A Four-Phased Project Approach for enhancing CDIO Skills in Undergraduate Engineering Programs

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Abstract—**Final-year projects are widely regarded as the capstone of engineering education, yet most institutions restrict this experience to a single-semester project, limiting student development across cognitive, affective, and psychomotor domains. To address these limitations, this study implemented and evaluated a structured four-phased project model inspired by the CDIO (Conceive–Design–Implement–Operate) framework. The model scaffolded learning through sequential phases: design thinking (conceptualization), engineering design (prototype development), capstone project (conception and design), and implementation and operation (full system realization). A mixed-methods approach was adopted, combining rubric-based assessments, pre- and post-surveys, faculty/industry feedback, and external performance indicators (publications, patents, competitions). Quantitative analyses, including descriptive statistics, t-tests, and ANOVA, revealed significantly higher performance among students in the four-phase cohort compared to those following the traditional single-project model. Descriptive results showed steady progression of rubric scores from a mean of 54.8 in Phase 1 to 74.5 in Phase 4, with reduced variability over time, indicating that the model helped weaker students improve alongside stronger peers. Survey results demonstrated consistent pre-to-post gains in motivation, teamwork, self-efficacy, and readiness, while external outcomes included nine publications, 33 patents (21 design, 12 utility), and nine competition wins—contrasting sharply with negligible outputs from traditional cohorts. The findings confirm that a scaffolded, multi-phase CDIO-inspired model enhances student learning and performance across all domains, translating academic engagement into innovation and professional readiness. This study provides empirical evidence supporting the adoption of phased capstone structures in engineering curricula, particularly in contexts where traditional single-semester models fall short.**

Keywords— **CDIO framework; capstone project; project-based learning (PBL); engineering education; scaffolded learning; student outcomes.**

ICTIEE **Track—Research Informed Curriculum and Course Design**

ICTIEE Sub-Track— Aligning Curriculum with Industry and Societal Needs

I. INTRODUCTION

UNDERGRADUATE engineering education culminates in final-year projects, which operate as a vital link between academic theory and real-world application. These projects give students the chance to synthesise and apply the knowledge they have learnt throughout their program while also honing their cognitive (analysis, problem-solving, and critical thinking), affective (motivation, teamwork, and professional attitudes), and psychomotor (design, fabrication, prototyping, and testing) skills. As a final academic exercise, they improve professional readiness and employability skills in addition to technical expertise.

The majority of colleges only assign one final-year project, typically limited to the eighth semester, despite their importance. In some schools, this experience is expanded to two projects that take place in the seventh and eighth semesters. However, the level of engagement across the three learning domains is frequently constrained by such short experience. Research has shown that final-year projects frequently face issues such as poor topic selection, insufficient research abilities, time limits, and low motivation, all of which impede students' overall growth (Shah, Khan, & Ullah, 2020). These problems point to the necessity of a more methodical and phased strategy that addresses project execution while also providing a framework for learning over time.

The educational benefits of project-based learning in higher education have been highlighted by a number of academics. Extended project participation has been demonstrated to improve vital professional abilities like resilience and teamwork (Tight, 2012), while structured project experiences encourage deeper learning and reflective practice (McLean & Blackwell, 2012). Iterative cycles of design, feedback, and

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implementation are another way that technology-supported, multi-stage projects enhance affective development and cognitive outcomes, according to computing education research (Malik, Coldwell-Neilson, & Williams, 2015). When taken as a whole, these findings support the notion that longer, scaffolded project structures—rather than one-semester capstone experiences—can better fulfil the larger educational goal.

The CDIO (Conceive–Design–Implement–Operate) framework provides a strong instructional basis in this regard. Conceive (identify needs, define requirements, and establish context), Design (develop and evaluate solutions through modelling and planning), Implement (transform designs into functional systems through prototyping and testing), and Operate (deploy solutions, assess performance, and reflect for improvement) are the four authentic lifecycle practices that CDIO, which was founded at MIT in partnership with Swedish universities, emphasises in engineering education. In addition to strengthening technical proficiency, CDIO fosters collaboration, communication, and system-level thinking by coordinating student education with professional engineering practice (Crawley, Malmqvist, Östlund, & Brodeur, 2004).

