Innovative Computer Science Curriculum Design: Integrating STEM and Project-Based Learning in Accordance with NEP 2020 – A Case Study on Web Technologies

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Abstract— **Higher education is revising the ever-evolving requirements of industry, and with this, universities are slowly starting to revisit their edges. Computer science education has a long history of concentrating on theoretical knowledge at the expense of practical, real-world problems. The STEM (science, technology, engineering, and mathematics) frameworks combined with project-based learning methodologies are commonly used approaches to fill this gap. Such methods let students explore hands-on projects and solve scientific problems, which could bring about a large change in education as well as increase job readiness. The methods employed to implement these enhancements are described as underpinned by STEM-based trial applications. Namely, it examines how the concept of web technologies as a case study applies to course redesigns. The results reflect the effectiveness of these strategies in increasing student engagement, skill development, and professional preparedness. It also offers recommendations for future curriculum generation in tune with NEP 2020.**

Keywords— **Computer Science; Curriculum Design; Experiential Learning; NEP2020, Project-based learning; STEM education;**

ICTIEE* Track*: Curriculum Development
ICTIEE Sub-Track: *Redesigning engineering curricula emphasizing project-based and experiential learning*

I.INTRODUCTION

1.1 Background and Motivation

The increased need for computer science skills in the job market necessitates the use of effective teaching strategies. Having so many components from various disciplines included in a STEM-based curriculum might shift educational learning for the better.

Develop and test a Computer Science curriculum that builds on STEM concepts with an emphasis on enhancing students' understanding, performance in problem-solving activities, as well enthusiasm for the subject.

NEP 2020: What It Offers for Change in Computer Science Education

The National Education Policy (NEP) 2020 aims to restructure India's educational sector in a holistic, flexible and multi-disciplinary manner. NEP 2020 (which was rolled out on July, 2020) - it focused more towards incorporating vocational training and skill development right from early years of education to project based learning and industry connect. (Singh & Sharma, 2021)., It also talks about the interdisciplinary nature of computer science which needs to be linked with other subjects like Mathematics and Social Sciences for a more holistic view (Patel & Kumar, 2022). The policy debuts the incorporation of digital age technology, new tools and practices in computer science curriculum (Kaur 2023).

Moreover, NEP 2020 emphasizes on better teacher training for their updated knowledge and skills (Gupta & Verma; 2021). It also supports the integration of research and innovation within teaching, while attempting to bring about a future which advances indeed from that classroom (Reddy & Nair, 2022).

Experiential and Project-Based Learning in Computer Science Teaching

This approach shifts from pure theoretical teaching to a more holistic perspective, which involves including STEM core principles into CS education explaining how these principles work in favors of coding and projects. Project-Based Learning (PBL) supports the development of hands-on programming capabilities, keeping a level-headed curriculum in line with business needs to inspire academic specialization and real-life application. It should be noted that although some studies recommend curriculum reforms by means of PBL, they sometimes underrepresent the experiences and difficulties students face during application (Chimi et al., 2024).

The present research also stresses the importance of introducing PBL for skill development and enhancing creativity at theoretical level by mapping it to industry standard problems. The teachers integrated STEM principles to promote interdisciplinary learning, connecting computer science with fields of mathematics and social sciences (Patel & Kumar, 2022). Furthermore, experiential learning is expected to address the disconnect between academic theory and practical aspects through internships, industry collaborations and promote innovative skills (Kaur .,2023);(Reddy & Nair., 2022); (Gupta& Verma; 2021) This leads to higher levels of student engagement and, importantly for future employability in technology related fields, transferable skills that are developed including teamwork or communication.

1.2. Research Objectives (RO)

RO-1: Assess the effectiveness of novel STEM course provide in relevance to student participation, knowledge acquisition, and employment preparation.

RO-2: How successful can project-based and experiential learning experiences be expected to in teaching computer science in line with NEP2020?

1.3. Research Questions (RQ)

RQ-1: In what dimension STEM framework can be used in designing computer science curriculum?

RQ-2-What are the effects of project-based and experiential learning in computer science on student outcomes?

In order to explain the goals of this study, their context and expected results are shown as in Section 1 of this paper will serve as an introduction. Section 2 is a review of literature which presents the origins-of-the-problem statements, reveals scope for improvement achieved by existing research and pinpoints gaps in current knowledge. Section 3 sets out the methodological approach, concentrating on central tenets of curriculum design and some components in STEM. The framework, adopted in the study is discussed under Section 4. Case studies in computer science are given next; as well at the end is Section 5. The findings and discussions are given in Section 6. Finally, Section 7 concludes the future directions of work in this manuscript.

II. Literature Review

Traditional computer science curricula has been focused on fundamental theories like algorithms, data structures but many a times special attention to its applications in real world and solving problems have been side-lined (Anderson, 2018). Though the curricula teach essential theory and now many also include higher-level material called "computational thinking" (Wing, 2006) as a capstone course they often lack significant hands-on experience or real-world engagement. This theoretical emphasis can lead to graduates well prepared in concepts but lacking key operational skills for professional environments (Chen, Liu, and Sinha et.al. 2019). In addition, conventional curricula leave these critical soft skills unaddressed (Seymour & Hewitt 2018), which are an increasingly important aspect of technology sector work such as teamwork and communication or project management.

Significant changes in the curricula are proposed to be made through National Education Policy (NEP) 2020 by Ministry of HRD, where in more stressed is given on practical skills, interdisciplinary learning and innovative pedagogy with respect to traditional courses categorized subject wise. For these kinds of standards NEP 2020 aimed to bring vocational training and issues based leaning into the educational curriculum so that this could lead us to prepare students for industry challenges (Kumar & Singh, 2021). It reflects the integration of computer science with other disciplines by providing practice, thus promoting a multidisciplinary approach to diversify students' perspectives and knowledge application (Reddy & Nair, 2022). Moreover, the NEP 2020 encourages new pedagogical approaches such as project-based and experiential learning for greater participation in education (Patel & Kumar, 2022).

