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# EIxD: A Team Operating System for Project-Based Engineering Courses

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# EIxD: A Team Operating System for Project-Based Engineering Courses

Abstract

Engineering curricula are team-intensive by design, yet students are often expected to collaborate effectively without explicit instruction in how to form, manage, and adapt as a team under project pressure. In MIT's chemical engineering project laboratory course, students work in small teams on open-ended experimental projects with real deadlines and sustained interaction with instructors, teaching assistants, and faculty supervisors. To make team processes explicit and actionable, the course uses EIxD, a structured team operating system that integrates emotional intelligence and team dynamics into the weekly routines teams use to execute their work. The EIxD team operating system serves as the skeleton and scaffolding that supports teams through uncertainty, uneven workload, procrastination, and the need for accountability in open-ended project work. Rather than treating teamwork as a separate or informal skill set, EIxD embeds collaborative behaviors into the way teams plan, document, reflect, and meet across the semester. This paper presents the six-component Team Formation Model, the required team routines and documents, and the course touchpoints through which the framework is implemented. Evidence from student-produced documents and end-of-semester completion reports collected between 2018 and 2025 suggests that although students may initially resist the framework's formality, many come to rely on its structure as project demands intensify. Instructor field notes and course records further suggest that the framework supports team coordination, accountability, and the development of major deliverables, including project proposals, presentations, and final reports.

## 1. Introduction

Teamwork is a defining feature of contemporary engineering education and practice. Students are repeatedly placed into teams to conduct design, experimentation, analysis, and reporting that mirror professional engineering work. This emphasis is reflected in engineering education literature on cooperative learning and team-based pedagogy [1], [2], and in common capstone and project course structures [3].

This need is also consistent with national calls to prepare engineers for complex, collaborative, and socially situated professional practice [4]. Despite the prevalence of teamwork, team formation in many courses remains largely implicit. Students often receive limited guidance on expectation setting, role clarity, conflict management, and inclusive communication, even though these factors influence how effectively teams perform and how equitably students participate. Engineering program outcomes and studies of graduates' workplace use of ABET-aligned competencies further reinforce the need for structured approaches to teamwork, including communication and professional skills [5], [6]. This paper provides a detailed, implementable description of EIxD's team formation model, required documents and routines, and course touchpoints, designed to support adoption and adaptation across project-based engineering courses regardless of discipline or institutional context.

EIxD is a team operating system: a semester-long weekly rhythm that couples execution routines and written records with explicit emotional intelligence behaviors and escalation/repair protocols

for when teams stall. Many courses teach pieces of this; EIxD's distinguishing feature is the integration. EI is integrated into the same written outputs teams already produce (agendas, minutes, activity lists, progress reports, and decision records) and into the existing stakeholder meetings. As a result, EI practices are applied in the moment, under real time pressure, rather than being treated as an additional "soft skills" add-on. This paper documents the design and implementation context and reports practice-based evidence from multiple years of student teams' documents (completion reports, baseline inputs on competencies/expectations, and team expectations worksheets) to characterize buy-in, implementation fidelity, and perceived teamwork effects, while transparently noting limitations and next evaluation steps.

## 2. Institutional and curricular context

### Implementation Context and Design Conditions

| Context element | EIxD implementation |
|---|---|
| Course type | Project-based engineering laboratory course with open-ended stakeholder projects; teams execute experiments/design work over a fixed academic term. |
| Class and team size | Class size = 9 to 36 students. Teams are comprised of 3 or 4 students. |
| Staffing model | Each team supported by a faculty advisor and teaching assistant; some projects include an industrial consultant. Communication instructors support technical writing and presentations. A project management lecturer supports team execution and EI-enabled routines. |
| Core weekly rhythm | Weekly team meeting plus regular stakeholder/advisor meetings; recurring written outputs (agenda, minutes, activity list/decision record, weekly progress report). |
| Role system | Three rotating roles: Leader, Recorder, Presenter each with required documentation outputs and knowledge transfer at each rotation. |
| Early-term alignment | Team Formation Workshop (Week 1) and stakeholder expectations-clarity discussion (Week 2) supported by a Team Expectations Worksheet prepared in advance. Strategic Planning and Design Workshop with all project stakeholders (Week 2). |
| Infrastructure and templates | Shared digital workspace with standardized naming/filing plus templates for agendas, minutes, progress reports, and decision records. |

*Box 1. Implementation context and design conditions for EIxD in projects lab course.*

### EIxD Semester Timeline and Touchpoints

| Timing | EIxD touchpoint | Required outputs (examples) |
|---|---|---|
| Week 1 (before workshop) | Pre-work: competencies and expectations intake; TKI self-assessment; team setup | Individual competencies and development opportunities; individual expectations (self, team, course staff); TKI self-assessment; team contact plan; folder/naming conventions; initial roles/rotation schedule; team calendar |
| Week 1 (Team Formation Workshop) | Team Formation Workshop (EI and team formation) | Team norms/ground rules draft; role definitions; initial activity list; communication plan; draft decision criteria and escalation triggers |

| | | |
|---|---|---|
| Week 2 | Stakeholder expectations meeting and Strategic Project Planning & Design workshop (adapted LogFrame is the planning tool) | Team Expectations Worksheet for advisor/TA/PM lecturer/consultant; documented stakeholder expectations; adapted LogFrame worksheet (scope, problem definition, assumptions, milestones); initial project design draft with TA/supervisor input |
| Weeks 3–13 (weekly) | Weekly execution routines (meetings and documentation) | Agenda sent in advance; meeting minutes; activity list with owners and due dates; lab plan; weekly progress report prior to advisor meeting; decision record updates as needed; laboratory notebook |
| After each oral presentation (proposal, progress, results) | Role rotation and knowledge transfer (after each oral presentation) | Role transition checklist; updated activity list and decision record; handoff notes (what changed, open risks, next actions) |
| Weeks 14–15 | Closeout and completion reporting | Completion report reflections discussed at Exit Conference with Project Management Lecturer; final report package; closeout documentation; lab/EHS checkout as applicable |

*Figure 1. Summary timeline of EIxD touchpoints and required outputs across a 15-week term.*

## 3. EIxD model and current implementation

### 3.1 Course context and purpose of the EIxD model in a projects laboratory course

EIxD is implemented in a team-based chemical engineering project laboratory course at MIT, where students conduct open-ended experimental work under fixed semester deadlines. Teams complete structured formation activities before intensive lab execution begins. Students attend one or two four-hour lab sessions per week. EIxD is presented as a team operating system that embeds emotional intelligence practices (e.g., listening, feedback, and conflict management) within standard project routines and documentation so that these behaviors are applied during real project work, not treated as a separate add-on.

### 3.2 Related work and positioning

Team based engineering projects are widely used because they create conditions for active learning, iterative problem solving, and professional skill development that are difficult to achieve through lecture alone [7]. Prior work frames these experiences as “pedagogies of engagement” that shift students from passive reception toward participation, accountability, and shared construction of knowledge [1]. Engineering education assessment scholarship also emphasizes that complex outcomes, especially teamwork and professional skills, require instruments and evidence that are aligned to the learning claims being made [8]. These imperatives align with accreditation expectations that graduates demonstrate teamwork, communication, and professional responsibilities that extend beyond technical competence [6]. However, team outcomes are not automatic. Reviews of team effectiveness research applied to engineering student teams emphasize that performance depends on how teams are structured, supported, and coached, including clear roles, shared norms, and explicit team processes [9], [10]. Teamwork research further identifies core behavioral dimensions of effective teams, including leadership, mutual performance monitoring, backup behavior, adaptability, and team orientation [11].