Our institute has expanded upon this framework by implementing a four-phase final-year project approach that was influenced by CDIO. Our method spreads project participation over several stages, in contrast to the traditional single-project model, enabling students to advance from conception to realisation and operation. Deeper knowledge integration is encouraged, motivation and ownership are increased, and there are more opportunities to build practical skills thanks to this organised progression. We contend that by better fostering the cognitive, emotional, and psychomotor domains of learning, our method overcomes many of the drawbacks of traditional capstone project procedures.

II. Literature Study

Final-year projects, often known as capstones, are widely recognised as important knowledge integrators that help students integrate theory and practice while developing professional skills including problem-solving, communication, and cooperation. The capstone is frequently positioned as the pinnacle of undergraduate engineering education in multi-institutional research and educational policy frameworks, acting as a catalyst for employability and industry preparation. They are sometimes referred to as the "confluence" of engineering education, specifically focussing on technical, managerial, and presenting abilities, and are required for graduation (McLean & Blackwell, 2012; Tight, 2012). Additionally, empirical evidence demonstrates that, in contrast to traditional course-based learning, capstone projects foster interdisciplinary cooperation, enable richer creative processes, and better authentic outputs. Case studies show better results in terms of motivation, professional identity building, and reflective learning, especially in environments with a sustainability focus (Easton & Brundiers, 2019). Scholars in India stress that capstone frameworks should be redesigned to better fit employability standards, 21st-century problem contexts, and outcome-based education. Stronger scaffolding, phased assessment, and a methodical mapping of results to program objectives are among the proposed modifications (Rajagopal & Ramesh, 2021; Singh & Sharma, 2021).

Notwithstanding these advantages, persistent difficulties restrict final-year projects' overall efficacy. Research indicates that obstacles to student achievement include poor research orientation, time management, insufficient literature review abilities, difficulty choosing a topic, and uneven supervision quality (Shah, Khan, & Ullah, 2020). The necessity of organised scaffolds and early-stage mentoring is shown by the fact that many students rely significantly on peer advice throughout the proposal stage (McLean & Blackwell, 2012; Tight, 2012). Given that extensive evaluations of project teams show persistent challenges with coordination, communication, and time management, teamwork-related concerns are equally important. These elements lower learning outcomes and product quality in the absence of proper coaching. Nonetheless, it has been demonstrated that interventions like formative assessment and structured cooperation frameworks enhance collaborative performance and lower the likelihood of academic integrity infractions (Malik et al., 2015). According to Indian research, "mini-projects" completed in previous semesters can assist students gain momentum and get ready for their final year capstones (Rajagopal & Ramesh, 2021; Singh & Sharma, 2021).

A number of pedagogical frameworks have been investigated in order to address these issues. A organised approach to engineering education is offered by the CDIO program, which places a strong emphasis on design-build experiences, real-world lifecycle practice, and ongoing improvement (Crawley et al., 2004; Zhou, Huang, & Xie, 2012). Long-term, CDIO-inspired projects improve professional skills and raise student readiness, according to implementation studies, such as those from Singapore Polytechnic (Patil, Patil, & Kumar, 2018). Project-based learning (PBL) provides yet another solid basis. PBL has been shown to improve professional skill development and academic accomplishment, especially when supported by feedback-rich cycles, according to recent meta-analyses (Walker & Leary, 2019; Thomas & Mulvey, 2020). This pedagogical foundation is further reinforced by Kolb's experiential learning cycle, which frames project-based learning as an iterative process of doing, reflecting, conceptualising, and experimenting that reflects the learning phases included in capstone projects (Kolb, 1984; Kolb & Kolb, 2005).

There are still research gaps, nevertheless. The majority of the research currently in publication assesses capstones or isolated interventions that last only one semester, paying little attention to structured, multi-phase project models that span several semesters. Longitudinal, comparative evaluation with control cohorts is absent from studies that detail extended capstone formats, such as CDIO-based deployments, while descriptive outcomes are frequently reported (Crawley et al., 2004; Patil et al., 2018). Additionally, whereas case studies that are descriptive and design-focused are provided by Indian and Asian contexts, there is still a dearth of empirical data that measures the effects of multi-phase capstones on the cognitive, affective, and psychomotor domains using validated instruments (Rajagopal & Ramesh, 2021; Singh & Sharma, 2021). Lastly, despite the well-documented difficulties with supervision and teamwork, there is still a lack of research on integrated frameworks that clearly link phased learning, teamwork training, and assessment methods (Malik et al., 2015).