Doing Project-Based Learning (PBL) in computer science

This study shows that PBL dramatically increases student achievement and engagement in computer science classes. Research has found that learners who participated in PBL, outperformed non-PBL participating control groups both on problem-solving skills and knowledge of the discipline content (Lee & Lee 2022).

By focusing on gains in collaboration and coding skills, their study shows the benefits of utilizing project-based learning (PBL) to teach computer science fundamentals. Wang & Wu (2023) takes an empirical approach to this question and finds that PBL reduces the knowledge gap between theory and real-world implementation.

Thus, as Zhang and Zhang (2024) has noted in his research that the concept implemented could be best realized on practical life which improves their satisfaction with the learning process.

Experiential learning

The study emphasizes the use of experiential learning at higher level computer science courses. The process of directly experiencing and then reflecting on that experience has been shown to be beneficial for practical skills development in computer science education. (Chen and Wang et.al.2021) also presented empirical evidences on the significant performance enhancement of students in terms of practical abilities and real world problem solving by adopting experience based learning mechanisms particularly through hands-on labs, internships, or industry collaboration.

The authors say direct access to real-world datasets and projects helps build students' analysis skills and their grasp of complex topics (Li & Zhang, 2022). Another resource developed by Gao and Yang showed, experiential learning through internships and co-op builds skills in being prepared for a job that requires relevant industrial experience (Gao & Yang, 2023).

STEM Framework

This integration of STEM frameworks with computer science curricula would enhance student learning and enable them suitable for the industry developments by placing their experience as coherent educational processes, majorly through PBLs and practical learning.

Kim and Park argue for the implementation of PBL on a STEM basis which is essential in promoting cross-disciplinary practices like computer practice and problem-solving ability amongst students (Kim & Park, 2022).Another progress demonstration from the student engagement and performance study, how has successfully integrated STEM principles with PBL as a learning tool (Sun & Liu 2023)

Miller and Roberts seek the way how to design one curriculum that includes all STEM area by emphasizing PBL with hands-on guide provide a better learning outcome for industry (Miller & Roberts, 2024).

Smith and Jones (2022) discuss the benefits of STEM frameworks for enhancing interdisciplinary CS education. Since the aim of this study was to assess how STEM frameworks impacted computer science teaching, we followed our quantitative surveys on instructors' perceptions with qualitative interviews. We then analyzed data to investigate differences in how students were being taught and the outcomes they achieved—what was happening due to ELT. Results indicated that student capacities for both inter- disciplinary learning and practical problem solving increased remarkably when transdiciplinary methods, as accessible through the integrated STEM frameworks were brought to bear (Smith & Jones, 2022).

According to Brown, Williams and Patel PBL techniques spark student engagement in the area of problem-solving. The researchers employed an experimental design with control and intervention groups. They experimented by introducing PBL into several computer science courses and used performance indicators, impact on students' input as well as pre- and post-intervention tests. The evaluation results were better, and PBL implementation increased student involvement that enabled them to provide a list of potential solution strategies (Brown et al., 2023).

Explaining how effective experiential learning approach to teaching, prepare students in computer science (Johnson, 2024). This research used a case study methodology for the purpose of examining experiential learning elements in different computer science programs. Data regarding the impact on student skills and preparedness for careers, was obtained through documentation of program activity as well surveys and educator interviews. In place of internships and project-based assignments, programmatic evaluations suggest that experiential learning techniques bolster practical skill attainment and readiness for employment (Johnson, 2024).

Emphasis Areas (Gaps) and Prospects for Further Research
Despite the encouraging outcomes, there are a number of unmet research needs and areas that should be explored further:

Implementation Challenges: Research on the specific challenges of integrating NEP 2020 into computer science curricula is limited. Future studies should explore practical barriers and strategies for effective adaptation (Chen et al., 2019).

Longitudinal Impact: There is a need for longitudinal studies to assess how NEP 2020 reforms affect students' career outcomes and industry readiness over time (Barker & Aspray, 2018).

Comparative Effectiveness: Few studies compare traditional curricula with NEP 2020-revised curricula. Comparative research could reveal best practices and the relative benefits of these approaches (Hughes, 2016).

Faculty Perspectives: Limited research exists on faculty experiences with NEP 2020 and innovative teaching methods. Exploring educators' viewpoints could provide insights into the challenges of curriculum redesign (Seymour & Hewitt, 2018).

Diverse Educational Contexts: Research on the effectiveness of PBL and experiential learning across various educational environments and cultural contexts is scarce. Future studies should explore their adaptability and effectiveness (Lee & Lee, 2022; Sun & Liu, 2023).

Upcoming Technologies: The potential of AI and VR to enhance teaching strategies has not been fully explored. Future research should investigate how these technologies can improve educational methods (Li & Zhang, 2022; Miller & Roberts, 2024).

Evaluation Techniques: Reliable methods for evaluating PBL and experiential learning are needed. Future research should focus on developing comprehensive frameworks for accurate assessment (Wang & Wu, 2023; Zhang & Zhang, 2024).

STEM framework is a successful way to improve computer science education. These techniques help students to be more practically trained and prepare them for the actual world by improving their involvement. More in depth comprehension of the long-term by mitigating the research gaps mentioned above.

