enabled research, administrative policies to enable creativity, faculty development programs, mentorship, and ecosystem enabling new initiatives in EER- can be enabling for EER in India. In what follows, we systematically describe our findings categorized in themes of "barriers" and "enablers" emerged at personal, institutional and policy level as discussed by various participants mentioned in pseudonyms to protect their privacy.

A. Barriers

1) Theme: Lack of Institutional support for research activities

Diversity and administrative variations among Indian universities create inconsistencies and challenges in coordinating and standardizing research efforts across institutions. Many universities are privately owned or have restricted access, making it difficult to establish collaborations or engage in research activities. As Dr. Rajesh Patel a researcher says, *"majority of the institutions if you see here are all mass education and academic oriented. Now slowly we must build a research culture"*. Most institutions being referred to are primarily focused on providing mass education and are geared toward academic-oriented programs. This implies that their primary emphasis has been on teaching and delivering educational content to a broad audience. However, Dr. Rajesh Patel emphasizes the need for a shift in perspective and priorities. He suggests that it's time to gradually cultivate a "research culture" within these institutions. The wide range of administrative styles and ownership structures creates complexities and challenges in attempting to navigate and penetrate these institutions for the purpose of EER. A engineering education researcher Mr. Ishaan said, *"... research (in engineering education) itself is not a priority across institutions in India,... like I mean outside (of a couple institutes) that promote intuitively those things within their system, I don't know of many other institutions that prioritizes (engineering educational) research and structurally that's been how you know education has been modelled."*

2) Theme: Convergence challenge: Bridging research and teaching practice in Indian academia

Participants revealed the feeling that experimental research with an emphasis on conducting experiments and analyzing the resulting data is valued more than qualitative research in engineering education in India. For the fewer ones doing research in engineering education, the nature of research varies from one individual to another, depending on their interests and the specific problems they aim to address in the country, however once concern raised was that the translation of the EER into practice is not happening to the scale desired. There might be even a disparity between the research conducted and its practical application within the same institute or across different institutes. For example. Mr. Darshan a EER researcher said, *"you know what they are researching, maybe the research is there, but may not be always applied by the same institute or by even other institutes, right?"*. Also, Professor Bhattacharya *said, "There is another big conflict that I see, research versus teaching. There is so much that one is expected to do and India being predominantly having institutions with teaching focus, there is a dichotomy you see among teachers."* In brief, he highlighted EER and effective teaching as two different areas that caused pressure in striking balance and exceling in both areas amongst faculty.

3) Theme: Disciplinary silos: Hurdles to multidisciplinary collaborations

The faculty's resistance to embracing collaborative efforts across disciplines is highlighted as a barrier to advancing research and innovation in their context. While intrinsic motivation to be better faculty, to learn and conduct EER, etc. might be observed at some places, there is largely an absence of extrinsic motivators. The traditional academic reward structure in many institutions prioritizes research in technical fields over EER. Many of the faculty members hold the belief that there is no value or appreciation for collaborations between different disciplines, such as engineering, arts, management, and education, thus deterring their motivation to do EER. As Dr. Raman an EER practitioner states, *"unless and until there is motivation from an individual who has been entering education, these conversations typically require encouragement."* Other faculty may perceive these additional conversations as burdensome, especially when they are already heavily committed to teaching and administrative duties. In addition to the above, a lack of incentives, recognition, and support for EER endeavors further hinder interdisciplinary collaboration.

4) Theme: Small community of engineering education researchers in India

Lack of a supportive and collaborative research community is challenging due to the fewer representation of faculty within it. Many faculty faculty associated with EER community choose to remain with their parent discipline, and not fully dive in as EER is not recognized as separate at many institutions. For example, Head of Teaching Learning Center, Professor Ram said, *"A number of associated faculty who kind of were associated with the center... and but they continue to be in their parent disciplines"*. Professor Sham said, *"I wish there was like more we could do and like at least I would be interested in like collaborations and things like that. But I don't think we're there*

https://doi.org/10.52202/073963-0019

yet." This leads to difficulties in finding individuals with whom researchers can openly discuss their challenges, successes, and another valuable knowledge. As a result, this limited community interaction becomes a barrier to sharing information and mutually benefiting from each other's experiences and insights. Also, researcher Arun adds, *"There are very less people with whom the researchers can share their problems or success or any other knowledge that they have which might be useful mutually in so that is another barrier."* Many researchers also mentioned that due to the limited small community of the people, EER is struggling to attract sufficient attention, funding, and recognition compared to larger academic disciplines.