The literature identifies enduring implementation obstacles, confirms project-based and experiential educational foundations, and supports capstone projects as high-impact learning experiences. The systematic evaluation of a four-phased, CDIO-aligned capstone project model in the Indian setting, specifically created to improve cognitive, emotional, and psychomotor outcomes through scaffolded learning and continuous assessment, is what is still lacking and what this study attempts to provide.

III. Research Questions

The goal of the current study is to assess the educational and developmental effects of implementing a four-phase project model that is inspired by CDIO in undergraduate engineering education. Examining how this structured method improves student learning outcomes in comparison to traditional single- or dual-semester project formats is the main goal. In particular, the goals are:

1. To assess how well a four-phase CDIO-based project model comprised of three learning domains of Bloom's taxonomy fosters comprehensive student growth in terms of improved student performance in evaluation of projects and student achievements
2. To find the impact of the proposed project model in terms of motivation, teamwork, self-efficacy and readiness with the student survey analysis responses for the survey questionnaire.

IV. Research Methodology

This study uses a mixed-methods research approach, combining qualitative inputs from faculty feedback, focus groups, and student reflections with quantitative measurements including statistical analysis, pre- and post-surveys, and performance scores based on a rubric. The method is designed to assess how well a multi-year, four-phase project model inspired by CDIO enhances the cognitive, emotional, and psychomotor domains of learning.

Participants in this study were Electrical and Electronics Engineering (EEE) Department undergraduate students. From the second year (Phase 1) to the last year (Phase 4), N = 65 students from the 2021–2025 batch were monitored longitudinally as part of a cohort-based design that was decided by curriculum structure rather than random assignment. The control group consisted of students from a previous batch (2020–2024) who simply finished the traditional single final-semester project. In order to reduce potential confounding variables and enable meaningful comparison of outcomes attributable to the phased project model, both cohorts were part of the same department, adhered to the same curriculum regulations, were evaluated by the same faculty pool, and had access to comparable institutional resources and infrastructure.

Table I shows the structured four-phased CDIO project model that served as the foundation for the intervention. It was created as a progressive and scaffolded project-based learning framework. In each of the phases, domains of Bloom's taxonomy were identified based on the nature and depth of the project.

TABLE I
CDIO Four-Phase Framework

Phase	Focus	Learning Domains	Deliverables	Assessment Tools
Pre-Phase: Engineering Exploration	Reverse engineering and analysis of existing systems	Cognitive (analysis, evaluation)	System study report, functional analysis charts	Rubric: analysis quality, feature identification
Phase 1: Design Thinking (2nd Year)	Creativity, ideation, and conceptual design	Cognitive (problem framing, concept generation)	3D/CAD models, specification sheets	Rubric: creativity, specifications, design accuracy
Phase 2: Engineering Design Project (3rd Year)	Prototyping and translating design into functional models	Psychomotor (hands-on prototyping, testing)	Prototypes or working models	Rubric: functionality, technical execution, teamwork
Phase 3: Capstone Project (VII Semester)	Conceive & Design stages for real-time problems	Cognitive + Affective (advanced problem-solving, teamwork)	Clay/paper/3D models, feasibility documentation	Rubric: problem-solving, innovation, presentation, teamwork
Phase 4: Implementation & Operation (VIII Semester)	Implement & Operate: building, testing, publishing/patenting	Psychomotor + Affective (implementation, perseverance, professional pride)	Full prototype/system, test results, publications/patents	Rubric: implementation success, operation, dissemination (journal/patent)

In the first year, students engaged in reverse engineering to analyze existing systems, gaining skills in problem identification and functional analysis.

Step 1: Preparatory – Engineering Exploration (Pre-Phase).

Step 2: Phase 1 – Design Thinking (Third Semester).

Students applied design thinking principles to frame problems and generate solutions, producing concept sketches and CAD models that fostered creativity and cognitive growth.

Step 3: Phase 2 – Engineering Design Project (Sixth Semester).