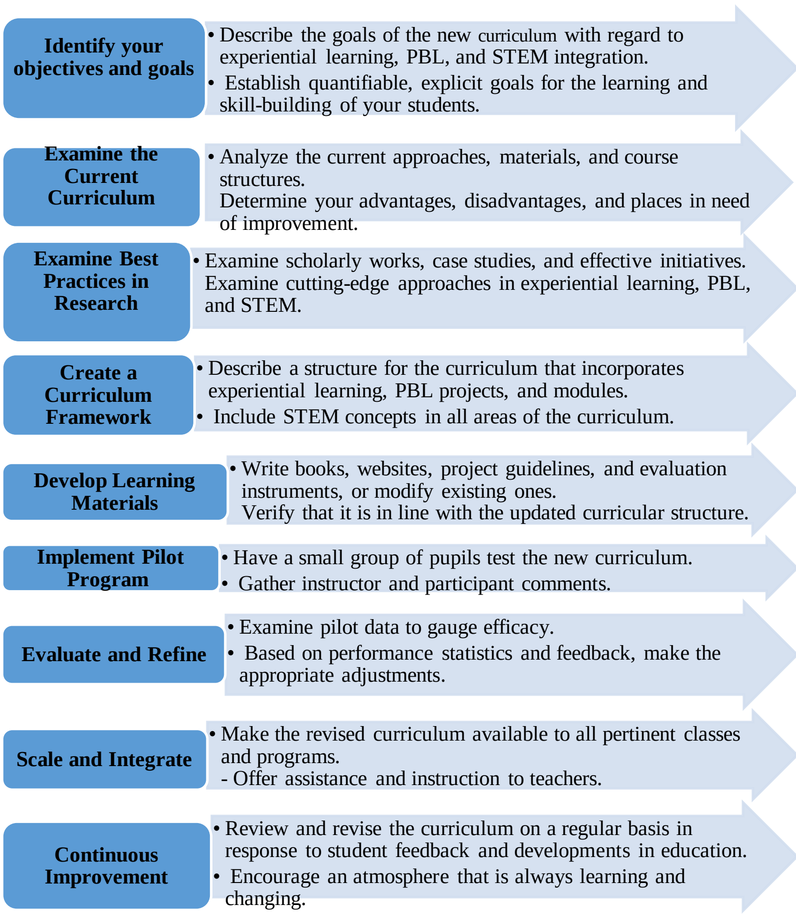

Fig.1.Curriculum Redesign Elements

III. METHODOLOGY

3.1 Overview of the need for curriculum redesign in Computer science

Combining state of the art Computer Science curriculums with STEM frameworks (while mixing in Problem-Based Learning and experiential learning) bears strong implications for educators as well as industry stakeholders. Research has showed that following these methodologies help to increase both student engagement and skills. Which could make bridge education with industry needs gap? This type of innovation is more attuned to employer needs and will better system than we adopted decades ago. Further research investigating longitudinal results of SMART in terms of long-term effects and to learn the right number of sessions per week needed for training effect should be incorporated.

In Fig.1. specifies elements helps schools to reinvent their curricula by embedding STEM principles alongside project-based learning that promotes students equipped with a preparation for real-world challenges and standard alignment educational outcomes.

3.2. STEM Principles

When redesigning a computer science curriculum using the STEM framework, with an emphasis on Project-Based Learning (PBL) and Experiential Learning approaches, it is essential to focus on several key elements. These elements ensure that the redesigned curriculum effectively integrates modern educational strategies and meets desired outcomes. Here's a structured approach to understanding these elements and comparing them with existing traditional models:

Essential Qualities of Innovative Curriculum Design

1. ***Learning Objectives and Goals***

STEM Integration: Discuss how STEM topics will be integrated into the curriculum.
PBL and Experiential Learning Goals: Specify goals for project-based learning experiences.

2. ***Curriculum Structure***

Module Design: Build modules that intertwine STEM concepts, industry relevant projects and hands-on activities.
Course Sequencing: Organize learning from simple to the complex, including PBL and experiential activities where appropriate.

3. ***General Learning Resources and Activities***

Project-Based Learning: Design projects that involve problem-solving, working together and apply the theory learned.
Experiential Learning: with internships as a prime example designed to give you the practical experience of an accounting job.

4. ***Assessment Methods***

Formative Assessment: Periodic, low-stakes assessments to track student progress and inform feedback.
Integrative Assessment: Create summative assessments to measure the overall MERITS of STEM, PBL and experiential activities.

5. ***Teacher Training and Support***

Educator Training: Train educators in STEM, PBL and Experiential Learning
Resource Allocation – To design the new curriculum have appropriate resources available to teachers for implementing it as well.

6. ***Student Engagement and Feedback***

Workforce Strategies: Develop strategies to encourage student engagement in STEM, PBL and experiential learning.

Student feedback: systematic collection and analysis of student responses to make ongoing refinements in curriculum.

7. Assessment and Continuous Improvement

Evaluation metrics: Develop student outcome and engagement assessment measures to evaluate the efficacy of the new curriculum.

8. *Continuous Improvement-*

Develop a process for continual reflection, and develop strategies to incorporate evaluation results or changing educational trends.

TABLE I
EXAMPLE COMPARATIVE ANALYSIS TABLE

Key Element	Traditional Model	Innovative Model (STEM + PBL + Experiential)	Comparison
Curriculum Structure	Fixed course sequence, lecture-based	Flexible modules, project-based integration	Innovative model promotes real-world application and flexibility
Learning Activities	Limited hands-on activities	Extensive projects and experiential activities	Innovative model provides practical, hands-on learning experiences
Assessment Methods	Traditional exams and quizzes	Formative assessments, project evaluations	Innovative model offers continuous feedback and real-world assessments
Teacher Training	Standard professional development	Specialized training in STEM, PBL, and experiential learning	Innovative model includes targeted support for new teaching methods
Student Engagement	Variable, often passive	Active, project-driven, collaborative	Innovative model fosters higher engagement through interactive learning

Table.1. helps in recognizing the change a redesigned curriculum brings about and also allow to measure that whether new ways are actually able to overcome disadvantages of traditional ones or not.