Several strands of literature inform how teamwork support is typically implemented in project-based courses. Cooperative learning research provides foundational mechanisms, including positive interdependence, individual accountability, and structured team interaction, and it cautions that teams need explicit process support rather than informal "figure it out" expectations [2]. Design education literature similarly notes that project work requires structured reflection, iterative decision-making, and integration of communication with technical work [12]. Experiential learning theory frames this as a cycle in which concrete experience must be paired with reflection and conceptualization to produce transferable learning [13]. Reflective practice scholarship similarly emphasizes that professionals develop judgment by examining action in context, especially when problems are uncertain, complex, or not fully solvable by technical rules alone [14]. These foundations support the premise that team skills can be intentionally developed, but they also raise a practical design question: where and how should teamwork instruction be embedded so that it remains usable under time pressure during execution.

Within engineering education practice, common approaches include team charters and early team formation activities, periodic reflection prompts, peer evaluation systems, and instructor or TA coaching interventions. A long standing example in research team contexts is the "Initial Team Dialogues" approach, which uses structured prompts to surface attitudes, expectations, and behavioral risks early, in order to accelerate trust and communication [15]. More broadly, work on leading teams emphasizes that strong team performance depends on enabling conditions, including a compelling direction, an enabling structure, and a supportive context that is reinforced over time [16]. Team process research also distinguishes between transition processes, such as planning and goal setting, and action processes, such as coordination and monitoring during execution, and it shows that different processes matter at different points in time [17]. This temporal lens is important because many team interventions are front loaded at formation or back loaded at the end of the course, while the highest coordination burden occurs during execution when deadlines, uncertainty, and task interdependence intensify.

EIxD is positioned in that gap. Rather than treating teamwork support as a set of episodic activities, EIxD treats team execution as an operating system problem. The "operating system" claim is not metaphorical decoration. It is a design assertion that repeatable routines and written records stabilize coordination during execution, especially when uncertainty and time pressure increase. This positioning is consistent with team effectiveness research that highlights the importance of shared mental models, coordination, and monitoring behaviors as teams move from planning into sustained task work [10], [17], [18]. It is also consistent with psychological safety research showing that learning and speaking up are shaped by local norms and interaction practices, not simply by individual confidence [19].

A second reason this execution focused approach matters is that team processes do not operate neutrally across students. Participation, influence, and role allocation are shaped by social dynamics that can disadvantage underrepresented students and women, particularly in project settings that rely heavily on live discussion. ASEE research on gender composition in project teams reports that participation patterns shift when teams are skewed, and that students' opportunities to contribute can be shaped by who is present and how discussion is managed [20]. Related ASEE work on gender stereotypes and role adoption shows that students may select or be assigned roles in ways that reflect stereotypes, which can shape who performs leadership, communication, or coordination work and who receives the learning opportunity associated with

those roles [21]. In capstone contexts, work in progress research on team role selection and execution further indicates that students' perceptions of role fit and success vary, and that role clarity and role execution practices influence both engagement and team functioning [22]. These findings support a core EIxD design choice: participation and inclusion should be treated as operational requirements that are supported by structured routines, not left to informal norms that can amplify dominance and silence.

In addition to who speaks in the room, communication itself has known failure modes in project work. Grounding theory explains why misalignment persists unless teams make understanding explicit and confirm it through acknowledgements, summaries, and repair moves [23]. Media richness theory adds that ambiguous, high stakes work often requires richer channels, but it also implies that teams need mechanisms to prevent interpretive drift after a meeting ends [24]. EIxD uses this logic to justify documentation practices such as advance agendas, minutes that record decisions and open questions, visible action tracking, and decision records that preserve rationale. These mechanisms are not treated as administrative compliance. They are treated as coordination infrastructure that reduces repeated meetings, prevents relitigation of prior decisions, and protects quieter contributors from having to reraise concerns to be heard.

Recent ASEE scholarship also supports the equity and inclusion rationale for treating communication and writing practices as collaboration infrastructure. Work on centering equity and inclusion in engineering collaboration and writing argues that team communication and writing norms can either reproduce exclusion or create more equitable access to influence, depending on how practices are structured and taught [25]. Similarly, a work in progress paper analyzing student response patterns to a team communication intervention reports that students respond differently to communication instruction, which suggests that implementation needs to be explicit, practiced in context, and reinforced through routines rather than delivered as abstract advice [26]. These studies align with EIxD's focus on observable behaviors that can be practiced inside the team's required operating routines, including meeting preparation, inclusive agenda building, structured decision-making, and documented follow through.

EIxD's emotional intelligence integration is also grounded in project relevant claims. Emotional intelligence scholarship defines competencies such as self awareness, self management, social awareness, and relationship management that are relevant to teamwork and leadership [27]. In engineering project contexts, ASEE work on emotional intelligence for aspiring project engineers argues that EI competencies are directly tied to project management effectiveness, including communication, conflict resolution, and trust, and that EI deficits can generate predictable project risks through unresolved conflict and poor coordination [28]. EIxD responds to this by embedding EI behaviors into team operating documents and required touchpoints, so that interpersonal skills are practiced where they matter, during execution and stakeholder interaction, rather than treated as a separate content unit.

Finally, EIxD's project management grounding draws on formal project management performance domains and principles, adapted for a semester length academic project [29]. The PM focus is not presented as additional management overhead. It is presented as the minimum structure required to make progress visible, coordinate interdependent work, and manage stakeholder expectations in an open-ended technical environment. Conflict is treated as expected, and EIxD uses established frameworks to help teams navigate it productively. Research on intragroup conflict distinguishes task and relationship conflict and shows that the relationship

between conflict and performance depends on context and how conflict is managed [30], [31]. EIxD incorporates individual conflict style awareness through the Thomas Kilmann instrument and a structured negotiation approach drawn from principled negotiation, then requires teams to document how they will address disagreement and escalation in advance [32], [33]. This "documented approach before pressure" design aligns with the broader team effectiveness literature that emphasizes anticipatory structuring rather than reactive crisis management [10], [18].

Taken together, the literature supports three positioning claims. First, team effectiveness depends on operational supports that persist through execution, not only on formation and reflection activities [10], [17]. Second, participation and role allocation are shaped by gender composition and stereotype related role adoption patterns, which makes structured routines and role clarity relevant to equity and inclusion outcomes [20], [21], [22]. Third, communication reliability, documentation practices, and conflict navigation are not ancillary skills; they are coordination mechanisms that determine whether teams can execute under uncertainty [23], [24], [30], [31]. EIxD contributes to this space by providing an integrated operating system approach that embeds project management practices and emotional intelligence behaviors into the same routines and documents teams already need to run their work [27], [28], [29].