5) Theme: Lack of recognition for EER as a field of inquiry

EER has not been given significant priority or recognition in various aspects within the academic and research community. The acceptance of EER as a distinct discipline encounters significant obstacles, primarily due to the abundance of teaching professionals within engineering faculties who may view themselves as pedagogical experts. Unlike conventional engineering fields, where peers might more readily acknowledge expertise, EER researchers frequently confront doubt concerning the necessity for evidence and the applicability of their discoveries. Establishing credibility becomes notably challenging when EER delves into the practical aspects of education, as colleagues might believe their own expertise suffices. For example. Head of the Teaching Learning Center, Professor Ram here expressed, *"See one of the thing is acceptance. You know, acceptance as a discipline is challenging for any engineering education research because there are everybody you know is a instructor okay. So there are 700 colleagues who do who teach like 3 courses a year and you are one of them. So now suddenly if you say, okay, I know how to teach and I know the pedagogy and you don't know or something or come, I will tell you that doesn't work well. So and a lot of people have a, you know, practitioners understanding of what it is to do education research, you know…so we have to keep talking to them about these levels of engineering education research and to say that okay, this is Level 3 actually we are trying to do at level 5 and you know what exactly is the difference. And a lot of times you know the need for evidence or the generalizability of findings. All those things are often questioned."* This credibility dilemma is particularly conspicuous in the domains of disciplinary and teacher education research, where numerous professionals perceive themselves as authorities, rendering the acknowledgment of EER's distinctive contributions an enduring hurdle. Additionally, the participants emphasize that the recognition of the importance of this research area by individuals and institutions could potentially overcome the barriers created by the lack of funding. This includes performance appraisals, where EER is not emphasized as much as technical research areas. For example, a researcher Mr. Mohan said, *"The weight that is given to the engineering education research. Whether it is in terms of, uh, yeah, the performance appraisals in the formal criteria, wherever the faculty is appraised. Uh, those have not been given priority."* Additionally, the publication opportunities and platforms for EER are comparatively limited when compared to those available for technical research. Due to the limited recognition and priority given to EER, many researchers in India may not be familiar with important practices which could potentially hinder the quality and effectiveness of their research efforts.

6) Theme: EER in India lacks strategic focus and direction

One recurrent theme is the ambiguity surrounding research direction. For example, Dr. Harpreet an EER reseacher mentioned *"Are we kind of like recreating the way things happened at like pretty where US origin, or like, are we trying to figure out what is the need in this case and are we kind of using so, you know, like what are the student aspirations, the needs, the needs of the community, right?"*. Additionally, EER often seems relegated to a secondary or retirement pursuit rather than a primary focus, impacting its perceived importance and the expectations associated with it. For example, Dr. Raghav also, an researcher said, "I care, but I have unfortunately seen this trend, I saw to get engaged in engineering education research and it's almost like a… you know, a retirement kind of a thing that, you know, I know that I don't need to teach or, you know, be doing technical research. I can safely retire and do ER." Altering these attitudes and perspectives poses a considerable challenge.

On a different note, the gap between industry requirements and the development of academic programs was also recognized as a key area needing research and enhancement in the field. For example, Dr. Meenakshi a dean mentioned, *"I always feel like there is not much connection between what the industry wants and what's being developed…I feel like that's something that would be interesting to see and I see a lot of like opportunity and potential in that to be able to kind of bridge that gap or think about research in that area".*