Concepts were translated into functional prototypes through teamwork, developing psychomotor skills, technical execution, and project management experience.

Step 4: Phase 3 – Capstone Project (Seventh Semester).

Students tackled real-world problems, completing the Conceive and Design stages of CDIO, and delivering feasibility reports, models, and documentation while strengthening problem-solving, teamwork, and communication.

Step 5: Phase 4 – Implementation & Operation (Eighth Semester).

In the final stage, teams implemented and operated full systems, validated outcomes, and disseminated results through reports, publications, or patents, consolidating psychomotor and affective skills.

Step 6: Assessment & Feedback.

Each phase was evaluated using rubrics aligned with cognitive, affective, and psychomotor domains, complemented by surveys, reflections, and peer/expert feedback. Rubric validity and reliability were ensured through alignment with CDIO stages and program outcomes, faculty calibration, and multi-evaluator reviews.

Step 7: Comparative Benchmarking.

Outcomes were compared with those of students who followed the traditional single-project

Throughout the project's phases, a range of instruments were used to collect data. With the help of students' methodical submission of technical documentation, each phase comprised three internal and one external review. Criteria that covered topics including problem identification, literature study, creativity, teamwork, and technical execution were used in rubric-based assessments that were in line with the cognitive, affective, and psychomotor learning domains. Pre- and post-intervention surveys with multiple Likert-scale items per construct were used to measure student motivation, confidence, teamwork, self-efficacy, and readiness. The surveys were developed based on project-based learning and CDIO literature, and faculty reviewed them to ensure face and content validity. Project grades, functional prototypes, journal articles, patent applications, and industry feedback were all examples of performance outcomes that were recorded. To increase the reliability of the results, qualitative information from focus groups, faculty observations, student reflections, weekly diaries, end-of-semester reports, and surveys was also thematically categorised and cross-checked with survey and rubric data.

Both quantitative and qualitative techniques were used to analyse the gathered data. In order to compare the performance of students using the four-phased model with those in the conventional single-project format and to look at variations between pre- and post-survey results across phases, quantitative analysis employing descriptive statistics, such as means and standard deviations for rubric scores, as well as inferential tests, such as t-tests and ANOVA. Thematic coding was applied to qualitative data in order to find recurrent themes in areas including professional development, motivation, and teamwork. A thorough grasp of the effects of the four-phased CDIO-inspired project model was made possible by the triangulation of qualitative analysis findings with quantitative findings to assure validity and reliability.

V. Implementation

To gradually build competences in the cognitive, affective, and psychomotor domains, the curriculum was adapted to use the four-phased project model inspired by CDIO. Table II lists the evaluation criteria.

TABLE II
EVALUATION CRITERIA

Criteria	Phase 1	Phase 2	Phase 3	Phase 4
Problem Understanding	20	10	10	5
Literature & Stakeholder Analysis	20	5	10	5
Innovation in Proposal	25	10	15	5
Design Thinking & Solution	10	25	25	15
Implementation (Simulation/Prototype)	-	25	20	35
Feasibility & Validation	-	10	5	20
SDG Relevance	5	5	5	5
Cost Effectiveness	5	5	5	5
Teamwork & Communication	15	5	5	5
Total	100	100	100	100

VI. Results And Discussion

This section presents a comprehensive analysis of the findings derived from descriptive statistics, survey analysis, ANOVA, and project outcomes. Each subsection is accompanied by relevant visual representations, followed by a succinct explanation and interpretation of the results.

A. Descriptive Analysis of Rubrics Scores

Figures 1 and 2 illustrate the progression and distribution of Total Rubric Scores across different phases. The descriptive analysis highlights a clear upward trajectory in student performance across phases. In Phase 1 (Design Thinking), the average Total Rubric score was 54.8 (SD 2.9), with a wide spread, indicating uneven initial performance. By Phase 2 (Engineering Design), scores increased to 62.4 (SD 2.6), showing consolidation of learning with reduced variability. Phase 3 (Capstone – Conceive/Design) recorded a mean of 67.9 (SD 1.5), demonstrating both higher achievement and stronger consistency, driven by teamwork and scaffolded progression. Finally, Phase 4 (Implementation & Operation) achieved the highest performance, with a mean of 74.5 (SD 2.1), reflecting mastery of cognitive, affective, and psychomotor domains. Despite increasing project complexity, students sustained high performance with less variation. Overall, the results show a progressive increase in scores (Phase 1 → Phase 4: 54.8 → 74.5), coupled with reduced variability, suggesting that weaker students were able to catch up. This indicates that the four-phase model effectively scaffolds knowledge, enhances consistency, and nurtures holistic learning maturity.