### 3.3 EIxD conceptual domains

This section documents the current implementation. It describes the conceptual domains that inform EIxD, the six component Team Formation Model completed during the Team Formation Workshop, and the semester-long reinforcement practices and deliverables required of all teams.

EIxD integrates five conceptual domains: project management, emotional intelligence, communication practices, conflict management, and growth mindset. EIxD is structured so these domains function as a coupled system rather than independent modules, with routine-based integration intended to reinforce one another during execution. The framework is operationalized through required tools and required student-produced deliverables. The model emphasizes observable team behaviors, including expectation setting, role clarity, meeting preparation, documentation, and reflection.

Figure 2. EIxD team operating system schematic showing conceptual domains coupled through required routines, written records, and escalation/repair protocols.

| EIxD operating system element | What teams do (observable behaviors and documentation) |
|---|---|
| Weekly routines | Run a weekly team meeting and a weekly advisor/stakeholder meeting with a written agenda sent in advance and minutes published after the meeting. Written weekly progress reports required for advisor meetings. |
| Written team memory | Maintain an activity list (owner, due date, status) and a decision record (decision, rationale, date, owner) so commitments and decisions are traceable. |
| Role rotation and handoff | Rotate Leader, Recorder, and Presenter roles after each oral presentation; complete a structured handoff (what changed, what is blocked, what is next). |
| Expectation alignment | Translate individual expectations into a Team Expectations Worksheet and use it in Week 2 to align/clarify expectations with project stakeholders. |
| EI behaviors embedded in execution | Use active listening, respectful directness, and feedback routines during meetings; name disagreements as task/process/relationship conflicts and choose an appropriate response. Students may use TKI modes as common language for conflict navigation. |

| | |
|---|---|
| Escalation and repair protocols | When stalled or misaligned, use brief reset protocols (e.g., 90-Second Reset; 10-Minute Scope Triage) and escalate to staff when triggers are met, with the issue and decision written down. |

The project management domain draws on core project management principles and performance domains, adapted for a semester-long academic laboratory project, and operationalized through required routines such as agendas, minutes, activity lists, progress reporting, and shared documentation [29]. Communication is treated as a coordination problem in high-ambiguity project work, drawing on grounding theory and channel-task fit to explain how teams establish shared understanding and prevent drift. EIxD operationalizes this through advance agendas, decision-focused minutes, written decision records, and rapid conversion of high-stakes discussions into written commitments [23], [24]. Emotional intelligence draws on Goleman's EI framework and related competency-based models to support self-awareness, self-management, social awareness, and relationship management in team contexts [27]. Conflict management is framed as natural and potentially productive when addressed with shared language and explicit strategy, using the Thomas Kilmann Conflict Mode Instrument and principled negotiation concepts [32], [33]. Growth mindset draws on Dweck to position team skills and leadership behaviors as learnable and improvable through practice and feedback [34].

### 3.3.1 Implementation timeline and required touchpoints

EIxD is implemented through a sequence of required activities and documentation that begins before experimental work and continues through the end of the semester. Before the four-hour Team Formation Workshop in Week 1, students complete individual preparation developed by the author: a competencies and gaps worksheet, an individual expectations worksheet, an EI self-assessment, and the Thomas-Kilmann Conflict Mode Instrument (TKI). The workshop opens with an active listening exercise and a brief orientation to the team practices and EI tools used in the course. Teams of three to four then complete the team formation sequence by creating a team calendar, establishing a role rotation schedule (Leader/Recorder/Presenter), drafting team ground rules (including communication norms and a documented conflict approach), and completing a team expectations worksheet. Following the workshop, team leaders solicit stakeholder expectations in writing (teaching assistant, project supervisor, external consultant when applicable, and project management lecturer) and integrate them into the Week 2 project supervisor meeting agenda and slides.

The second half of the Team Formation Workshop includes a structured, time-bounded team collaboration exercise (pasta bridge prototype build) designed to make coordination behaviors observable early. Teams are required to produce a SMART objective, a sketch, and an execution plan before building under explicit constraints and safety requirements. The time limit intentionally converts a simple build into a collaboration challenge, creating an early opportunity to practice EIxD routines and EI behaviors under pressure.

Structure and accountability are reinforced through required weekly routines across the semester, including distributing agendas and weekly progress reports by email twenty-four hours in advance, maintaining a weekly activity list authored by the team leader, and recording minutes that capture decisions, action items, and stakeholder questions. Teams maintain a shared project management folder accessible to stakeholders and keep a lab notebook. Teams attend a 90

minute Strategic Planning Workshop in Week 2. An “adapted LogFrame,” developed by the author, is used as the strategic planning worksheet to define objectives, risks, assumptions, milestones, and a work plan including a work breakdown structure and Gantt chart. This document informs individually written proposals that must align across teammates.

Mid-semester, teams participate in a leadership check in that includes situational leadership and Goleman leadership styles instruction, an individual leadership self-assessment, and teammate feedback. At the end of the semester, each team submits a completion report before the exit conference. The report includes structured ratings and narrative prompts on expectations alignment, team routines, leadership/role rotation, conflict, communication, planning, and collaboration, and serves as the primary end-of-term evidence source analyzed in this paper.

3.3.2 Emotional intelligence as observable behaviors

Emotional intelligence in EIxD is defined as observable team behaviors practiced through required routines, not as a standalone topic. The central design choice is that interpersonal expectations are embedded in the same operating documents teams use to run their work, including ground rules, agendas, minutes, activity lists, progress reports, and decision records. This integration is the mechanism that differentiates EIxD from approaches that teach emotional intelligence as an added module rather than as part of day-to-day execution under time pressure.

Operationalization by emotional intelligence domain is intentional. Students practice self-awareness by reviewing EI self-assessment results and translating them into concrete team agreements, including ground rules and role rotation choices for Leader, Recorder, and Presenter, with explicit expectations for communication and accountability. Self-management is practiced through preparation and documentation requirements, such as sharing agendas and progress materials in advance, maintaining minutes that capture decisions and action items, and using the ground rules document to guide behavior during disagreement or time pressure. Social awareness and empathy are practiced through structured expectation setting within the team and through written requests for stakeholder expectations, which require students to account for constraints and success criteria beyond their own. Relationship management is practiced through recurring stakeholder communication, including weekly progress reporting, and through leader responsibilities that require facilitation, coordination, and follow-up.

These same documents also support inclusive team behavior by reducing ambiguity about participation, decision-making, and disagreement. For example, agendas distributed in advance create a meaningful and lower-risk opportunity for all team members to contribute topics, questions, and concerns before the meeting, rather than relying on who speaks first or most confidently in the room. Minutes record decisions, commitments, and unresolved questions so quieter members do not have to repeatedly raise issues to be heard. Ground rules establish professional norms for discussion, feedback, and conflict repair, which increases psychological safety early in the semester and supports trust building as the team enters higher-pressure phases of the project.

Mid-semester, students complete a leadership self-assessment developed for this course and receive teammate feedback, providing an additional structured opportunity to practice feedback and behavioral adjustment. At the end of the semester, the completion report prompts reflection

on expectations alignment, ground rules, leadership behaviors, conflict management, and communication routines, reinforcing emotional intelligence as a component of technical team practice.

