

# INTEGRATING CDIO AND TEAM-BASED LEARNING IN A MANAGEMENT COURSE: ACTION RESEARCH STUDY

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## ABSTRACT

Current management education faces challenges including low student motivation, digital distractions, and superficial team interactions. Traditional didactic teaching often fails to cultivate talent capable of practical problem-solving. This study addresses these pedagogical pain points by cross-disciplinarily applying the engineering-based CDIO (Conceive, Design, Implement, Operate) framework to a first-year Management course, integrated with Team-Based Learning (TBL) strategies. Adopting an action research approach with 68 first-year students, the study utilized mixed methods for data collection. The instructional design implemented CDIO standards and TBL mechanisms (iRAT/tRAT) to facilitate active learning through strategic planning projects based on real-world corporate scenarios. The results indicated that: (1) learning motivation significantly improved ( $p < 0.05$ ), demonstrating that CDIO and TBL can positively influence student motivation; (2) team learning effectiveness surpassed individual learning, with tRAT scores consistently exceeding iRAT scores; (3) guided by the CDIO process in executing corporate case analyses, students showed increased confidence in practical skills; and (4) TBL fostered a positive collaborative environment, enhancing students' sense of participation within their teams. The study concludes that combining CDIO with TBL effectively improves practical abilities and collaboration satisfaction, assisting students in transitioning from passive knowledge receivers to active learners. These findings provide a reference for future curriculum design in business education.

## KEYWORDS

CDIO, Team-Based Learning (TBL), Action Research, Management Education, Learning Motivation, Standards:3, 4, 5, 7, 8

## RESEARCH MOTIVATION

In the landscape of contemporary management education, cultivating management talent equipped with practical problem-solving skills and higher-order thinking is crucial (Ahmad et al., 2025). Industry practitioners have also reflected on the prevalent "gap between theory and practice" in traditional business education. However, an examination of current pedagogical practices reveals that students face multiple challenges regarding learning motivation and effectiveness, creating significant pedagogical pain points. The instructional setting must shift from merely transmitting knowledge to cultivating students' ability to navigate real-world work environments in the future.

Observations from the course indicate that students' lack of autonomous learning ability is a significant issue. Students are generally accustomed to a passive, lecture-listening mode of receiving knowledge and lack the willingness for independent exploration and critical thinking. This phenomenon primarily stems from the influence of traditional didactic teaching, which diminishes students' agency in constructing knowledge and hinders the development of autonomous learning habits (Grangeat, 2016).

Secondly, distraction and fragmented attention interfere with learning outcomes. With the ubiquity of mobile devices, students are easily distracted by messages on phones and tablets during class. Such distractions not only affect individual cognitive absorption but also create an adverse effect on the overall learning atmosphere of the classroom. Furthermore, team interactions often remain superficial. In group collaboration tasks, students rely on AI tools to quickly obtain answers. Although responsibilities are divided, the outcome often becomes a fragmented collection rather than a genuinely collaborative effort. There is a lack of deep analysis of management issues and a failure to build consensus, which compromises the quality of reports. Groups often lack in-depth dialogue and dialectic engagement, missing the connection between reflection and theory.

To address these challenges, the instructional setting must introduce a teaching framework that is both systematic and practical. Compared to traditional lecture-based teaching methods, Team-Based Learning (TBL) uses structured group activities to promote student engagement (Bingjie et al., 2022; Jeno et al., 2017), requiring students to apply concepts in realistic contexts (Chen et al., 2018; Azim et al., 2018). TBL's emphasis on collaboration stimulates members' intrinsic motivation. Students become more invested in the learning process due to their accountability to peers. Many students report a preference for team activities over traditional lectures, which helps enhance their learning experience (Azim et al., 2018; Shoair et al., 2023).

CDIO is an integrative and practice-oriented educational framework that provides a new pathway for transforming the classroom in business education. Over the past several years, Feng Chia University has actively institutionalized the CDIO (Conceive, Design, Implement, Operate) approach within its pedagogical practices, integrating it comprehensively across diverse disciplines and educational levels, from first-year courses to graduate programs. Although the CDIO educational model originated in engineering education (Crawley et al., 2014; Worldwide CDIO Initiative, n.d.-a), its emphasis on "learning by doing" and experiential learning aligns seamlessly with management concepts such as planning, organizing, leading, controlling, and business models. Therefore, this teaching practice research adapts the CDIO framework for a management course to strengthen learning motivation and address observed pedagogical problems:

- Conceive: Guide students to start with secondary data to understand the enterprise, define corporate problems, and comprehend market demands and management issues, thereby addressing the problem of passive learning.
- Design: Connect classroom management theories (e.g., Porter's Five Forces, SWOT, organizational structure, strategic management) with practical experiences in corporate case analysis. Students apply management theories to plan solutions or business models, enhancing their focus.
- Implement: Concretize theories through actual plan execution, prototyping, or corporate case simulations.
- Operate: Assess the feasibility and sustainability of the plan. Students are required to collect feedback during the implementation phase and make iterative corrections.