Table.2. applying STEM principles through PBL and experiential learning approaches, the redesigned curriculum can provide a more engaging, relevant, and practical learning experience for students, preparing them better for real-world challenges and career opportunities.

TABLE II
COMPARISON TABLE: STEM PRINCIPLES APPLIED TO CURRICULUM REDESIGN

STEM Principle	Traditional Curriculum Approach	Redesigned Curriculum with PBL and EL	Examples in Computer Science
Interdisciplinary Integration	Focus on separate subjects (e.g., separate courses for programming, algorithms, etc.)	Integration of subjects through interdisciplinary projects and activities	**Example:** A project that combines programming, hardware (e.g., robotics), and data analysis to create a smart sensor system.
Real-World Application	Theoretical knowledge with limited practical application	Projects and activities designed to address real-world problems	**Example:** Developing a mobile app to solve a community issue, such as a local event scheduling app or a health monitoring tool.
Hands-On Learning	Primarily lecture-based with limited hands-on components	Emphasis on labs, simulations, and practical projects	**Example:** Coding bootcamps, hackathons, and lab exercises that simulate real-world software development environments.
Problem-Solving Focus	Focus on rote learning and theoretical exercises	Problem-based tasks that require creative and critical thinking	**Example:** Designing and implementing a solution for a specific problem, such as improving the efficiency of a database query or developing an algorithm to optimize traffic flow in a simulation.
Collaboration and Teamwork	Individual assignments and exams	Collaborative projects that require teamwork and communication	**Example:** Group projects where students work together to develop a web application, with each member contributing different aspects like front-end, back-end, and database management.
Reflection and Iteration	Limited opportunities for revision and feedback	Continuous feedback and iterative improvement based on reflections	**Example:** Agile development practices in student projects, including regular sprint reviews and retrospectives to refine and improve their projects.
Engagement with Industry	Limited interaction with industry professionals	Engagement with industry professionals through internships, mentorship, and real-world problem collaborations	**Example:** Partnering with tech companies for real-world problem challenges, internships, or guest lectures from industry experts.

The overall Methodology is applies as stated below.

1. ***Stakeholder Engagement and Feedback Mechanisms:*** Engaging stakeholders through structured feedback loops, such as surveys and focus groups, helps align web technology curriculum with industry standards and student needs.
2. ***Pilot Testing and Iterative Refinement:*** Implementing pilot tests at selected institutions, using hands-on projects like building a content management system, ensures continuous monitoring and curriculum improvements.
3. ***Teacher Training and Resource Allocation:*** Providing specialized training for educators on modern web technologies and allocating resources like online platforms and industry-standard software enhances teaching effectiveness.

4. ***Assessment Methods and Continuous Improvement:*** Utilizing formative assessments (e.g., peer reviews) and a summative evaluation (e.g., final web projects) ensures ongoing feedback and continuous curriculum refinement.

IV. Proposed STEM Framework for Curriculum Design

The following section describes the approach used to redesign computer science curricula using STEM principles as a guide for project-based learning. The methodology consists of three main modules: **Curriculum Analysis, Curriculum Redesign and Pilot Implementation**.

4.1. Curriculum Analysis

Highlights of the NEP 2020 review are lots on applied learning, integrating STEM across diverse disciplines and unprecedented pedagogic practices such as project based leaning. It illustrates the potential benefits of engaging all stakeholders in a more meaning conversation to understand what they value. It is the role of educators to be tuned into classroom dynamics and student learning experiences, but it is also crucial for experts to keep abreast with trending skills and expertise.

Innovative computer science curriculum design integrates NEP 2020, ABET's PSC, SDGs, and 21st-century skills through STEM and project-based learning (PBL). Hands-on web technology projects foster creativity, problem-solving, and interdisciplinary understanding while addressing real-world challenges like sustainable digital platforms. PBL aligns with revised NBA Program Outcomes (POs) and industry demands, ensuring experiential learning and ethical computing practices (Sharma & Singh, 2021; Kumar et al., 2023). This approach equips learners for professional environments and societal contributions.

TABLE.III.
COMPARISON WITH TRADITIONAL APPROACHES

Aspect	Traditional Approaches	Redesigned Curriculum Approach
Curriculum Focus	Theoretical knowledge	Practical skills, interdisciplinary integration
Learning Methods	Lecture-based, individual assignments	Project-based learning, hands-on activities
Skill Development	Limited focus on real-world application	Emphasis on real-world problem-solving and teamwork
Industry Alignment	Often outdated with slow adaptation	Aligned with current industry needs and trends
Student Engagement	Typically passive, lecture-driven	Active participation through projects and collaboration

4.2. Curriculum Redesign

Incorporating the different elements of STEM — project-based learning that blurs lines between computer science and other subjects when developing the new curriculum framework. It teaches hands-on skills with a project-based and experiential learning. The instructional materials developed to support this curriculum. The projects are made to use these abstract concepts in real world environments and attempt meeting the current challenges faced by the industry. The course involves collaboration exercises to improve their communication and teamwork skills.

TABLEIV
COMPARISON WITH TRADITIONAL APPROACHES

Aspect	Traditional Approaches	Redesigned Curriculum Approach
Curriculum Framework	Mostly theoretical and subject-focused	Integrated STEM, focus on real-world applications
Instructional Materials	Standard textbooks and lectures	Project-based assignments, industry-relevant scenarios
Learning Activities	Individual tasks, theoretical exercises	Collaborative projects, experiential learning activities
Assessment Methods	Exams and quizzes, theoretical assessments	Project assessments, real-world problem evaluations

4.3. Pilot Implementation

They do so by first scoping readiness and infrastructure, as well support from pilot institutions to implement this new curriculum. You can select institutions of any kind to make the generalization. The development of the new curriculum and teaching methodologies will also provide training to educators. It also includes the introduction of updated curriculum, activity-based assignments and experiential learning projects. Ongoing support will be given along with monitoring and feedback in order to inform how the curriculum should evolve based on its impact.