### 3.3.3 Principled negotiation as a decision routine

Principled negotiation is incorporated in EIxD as a practical routine for conflict navigation and stakeholder negotiation during technical work. Because open-ended laboratory projects routinely generate disagreement about priorities, roles, timelines, and technical direction, the course provides shared language and a structured decision process through two complementary elements: individual conflict style awareness using the Thomas Kilmann Conflict Mode Instrument and a principled negotiation approach to reaching agreement. Teams are also taught to treat their team operating documents as objective criteria for decision-making and conflict navigation when opinions differ or stakes are high, including ground rules, decision records, and activity lists. In implementation, teams use principled negotiation as a repeatable routine by clarifying interests, defining decision criteria, generating options, and recording commitments. Teams establish a conflict approach and escalation protocol in their ground rules and use required meeting preparation and written records to surface issues early and preserve negotiated outcomes. Meeting minutes and action items capture agreements reached in stakeholder discussions, creating traceability for decisions that were contested or revised over time. The completion report prompts teams to reference the Thomas Kilmann Conflict Mode Instrument and principled negotiation when reflecting on difficult decisions and conflict management during the semester.

Table A below summarizes the six component Team Formation Model. Table B summarizes reinforcement across the semester through required recurring student produced deliverables and workshops.

## 3.4 EIxD team formation model: six components, tools, and team foundation documents

Table A. EIxD Six Part Team Formation Model, mapping foundations to tools, documentation, and team behaviors

| EIxD Team Formation component | EIxD domain | Framework or theory anchor | Tool, skill, or instrument | Team foundation documents | Intended team behavior and routine |
|---|---|---|---|---|---|
| Set clear expectations | Communication practices and stakeholder management | Project management stakeholder alignment; grounding theory for shared understanding | Individual expectations worksheet; Team expectations worksheet; active listening exercise | Team expectations document; stakeholder expectations summary (integrated into Week 2 agenda and slides) | Teams make implicit assumptions explicit and establish shared standards for communication, reliability, and work quality; expectations become a written reference point |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | for alignment discussions |
| Assess competencies and assign roles | Project management and team coordination | Role clarity; team composition; role rotation as a coordination mechanism | Competencies and gaps worksheet; strengths and gaps discussion | Team strengths and gaps summary; role rotation schedule (Leader, Recorder, Presenter); initial responsibilities outline | Teams assign roles based on strengths, gaps, and learning goals; role clarity reduces coordination failures and supports equitable workload distribution over time |
| Identify individual goals | Growth mindset | Growth mindset theory | Individual learning goals articulation | Individual development goals summary; role rotation schedule annotated with development intent | Teams treat leadership and teamwork skills as learnable; role rotation is used to support development as well as performance, and progress is revisited during feedback points |
| Establish communication norms | Communication practices | Grounding theory for common ground; channel task fit for selecting communication media | Team discussion of meeting routines; tool norms; active listening; decision clarity prompts | Communication norms embedded in ground rules; agenda expectations; minutes standards; decision record template | Teams create predictable routines for preparation and alignment; agendas are shared in advance, meetings produce written decisions, and teams convert high stakes discussions into written commitments to prevent drift |
| Set ground rules | Emotional intelligence and inclusive team behavior | Goleman EI competencies; team norm setting; psychological safety through explicit norms | EI self assessment results; facilitated norms discussion; feedback expectations | Written ground rules document stored in shared folder; participation norms; accountability norms; repair and feedback norms | Teams define observable behavioral agreements that support respect, accountability, meeting discipline, and inclusive participation; ground rules function as |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | objective criteria when behavior or expectations need correction |
| Develop conflict management strategy | Conflict management and negotiated decision-making | Thomas Kilmann Conflict Mode Instrument; principled negotiation | TKI results used to build a team conflict profile; principled negotiation decision routine (interests, criteria, options, commitments) | Conflict approach and escalation protocol embedded in ground rules; decision record used for contested choices; meeting minutes and action items preserve agreements | Teams anticipate conflict patterns, negotiate decisions using shared criteria, and follow an agreed escalation process before issues become relationship or schedule failures; negotiated outcomes are recorded for traceability |

### 3.4.1 Set clear expectations

Prior to the Team Formation Workshop, students complete an individual expectations worksheet that records what they expect of themselves as team members and what they expect from teammates. Teams also complete a stakeholder expectations worksheet that specifies what the team expects from key stakeholders and what the team anticipates stakeholders will expect from the team. These written statements make implicit assumptions explicit and provide a shared reference point for alignment throughout the semester.

During the Team Formation Workshop, teams practice active listening while comparing individual expectations with anticipated stakeholder expectations. The Recorder produces a written expectations summary.

After the workshop, the Leader requests five expectations in writing from each stakeholder group, including the teaching assistant, project supervisor, external consultant when applicable, and the project management lecturer. The team integrates these inputs into the Week 2 project supervisor meeting through the agenda and a brief slide summary, and the project management lecturer attends to support the student-led expectations discussion and reinforce the use of written expectations as objective criteria for coordination and follow through.

### 3.4.2 Assess competencies and assign roles

Students complete a competencies and gaps worksheet developed for the course to identify strengths and development opportunities relevant to technical work and team functioning. Teams

use these inputs to assign initial responsibilities and to build a role rotation schedule that supports both execution and learning.

Teams establish a rotation plan for three roles, Leader, Recorder, and Presenter, with three planned role rotations across the semester. Role assignments are selected based on identified strengths and gaps and on individual learning goals so that each student has structured opportunities to practice leadership, documentation, and stakeholder communication.

### 3.4.3 Identify individual goals

Students articulate individual learning goals for the semester. Teams integrate these goals into the role rotation schedule so that development objectives are connected to real team responsibilities rather than treated as separate reflection work.

### 3.4.4 Establish communication norms

Teams create a shared team calendar during the Team Formation Workshop and establish recurring meeting and reporting routines. Agendas and weekly progress reports are distributed by email twenty four hours before scheduled meetings.

The Recorder takes minutes at every meeting, capturing decisions, action items with owners and due dates, and questions for project stakeholders. Minutes and related project management documents are stored in a shared project management folder accessible to the team and relevant stakeholders, providing a stable written record that reduces drift.

### 3.4.5 Set ground rules

Teams develop written ground rules during the Team Formation Workshop or within the following two weeks, based on team circumstances. Individual EI self assessment results inform the norms discussion, and team members use active listening to surface and confirm expectations. Individual Thomas Kilmann Conflict Mode Instrument results inform the conflict related elements of the ground rules.

Ground rules define observable expectations for roles and responsibilities, meeting practices and communication, preparation and pre laboratory work, use of resources and tools, learning and skill development, decision-making and problem solving, ethics and safety, and deadlines and accountability. The ground rules document is stored in the shared project management folder and used as objective criteria for decision-making and conflict navigation.

### 3.4.6 Develop conflict management strategy

Students complete the Thomas Kilmann Conflict Mode Instrument and review individual results. Teams synthesize these patterns into a team conflict profile using a course-developed worksheet, producing a shared approach to disagreement.