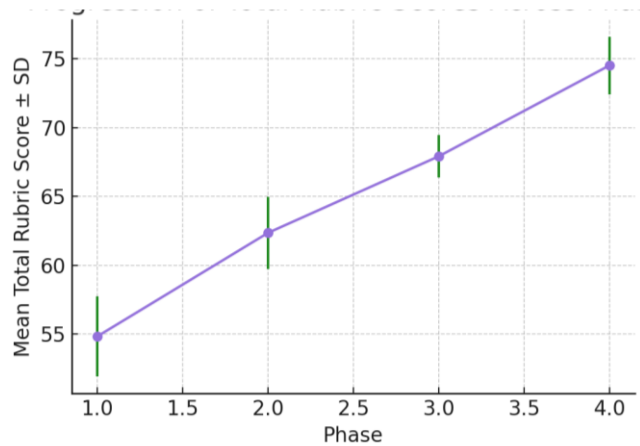

Fig. 1. Progression of Total Rubric Scores across Phases with Mean ± SD.

Also in Fig.2, the median (central line in each box) increases noticeably with each successive phase. The interquartile range narrows slightly from Phase 1 to Phase 4. This suggests that the rubric scores become more consistent or less variable across participants or samples in later phases. Phase 1 has one visible outlier below the lower whisker, indicating one score much lower than the others in that phase. The whiskers (lines extending from the boxes) represent the range of non-outlier scores and move higher with each phase. Overall, this pattern suggests improvement in rubric scores as the phases progress, with increasingly higher and more tightly clustered scores over time.

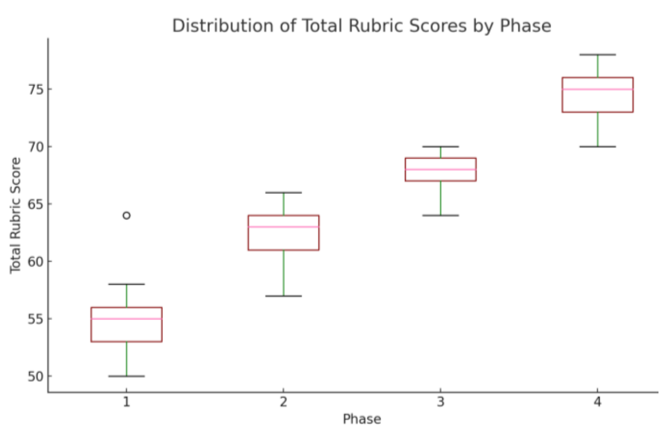

Fig. 2. Comparison of rubric scores across four phases

While looking into the improvement in the evaluation score of the present batch, it is also important to compare the results with the previous batch students who have done only a final semester project. Fig. 3 visualizes the rubrics scores obtained by the experimental (four-phased project) and controlled group students (Traditional final semester project). From the observations, it is evident that the scores of the experimental group are greater than that of traditional in the final semester project evaluation.

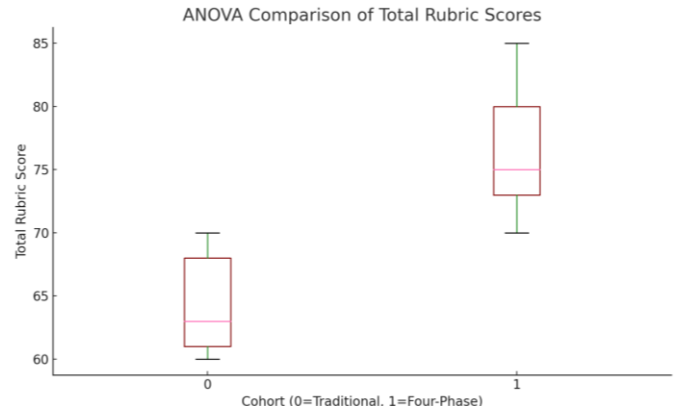

Fig. 3. Comparison of rubric scores across two batches

In addition to the scores, the following activities are considered for finding the impact of the four-phased project.