7) Theme: Lack of funding for EER

The lack of sufficient research funding is a significant barrier to advancing EER in India. Adequate funding emerges as a critical factor for advancing EER, while success stories from other regions serve as valuable models. The speakers express a sense of frustration and limitation due to the insufficient funding available for this field compared to other countries like the US. For example, Dr. Rao, an institutional TLC leader and researcher mentioned, *"Money speaks. You look at US right there is so much funding for engineering education research. It is it is unbelievable. I mean, I am in awe of how much money NSF is providing [for EER]."* Another participant leader indicated how it could be frustrating to find no funding even if faculty might be trained for excellence in research in the area. For example, Dr. Gupta an EER practitioner said, "*It is unfortunate that you know, in terms of research money, we don't have enough research money. NITs today have the kind of faculty members, the younger lot in NIT. They are all very well*

https://doi.org/10.52202/073963-0019

trained. These faculty members come from good schools, and they're trained in, you know, top 80s or abroad. You know, these are well trained faculty members, but they don't have [funding]. They go back to NIT, and they don't [find support] they find that there is no research infrastructure. So, they struggle, they struggle, right…and, you know, in research, research is such a thing that if you were not on that train for, three years after that, you can't catch the train. You know it's gone, right?" These examples highlight the need for funding and support for the growth and recognition of EER.

Thus, the barriers encountered by stakeholders in India encompass a lack of a supportive and collaborative research community, insufficient recognition of EER, unfamiliarity with vital research practices, administrative variations among universities, resistance to interdisciplinary collaboration, and limited research funding. These challenges collectively hinder the progress of EER in the country. However, there is potential for growth and improvement of EER through heightened awareness, comprehensive training initiatives, and increased recognition, as elaborated below.

B. Enablers

1) Theme: Motivation to advance engineering education in India

Motivation emerges as a crucial enabler within Engineering Education Research (EER), driving engagement, innovation, and progress. The motivation to engage in EER also originates from a sense of responsibility towards sculpting the students and a desire to contribute to India's educational advancement. For example, Professor Pandit says, *"I am an educator and I think the want and the desire to do engineering research stemmed out of the need to want to be a better [educator]."* Collaborative initiatives, like conferences and workshops, motivated by passionate practitioners, foster engagement, and dialogue within the EER ecosystem. Global collaborations, nurtured by a shared motivation to enhance research quality and impact, enrich the field by exchanging expertise and methodologies. This motivation is exemplified in the initiatives undertaken by individuals like Professor Rohan, who established platforms like Engineering Education Trust and engineering education journals, inspiring active participation. Furthermore, a motivated drive to enhance teaching methodologies and incorporate experiential learning underlines the commitment of faculty members to evolve pedagogical approaches. In essence, motivation emerges as the driving force propelling active contributions, global connections, innovative initiatives, and continuous improvement in teaching practices, collectively shaping the future of EER.

2) Theme: Institutional recognition of EER activities

Institutional support plays a significant role in enhancing the growth and development of EER by encouraging faculty engagement with EER. By recognizing EER achievements in faculty appraisals and career progression, institutions could validate the significance of this field and motivate educators to actively contribute to it. Such recognition not only benefits individual researchers but also elevates the status of EER within the academic community. It also facilitates collaboration and networking within the EER community. For example, Dr. Kalawati an EER researcher said, *"Institutional support first of all comes from the leadership and the leadership has to prioritize in terms of what is it that they need and be aware of the needs as well."* By organizing seminars, workshops, and conferences focused on EER, institutions can foster a vibrant ecosystem where researchers exchange ideas, share insights, and collaborate on joint projects. This collaborative environment not only enriches research quality but also helps in disseminating findings effectively.

3) Theme: Acknowledgment of EER by engineering community in India

While the initial lack of recognition from both individuals and institutions presented a notable barrier, it's crucial to underscore that acknowledging the importance of EER has the potential to evolve into a potent enabler. Recognizing and valuing EER can help in its development and impact in shaping more effective practices in engineering education. Hence, acknowledgment is an enabler because it emphasizes the importance of changing prevailing attitudes towards EER. By altering the perception that EER is somehow less significant or less serious than technical research, there is an opportunity to create a more supportive environment that recognizes the value and impact of EER. Professor Prakash mentions, "*Research can be done on what should be the appraisal for faculty, HR related. What will be the best method to do the appraisal of faculty so that they continuously learn then?".* This shift in mindset can motivate researchers and institutions to invest more in EER, ultimately fostering its growth and impact in India's educational landscape.