Teams document their conflict approach and escalation protocol in the ground rules and use meeting preparation and written records to surface issues early and preserve negotiated agreements.

3.5 EIxD reinforcement across the semester through required weekly practices and workshops

Table B. EIxD Reinforcement across the semester, required recurring documentation, and intended performance mechanisms

| Timing | EIxD reinforcement touchpoint | Required recurring documentation or deliverables | Intended performance mechanism |
|---|---|---|---|
| Week 1 (pre work and Team Formation Workshop) | Team formation sequence and collaboration exercise | Competencies and gaps worksheet; individual expectations worksheet; EI self-assessment; TKI; team calendar; role rotation schedule; team expectations worksheet; ground rules draft; SMART objective and execution plan for collaboration exercise | Convert baseline self-assessment into shared agreements and routines; make coordination behaviors observable early; establish written norms and role clarity before intensive lab execution |
| Week 2 | Stakeholder expectations clarity discussion and Strategic Planning and Design Workshop (adapted LogFrame) | Written stakeholder expectations requested in advance; stakeholder expectations summary integrated into meeting slides; adapted LogFrame worksheet (scope, problem definition, assumptions, milestones, risks); initial work breakdown structure and Gantt chart | Align success criteria with stakeholders and reduce hidden assumptions; translate ambiguity into a written project design that guides individual proposals and early execution |
| Weeks 3 to 13 (weekly) | Weekly execution operating system | Agenda and progress materials distributed in advance; meeting minutes capturing decisions and action items; activity list with owners and due dates; weekly progress report prior to advisor meeting; decision record updates as needed | Maintain shared understanding and accountability through repeatable routines; preserve traceability for commitments and contested decisions; reduce coordination failures under time pressure |
| After each oral presentation | Role rotation and knowledge transfer | Role transition checklist; handoff notes; updated activity list and decision record; updated role responsibilities | Prevent loss of team memory during leadership changes; distribute leadership practice across teammates while maintaining continuity of decisions, risks, and next actions |
| Mid-semester | Leadership check-in and teammate feedback | Individual leadership self-assessment; teammate feedback; reflection prompts tied to team routines and roles | Create a structured point for behavioral adjustment, feedback practice, and re alignment of workload, communication, and leadership behaviors |

| | | | |
|---|---|---|---|
| Weeks 14 to 15 | Closeout, completion report, and exit conference | Team completion report (ratings and narratives on expectations, routines, leadership, conflict, communication, planning, collaboration); closeout documentation and lab checkout as applicable | Consolidate learning and evidence of implementation fidelity; prompt reflection on mechanisms and lessons learned; create a consistent end-of-term review process |

### 3.5.1 Weekly project management operating system

The Team Formation Workshop establishes team operating routines that are reinforced through weekly practice. Teams hold recurring meetings and produce a standard set of written outputs that make coordination visible and reduce drift. Teams present a weekly progress report at the project supervisor meeting using slides, and the meeting agenda and progress materials are distributed by email twenty-four hours in advance.

Minutes are taken at every meeting and capture decisions, action items with owners and due dates, and questions for project stakeholders. The Leader maintains the activity list and prepares meeting agendas, and the Recorder drafts the weekly progress report and publishes minutes. Teams maintain a lab notebook and assign responsibility for data analysis. All operating documents are stored in a shared project management folder accessible to stakeholders, providing a consistent written record for accountability and decision traceability.

### 3.5.2 SMART objective instruction and team collaboration exercise

Students learn Doran's SMART objective setting strategy, defined as specific, measurable, assignable, realistic, and time-related, in advance of the Strategic Planning Workshop [35]. Students practice SMART objective setting during the Team Formation Workshop by participating in a time-bounded team collaboration exercise. A representative exercise is a pasta bridge prototype build in which teams produce a SMART objective, a written design, and an execution plan before constructing under explicit constraints and safety requirements. The time limit is intentional because it makes planning quality, role clarity, communication, and conflict navigation observable early. Teams submit the required materials, including the objective, plan, and build documentation, through the course learning system.

### 3.5.3 Strategic Planning Workshop

In the Strategic Planning Workshop, teams apply SMART objective setting to define project scope and translate objectives into an executable plan. Teams use the strategic planning worksheet to identify objectives, assumptions, risks, milestones, and criteria for success and failure. Teams develop a work breakdown structure and a Gantt chart with the teaching assistant and project supervisor present to answer technical questions. The resulting plan serves as the shared basis for individual project proposals that must align across teammates.

### 3.5.4 Mid-semester leadership workshop

Mid-semester, teams participate in a structured check-in that reinforces leadership and team operating practices. Students share team management practices and complete additional

leadership instruction drawing on situational leadership and Goleman's leadership styles [27]. Students complete an individual leadership self assessment developed for the course and compare self ratings to teammate feedback, creating a structured opportunity to practice feedback and behavioral adjustment.

### 3.6 Required student actions and deliverables

EIxD implementation relies on required student actions and deliverables that make team routines observable. Individual preparation includes the competencies and gaps worksheet, individual expectations worksheet, team expectations worksheet, EI self assessment results, Thomas Kilmann Conflict Mode Instrument results, and individual learning goals.

Team foundation documents include a team calendar, role rotation schedule, ground rules document that includes a conflict approach and escalation protocol, and a written expectations summary, including stakeholder expectations requested in writing and integrated into the Week 2 project supervisor meeting.

Weekly operating documents include meeting agendas, an activity list maintained by the Leader, a weekly progress report drafted by the Recorder and presented using slides, and meeting minutes that preserve decisions, action items, and stakeholder questions. All documents are stored in a shared project management folder accessible to stakeholders, and teams are expected to use these records as objective criteria for decision-making, accountability, and conflict navigation.

### 3.7 Semester closure documentation: team completion report

At the end of the semester, each team submits a completion report before the exit conference with the project management lecturer. The report includes structured ratings and narrative prompts reflecting on expectations alignment, ground rules, leadership and role rotation, conflict management, communication routines, planning, and collaboration. These completion reports serve as the primary end-of-term evidence source analyzed in this paper and provide a structured mechanism for team reflection and course improvement.

## 4. Practice-based evaluation and evidence

The primary evidence source for this paper is the end of semester team completion report. The completion report captures team reflections on challenges and successes across the project life cycle, leadership development, and recommendations for future team based work. It includes required open-ended prompts and scaled ratings that map directly to EIxD implementation.

The completion report is designed as both a course reflection and a professional closeout exercise. It asks teams to examine how they worked across the project life cycle and to practice the kind of disciplined project review expected in professional engineering settings. The purpose is not simply to describe what went well. Teams are asked to identify what supported execution, what broke down under pressure, and what should be handed off to future teams. They also consider whether gaps in communication, planning, delegation, documentation, or decision-making created risks for safety, quality, or stakeholder alignment. In this way, the report turns reflection into a practical review of team process, project execution, and professional judgment.

The final questions ask students what they would change, what they would preserve, and what they would carry into their next team-based project experience.

