Engineering Educators' Adoption and implementation of Project-Based Learning: Experiences from a South Indian University

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***Abstract*—This research investigates the attitudes and perceptions of engineering educators in Kerala, India, towards the implementation of Project-Based Learning (PjBL) within the framework of APJ Abdul Kalam Technological University (APJAKTU), Kerala. Despite the growing emphasis on experiential learning, only limited research studies focus on understanding the attitudes and perceptions of engineering faculty members towards PjBL. Against this backdrop, the present study aims to critically examine the readiness of engineering educators in adopting and identifying PjBL strategies for its effective integration into engineering curricula. The paper explores various dimensions of engineering educators' engagement with PjBL, including faculty interest levels, satisfaction of implementation, perceived effectiveness, and career implications. The data were collected from engineering faculty members by distributing a comprehensive questionnaire titled Project-Based Learning in Engineering Education in Kerala (PLEEK), uniquely designed by the researchers. The research findings reveal that over 90% of the surveyed faculty members have shown keen interest in implementing PjBL, while the remaining respondents exhibited a neutral stance. This underscores a noteworthy receptivity to PjBL among engineering educators in Kerala. Suggestions from participants indicate that, if implemented correctly, PjBL would be highly effective, although time constraints pose a significant challenge. The results obtained are pivotal as they provide an explicit idea of the current status of the engineering education settings and the discrepancies between traditional theoretical instruction and project-based learning.**

***Index Terms*—Engineering Education, Engineering Educators, Engineering Pedagogy, Experiential Learning, Project-Based Learning (PjBL)**

I. Introduction

In recent years, the landscape of engineering education has witnessed a significant paradigm shift, moving away from traditional lecture-based instruction towards more interactive, experiential learning approaches. Among these, PjBL has emerged as a promising pedagogical method, emphasizing student-centered, inquiry-driven learning experiences aimed at developing critical thinking, problem-solving skills, and collaborative abilities. PjBL immerses students in real-world, interdisciplinary projects, where they apply theoretical knowledge to solve authentic problems, nurturing deeper understanding and retention of concepts.

Within the context of APJ Abdul Kalam Technological University (APJAKTU), which oversees the engineering curriculum across the state of Kerala, India, there exists a pressing need to assess the readiness of engineering educators to adopt PjBL practices. As engineering education evolves to meet the demands of a rapidly changing technological landscape and industry expectations, it becomes imperative to explore faculty attitudes towards innovative teaching methods like PjBL, which have the potential to enhance student engagement, learning outcomes, and workforce readiness.

II. Literature Review

Project-based learning offers a distinct advantage over traditional methods by enhancing students' abilities to tackle real-world challenges and think innovatively to find solutions. It encourages the application of theoretical knowledge to practical problems, thereby deepening understanding and retention [1]. In this highly competitive era, the skills and knowledge that today's youth possess will undoubtedly shape the future of our societies [2]. PjBL can cultivate the essential skills for youth such as teamwork, communication, and collaboration, which are crucial for engineering students to thrive in the industry [3]. It also helps in the development of educational resources, methodology of teaching, curriculum improvement and evaluation procedures [4]. Project Work (PW) is one of the learner-centered pedagogical approaches used to engage learners in active and collaborative learning in PjBL. It offers students the opportunity to explore the inter-relationships and inter-connectedness of subject-specific knowledge and to apply

synthesized knowledge critically and creatively to real-life situations. It helps students to have a better understanding of the concept and gain practical knowledge [5], [6].

While PjBL offers numerous advantages, educators may encounter barriers during its implementation, including curriculum constraints, assessment challenges, and resistance to change [7]. In the initial stages of implementing PjBL, teachers may have negative experiences, including anxiety, doubts, and frustration [8]. Addressing these issues require careful planning, collaboration, and ongoing support from stakeholders at all levels of the educational system. Furthermore, evaluating PjBL projects require specific methods distinct from traditional assessment approaches [9]. PjBL has been associated with positive student outcomes, including improved academic performance, increased motivation, and enhanced problem-solving abilities [10]. Projects can capture students' interests, provoke serious thinking, and enable students to apply their knowledge in a problem-solving context [11], [12]. Thus, project-based learning creates favorable conditions for initiative and enhances motivation to learn while enabling students to experience the freedom of creation and assume responsibility for their own activities [13]. In the engineering discipline, the effectiveness of learning is measured by how well students can foster a deep understanding of fundamental concepts and principles. PjBL excels in these areas by providing a comprehensive approach to education that emphasizes not only the acquisition of theoretical knowledge but also the practical application of skills [14].