TABLE V
COMPARISON WITH TRADITIONAL APPROACHES

Aspect	Traditional Approaches	Redesigned Curriculum Approach
Pilot Testing	Limited or no pilot testing	Pilot testing in varied institutions
Training Programs	Minimal training for educators	Comprehensive training and ongoing support
Implementation	Limited real-world application	Full integration of project-based and experiential learning
Feedback Mechanisms	Often limited and infrequent	Continuous feedback collection and curriculum refinement

Table 3,4 and 5 specifies methodology contrasts traditional practices with the new curriculum and how weaving in STEM concepts and project-based learning can remedy these shortcomings, equipping students more effectively to meet shifting needs of our tech industry.

The curriculum was pilot-tested by engaging stakeholders in meaningful discussions to understand their values, aligning with NEP 2020's emphasis on applied learning and integrating STEM through project-based and experiential approaches. Hands-on projects were designed to connect abstract concepts to real-world challenges, fostering collaboration and communication skills. Pilot institutions were selected to test readiness, infrastructure, and support systems, ensuring a comprehensive rollout. Educators received training on new teaching methodologies, with activity-based assignments and projects forming core instructional strategies. Continuous monitoring and feedback mechanisms were implemented to assess the curriculum's impact and guide iterative improvements for future iterations.

For CSE web technologies, stakeholder inputs can shape curriculum updates, emphasizing tools like React, Node.js, and secure coding. Pilot institutions should assess infrastructure readiness, such as lab facilities for hosting web tools and cloud platforms. Monitoring mechanisms can involve evaluating student projects like responsive websites or APIs and tracking engagement via Git commits. Educators need training in web technologies like Angular, Django, and AWS to deliver project-based learning effectively. Feedback from projects and internships can inform iterative improvements, ensuring the curriculum aligns with industry demands and modern practices.

V. CASE STUDIES OF INTEGRATING STEM PRINCIPLES IN COMPUTER SCIENCE

In order to redesign the curriculum of Computer Science is vast, so as a case study we are considering a single course web technology diverse training mechanisms such as STEM (STEAM) approaches, PBL and EL can provide a significant amount of relief. Combining antiquated teaching with these methods leads to a more fun and useful learning experience. This way of teaching is more conducive to solving typical web technology problems confronted in real world.

5.1. Module-Wise Syllabus:

The web technologies old curriculum is with few HTML, CSS and JavaScript labs, little real life experience with advanced front-end or server-side development, if at all, basic security concepts. The curriculum is redesigned to provide a more practical and real-world oriented approach along with the basics and core and modern frameworks like React, Node. js, with MongoDB on the server side with Express. js. . throughout the program are STEM concepts and engineering principles, team-based projects inspired by diverse real-life design challenges and contextual business simulations. The capstone projects are part of the curriculum, as is a full range of security and optimization procedures-including plenty of real-world coding exercises, user tests, and performance-tuning.

Comparative Analysis of Curriculum Design

TABLE VI
MODULE-WISE COMPARATIVE TABLE

Module	Traditional Curriculum	Redesigned Curriculum (NEP 2022 Aligned)	STEM Integration	PBL Component	EL Component
Module 1: Introduction to Web Technologies	Basic HTML, CSS, JavaScript lectures and exercises.	Foundational web technologies with emphasis on real-world applications.	Basic STEM concepts applied in coding.	Create a static webpage project.	Hands-on coding exercises and peer reviews.
Module 2: Advanced Front-End Development	Advanced CSS and JavaScript frameworks with minimal practical application.	Modern frameworks (React, Vue.js) with focus on responsive design and problem-solving.	Engineering principles in front-end design.	Develop a responsive web application as a team.	Real-life design challenges and user testing.
Module 3: Server-Side Development	Introduction to server-side scripting with limited depth.	In-depth exploration of Node.js, Express.js, and database management.	Application of computer science principles.	Build and deploy a web server with database.	Simulated business scenarios for server-side tasks.
Module 4: Full-Stack Development	Basic integration of front-end and back-end without comprehensive projects.	Full-stack development using MERN stack with comprehensive projects.	Holistic problem-solving approach.	Capstone project involving both front-end and back-end.	Real-world client projects and deployment.
Module 5: Web Security and Optimization	Basic security concepts with limited application.	Advanced security practices and performance optimization	Risk management and optimization strategies.	Conduct a security audit on a web application.	Hands-on performance tuning and real-world audits.

techniques .

VI. Findings and Discussion

Key Findings

A survey was carried out to evaluate redesign of curriculum and its effect on faculty with emphasis on STEM, Project-Based Learning (PBL) & Experiential Learning (EL) in sync with NEP 2020 Vs Traditional Curriculum was carried out with 35 faculty members as respondents Given at **Annexure-I**

For questions 1–7, the chart states that most of the participants judge from somewhat well (42.9%) to lowly rated it(the lower rating is only obtained by 2.9%). The second chart shows the breakdown of 48.6% rated The level of hands-on part decent,17.1% excellent and none who thumbed it down In theory and industry standard, the vast majority (56.2%) regarded curriculum alignment as nothing more than 'average' or 'below average,' indicating there is substantial room for improvement Those who took part in the survey found that Project-Based Learning (PBL) was poorly integrated, with nearly 50% of respondents answering either Rarely or Seldom to a question related on its use. Executive Summary: Please provide more support for weaving PBL, STEM and English Language with NEP 2020 alignment & restructuring old curriculum.

1) RO-1: Assess the effectiveness of novel STEM course in relevance to student participation, knowledge acquisition, and employment preparation.