### 4.1 Data sources

EIxD is evaluated using practice based evidence generated through normal course operation. To avoid adding burden to students or staff, the evaluation relies on required course deliverables that are already embedded in the EIxD implementation sequence. The evidence set used in this paper includes one data source: the end of semester outcomes and reflections in the Project Lab completion report (2022 to 2025; n = 24 team reports total). The completion report includes scaled ratings of key EIxD routines and open-ended narratives describing what supported or hindered team execution. Report counts by year are 2022 n = 8, 2023 n = 8, 2024 n = 6, and 2025 n = 2.

These data support claims about feasibility, student buy in, implementation fidelity for key EIxD mechanisms, and perceived mechanisms of impact on team execution. They do not establish causal effects on grades or other technical performance outcomes. All counts and pooled summaries reported in Section 4 are traceable to the verification workbook prepared for this paper.

### 4.2 Analysis approach

Open-ended completion report narratives were coded using an a priori codebook. The codebook was aligned with the paper's central claims: that EIxD operates as a coordination and execution system, and that it integrates emotional intelligence and project management through routine documents and stakeholder touchpoints. Because EIxD has been refined through repeated implementation, classroom evidence, and redesign of course routines, the evaluation approach is consistent with design-based research traditions in education [36]. The codebook includes themes tied to the intended mechanisms of EIxD, including the following: 1) expectations alignment and stakeholder management, 2) communication and coordination routines, 3) documentation and traceability, 4) accountability and follow through, 5) role transition knowledge transfer, 6) conflict navigation and decision-making, and 7) inclusion related behaviors such as psychological safety and equitable participation.

Coding was conducted at the team report level for the pooled 2022 to 2024 completion reports (N = 22 team reports). A theme was counted as present only when the narrative included explicit textual evidence supporting the tag. Coding proceeded in two passes. The first pass tagged candidate themes within each team report. The second pass verified that each tag was supported by explicit evidence and selected representative excerpts that illustrate the mechanism. Percentages reported for structured expectations reflect a manual coding pass conducted by the author using the a priori codebook, with tallies verified against the raw responses in a verification workbook prepared for this paper. Theme frequencies therefore represent the number of team reports in which a theme appeared, and a single report could include multiple themes. Instructor field notes from exit conferences are used as illustrative context only and are not included in coded counts.

Conflict related codes include both prompted use of shared terminology introduced in the course and applied conflict navigation behaviors such as decision criteria, repair moves, and escalation

or help seeking. These elements are reported separately in Section 4.3 to avoid overstating prompted uptake as evidence of impact.

Completion report scaled items were summarized using descriptive statistics by year. For cross year reporting, pooled 2022 to 2024 means were computed as weighted means across all individual ratings using year specific response counts as weights. This pooled period is treated as the primary quantitative summary because 2025 included two teams and several instructional elements changed in 2025, including a redesigned Logical Framework activity. For transparency, 2025 means are reported separately. All counts, pooled means, and coded tallies reported in Section 4 are traceable in the verification workbook prepared for this paper.

### 4.3 Results summary

This paper argues that EIxD functions as an operating system for technical project teams. The mechanism is repeatable routines and written records that stabilize coordination under ambiguity and time pressure. Completion reports provide practice-based evidence consistent with this mechanism. Teams rate the core routines highly and describe agendas, minutes, activity tracking, and stakeholder updates as improving continuity and execution, not as compliance tasks. Conflict navigation is more uneven. Across the pooled set (N = 22), teams described a conflict resolution outcome in 13 reports, used decision criteria or an explicit decision process in 7 reports, and referenced escalation or help seeking in 6 reports. Logical Framework use remains lower than other routines, suggesting it requires tighter linkage to proposal writing and decision points to function as a routine tool. 2025 results are reported for transparency only and are not interpreted as confirmatory evidence due to the small cohort size and instructional changes.

#### 4.3.1 Scaled ratings of core routines

Table 1 reports completion report ratings by year and pooled results for 2022 to 2024. Ratings use a 1 to 5 scale.

Table 1. Completion report ratings by year and pooled mean (scale 1 to 5)

| Class Year (n) | Weekly routines | Role transitions | Collaborative writing | Ground rules | Logical Framework |
|---|---|---|---|---|---|
| 2022 (n=8) | 4.75 | 4.38 | 4.38 | 4.50 | 3.00 |
| 2023 (n=8) | 4.62 | 4.25 | 4.12 | 4.00 | 3.12 |
| 2024 (n=6) | 4.33 | 4.50 | 4.33 | 4.50 | 4.00 |
| 2025 (n=2) | 4.50 | 5.00 | 4.00 | 4.00 | 3.50 |
| 2022–2024 pooled (n=22) | 4.59 | 4.36 | 4.27 | 4.32 | 3.32 |

Across 2022 to 2024, students rated weekly routines, role transitions, collaborative writing, and ground rules highly. Logical Framework ratings were lower. This pattern is consistent with the operating system claim. Students report strong value for routines that structure weekly coordination, while planning frameworks show more variable uptake depending on how directly they connect to proposal writing and decision points. “The logical framework was useful in setting our goal more accurately, however it was not nearly as helpful in our week-to-week activities.” Completion report, Team 1 (2022).

### 4.3.2 Narrative evidence of operating system mechanisms

Open-ended completion report narratives were coded at the team report level for 2022 to 2024 (N = 22 team reports). Table 2 reports theme frequencies. A theme is counted only when the report includes explicit textual evidence.

Table 2A. Coded completion report themes that support the operating system mechanism (2022–2024 pooled; N = 22)

| Theme | Count (of 22) | Percent |
|---|---|---|
| Stakeholder updates and expectation alignment | 16 | 72.7% |
| Preparation and efficiency gains from routines | 12 | 54.5% |
| Documentation and traceability (agendas, minutes, tracking) | 11 | 50.0% |
| Decision criteria or decision process described | 7 | 31.8% |
| Escalation or help-seeking described | 6 | 27.3% |
| Principled negotiation approach described | 3 | 13.6% |

Two themes provide direct evidence of the operating system mechanism.

Stakeholder alignment was referenced in most reports. Teams described weekly updates and meeting preparation as improving clarity, feedback cycles, and forward progress. “It gave the faculty a background of our week and allowed them to suggest additional agenda items for the upcoming meeting.” Completion report, Team 10 (2023). This supports the claim that EIxD increases the quality of stakeholder touchpoints by requiring advance preparation and by converting outcomes into written records.

Documentation and traceability were referenced in half of reports. Teams described agendas, minutes, and written tracking as tools that preserve continuity and reduce rework under time pressure. “Taking minutes allowed the team to recall important information from previous meetings, thus making lab sessions and meetings more productive.” Completion report, Team 5 (2023). This supports the claim that coordination becomes more stable when commitments, questions, and decisions are captured in shared records.

Decision criteria language and escalation or help seeking were less common. This is a useful finding for refinement. It indicates that teams consistently describe routine coordination supports, while fewer teams explicitly describe decision framing practices and escalation behaviors. These elements remain targets for strengthening EIxD instruction and templates. Taken together, these narratives suggest that EIxD’s value is not limited to the existence of particular documents. Its value emerges as teams learn to use those documents differently over time. First students learn to use them as required structures, and later as practical tools for preserving continuity, supporting psychological safety, coordinating laboratory work, managing stakeholder feedback, and making decisions under time pressure.