The traditional method involves a more dominant role for the teacher in the learning process rather than understanding concepts. It focuses much more on memorization and repetition of topics. On the other hand, in the PjBL method, students are given much more analytical and meaningful problems. This lays the foundation for students to think critically and formulate questions. In this approach, the teachers can support the students in solving the problems. They assume more of a supporting role which helps to strengthen the bond between the student and the teacher. It further accelerates the improvement that can occur in the student. For this to happen, universities should understand the importance of teacher professional development in preparing educators for the challenges of implementing PjBL [15]. Effective training programs provide teachers with the necessary skills, knowledge, and support to design and facilitate PjBL activities effectively [16]. Additionally, there is a need for adequate time, support, and resources for effective implementation of Project-Based Learning into the curriculum in educational settings [17]. While PjBL can significantly enhance academic outcomes, it is not necessary to replace traditional teacher-initiated instruction (TI) entirely. The potential of combining PjBL with traditional teaching methods can offer a more rounded educational experience, particularly in areas where foundational knowledge is crucial [18].

In the context of engineering education in Kerala, only limited research has been conducted on the perceptions and attitudes of teachers towards PjBL implementation. Given the unique socio-cultural and educational landscape of Kerala, it is essential to explore the factors influencing educators' readiness to adopt PjBL and identify strategies to support its effective implementation in engineering curricula.

III. SIGNIFICANCE OF THE STUDY AND RESEARCH OBJECTIVE

This study holds significant promise in shaping the future of engineering education through the effective implementation of PjBL. PjBL offers transformative opportunities for both students and educators by providing immersive, hands-on learning experiences that foster critical thinking, problem-solving skills, and collaboration. Moreover, PjBL empowers educators to create more engaging and interactive classroom experiences, bridging the gap between theory and application. In essence, this research has the potential to revolutionize engineering education, empowering students to excel academically, secure meaningful employment, and contribute meaningfully to society. The questionnaire holds significance as a key tool for capturing and understanding the attitudes and perceptions of engineering educators towards Project-Based Learning (PjBL). It provides valuable insights into faculty readiness and receptivity towards PjBL practices, informs strategic decision-making, and guides the development of interventions to support its effective implementation. The objectives of this study were a) to explore the interest level of educators in integrating PjBL into their courses, b) to comprehend its capacity to promote lifelong learning skills and student autonomy c) to analyze the perceived strengths and weaknesses of PjBL in engineering education and d) to examine how receptive are the students and educators to PjBL compared to traditional teaching methods.

IV. METHODOLOGY

A combination of qualitative and quantitative analysis methods was employed for this study. The research was based on the analysis of a comprehensive questionnaire titled Project-Based Learning in Engineering Education in Kerala (PLEEK), which comprised five sections and was utilized to analyze the attitudes and perceptions of engineering teachers in Kerala towards Project-Based Learning (PjBL). Data collection was facilitated through both online and offline modes, ensuring participation from engineering faculties across the state.

A. Participants

The questionnaire was designed to gather data on participants' attitudes and perceptions towards PjBL integration. Responses to each question were rated on a five-point Likert scale to determine their relevance based on the importance of the question. Following a pilot study to assess the feasibility of the research design, the questionnaire was distributed to engineering faculties through the network of IEEE Organizational Units (OUs). Additionally, the questionnaire included an open-ended question for suggestions, opinions, and comments on the

theme. The study population comprised engineering faculty members from diverse institutions and disciplines affiliated with APJAKTU. The faculty members who participated in the study include professors, associate professors, and assistant professors from various engineering departments.