Using the CDIO framework combined with the TBL model, the course transforms classroom participation into small-group collaborative learning to analyze its impact on students' learning motivation and teamwork effectiveness in the management course.

## RESEARCH PURPOSES

Based on the aforementioned problems in the management education setting—such as low student learning motivation, distraction, and superficial team interactions—this study applies the CDIO pedagogical framework, combined with TBL strategies, to construct an innovative teaching model suitable for first-year students in the College of Business. Referencing the 12 CDIO Standards (Worldwide CDIO Initiative, n.d.-a), this study sets the following research purposes:

- To establish a practical management teaching model guiding students from "Conceive" to "Implement." This purpose aims to provide first-year students with an introductory framework that offers a comprehensive view of management practices, sparking their interest in the professional field. Simultaneously, by guiding students to shift from passive listening to active environmental scanning and strategic design, they experience the complete cycle from "Conceive" to "Implement," cultivating the ability to solve real-world problems. This purpose responds to the content of Standard 4 (Introduction to Engineering/Management) and Standard 5 (Design-Implement Experiences).
- To explore the impact of the TBL mechanism on learning motivation. To address issues of student distraction and passive learning, the course employs the TBL pedagogy to investigate its impact on student learning motivation. This study examines how the TBL mechanism encourages students' willingness to engage in active learning, thereby influencing their motivation. This purpose relates to Standard 8 (Active Learning).
- To investigate the impact of CDIO and TBL on learning effectiveness. Addressing the issue of superficial group interaction, this instructional design utilizes the CDIO framework and TBL to enhance peer dialogue and consensus-building, resolving the problem of "division of labor without collaboration." By observing changes in communication quality, conflict resolution skills, and collaboration patterns during the implementation of the CDIO project, the study aims to increase students' confidence in problem-solving and cultivate management talent equipped with collaborative skills. This purpose aims to examine whether the course achieves Standard 7 (Integrated Learning Experiences)—that is, fostering students' Standard 3 (Interpersonal and Teamwork Skills) while teaching professional management knowledge.

Corresponding to the purposes of this teaching research and the CDIO Standards (Worldwide CDIO Initiative, 2020), the specific implementation practices in the course are shown in Table 1.

Table 1: Course Implementation Goals and Practices Based on CDIO Standards

CDIO Standard	Summary of Definition	Specific Course Implementation
Std 3: Interpersonal and Teamwork Skills	To cultivate personal and interpersonal skills.  Focuses on developing students' ability to work effectively in teams and communicate.	Adopting TBL mode: Students collaboratively analyze cases, solve problems, and present group reports to practice interpersonal dynamics.
Std 4: Introduction to Engineering*  (Adapted as Introduction to Management)	To provide fundamental knowledge of management theories.  Serves as the introductory framework for the discipline.	Bridging theory and practice for first-year students: Assisting students in applying theories to real-world cases at an introductory level, thereby stimulating enthusiasm for the management field.
Std 5: Design- Implement Experiences	To provide opportunities for case analysis and practical implementation.  Emphasizes learning through the creation and operation of products/processes.	Guiding the strategic planning process: Teams are guided through the complete cycle of problem definition, data analysis, and strategic design for specific corporate cases.
Std 7: Integrated Learning Experiences	To integrate disciplinary knowledge with professional skills.  Merges academic content with personal and interpersonal competencies.	Reflective and collaborative integration: Through collaborative learning, the course requires groups to complete case analysis reports and team reflections, alongside individual learning reflections, to integrate analytical experiences with professional knowledge insights.
Std 8: Active Learning	To employ TBL to engage students in thinking.  Engages students directly in thinking and problem-solving activities.	Implementing TBL with iRAT/tRAT mechanisms: Utilizing readiness assurance tests to facilitate deep peer discussion and immediate feedback, effectively addressing issues of distraction and passive learning behavior.

## RESEARCH METHODOLOGY

This study employs an action research approach to investigate the impact of the CDIO-integrated TBL pedagogical model on university students' learning motivation, team interaction quality, and learning effectiveness.