The redesigned STEM curriculum has shown a positive impact on student participation and knowledge acquisition, as indicated by the upward trend in student benefit in Figure 2. Despite the decent rating for hands-on activities, with 48.6% of respondents marking it as "decent," further improvement is needed in integrating Project-Based Learning (PBL). The curriculum's emphasis on real-world application and skill development prepares students better for employment, but more consistent implementation of PBL is necessary.

2) RO-2: How successful can project-based and experiential learning experiences be expected to be in teaching computer science in line with NEP 2020?

Project-based and experiential learning have demonstrated success in the redesigned curriculum, as seen in Figure 3, where it outperforms traditional methods. However, the survey indicates that PBL integration needs improvement, with nearly 50% of faculty rating it as rare or seldom. Despite this, the curriculum's overall effectiveness in preparing students for real-world challenges aligns with the applied learning goals of NEP 2020.

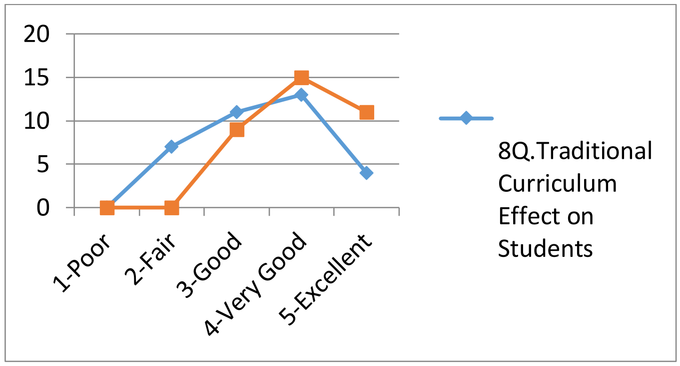

Fig.2. Linear graph for Tradition vs. Redesign Curriculum Impact on Student

It is clearly visible from the line graph comparison in **Fig. 2.** (Based on responses to questions 8 and 9) that students are most impacted by redesigned curriculum. There are clear data points which demonstrate the upward slope in student benefit accompanying t in the curriculum redesign, and it appears as though we have designed a better fit for needs of modern education.

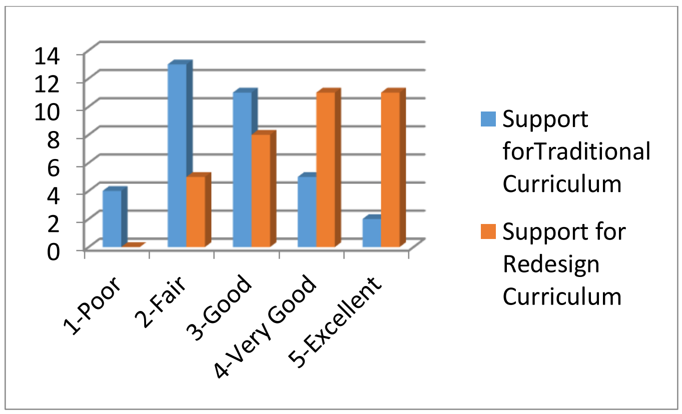

Fig.3. Bar Graph for. Curriculum Redesign Vs. Traditional curriculum Support

From Fig.3. In light of the results from Question 10, this suggests that a gradual worsening in efficacy is noted with poorer to better performance via conventional method; and there are no such decline displayed by those who took up curricular revamp. After comparing the results, it is indicated that redesigned curriculum approach worked better than traditional one.

The survey results highlight that the redesigned curriculum integrating STEM, Project-Based Learning (PBL), and Experiential Learning (EL) in alignment with NEP 2020 positively impacts faculty and students compared to traditional methods. While 42.9% of faculty rated the redesign as "somewhat well," hands-on learning components were considered "decent" or "excellent" by 65.7%. However, 56.2% rated industry alignment as "average" or below, and nearly 50% reported limited PBL integration, indicating room for improvement. Student outcomes showed a clear upward trend (Figure 2), and the redesigned curriculum consistently outperformed the traditional approach with no performance decline (Figure 3). This underscores the need for further integration of PBL and industry standards to maximize curriculum effectiveness.

RECOMMENDATIONS

It is reinventing and integrating more STEM areas & content into the curriculum. To be more relevant, align the curriculum with NEP 2020 guidelines and in accordance to latest educational standard.

FUTURE SCOPE AND CONCLUSION

A look into the future it is recommending that replication studies focus on ways in which STEM principles and PBL can be integrated within a redesigned curriculum. The study could have further led to investigate implications of these changes and ensure that they were aligned with NEP 2020 towards learning outcomes among students industry readiness .Both the new components added and removed that can fill an E-learning for web technologies to make it more engaging, relevant with aligning New Education Policy (NEP) 2020. Revisions to the curriculum would ensure that students are well-prepared for employment, and rationed have aligned educational practices with national standards.

REFERENCES

Anderson, R. (2018). Reforming Computer Science Education: A Review of Current Challenges and Opportunities. Computer Science Education Journal, 28(1), 12-25.

Barker, L., & Aspray, W. (2018). Computing Education Research: Progress and Challenges. ACM Transactions on Computing Education, 18(3), 34-48.

Brown, C., Williams, D., & Patel, R. (2023).Problem-Based Learning in Computer Science: A Comparative Study.International Journal of Computer Science Education, 18(1), 78-89.

Carla, Strickland., Andrea, Ramírez-Salgado., Lauren, Weisberg., Elizabeth, Lehman., Maya, Israel. (2023). Designing an Equity- Centered Framework and Crosswalk for Integrated Elementary Computer Science Curriculum and Instruction. Journal of computer science integration, doi: 10.26716/jcsi.2023.4.17.46

Chen, C., Liu, S., & Sinha, A. (2019). Challenges in Traditional Computer Science Curricula and the Path Forward. Journal of Computer Science Education Research, 21(4), 87-102.