B. Research Instrument

A questionnaire was prepared using a five-point Likert scale. The collection of data was conducted using both Google Forms for the online responses and the physical distribution of questionnaires in various colleges for the offline responses (N=56). The questionnaire consisted of 24 questions which is divided into five sections. Four questions were demographic, while the remaining 20 were evenly distributed across four sections. The questions focused on a) demographic information of the participants, b) their interest and satisfaction regarding the integration of PjBL into the curriculum, c) its effectiveness and impact on student learning outcomes, engagement, and skill development, d) career implications of adopting PjBL practices and their role in fostering lifelong learning among students, and e) the overall reception of PjBL and perceptions regarding its feasibility, challenges, and potential benefits.

C. Data Analysis

The responses collected through the questionnaire were analyzed using both quantitative and qualitative methods. Quantitative analysis involved using statistical techniques to quantify participants' responses and identify patterns or trends. Qualitative analysis entailed thematic coding of open-ended responses to extract deeper insights into participants' attitudes and perceptions towards PjBL integration. The average mean of the responses was taken to analyze the data. The researchers also employed various statistical tools like percentage analysis, descriptive statistics and graphical analysis to analyse the collected data.

V. Results and Findings of the Study

This section presents a detailed analysis of the responses from the 56 participants regarding their perceptions and attitudes towards Project-Based Learning (PjBL) in the context of engineering education in Kerala. The findings are structured around key thematic areas, followed by a discussion that integrates insights from existing literature. The participants in this survey were engineering faculty members from various academic positions and educational backgrounds. The majority of the respondents were Assistant Professors (72.7%), followed by Professors (16.4%) and Associate Professors (10.9%). Most respondents held M. Tech. degrees (61.8%), while others had Ph.D. degrees (25.5%) and M.Sc. degrees (7.3%). The data were primarily collected from engineering departments such as Computer Science and Engineering (21.4%), Electrical and Electronics Engineering (14.2%), and Electronics and Communication Engineering (14.3%). Other engineering departments also contributed to the study. In terms of gender, the majority of respondents were female (75.9%), with males comprising 24.1%.

Interest in Project-Based Learning (PjBL) was strong among faculty, with 45.5% highly interested and 52.7% interested in integrating it into their courses, leaving only one respondent neutral. While 50.9% were satisfied with institutional support for PjBL, only 14.5% were highly satisfied, and a notable 29.1% remained neutral, with 5.5% dissatisfied, indicating a need for better support. Time constraints were a significant barrier, with 45.5% viewing it as a moderate constraint and 40% as a significant constraint. Opinions on the curriculum's support for PjBL were mixed, with 60% feeling it was promoting or highly promoting, 29.1% neutral, 5.5% hindering, and 5.5% seeing it as highly hindering. Satisfaction with professional development opportunities among engineering faculty was low, with 14.5% dissatisfied or highly dissatisfied, 31% neutral, and only 55.3% satisfied or highly satisfied. These findings align with the literature, emphasizing the need for adequate time, resources, and institutional support for effective PjBL implementation. The strong interest in PjBL highlights its acknowledged advantages in enhancing real-world problem-solving skills and fostering innovative thinking. However, the dissatisfaction with professional development opportunities among engineering faculty underscores the need for extensive training programs to equip them with the skills necessary to implement PjBL.

An overwhelming majority (92.7%) of respondents perceived Project-Based Learning (PjBL) as highly effective or effective in enhancing learning outcomes, with none finding it ineffective. Almost all respondents (96.4%) agreed or highly agreed that PjBL enhances student engagement, making learning more interactive. Furthermore, 96.4% believed PjBL enhances or highly enhances critical and higher-order thinking skills, while 98.2% viewed it positively for fostering teamwork and collaboration. Additionally, 92.8% deemed PjBL effective or highly effective in improving communication skills. These positive perceptions align with existing research that highlights PjBL's advantages over traditional teaching methods. The emphasis on teamwork, communication, and critical thinking in PjBL matches the skills required in the modern engineering industry, supporting the notion that PjBL significantly enhances the educational experience and prepares students for their professional careers.