### 4.3.3 Evidence of practical EI and PMI integration

EIxD’s core integration claim is that emotional intelligence behaviors and project management practices are embedded in the same operating documents teams already use to run their work. Completion report narratives provide evidence consistent with this mechanism.

Teams describe EI-relevant behaviors in operational terms and tie them directly to routine documents. Students point to ground rules as a tool for setting expectations and preventing avoidable friction, not as a one-time exercise. One team wrote, “We all plan on using ground rules and expectations so everyone in the team can be on the same page.” Completion report, Team 8 (2024). Teams also describe participation and voice as outcomes of structured routines rather than personality or confidence. One team emphasized that intentional meeting structure reduced avoidance and made space for contribution: “We have been less avoidant in disagreements and have been more willing to voice our opinions.” Completion report, Team 3 (2024). Another team described how advance preparation created a safer opportunity for input: “Everyone would have had the chance to look it over before meeting and share thoughts.” Completion report, Team 7 (2024). These descriptions support the claim that EIxD operationalizes emotional intelligence as observable team behaviors embedded in weekly routines, including participation norms that reduce reliance on dominance in live discussion.

Teams also describe PMI aligned practices through the same documents and stakeholder touchpoints. Students describe weekly progress reporting and prepared agendas as execution supports that improve stakeholder feedback and keep work aligned. One team described the weekly progress report as a structured feedback mechanism: “Whenever we give our weekly progress report, it is a great opportunity for feedback that can help guide our efforts.” Completion report, Team 8 (2022). Another team described agenda discipline as an execution control tool: “Our meetings are on track of time and follow the scheduled agenda.” Completion report, Team 8 (2023). This pattern supports the claim that EIxD makes project management practical by requiring repeatable coordination routines and written records that improve stakeholder alignment and week-to-week execution. Importantly, this pattern indicates behavioral integration rather than simple terminology uptake. Teams describe the routines as useful when they become part of how the team prepares, decides, records, follows up, and adapts during the project. In contrast, Logical Framework ratings and narratives suggest that planning frameworks require tighter linkage to proposal writing and decision points in order to function as a routine tool rather than a front-end exercise.

#### 4.3.4 Conflict language

TKI-related evidence is interpreted here as behavioral translation rather than terminology uptake. During exit conferences teams described using individual TKI profiles to design meeting norms and written ground rules that ensured participation, including rules requiring each member to state an opinion before major decisions and brief check in routines such as two-minute wellness checks. These reports support the claim that EIxD embeds EI behaviors in operating documents and weekly routines.

Table 2B reports conflict navigation themes coded from the open-ended completion report narratives for 2022 to 2024 (N = 22 team reports). Because TKI is explicitly prompted in the completion report and discussed during the course, TKI mention is not used as an outcome indicator. The table therefore focuses on behavioral evidence of conflict navigation described by teams, including conflict resolution outcomes, explicit decision process language, escalation or help seeking, and use of principled negotiation concepts.

Table 2B. Conflict navigation themes in completion reports, excluding prompted TKI uptake (2022–2024 pooled; N = 22 team reports)

| Theme | Count (of 22) | Percent |
|---|---|---|
| Conflict resolution outcome described | 13 | 59.1% |
| Decision criteria or decision process described | 7 | 31.8% |
| Escalation or help-seeking described | 6 | 27.3% |
| Principled negotiation approach described | 3 | 13.6% |

#### 4.3.5 Inclusion mechanism and field note context

Instructor field notes from exit conferences are included as illustrative context only and are not part of the coded dataset. One student reflected that the structured routines shifted influence away from volume. The student noted that it was not always the loudest person in the room who gets heard because advance agendas and written records created space for all voices to be considered and supported decisions grounded in logic and data. This observation is consistent with the operating system mechanism described above.

#### 4.3.6 Limitations

This practice based evidence is descriptive and has limitations. Completion report ratings and narratives are self-reported and may reflect satisfaction, recall bias, or response bias. The design does not include a comparison group, pre-post measures tied to outcomes, or linkage to grades or technical project results, so causal claims are not supported. Qualitative coding was conducted by the author using an a priori codebook. Counts and excerpts are traceable in the verification workbook, but the analysis does not include a second coder or formal inter-rater reliability. Finally, 2025 includes two teams and instructional elements changed in 2025. For that reason, pooled 2022 to 2024 results are treated as the primary summary and 2025 is reported for context only.

#### 4.3.7 Next steps using existing course data

Future work will strengthen this evidence base using existing course data sources. First, conflict related analysis will separate prompted uptake from applied behavior by distinguishing prompted terminology from unprompted descriptions of repair moves, decision criteria, and escalation. Second, operating routines will be linked to downstream indicators already present in course work, including completeness and timeliness of weekly progress reports, quality of decision records, and evidence of stakeholder expectation drift. Third, the redesigned Logical Framework activity will be evaluated by assessing whether narrative references and ratings increase when the framework is tied to specific proposal decisions and mid-semester pivots.

## 5. Lessons learned

EIxD has been refined through repeated course offerings. Several practice based lessons shape the current implementation.

First, EIxD emerged in direct response to student feedback. Earlier versions of the course treated project management practices as a parallel requirement, and students reported that the work felt separate from the technical project. The current implementation addresses that complaint by integrating team practices into the same stakeholder touchpoints and execution needs that already

drive project progress. A key example is the Week 2 project supervisor meeting. The team leader requests stakeholder expectations in writing, integrates them into the meeting agenda and slides, and the project management lecturer attends to facilitate an expectations alignment discussion with all stakeholders present. This positioning makes the team operating practices part of technical execution rather than an additional task layer.

Second, team formation must occur before experimental work begins. Early project weeks are where misalignment, uneven participation, and hidden assumptions form. When students translate individual expectations and self-assessment insights into shared operating documents before technical execution, teams start with a common standard for communication, participation, and follow through.

Third, the model depends on reinforcement through required weekly touchpoints. Routines hold when they are tied to real meetings with consequences. Agendas sent in advance, minutes that capture decisions and open questions, a visible activity list, and weekly progress reporting function as execution supports rather than administrative tasks. This lesson is consistent with the completion report evidence, where students rate the weekly routines and ground rules highly and describe documentation and stakeholder updates as enabling smoother execution.

Fourth, staff alignment matters as much as student effort. Uptake improves when teaching assistants, project supervisors, and communication or project management instructors reinforce the same expectations in the same language. When staff practices drift, teams treat the routines as optional. When staff expectations are consistent, teams treat the routines as the normal way technical work is conducted.

Fifth, customization is not optional in an open-ended laboratory course. Different teams are running different experiments, using different equipment, and facing different uncertainty and safety constraints. For that reason, EIxD tools and templates are designed to be adapted. Students are taught that the operating documents exist to serve the work. Teams adjust meeting frequency, document detail, and tracking methods to fit project needs and supervisor preferences, while preserving the core mechanism of written decisions and accountable follow through. Grading emphasizes substance rather than format. If the project management work begins to feel like low value overhead, that is treated as a signal that the team should adjust the documents so they better support execution.

Customization also appears to be a marker of maturity rather than drift from the model. As teams move further into technical execution, the most effective use of EIxD is not rigid compliance with a template, but disciplined adaptation of the template while preserving written decisions, visible ownership, and timely stakeholder communication.