4) Theme: EER Community for Capacity Building and Collaborations

The network plays a pivotal role in enhancing EER endeavors through its multifaceted contributions. Consciously promoting networking facilitates knowledge exchange, enabling global collaborations, offering publication avenues, and fostering active participation in conferences and workshops. Additionally, the alumni network creates an enriched environment for research growth. This platform not only addresses the potential isolation that can arise from the institution's small size but also serves as a medium for maintaining connections, sharing experiences, and engaging in insightful discussions. This collaborative atmosphere is nurtured by the regular interactions maintained with alumni, who bring diverse expertise from various industries and research fields. For example, Teaching and Learning center head- Dr. Ram said, *"Since we are small and people are likely to get isolated, so what we have very consciously done is to set*

https://doi.org/10.52202/073963-0019

up a very strong alumni network. So, we keep interacting with our alumni. They come and give guest lectures in our courses and then we do have meetings with them". Moreover, the network's impact extends to education as well, with former students providing guest lectures that infuse real-world insights, industry trends, and relevant case studies into the learning experience. This dynamic transfer of knowledge becomes especially valuable for research aimed at bridging academia and industry.

5) Theme: Technology based research

Technology-based research serves as a significant enabler within the field of EER. It catalyzes transformative shifts in teaching and learning methodologies. The realization that technology is not merely a tool for course transmission, but also a medium for innovative research, propels institutions to explore its diverse applications. For example, researcher Dr. Rishabh says, *"I'm always interested in using technology in interesting ways. That's one of the things that I always look for in the work that I do. Like what can we do in this kind of interesting moment where technology has become more accessible.*" - showing his excitement towards technology and his acceptability towards the same in EER. He expresses a strong interest in utilizing technology in creative ways and conveys excitement about its potential applications. Similarly, if encouraged, the integration of technology with pedagogical innovation can drive institutions to contemplate the initiation of programs like PhDs to further investigate these intersections. The inclination towards technology is also reflective of a forward-looking approach, seeking to harness its accessibility and potential to redefine educational spaces. By leveraging technology creatively, educators can cultivate engaging learning environments and foster a sense of belonging. This visionary stance fosters a departure from traditional gap-filling approaches and embraces future-oriented perspectives. The fusion of technology and pedagogy not only transforms educational ecosystems but also extends its impact to institutional rankings. The ability to virtually conduct interviews or classroom sessions is a testament to technology's role in facilitating remote learning experiences. Overall, technology-based research introduces dynamic possibilities, reshaping teaching paradigms, enhancing engagement, and amplifying the role of institutions in driving educational advancements.

6) Theme: National Education Policy (NEP) 2020

As universities shift their focus towards research, there is a concern that attention to teaching-learning might diminish. Striking a balance between teaching and research is crucial, and this is where policies come into play at both institutional and national levels. Policies can guide how much emphasis is given to research while still valuing effective teaching. Policies can be enabling to support those who want to teach core engineering subjects, at the same time incentivize to pursue research in engineering education. This two-fold approach aligns with the interest of external factors like governments, who see value in research to inform policies and educational practices. This alignment validates the efforts of engineering education researchers. The national education policy's focus on employability skills and multidisciplinary education serves as an enabler in EER by promoting curriculum enhancements and interdisciplinary approaches to better prepare engineering students and promote holistic development. For example, Professor Chattopadhyay an institutional leader says, *"the next big thing that is happening is national education policy where, you know, it talks about employability skills of the undergraduate engineers and multidisciplinary education leading to holistic development of individuals*." With the backing of policies and growing enthusiasm, institutions are encouraged to implement such initiatives. Collaborations like Indo Universal Collaboration for Engineering Education (IUCEE) further contribute to creating platforms for these efforts. These enablers collectively can pave the way for a thriving an impactful EER ecosystem in India.