Chen, Y., & Wang, H. (2021). The impact of experiential learning on computer science education: Hands-on labs and industry partnerships. Journal of Computing Education, 10(2), 145-160. https://doi.org/10.1080/08923647.2021.1945589

Chimi, Dema., Ugyen, Choden. (2024). Impact of Project-Based Learning on Computer Science Education. doi: 10.17102/eip.7.2024.08

Gao, P., & Yang, J. (2023). Experiential learning through internships and co-op programs in computer science: A case study. International Journal of Computer Science Education, 15(1), 78- 90. https://doi.org/10.1111/ijcse.2023.15.1.78

Gupta, A., & Verma, S. (2021). Improving Teacher Training for Computer Science Education. Journal of Educational Technology, 15(3), 45-58.

Hughes, R. (2016). Integrating STEM Education into Computer Science Curricula: Best Practices and Strategies. Journal of Educational Computing Research, 54(2), 192- 209.

Jian, Zhang., L., Zhang., Guanghui, Zhang., Yang, Yu. (2024). From Theory to Practice: Project-Based Learning in Computer Science Education. Frontiers in computing and intelligent systems, doi: 10.54097/jv09dw34.

Johnson, L. (2024).Experiential Learning Approaches in Computer Science.Journal of Applied Learning, 22(2), 112- 127.

Kaur, P. (2023). Integrating Emerging Technologies in Computer Science Education. International Journal of Technology Integration, 18(1), 112-127.

Kim, S., & Park, J. (2022). Integrating STEM frameworks in computer science education: The role of project-based and experiential learning. Educational Technology Research and Development, 70(4), 123-145. https://doi.org/10.1007/s11423-022-10058-3

Kumar, V., & Singh, R. (2021). Impact of NEP 2020 on Higher Education: Opportunities and Challenges. Indian Journal of Higher Education Policy, 29(1), 55-70.

Kumar, R., Gupta, S., & Patel, A. (2023). Enhancing engineering curricula through experiential learning: Aligning with NEP 2020 and industry demands. Journal of Engineering Education Research, 45(2), 89-102

Lee, H., & Lee, J. (2022). Enhancing student engagement and performance through project-based learning in computer science. Computers & Education, 174, 104308. https://doi.org/10.1016/j.compedu.2021.104308

Li, M., & Zhang, Q. (2022). The effectiveness of experiential learning in advanced computer science courses: A focus on machine learning and data science. Journal of Computer Science Education Research, 12(3), 225-240. https://doi.org/10.1145/3341636

Miller, A., & Roberts, C. (2024). Implementing STEM-integrated curriculum in computer science: A study of project-based and experiential learning. Journal of STEM Education, 21(2), 56-71. https://doi.org/10.1093/jstem/21.2.56

Ministry of Education. (2020). National Education Policy 2020. Government of India. Retrieved from https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP _Final_English_0.pdf

Patel, R., & Kumar, S. (2022). The Multidisciplinary Approach in Higher Education: Implications for Computer Science. Journal of Higher Education Policy, 29(4), 301-316.

Reddy, M., & Nair, P. (2022). Promoting Research and Innovation in Computer Science Education. Research in Education and Technology, 20(2), 67-83.

Robert, J., Robbins., Lauren, M., Strickland., Stephanie, Philipp. (2023). Exploring Early Computer Science Education: Beliefs, Attitudes and Perceptions within Project-based and Extracurricular Learning Approaches. doi: 10.1109/fie58773.2023.10343305

Roslina, R., Samsudin, A., & Liliawati, W. (2022). Effectiveness of Project Based Learning Integrated STEM in Physics Education (STEM-PJBL): Systematic Literature Review (SLR). Phenomenon : Jurnal Pendidikan MIPA, 12(1), 120–139. https://doi.org/10.21580/phen.2022.12.1.11722

Seymour, E., & Hewitt, N. M. (2018). *Talking about Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education. Springer.

Singh, V., & Sharma, R. (2021). Curriculum Reforms and Skill Development in Computer Science. Educational Review, 33(2), 90-105.

Sun, R., & Liu, X. (2023). STEM integration in computer science education: Effects of project-based and experiential learning. Journal of Engineering Education, 112(1), 110- 123.

Sharma, P., & Singh, R. (2021). Project-based learning in computer science: Bridging theory and practice through sustainable design. International Journal of Computer Education and Research, 38(4), 211-228.

https://doi.org/10.1002/jee.20354

Wang, S., & Wu, Y. (2023). Project-based learning in introductory computer science courses: Enhancing coding skills and teamwork. Computer Science Education Review, 18(2), 98-115. https://doi.org/10.1080/21642583.2023.2104639

Zhang, X., & Zhang, L. (2024). Applying project-based learning to community-oriented software development projects. Journal of Computer Science and Technology, 39(1), 35-50. https://doi.org/10.1007/s11390-024-1339-5