PjBL was seen as effective or highly effective in addressing industry-relevant skills by 94.5% of respondents, with 5.5% neutral. It was viewed positively for promoting lifelong learning by 94.5% of respondents, though 5.5% were neutral. The promotion of student autonomy through PjBL was highly endorsed by 92.8% of respondents, and it was considered highly helpful or helpful in retaining knowledge and concepts by 94.6%. Additionally, all respondents viewed PjBL as highly beneficial or beneficial for students' career prospects. These findings highlight PjBL's effectiveness in fostering crucial skills for lifelong learning and career success in engineering. The positive impact on student autonomy and

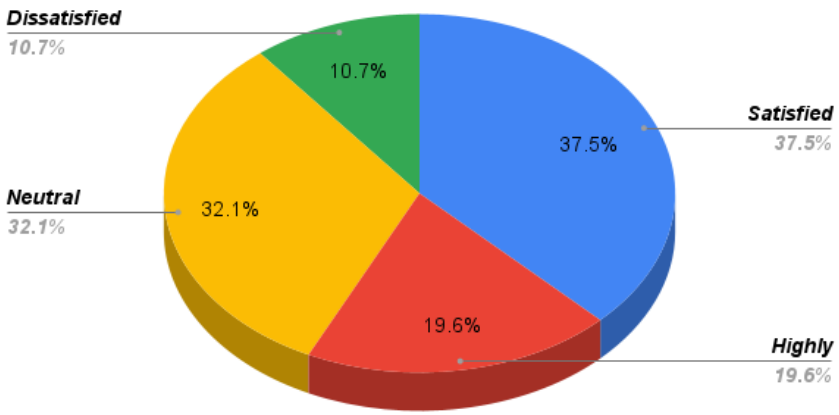

Fig. 1: Average mean satisfaction with support, curriculum, and development opportunities

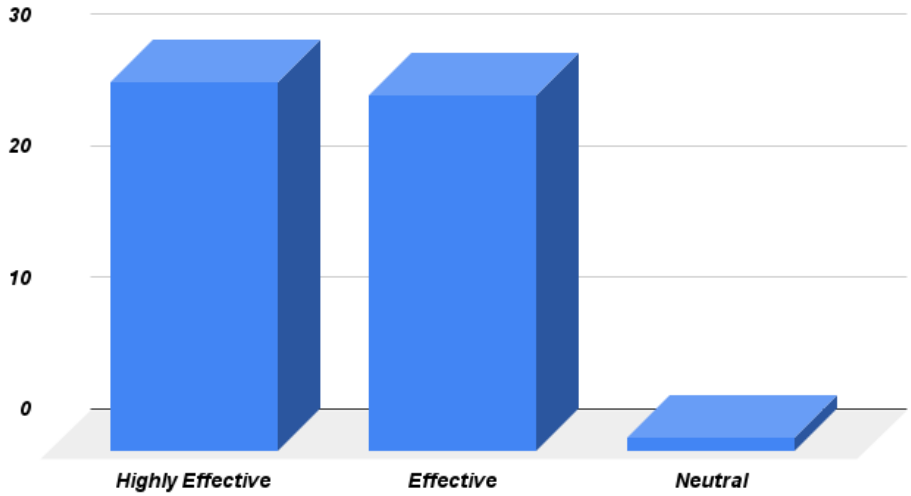

Fig. 2: Mean effectiveness & impact of PjBL on outcomes, engagement, thinking, teamwork, and communication

knowledge retention underscores PjBL's potential to create self-reliant learners better equipped for the challenges of the engineering profession. These outcomes align with the literature, emphasizing the need for educational methods that go beyond traditional rote learning to cultivate practical and critical thinking skills.

Students were perceived as highly receptive or receptive to Project-Based Learning (PjBL) by 89.9% of respondents, with 10.1% neutral. 98.2% of the respondents saw PjBL as highly preparing or preparing students for real-world challenges. 96.4% considered PjBL highly motivating or motivating. Additionally, 94.5% of respondents agreed that PjBL promotes interdisciplinary learning. PjBL was perceived to foster innovation and creativity by 94.5% of respondents, with 5.5% neutral. These findings resonate with the literature, highlighting PjBL's effectiveness in motivating students and preparing them for real-world challenges. The method's ability to promote interdisciplinary learning is critical for developing well-rounded engineers capable of innovative thinking. The positive perceptions regarding innovation and creativity further support the argument that PjBL can significantly enhance the educational experience by encouraging students to think outside the box and apply their knowledge creatively.