The enablers` collectively show the path towards enhancing the quality and effectiveness of engineering education with a plus hand of overcoming the barriers mentioned there as well. The proactive promotion of a research culture, adequate funding support, collaborative networks, innovative teaching practices, the incorporation of technology, and effective dissemination mechanisms collectively contribute to the advancement of EER.

V. DISCUSSION

The themes presented in the results section can be categorized into three levels – personal, institutional, and policy level, as shown in figure 1. At personal level, it's crucial to acknowledge that the barriers faced by engineering education researchers in India are multifaceted and demand strategic attention for the field to thrive. These challenges encompass a limited collaborative community due to minority representation, unfamiliarity with vital research practices, resistance to interdisciplinary collaboration, and the interdisciplinary nature of EER. Despite these challenges, many Indian faculty members recognize the intrinsic value of EER and are self-motivated to become better teachers, which drives them to conduct EER, as mentioned for other global counterparts in literature (Kittur et al., 2020). Faculty members, regardless of their backgrounds, are actively engaging in this field, showcasing the potential of EER to revolutionize engineering education and foster inclusivity.

Moving to the institutional level, we find that support from institutions is pivotal. This includes active encouragement for research in the engineering education domain (Kandakatla et al., 2018), funding opportunities, recognition in appraisal policies, and the acceptance of publications in the EER domain as equivalent to other engineering disciplines for promotion. Additionally, a balanced focus on both teaching and research

https://doi.org/10.52202/073963-0019

initiatives, rather than being solely teaching-centric, is crucial to help the EER community grow in India and ensure that all faculty members can contribute effectively.

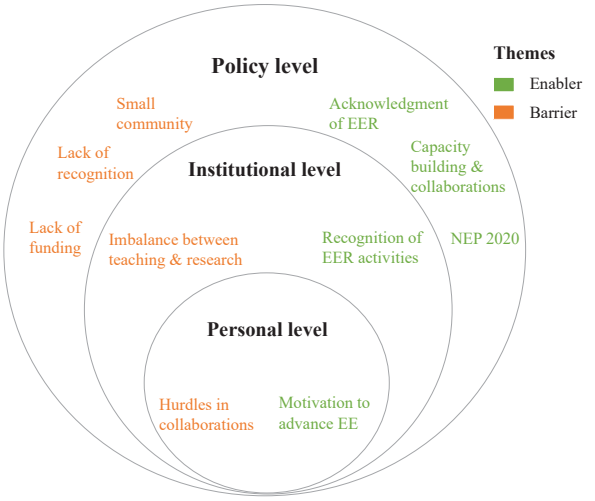

Figure 1: Barriers (orange) and enablers (green) at Personal, Institutional and Policy level identified from data analysis.

Collaborations through professional societies and international partnerships, provide avenues for networking, knowledge transfer, and joint research efforts, enhancing the overall impact of engineering education research and promoting a diverse and inclusive research community (Delaine et al., 2018). Early efforts in this direction, such as blended certification programs focused on building EER capacity among engineering faculty in India (Nagabhushan & Sohoni, 2020), highlight the commitment to inclusivity and capacity building.

To foster Engineering Education Research (EER) in India at the policy level, a comprehensive strategy must address various vital themes. First and foremost is the imperative recognition of EER's significance within academia, supported by incentives and acknowledgment at both policy and institutional levels. Second, the need to cultivate a larger EER community necessitates policies that encourage networking and collaboration among practitioners across institutions. Communities of practice particularly have been reported to enable growth of ecosystems that could contribute to large-scale change (Kandakatla & Palla, 2020). Third, addressing the scarcity of funding opportunities for EER projects requires dedicated resources and grants. Furthermore, identifying, and prioritizing EER focus areas, guided by the National Education Policy (NEP) of 2020, can ensure relevance and growth. Lastly, facilitating faculty transitions from traditional engineering roles to EER-focused positions through capacity-building efforts is crucial. These approaches, as emphasized by (Vijaylakshmi et al., 2022), collectively promote the development and impact of EER in India, ultimately contributing to enhanced engineering education quality, equity, and national development objectives.