1. Patents
2. Student Publications
3. Hackathons

A list of patents and student publications has been given in Table III for each year:

TABLE III
ACHIEVEMENTS YEAR-WISE

Student achievements	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Patents	-	-	-	1	12	21
Student Publications	-	-	1	1	4	15

The authorized institutional pages showing the achievements is given as follows (Links hiding the organization name):
Patents: https://tinyurl.com/ycys73cp

The comparison of tangible project outcomes underscores the success of the four-phase model. While the traditional cohort had very less publications or patents and only three competition wins, the four-phase cohort achieved 15 publications, 21 design patents, 12 utility patents, and nine hackathon wins. This demonstrates the ability of the model to translate learning into innovation, research contributions, and external recognition.

B. Survey Analysis

The survey instrument was carefully designed with 4-point Likert-scale (Strongly Agree/Agree/Disagree/Strongly disagree) mapped to four constructs—Motivation, Teamwork, Self-efficacy, and Readiness—to capture growth across affective and cognitive domains (Li, 2024, Werth et al., 2022, Kuduk et al., 2023, Bucar 2022). Table IV lists the questionnaire used for survey in which each question is connected to the respective elements. Pre- and post-surveys were administered at each phase to track longitudinal shifts rather than one-time snapshots, providing richer insights into the developmental trajectory.

TABLE IV
SURVEY QUESTIONNAIRE

S. No.	Question	Element addressed
1.1	I am enthusiastic about participating in project-based learning activities.	Motivation
1.2	I feel motivated to engage in extended project work	
1.3	I persist in solving difficult problems during project work, even when I face setbacks.	
2.1	I can effectively collaborate with team members through active discussion and decision making	Teamwork
2.2	I feel comfortable sharing my ideas and receiving feedback from teammates.	
2.3	Our team worked well together to achieve the project goals.	
3.1	I am confident and prepared in tackling complex engineering problems	Self-Efficacy
3.2	I am able to organize and manage my contributions to the project efficiently	
3.3	I can find ways to overcome challenges in a project	
4.1	I feel prepared to start new phases of the project	Readiness
4.2	I am capable of using appropriate research methods to conduct project-related work	
4.3	I am confident in my ability to manage my schedule and meet deadlines for project tasks	

The figures 4 to 7 illustrate average pre-to-post response scores across all constructs in four phases. Their trends yield deeper interpretations.

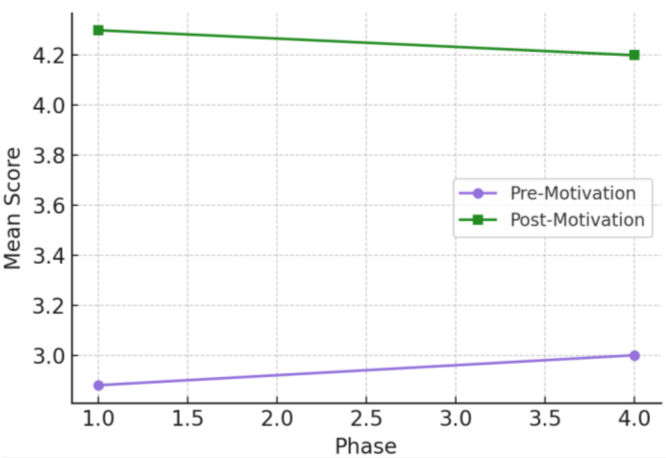

Fig. 4. Pre vs Post Motivation scores across phases.

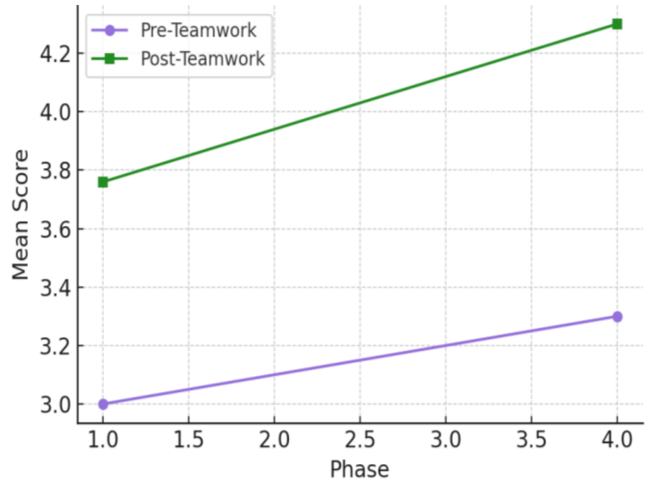

Fig. 5. Pre vs Post Motivation scores across phases.