VI. Discussion

The key stakeholders in the survey were faculty members from different engineering colleges in Kerala. This study intended to learn more about their attitudes, views, and

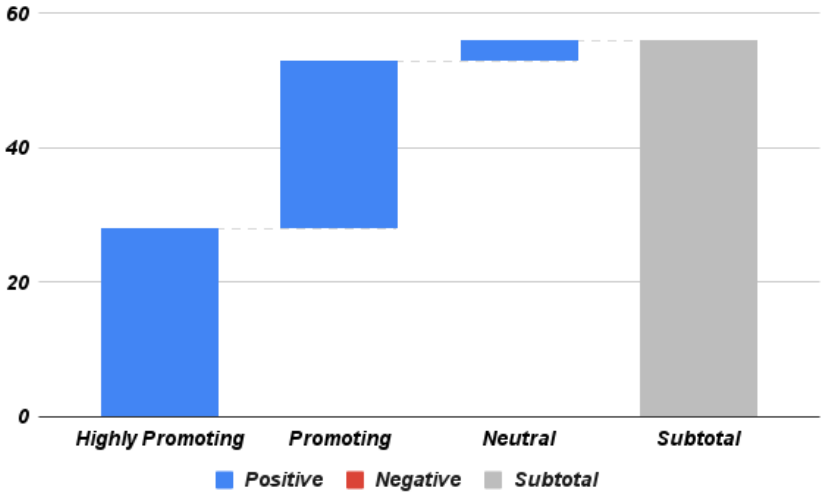

Fig. 3: The effectiveness of PjBL for career & lifelong learning, autonomy, retention, and other prospects

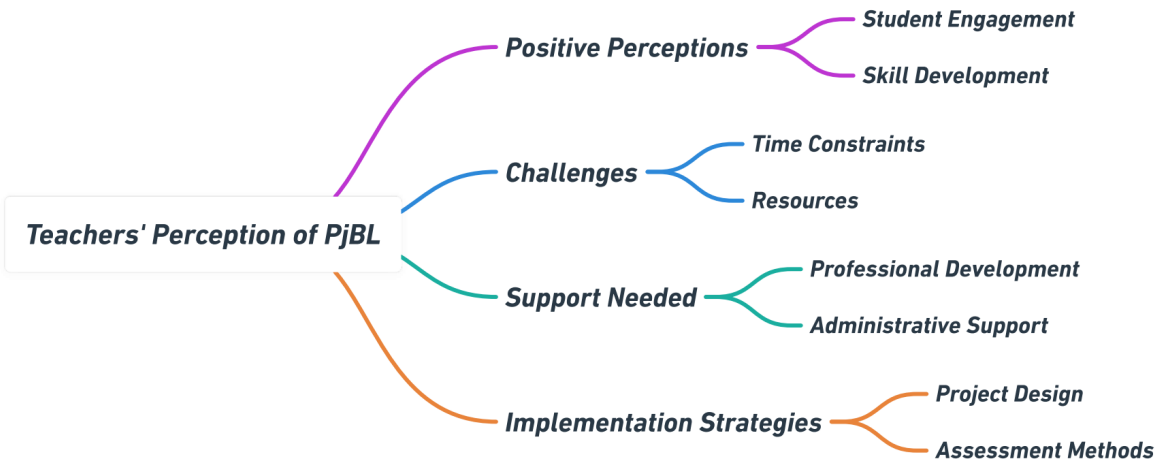

Fig. 4: An overview of teacher's perspectives on PjBL integration

experiences regarding PjBL. Several respondents highlighted the significant benefits of PjBL, including increased student engagement, better conceptual understanding in practice, and improved critical thinking ability, which aligns with existing research [10]. Projects have the power to draw students' interests, encourage critical thought, and let them use what they've learned to solve problems, as confirmed by earlier researches [11,12]. Along with these advantages, the teachers also noted several implementation difficulties, such as lack of assistance, lack of time, and lack of support. Despite the benefits of PjBL, the teachers also encounter obstacles such as curricular limitations, difficulties with assessment, and resistance to change while implementing it, as highlighted in previous researches as pointed out by C.E. Hmelo-Silver, R.G. Duncan, and C.A. Chinn [7]. According to a previous study, teachers may have negative experiences, such as anxiety, doubts, and frustration during the initial stages of implementing PjBL [8]. Despite these challenges, the teachers stated that in order to overcome these obstacles, there should be more institutional support in the form of extensive training programs for the faculty, improved access to facilities and resources, and a well-organized framework for incorporating projects into the curriculum. There is a need for universities to understand the importance of professional development training for engineering educators to overcome the challenges posed by the implementation of PjBL, as emphasized in previous literature [15]. D. Gijbels, F. Dochy, P. Van den Bossche, and M. Segers point out that the implementation of effective