These findings underscore that addressing the multifaceted barriers to EER in India requires action at personal, institutional, and policy levels. A concerted effort from all stakeholders, including institutions, policymakers, and researchers, is necessary to overcome these challenges and leverage enablers for the advancement of EER in India. The key takeaway message for all stakeholders is the need for community, collaboration, focused efforts, capacity building, recognition, and support for EER to improve the quality of engineering education in the country.

VI. CONCLUSION

In conclusion, our study's findings, while aligning with existing knowledge in several aspects, offer specific insights into the barriers and enablers of EER within the Indian context. Our findings emphasize the multifaceted nature of the challenges confronting EER in India, encompassing conceptual clarity, perceptions, financial support, and alignment with industry needs. A call for proposals with specific themes that have priority could remove this ambiguity in defining and prioritizing EER efforts in India. This comprehensive analysis of the challenges and opportunities within the Indian EER landscape contributes to a deeper understanding of the field, providing valuable guidance for future research and policy initiatives aimed at enhancing engineering education in the country. Our discussion effectively bridges these findings with the existing literature, emphasizing the critical need to address these barriers and harness the identified enablers at personal, institutional, and policy levels to promote EER and elevate the quality of engineering education in India. In a resource-constrained, and infrastructure-constrained environment of a developing country of India, EER can provide benefit to Indian researchers to make their mark using the unique Indian engineering educational landscape and many unexplored research areas. However, many barriers that are currently hindering this effort, include lack of funding, lack of institutional support in recognizing EER at par with other research areas in engineering, minimal awareness about suitable approaches and correct research methodologies for EER, lack of focus in research questions specific to India's educational system, missing a supportive ecosystem, incentives, platforms for disseminating high-quality EER and a poor mindset for appreciating EER engagement of stakeholders.

Overall, funding, fostering collaborations within and outside India with people doing EER, cross-disciplinary collaborations and learning from diverse colleagues facilitated via conferences, industry engagement to drive technology-based research in engineering education, external validation, and a shifting mindset could be additional pivotal forces propelling

Proceedings of REES 2024 KLE Technological University, Hubballi, India, Copyright © Pallavi Meshram, Rucha Joshi*, Rohit Kandakatla, Shreel Prasad, Mayanglambam Pooja Devi, and Ashish Agrawal <Enablers and barriers for Engaging in Engineering Education Research in India >2024

https://doi.org/10.52202/073963-0019

EER's growth and enhancing its contribution to India's educational landscape. However, it is important to acknowledge the limitations of this study. The research sample consisted of a relatively small group of 18 participants, all of whom were from India. Furthermore, the gender diversity within the sample was limited, with only 4 female participants. This restricted sample size and gender imbalance may impact the generalizability of the findings to a broader population. In future EER studies, efforts should be made to include a more diverse and representative sample, both in terms of numbers and demographic characteristics, to enhance the robustness of research outcomes.

ACKNOWLEDGMENT

The authors declare that they have no conflict of interest. Authors would like to thank all the participants including the Teaching and Learning Center Heads, Engineering education researchers, Practitioners, and Leaders of various engineering institutes for giving their insights and time in the interview. We would also like to thank Plaksha University for providing us technical support with Microsoft Teams software with transcription feature for conducting the interviews.

REFERENCES

Beddoes, K. D., Jesiek, B. K., & Borrego, M. (2010). Identifying Opportunities for Collaborations in International Engineering Education Research on Problem- and Project-Based Learning. *Interdisciplinary Journal of Problem-Based Learning*, *4*(2). https://doi.org/10.7771/1541-5015.1142

Bernhard, J. (2018). Engineering Education Research in Europe–coming of age. In *European Journal of Engineering Education* (Vol. 43, Issue 2, pp. 167–170). Taylor & Francis.

Borrego, M., & Bernhard, J. (2011). The Emergence of Engineering Education Research as an Internationally Connected Field of Inquiry. *Journal of Engineering Education*, *100*(1), 14–47. https://doi.org/10.1002/j.2168-9830.2011.tb00003.x

Borri, C., & Maffioli, F. (Eds.). (2008). *Re-engineering Engineering Education in Europe* (1st ed., Vol. 39). Firenze University Press. https://doi.org/10.36253/978-88-8453-676-1

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brodie, L., Bullen, F., & Gibbings, P. (2011). Developing an engineering education research culture. *2011 IEEE Global Engineering Education Conference (EDUCON)*, 214–219.