### **Research Subjects**

The research subjects were first-year students from the Department of International Business, enrolled in the compulsory "Principles of Management" course. A total of 68 students participated in the course. The gender distribution was 85% female and 15% male. This sample was selected because first-year students are in a critical transition period of their learning patterns, and management serves as an introductory course to the business field, making this group highly representative for this study.

## Course Design and Implementation

This study structured the course around the CDIO (Conceive, Design, Implement, Operate) framework and integrated Team-Based Learning (TBL) into the weekly management classes. To ensure systematic progression, this study divided the 18-week teaching activities into four phases: Conceive, Design, Implement, and Operate. This study was deliberately designed to address persistent pedagogical challenges in traditional management education, including the gap between theory and practice, low student motivation, and free riding in team-based tasks. Through group collaborative projects focused on analyzing corporate cases, this study guided students through a comprehensive cycle of applying management concepts to real-world problems. The detailed implementation framework is presented in Table 2.

Table 2. Course Operation Framework

Phase / CDIO Standards	Goal	Pedagogical Focus	Practical Task	TBL Mechanism
Conceive (Weeks 1-4)  <i>Std 4: Intro to Mgmt</i>  <i>Std 8: Active Learning</i>	Field Exploration and Problem Definition	Establishing foundational management theory; Environmental scanning.	Students actively search for and select a Small and Medium-sized Enterprise (SME) to conduct secondary data collection and analysis.	iRAT/tRAT (Individual/Team Readiness Assurance Tests): Ensuring comprehension of foundational vocabulary and reinforcing pre-class study motivation through active learning.
Design (Weeks 5-9)  <i>Std 3: Teamwork Skills</i>  <i>Std 4: Intro to Mgmt</i>	Theory Application and Strategic Planning	Systematic diagnosis using analysis tools (PEST, Porter's Five Forces, SWOT).	Groups transform market information into structured analysis reports, proposing analytical results and defining case problems.	Positive Interdependence: Members discuss, complete individual analysis dimensions, report back to the group, and integrate findings to establish task interdependence.
Implement (Weeks 10-14)  <i>Std 5: Design-Implement</i>  <i>Std 7: Integrated Learning</i>	Concretizing Action Plans	Strategic evaluation and recommendations for the case study.	Producing specific analysis reports. Students propose recommendations for marketing, HR, and strategy, converting abstract strategies into actionable Action Plans.	Group Deliverables: The team collaborates to produce tangible analytical outputs and specific solutions.
Operate (Weeks 15-18)  <i>Std 3: Teamwork Skills</i>  <i>Std 7: Integrated Learning</i>	Outcome Presentation and Field Verification	Professional communication, persuasion, and reflection.	Holding a final presentation, simulating a professional briefing to business owners.	Peer Evaluation & Reflection: Conducting peer evaluations and writing reflective journals on the collaborative process.

## **Data Collection Instruments**

This study employs a mixed-methods approach, utilizing methodological triangulation to ensure the reliability and validity of the data:

### *Quantitative Measures*

- **Motivated Strategies for Learning Questionnaire (MSLQ):** Adopting the scale developed by Pintrich et al. (1991), this questionnaire was administered at the beginning and end of the semester. A paired-samples t-test was used to analyze differences in students' learning motivation and learning efficacy dimensions.
- **Team Interaction Assessment:** This study employed Michaelsen's Method, utilizing peer evaluation scores from TBL sessions to assess individual contributions and the collaborative climate. Individual impact was quantified by calculating the mean deviation of these peer scores.
- **Learning Performance Tests:** Including scores from iRAT and tRAT, as well as assessments of the final project.

### *Qualitative Measures*

- **Reflective Reports:** Students wrote reflective journals after the conclusion of each CDIO phase, documenting the difficulties encountered and the strategies used to resolve them.
- **Focus Group Interviews:** A purposive sampling approach was employed at the conclusion of the semester. Teams were selected from both high-performing and low-performing clusters to explore the nuanced impact of the CDIO project on their teamwork models. A total of 16 students participated in semi-structured interview sessions, each lasting 20–30 minutes, providing diverse perspectives across varying achievement levels.
- **Team Interaction Assessment:** To assess team interaction, students were required to provide a concise qualitative peer feedback for each teammate, specifically highlighting their individual contributions to the collective task. This approach facilitated a deeper understanding of the team's interpersonal dynamics and the specific collaborative behaviors of the students.