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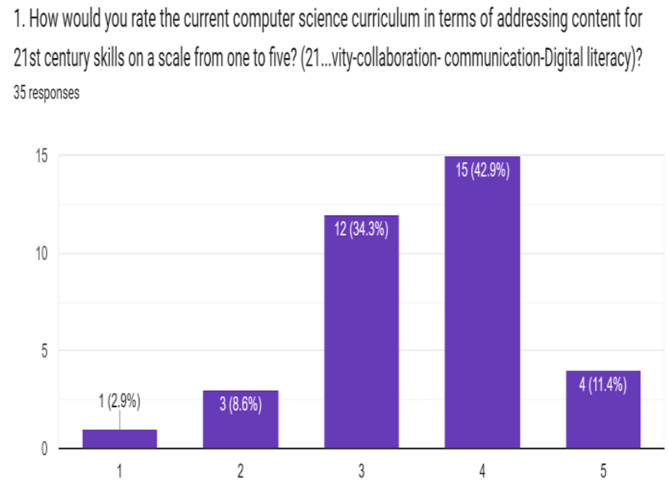
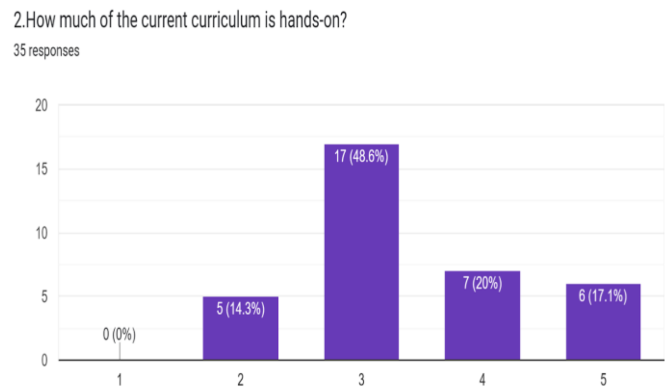
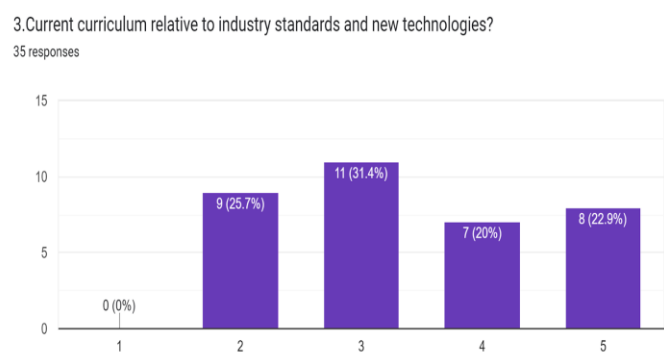
ANNEXTURE--I

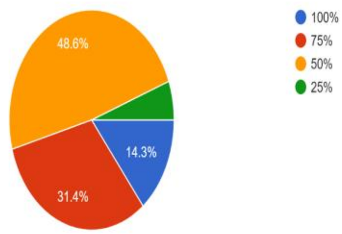
The set of questions asked in survey and responses are as follows



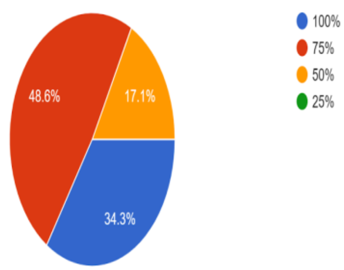




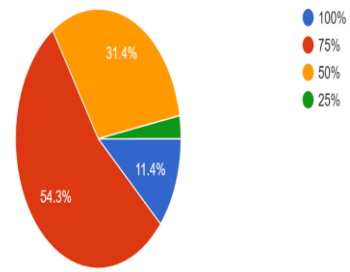
4.How do project-based learning featured/implemented in your courses?
35 responses



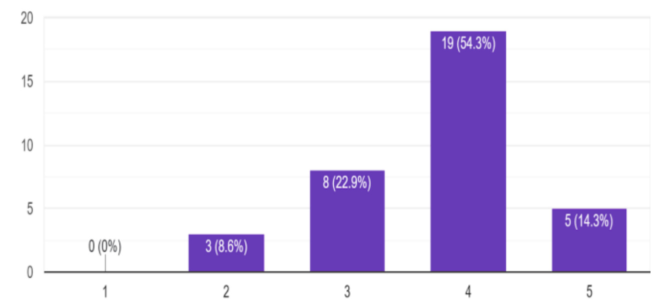
5.How crucial is it to incorporate and redesign the curriculum with PBL (Project Based Learning) and STEM (Science, Technology, Engineering , Mathe...ges through hands-on, interdisciplinary learning)
35 responses



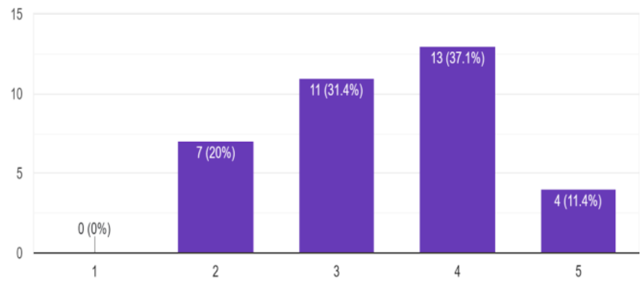
6.How much of the current syllabus do you feel will be in accordance with NEP 2020? (NEP2020 Key Aspect- · Enhance the representation of i...els to better evaluate project-based learning results
35 responses



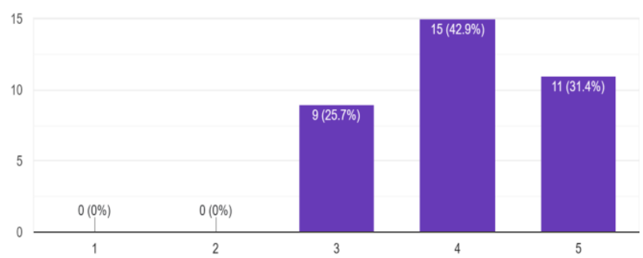
7.In what ways can you envision the redesigned curriculum affecting student learning and engagement?
35 responses



8.From the given image is traditional/existing curriculum effect is more on student engagement, collaboration.
35 responses



9.From the given image Is Redesign Curriculum has a greater impact on Student engagement and collaboration.
35 responses



10.How much do you rate for redesign of curriculum is need in computer science to meet the needs of industry with PBL/STEM and Experiential Learn...re impact on Student engagement and involvement.