training programs equips teachers with the requisite skills, knowledge, and support to successfully design and facilitate PjBL activities [16]. Aligning with the prior studies of V. Basilotta Gómez-Pablos, M. Martín del Pozo, and A. García-Valcarcel Muñoz-Repiso [17], the current study emphasizes that adequate time, support, and resources are necessary for the successful implementation of project-based learning within the curriculum. The survey's quantitative results revealed a high response rate and a preponderance of favorable input, albeit with notable segments highlighting challenges. The educators indicated many key areas for development, including expanded curriculum flexibility, improved techniques for assessing PjBL outcomes, and improved collaboration between business and academics.

It is evident from the findings that faculty members are highly interested in implementing PjBL in Kerala's engineering curriculum. The study reveals that even though the educators show significant interest, PjBL faces barriers such as time constraints and insufficient professional development opportunities for faculty members. These issues must be addressed effectively in order to facilitate the successful integration of PjBL into the curriculum. The alignment of these findings with existing literature underscores the potential of PjBL to revolutionize engineering education by enhancing student engagement, fostering critical skills, and better-preparing students for their professional careers. Previous studies by R. Blonder and M. Ostergren support the idea that essential industry specific skills like teamwork, communication and collaboration can be developed through PjBL, suggesting a correlation between our findings and prior researches [3]. Additionally, it contributes to the creation of educational resources, the refinement of teaching methodologies, curriculum development, and the improvement of evaluation procedures, consistent with conclusions obtained from the study conducted by A. John [4]. In order to maximize the benefits of PjBL, institutions should focus on providing comprehensive support and resources to educators, and ensure that they are well-equipped to implement this innovative teaching methodology effectively.

A. SUGGESTIONS AND RECOMMENDATIONS

The successful implementation of Project-Based Learning (PjBL) in engineering education necessitates addressing various challenges and leveraging the enthusiasm of educators. The following suggestions and recommendations are based on the analysis of faculty responses. It aims to provide a structured approach in integrating PjBL effectively within the curriculum. By addressing these points, institutions can enhance the educational experience and outcomes for engineering students.

- **Promote PjBL Interest and Engagement Among Engineering Educators**: A significant number of educators have demonstrated a keen interest in the implementation of Project-Based Learning (PjBL). This enthusiasm reflects the recognition of PjBL's potential to enhance student engagement and learning outcomes. Institutions should capitalize on this interest by providing opportunities for teachers to engage in professional development programs focused on PjBL methodologies.
- **Addressing the Challenge of Short Semesters**: A common concern among educators is the limited duration of academic semesters, which can impede the effective implementation of PjBL. To mitigate this issue, it is recommended that PjBL be introduced in a phased manner, initially integrating smaller-scale projects that align with the existing curriculum framework. Furthermore, academic institutions should consider revising the academic calendar or providing more flexible scheduling options to accommodate the demands of PjBL activities.
- **Ensuring Effective Implementation of PjBL**: The efficacy of PjBL is contingent upon its proper implementation. Therefore, it is essential to offer comprehensive training and professional development programs for educators. These programs should encompass the design and facilitation of PjBL activities, assessment of project outcomes, and management of classroom dynamics. Institutions can guarantee the successful implementation of PjBL by providing educators with the required training and resources.
- **Supporting First-Time Implementers**: Many teachers have not previously utilized PjBL in their teaching practices, leading to uncertainties about its effectiveness and implementation. To support these educators, institutions should establish robust support systems, including mentorship programs, collaborative planning sessions, and resource-sharing platforms. These initiatives will provide teachers with the guidance and confidence needed to effectively integrate PjBL into their courses.
- **Integrating Theory with Practical Projects**: Some educators advocate for a hybrid approach that combines traditional theory-based instruction with project-based activities. This model ensures that students receive a solid foundation of theoretical knowledge while also engaging in practical, real-world applications of their learning. Institutions should explore curriculum designs that balance theoretical instruction with project-based learning to optimize educational outcomes.
- **Provision of Institutional Support and Resources**: The successful implementation of PjBL requires adequate institutional support, including access to necessary resources, technology, and materials. Academic institutions should invest in these areas and establish dedicated support teams to assist teachers in incorporating PjBL into their curricula. Providing these resources will facilitate a smoother transition and more effective implementation of PjBL methodologies.
- **Continuous Evaluation and Feedback**: To continuously improve PjBL practices, it is imperative to establish mechanisms for ongoing evaluation and feedback. Regular surveys, focus groups, and feedback sessions with