## **Data Analysis**

- **Quantitative Analysis:** This study utilized SPSS 24.0 statistical software to conduct data analysis. It performed descriptive statistics to examine sample characteristics, applied t-tests to assess changes in learning motivation and learning outcomes, and employed regression analysis to evaluate the significance of relationships among variables.
- **Qualitative Analysis:** Transcripts from interviews and reflective journals were subjected to coding and inductive analysis to extract key themes affecting learning outcomes. These findings were then cross-referenced and interpreted in conjunction with the quantitative data.

## **RESEARCH RESULTS**

### ***Sample Structure and Gender Difference Test***

This study involved a total of 68 students, comprising 85% females and 15% males. To examine gender differences, this study conducted an independent-samples t-test. The analysis revealed no significant differences between male and female students in learning motivation or learning outcomes ( $p > 0.05$ ). These findings suggest that the CDIO and TBL

pedagogical models implemented in this course exhibit generalizability, indicating that their effectiveness is not contingent upon student gender.

### **Effectiveness of TBL Learning and Immediate Feedback**

Analysis of the iRAT and tRAT data reveals that the average scores of the tRAT were significantly higher than those of the iRAT. The results demonstrate that through peer discussion and cooperative learning, students were able to correct misconceptions and achieve the effect of knowledge construction (Figure 1).

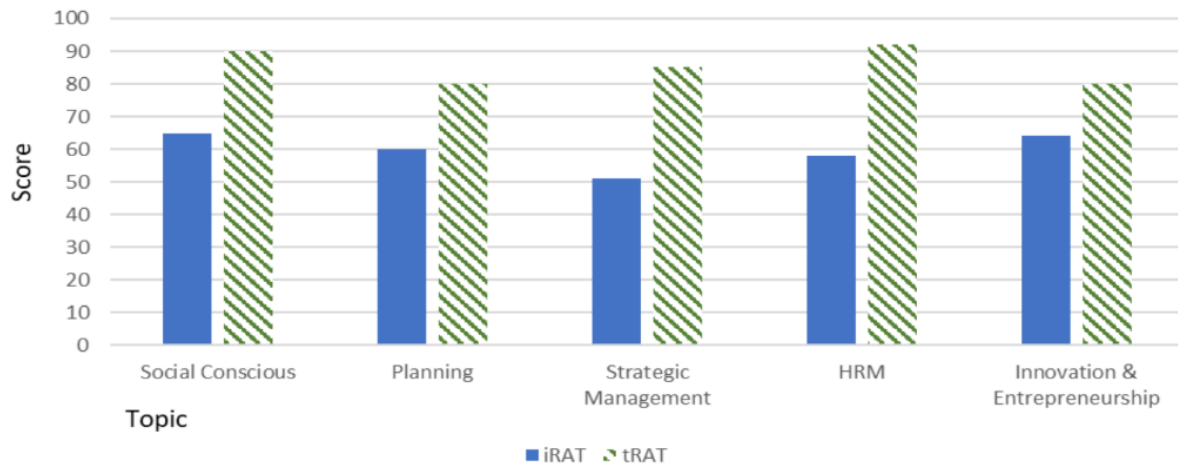


Figure 1. Comparison of iRAT and tRAT Scores

### **Analysis of Learning Motivation**

Regarding the verification of instructional effectiveness, the results indicate that students' learning motivation at the end of the course was significantly higher than at the beginning ( $p < 0.05$ ). Specifically, facilitated by TBL and group discussion mechanisms, students' post-course learning motivation was significantly superior to their pre-course motivation (Figure 2). The result demonstrates that, in this pedagogical research, the introduction of team learning mechanisms effectively enhanced students' sustained motivation for learning. The study further analyzed the relationship between learning motivation and learning outcomes. The results reveal that learning motivation has a significant positive influence on learning outcomes ( $p < 0.05$ ).