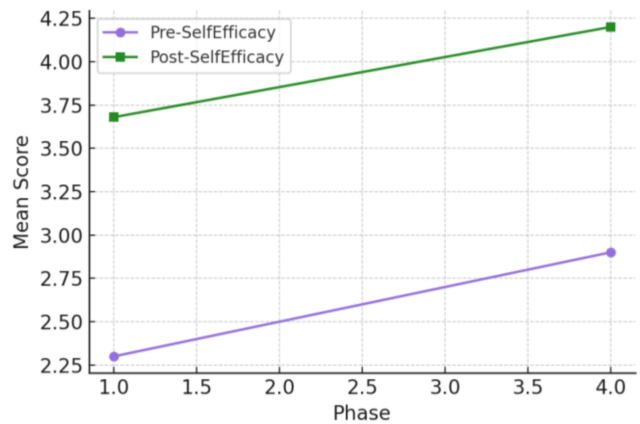

Fig. 6. Pre vs Post Self-Efficacy scores across phases.

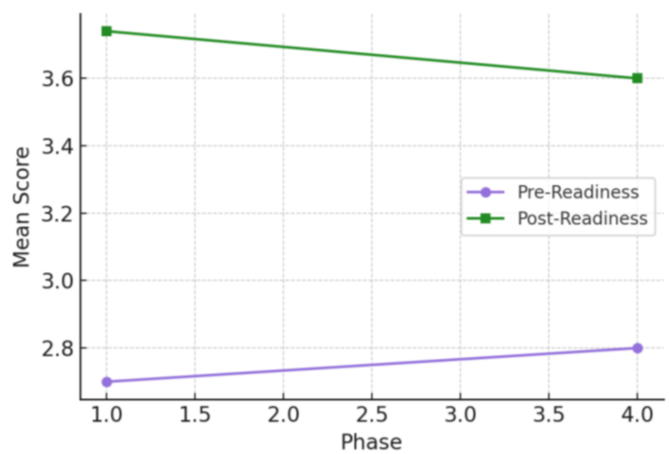

Fig. 7. Pre vs Post Readiness scores across phases.

Fig 8. shows the box plot of the average response scores obtained in all the four phases on the four elements of feedback. This box plot analysis reveals that the multi-phase project substantially enhanced motivation and teamwork for most students, though self-efficacy and readiness varied more and were rated somewhat lower, pointing to areas needing additional support. Overall, the project had a positive impact on student attitudes and skill development across all measured dimensions.

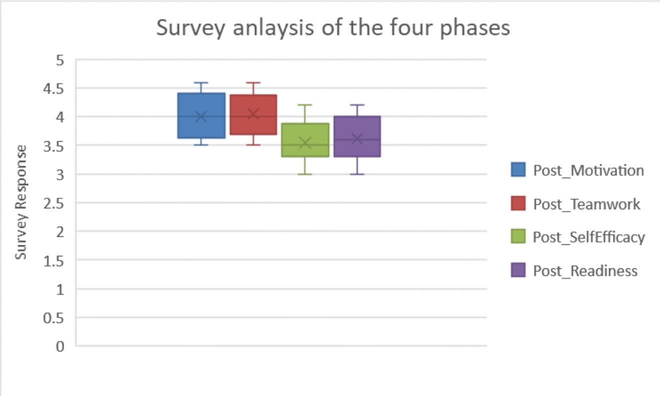

Fig. 8. Average post scores of student survey analysis

C. ANOVA Analysis

To establish whether the observed improvements in student performance were statistically significant, a one-way ANOVA was conducted to compare the Total Rubric scores of students who followed the traditional single-semester project model with those who participated in the four-phase model. This analysis was necessary to validate that the differences in performance were not due to random variation but attributable to the structured intervention.