both educators and students can help identify challenges, share best practices, and make necessary adjustments. This iterative process will ensure that PjBL remains responsive to the needs of both teachers and students, leading to sustained improvements in teaching and learning.

VII. Conclusion and Future Scope

This study provides an in-depth investigation of the attitudes and perceptions of engineering educators in Kerala, Southern India toward Project-Based Learning (PjBL). The data show a substantial level of interest and positive reaction among engineering educators, with over ninety percent enthusiastic about implementing PjBL. Educators reported numerous advantages, including higher engagement among students, a better practical understanding of academic concepts, and improved critical thinking skills. However, substantial problems were recognized, such as limited resources and time limits. These obstacles underscore the need for more institutional support, such as access to resources, thorough training programs, and a defined framework for incorporating projects into the curriculum. Despite these challenges, good feedback highlights PjBL's potential to improve engineering education by making it more interactive, interesting, and applicable to real-world applications.

However, the introduction of PjBL encounters certain impediments. Teachers highlighted several challenges, including lack of institutional support, limited time for project design and management, and inadequate opportunities for their own professional development in PjBL techniques. These limits indicate that, while there is a great willingness to use PjBL, considerable barriers must be overcome to permit its general acceptance. Faculty members underlined the need for more intensive training programs to provide them with the skills and knowledge required to properly implement PjBL. They also advocated for better access to facilities and resources, which are essential for the successful completion of project-based duties.

During the course of this research, certain limitations were encountered, which warrant acknowledgment and consideration for future studies. One notable limitation concerns the scope of respondent participation. Although responses were collected from faculty members across Kerala, there is room for further engagement to enhance the response rate. This indicates a need for further exploration to encourage broader participation. Additionally, this study is geographically restricted to Kerala, which may limit the generalizability of the findings. Attitudes and perceptions of engineering educators toward Project-Based Learning (PjBL) may differ in other regions due to variations in educational systems, cultural influences, and institutional practices. Therefore, the findings and conclusions presented here may not be generalizable to other regions of India or international contexts. Furthermore, the study does not encompass every engineering department, which may affect the comprehensiveness of the analysis. Future research should explore broader geographical contexts and a wider range of departments.

The future scope of study on engineering educators' attitudes and perceptions on Project-Based Learning (PjBL) in Kerala's academic environment has immense potential for influencing pedagogical practices and enhancing student outcomes. Comparative evaluations of different PjBL models and techniques can help educators identify best practices and adopt effective strategies adapted to their situations. Creating new assessment methods for PjBL outcomes assessment is another critical area for assuring accurate evaluation of student learning and achievement of goals. Furthermore, focusing on comprehensive training for educators and fostering stronger collaboration between academia and industry can improve the implementation and integration of PjBL into engineering curricula, thereby enriching students' learning experiences and preparing them for real-world challenges.

VIII. ACKNOWLEDGEMENT

The authors extend their sincere gratitude to the IEEE Education Society Kerala Chapter for granting the invaluable opportunity to conduct this study. We express appreciation to all who generously participated in our survey, dedicating their time and expertise. Special acknowledgment is extended to those who assisted in the preparation and distribution of the questionnaire. We also acknowledge the guidance and support provided by the IEEE Kerala Section and the IEEE Education Society Kerala Chapter Research Committee throughout this endeavor. Additionally, we thank all engineering educators across Kerala for their participation and significant contribution which led to the success of this study.

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