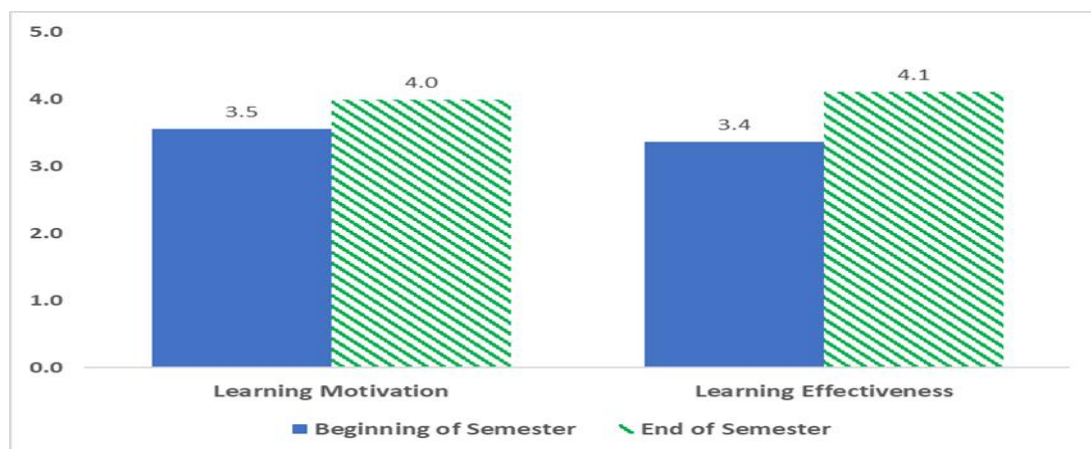


Figure 2. Changes in Learning Motivation and Learning Outcomes: Pre-test vs. Post-test

### **Impact of Classroom Participation**

This study categorized students into a High Participation Group (4-5 points) and a Low

Participation Group (1-3 points) based on their self-assessed classroom participation (scale of 1-5). Independent samples t-test results indicated that the High Participation Group scored significantly higher than the Low Participation Group in both learning motivation and engagement in group discussions ( $p < .05$ ).

Furthermore, comparing the High Motivation Group (score $\geq 7$ ) and Low Motivation Group (score $\leq 6$ ) based on self-assessed learning motivation (scale of 1-10), findings revealed that high-motivation students performed significantly better in weekly course completion and the quality of group interaction.

Notably, the data showed that regardless of individual motivation levels, students exhibited high satisfaction with group participation. Qualitative results further clarified that the primary reason for low-motivation students' satisfaction was their positive evaluation of the group discussion process. Students noted:

*"Team members participated actively, made efforts to share ideas, and cherished each other's diverse viewpoints."*

*"The diverse insights brought by members not only sparked more creativity but also made the conclusions more comprehensive."*

*"The discussion atmosphere was harmonious, with smooth interaction and mutual respect."*

*"Although there were occasional communication challenges, I enjoyed the overall interaction experience, which aided personal growth and deepened thinking."*

*"Discussions made me braver in expressing myself."*

The result demonstrates that the TBL mechanism successfully created a positive atmosphere of peer mutual aid, allowing even low-motivation students to find a sense of belonging and participation within the team.

### **Specific Effectiveness of the Implementation Project**

Regarding CDIO implementation outputs, teacher grading indicated that 65% of the groups were able to propose specific analysis content and recommendations for their research cases, demonstrating students' understanding of course content and their ability to apply it to practical scenarios. Grading results also showed improved scores in environmental analysis and SWOT analysis.

However, some group project reports remained superficial and lacked in-depth analysis. These limitations point to an area for future improvement, suggesting that instructors should provide targeted guidance to underperforming groups. Additionally, student feedback indicated an increase in self-confidence regarding practical skills such as secondary data collection, environmental analysis, SWOT analysis, and report writing (Figure 3).

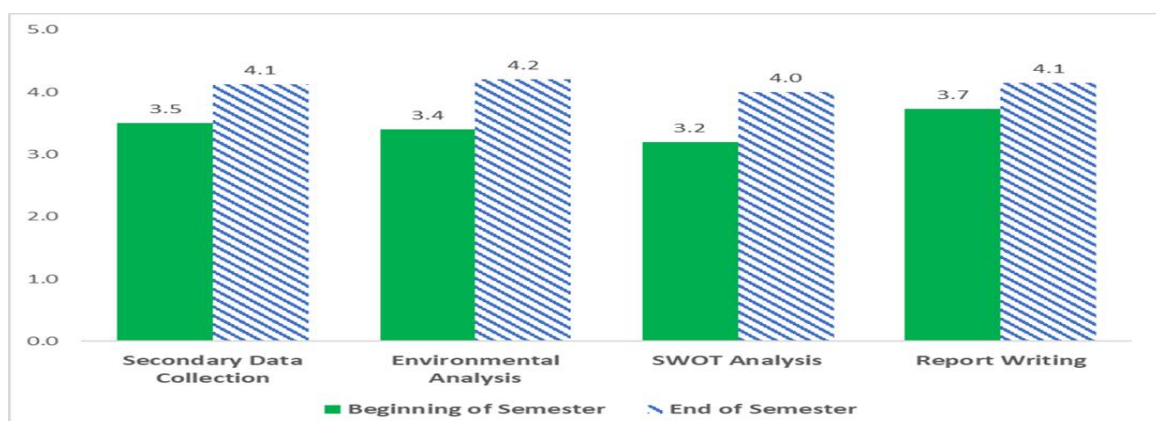


Figure 3. Changes in Student Confidence Levels Regarding Group Project Skills: Pre-semester vs. Post-semester