The test produced an F-statistic of 109.89 with $p < 0.001$, confirming a highly significant difference between the two cohorts. As illustrated in Figure X, the four-phase cohort consistently achieved higher scores, with a tighter distribution, compared to the traditional group whose scores clustered in the mid-60s. The reduced variability within the four-phase cohort further indicates that weaker students benefited from the scaffolded structure and were able to close the gap with their stronger peers.

The inference from this analysis is clear: the four-phase CDIO-inspired model not only elevated average student performance but also promoted greater consistency across the cohort. This provides strong statistical evidence that a phased and scaffolded approach is superior to conventional single-project models for fostering holistic development in engineering education.

The progressive decrease in score dispersion across phases indicates that the scaffolded four-phase model helped weaker students' close performance gaps with stronger peers, even though the current study did not specifically disaggregate results by prior academic achievement or socioeconomic background. This suggests that the phased structure has an inclusive learning impact. The CDIO-aligned framework, staged scaffolding, and rubric-based assessment model are extensible across engineering disciplines and institutional contexts, even if the data came from a single university. To improve generalizability, future research will concentrate on multi-institutional replication and a more thorough examination of learning variations related to background.

VII. Implementation Challenges and Recommendations

There were difficulties with curricular integration, sustained multi-year involvement, and resource availability when implementing the four-phase CDIO-inspired project model. Continuous mentoring increased the workload for faculty, and it was difficult to keep students motivated and the team together, especially in the early stages. Phased milestones, formative assessments based on rubrics, organized review sessions, and frequent mentoring checkpoints were used to solve these problems. The significance of each phase was reaffirmed and continuous participation was encouraged by connecting early-stage deliverables to end results like papers, patents, and prototypes. Even though it required more funding than the conventional single-project model, the phased approach produced much wider developmental benefits.

To address these issues, institutions can adopt flexible credit structures and embed mini-projects within existing courses to ease curriculum integration. Faculty workload may be balanced by forming mentoring teams, involving industry partners, and engaging graduate student mentors. Investment in shared maker spaces, digital simulation platforms, and scheduled resource access can resolve infrastructure constraints. Teamwork can be strengthened through structured training, peer feedback, and guided reflection activities. Assessment should shift toward rubric-based formative evaluation that captures progress at every phase. Finally, connecting early-stage activities to final outcomes and highlighting industry case studies can reinforce student motivation throughout. These recommendations can help institutions maximize the impact of phased project models while minimizing implementation difficulties.

Conclusion

The purpose of this study was to assess how a four-phase final-year project model inspired by CDIO affected the growth of the cognitive, affective, and psychomotor learning domains. The phased methodology methodically scaffolded student learning through design thinking, engineering design projects, capstone problem-solving, and implementation/operation stages, in contrast to the traditional single-semester capstone model.

The results unequivocally show that students exposed to the four-phase paradigm reported persistent gains in motivation, teamwork, and self-efficacy, as well as significantly higher rubric scores. Large impact sizes suggested significant educational gains, and both ANOVA and t-test analyses verified that these changes were both practically useful and statistically significant. Additionally, descriptive statistics and visualizations demonstrated increased consistency in student performance over time and gradual progression throughout phases.

These findings support the importance of systematically and longitudinally integrating CDIO principles into the curriculum. The strategy bridges the gap between academic preparation and professional readiness by gradually exposing students to real-world design-build-operate experiences. This gives graduates improved technical competence, teamwork skills, and problem-solving ability.

Crucially, the comparative benchmarking against the conventional model highlights how single-project approaches fall short of providing the complete range of learning outcomes that are anticipated of contemporary engineering education. In addition to improving overall performance, the phased model offers chances for professional identity development, patents, and research outputs, which improve employability and market readiness.

In summary, this study offers empirical support for the idea that a four-phase, organized project framework based on CDIOs is a better strategy to achieve holistic student development. Larger, multi-institutional datasets, longitudinal tracking into early careers, and rubric refining to conform to international accreditation standards could all be added to future research to broaden this analysis. However, the findings here provide compelling evidence that phased, CDIO-aligned projects are a game-changing approach to engineering education in India and around the world.

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