Buckley, J., Wallin, P., Matemba, E., Power, J., Mohanty, A., & Bombaerts, G. (2023). The Future of Engineering Education Research. In *International Handbook of Engineering Education Research* (pp. 711–729). Routledge.

Burbules, N. C., & Torres, C. A. (2000). *Globalization and education: Critical perspectives*. Routledge.

Chen, Y., Nixon, M. R., Gupta, A., & Hoshower, L. (2010). Research productivity of accounting faculty: An exploratory study. *American Journal of Business Education (AJBE)*, *3*(2), 101–115.

Council, N. R. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.

Cresswell, K. M., Worth, A., & Sheikh, A. (2012). Integration of a nationally procured electronic health record system into user work practices. *BMC Medical Informatics and Decision Making*, *12*, 1–12.

Dart, S., Seniuk Cicek, J., & Sohoni, S. (2023). REES AAEE special issue on engineering education research capability development: Introduction by guest editors. *Australasian Journal of Engineering Education*, *28*(1), 2–7. https://doi.org/10.1080/22054952.2023.2231768

Delaine, D. A., Cukierman, U., Kandakatla, R., Morell, L., & DeBoer, J. (2018). Leveraging Professional Networks for an Equitable, Smart Society—A Case Study on the International Federation of Engineering Education Societies. In M. E. Auer & K.-S. Kim (Eds.), *Engineering Education for a Smart Society* (pp. 237–252). Springer International Publishing.

Duschl, R. A., & Bybee, R. W. (2014). Planning and carrying out investigations: An entry to learning and to teacher professional development around NGSS science and engineering practices. *International Journal of STEM Education*, *1*(1), 1–9.

Edström, K., Kolmos, A., Malmi, L., Bernhard, J., & Andersson, P. (2018). A bottom-up strategy for establishment of EER in three Nordic countries–the role of networks. *European Journal of Engineering Education*, *43*(2), 219–234.

Feiman-Nemser, S. (1989). *Teacher preparation: Structural and conceptual alternatives*. National Center for Research on Teacher Education.

Gardner, A., & Willey, K. (2018). Academic identity reconstruction: The transition of engineering academics to engineering education researchers. *Studies in Higher Education*, *43*(2), 234–250. https://doi.org/10.1080/03075079.2016.1162779

Godfrey, E., & Hadgraft, R. (2009). Engineering education research: Coming of age in Australia and New Zealand. *Journal of Engineering Education*, *98*(4), 307–308.

Haigh, N., Gossman, P., & Jiao, X. (2011). Undertaking an institutional 'stock-take'of SoTL: New Zealand university case studies. *Higher Education Research & Development*, *30*(1), 9–23.

Jesiek, B. K., Newswander, L. K., & Borrego, M. (2009). Engineering education research: Discipline, community, or field? *Journal of Engineering Education*, *98*(1), 39–52.

Johri, A., & Olds, B. M. (2014). *Cambridge handbook of engineering education research*. Cambridge University Press.

Kamp, A. (2020). Navigating the landscape of higher engineering education. *Education*, *2*, 115ce70ecb98.

Kandakatla, R., Goldenstein, A., Evenhouse, D. A., Berger, E. J., Rhoads, J. F., & Deboer, J. (2018, June 23). *MEERCat: A Case Study of How Faculty-led Research Initiatives Gave Rise to a Cross-departmental Research Center with Potential to Inform Local Policy*. 2018 ASEE Annual Conference & Exposition. https://peer.asee.org/meercat-a-case-study-of-how-faculty-led-research-initiatives-gave-rise-to-a-cross-departmental-research-center-with-potential-to-inform-local-policy

Kandakatla, R., & Palla, A. (2020). Role of Community of Practice (CoP) to Facilitate Change in STEM Instructional Practices through Faculty Development Programs. *2020 IFEES World*

Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC), 1–5. https://doi.org/10.1109/WEEF-GEDC49885.2020.9293660

Kittur, J., Coley, B. C., & Kellam, N. N. (2020). Understanding how novice Indian faculty engage in engineering education research. *2020 ASEE Virtual Annual Conference Content Access*.