## **CONCLUSIONS AND SUGGESTIONS**

### ***Conclusion***

This study aimed to explore the effectiveness of integrating the CDIO engineering education framework with Team-Based Learning (TBL) in a first-year Management course.

Synthesizing the quantitative data and qualitative analysis results, the study summarizes the following four core conclusions:

- The CDIO framework and TBL mechanism ameliorate passive learning and deepen students' knowledge construction (Responding to Standard 8). The results indicate that TBL significantly enhanced students' learning motivation and satisfaction with interaction quality. The fact that tRAT scores consistently surpassed Individual iRAT scores demonstrates that peer cooperative learning promotes a more profound understanding of knowledge. Addressing the challenge of fragmented attention, this study found that the appropriate introduction of real-time digital feedback tools (e.g., Kahoot, Quizizz) can foster student interaction and engagement, effectively refocusing student attention within the instructional context.
- CDIO implementation projects strengthen the link between theory and practice. Through the introduction of Small and Medium-sized Enterprise (SME) analysis projects, students experienced the complete cycle from environmental scanning and strategic planning to the formulation of action plans. The implementation outputs evidence that students have acquired the ability to transform abstract theories—such as environmental analysis and SWOT analysis—into concrete solutions. The result shows that the CDIO model effectively acts as a bridge for "integrating learning and application," achieving the goals of Standard 5 (Design-Implement Experiences) and Standard 7 (Integrated Learning Experiences).
- Team discussion enhances cooperative motivation (Responding to Standard 3). The study found that even students with lower learning motivation maintained high satisfaction with "group participation," primarily influenced by their willingness to engage in group interactions. Furthermore, the CDIO-integrated TBL model demonstrates good generalizability; this framework enhances learning motivation and effectiveness, making it suitable for comprehensive promotion within business schools.
- Assisting first-year students in establishing foundational management knowledge (Responding to Standard 4). As an introductory course for first-year students, this model not only imparted management knowledge but, more profoundly, helped students undergo an identity transformation from "passive receivers" to "active learners." Through the CDIO pedagogical architecture, students established a cognitive framework for management practices early on, laying the groundwork for autonomous learning throughout their four years at university.

### ***Reflections and Suggestions***

To address these limitations and inform future teaching research, the following recommendations are proposed:

- Reinforce the Scaffolding Mechanism for Reflection. Instructors should provide more detailed reflection guidelines or structured assessment rubrics to support students in transitioning from descriptive accounts of activities (i.e., what was done) to critical

reflection (i.e., what was learned and how improvement can be achieved). This approach aims to deepen the development of personal and metacognitive skills.

- **Intervention for Underperforming Project Groups:** Results showed that some group project reports remained superficial and lacked in-depth analysis. To address this, instructors should intervene earlier with groups that are lagging to understand their difficulties in the learning or case analysis process, guiding them to reinforce group dynamics and momentum.
- **Longitudinal Tracking of Learning Transfer:** Future research could further track this cohort of first-year students trained under the CDIO model to observe whether they continue to demonstrate superior project implementation and teamwork capabilities in advanced courses during their sophomore and junior years, thereby verifying the long-term benefits of this model.

Since this study employed a single-cohort design without a control group, a potential limitation involves self-reporting bias. Students might have exhibited social desirability bias, providing overly positive responses to reflect their support for the new instructional model. To minimize this effect, all surveys were conducted anonymously, and students were explicitly informed that their feedback would not influence their final grades. Furthermore, qualitative insights from the focus group interviews were used to cross-verify the depth and authenticity of the survey results, ensuring a more robust interpretation of the pedagogical outcomes.

While traditional engineering CDIO emphasizes technical reliability, this research demonstrates that Management CDIO prioritizes 'Adaptive Resilience'—the ability of a team to pivot their business model effectively under simulated market volatility. These findings suggest that the CDIO standards can evolve into a cross-disciplinary pedagogical framework, successfully integrating technical systems with human-centric organizational dynamics to prepare business students for complex, real-world environments.

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