Klein, C., Lester, J., Rangwala, H., & Johri, A. (2019). Learning analytics tools in higher education: Adoption at the intersection of institutional commitment and individual action. *The Review of Higher Education*, *42*(2), 565–593.

Ko, M., Mirabelli, J. F., Barlow, A. J., Jensen, K. J., & Cross, K. J. (2021). Faculty motivations and barriers for engineering education research. *American Society for Engineering Education Annual Conference*.

Lohmann, J., & Froyd, F. (2010). Chronological and ontological development of engineering education as a field of scientific inquiry. *Second Meeting of the Committee on the Status, Contributions, and Future Directions of Discipline-Based Education Research, Washington, DC. Available: Http://Www7. Nationalacademies. Org/Bose/DBER_Lohmann_Froyd_October_Paper. Pdf*.

McKinney, K. (2002). The scholarship of teaching and learning: Current challenges and future visions. *Remarks Presented at the Ceremony to Install the Cross Chair in the Scholarship of Teaching and Learning at Illinois State University. Accessed May*, *10*, 2010.

Mehta, P., & Berdanier, C. (2019). A Systematic Review of Additive Manufacturing Education: Toward Engineering Education Research in AM. *2019 ASEE Annual Conference & Exposition Proceedings*, 32006. https://doi.org/10.18260/1-2--32006

Nagabhushan, P., & Sohoni, S. (2020). An Introductory Course on Research in Engineering Education- An experiment in training faculty in India. *2020 IEEE Frontiers in Education Conference (FIE)*, 1–7. https://doi.org/10.1109/FIE44824.2020.9273918

National Academies of Sciences, E. (2018). *The integration of the humanities and arts with sciences, engineering, and medicine in higher education: Branches from the same tree*.

Smith, B., & McGannon, K. R. (2018). Developing rigor in qualitative research: Problems and opportunities within sport and exercise psychology. *International Review of Sport and Exercise Psychology*, *11*(1), 101–121.

Streveler, R. A., Brown, S., Herman, G. L., & Montfort, D. (2015). Conceptual change and misconceptions in engineering education: Curriculum, measurement, and theory-focused approaches. In *Cambridge handbook of engineering education research* (pp. 83–102). Cambridge University Press.

Streveler, R. A., & Smith, K. A. (2010). From the margins to the mainstream: The emerging landscape of engineering education research. *Journal of Engineering Education*, *99*(4), 285–287.

Valero, M. (2022). Challenges, difficulties and barriers for engineering higher education. *Journal of Technology and Science Education*, *12*(3), 551. https://doi.org/10.3926/jotse.1696

van Hattum-Janssen, N., Williams, B., & de Oliveira, J. N. (2015). Engineering education research in Portugal, an emerging field. *International Journal of Engineering Education*, *31*(2), 674–684.

Vijaylakshmi, M., Kandakatla, R., Baligar, P., Joshi, G., & Shettar, A. (2022). Design of Research Canvas to align Research Efforts at Engineering Education Research Centre in India. *2022 IEEE Global Engineering Education Conference (EDUCON)*, 844–849. https://doi.org/10.1109/EDUCON52537.2022.9766458

Wankat, P. C., Felder, R. M., Smith, K. A., & Oreovicz, F. S. (2002). The scholarship of teaching and learning in engineering. *Disciplinary Styles in the Scholarship of Teaching and Learning: Exploring Common Ground*, 217–237.

Wenger, E., Trayner, B., & De Laat, M. (2011). *Promoting and assessing value creation in communities and networks: A conceptual framework*. Rapport.

Wisnioski, M. (2015). What's the use? History and engineering education research. In *Journal of Engineering Education* (Vol. 104, Issue 3, pp. 244–251). Wiley Online Library.

APPENDIX

Appendix I - Interview questionaire.docx