Finally, students are often most receptive to emotional intelligence and conflict instruction when it is connected to the ordinary pressure points of project work. A teammate reacts defensively to feedback. Someone misses a commitment or waits too long to communicate that work will not be done on time. The team procrastinates, relies on assumptions that later prove wrong, or reaches a key decision point without a clear process for discussing project direction. In those moments, general advice to “communicate better” is not enough. Students need practical language, shared expectations, and a decision process they can use while the work is still moving forward. For that reason, EIxD treats emotional intelligence as behavior under pressure rather than as a separate

topic. Participation norms, feedback expectations, and conflict-navigation routines are embedded in the team's operating documents so students have a professional structure to rely on when the team is stressed, behind schedule, or negotiating direction with stakeholders.

This set of lessons informs the current EIxD implementation and highlights adoption conditions for instructors: integrate team practices into stakeholder touchpoints, front load team formation, reinforce routines weekly, align staff expectations, and require customization so the operating documents support real technical execution.

## 6. Future directions

Future work will focus on improving three aspects of EIxD implementation that emerged from the present findings: transferability for adopters, stronger use of planning tools during mid-semester decision-making, and clearer evidence of behavioral uptake over time. First, EIxD will be packaged into an instructor-ready toolkit that includes EI basics, workshop agendas, templates, examples, and customization guidance tied to course conditions such as team size, meeting structure, stakeholder availability, and laboratory constraints. The goal is adoption with minimal added burden: instructors should be able to implement the core mechanism without redesigning their course.

Second, the Logical Framework instruction will be refined and evaluated following the 2025 redesign. Future offerings will examine whether students use the adapted LogFrame worksheet not only during proposal development but also as a recurring decision support tool during mid-semester pivots and stakeholder negotiations, including clearer linkage to proposal writing and explicit decision points.

Third, the practice-based evaluation approach will be strengthened while preserving the low-burden design. Planned improvements include separating prompted terminology from unprompted behavioral evidence, adding a second coder for a subset of reports to assess coding consistency, and incorporating course-linked indicators of implementation fidelity, including timeliness and completeness of weekly progress reports, quality of decision records, and evidence that teams adapted operating documents during execution.

## 7. Conclusion

EIxD treats student project teams in an engineering project laboratory course as systems that can be intentionally designed and supported. The framework integrates project management practices and emotional intelligence behaviors by embedding them in the same operating documents and stakeholder touchpoints teams already use to execute technical work. This paper documented the current implementation, including the six-component Team Formation Model and the semester-long set of required routines that reinforce coordination, accountability, and inclusive participation under time pressure.

Practice-based evidence from required course deliverables supports feasibility, student buy-in, and mechanisms consistent with the operating system claim. Completion report ratings indicate strong student-perceived value for weekly routines, ground rules, role-transition knowledge transfer, and collaborative writing, while qualitative narratives describe documentation, preparation, and stakeholder updates as improving execution and continuity. Utilization of the

Logical Framework appears more sensitive to instructional scaffolding and remains a target for continued refinement.

EIxD addresses a persistent instructional challenge in project-based engineering courses: helping students develop professional teamwork maturity while navigating ambiguity, deadlines, and technical uncertainty. The framework does not claim a foolproof method. Instead, it takes a practical stance: interpersonal skills become teachable when they are translated into observable behaviors embedded in routines teams already need to execute. Students report that the routines reduce confusion, improve coordination, and create more equitable participation by making space for quieter voices. Students also reported during exit conferences transfer of these tools beyond the course, including other classes and extracurricular teams, suggesting that an operating system approach can make inclusive, disciplined teamwork more achievable under real project constraints.

## Appendix A. Implementation pathway for adoption

EIxD is designed for adoption across project-based courses without requiring a specific course structure. The goal is reliable team execution through a small set of required routines and documents, with optional elements instructors can adapt to fit local constraints.

### Quick start for adopters

Required for first-time implementation

1. Run a structured team formation session before technical work begins.
2. Require four weekly operating documents: agenda, minutes, activity list, decision record.
3. Use role clarity with rotation for Leader, Recorder, and Presenter.
4. Run an early expectations alignment discussion with key stakeholders.

Optional after the basics work reliably

- Add short reset protocols for misalignment, scope drift, stuck decisions, and uneven workload.
- Add a mid-semester leadership self-assessment and teammate feedback.

### Step 1: Define course conditions

Record team size, project type, meeting frequency, staff capacity, access constraints, and grading approach. These conditions determine how much scaffolding teams need and which touchpoints you can require.

### Step 2: Team formation before technical work begins

A structured team formation session is the anchor. It converts individual insight into team agreements and produces the documents that will run the semester.

Pre-work completed by students focused on documentation of student self-awareness

1. Competencies and gaps worksheet
2. Individual expectations worksheet
3. Emotional intelligence self-assessment
4. Thomas Kilmann Conflict Mode Instrument results reviewed by each student

In session instruction and practice

1. Brief emotional intelligence instruction focused on observable team behaviors in meetings and decisions
2. Active listening practice
3. Conflict navigation framing using Thomas Kilmann as a shared language
    - Teams learn to classify disagreement before responding by naming conflict type as task, process, or relationship. Teams then select an appropriate response strategy, including when to use Thomas Kilmann language for self-awareness and when to use a principled negotiation approach for joint problem-solving.

Team deliverables produced during the session

1. Team calendar
2. Role definitions and a role rotation schedule for Leader, Recorder, Presenter
3. Team ground rules with measurable communication and accountability norms
4. Decision participation rule that ensures every member is heard before important decisions, especially when members tend to avoid or accommodate
5. Ground rules include a written conflict navigation approach that begins with naming conflict type as task, process, or relationship, followed by an agreed response plan and escalation pathway
6. Team expectations summary for internal functioning
7. Short execution practice under time pressure
    - Run a brief collaboration exercise that requires a written objective and work plan before execution. Require a short written reflection on what the team will change in meeting routines, follow through, and decision-making.

Step 3: Early expectations alignment with stakeholders

Before the first major stakeholder meeting, require teams to request written expectations from the stakeholders they rely on, such as an advisor, teaching assistant, consultant, or course staff member as applicable. Teams consolidate these into a Team Expectations Summary and use it to facilitate an expectations clarity discussion in the early meeting.

Step 4: Establish the weekly operating system

Keep the required weekly documentation set small and consistent.
Minimum weekly requirements

1. Agenda distributed in advance by the Leader
2. Minutes published after the meeting by the Recorder, capturing decisions, action items, and open questions
3. Activity list maintained with owners and due dates
4. Decision record used when rationale, criteria, or tradeoffs must be preserved
5. Weekly progress report is the update used as the input to stakeholder meetings when those meetings occur

Step 5: Grade for usefulness, not formatting

If you grade documents, grade for execution value. Decisions recorded. Owners assigned. Due dates realistic. Blockers visible. Follow through tracked. Make explicit that if the work feels like

busy work, the correct response is to adjust the templates so the documents better serve the team and project. Customization of tools using critical thinking is the focus.

Step 6: Reinforcement moments

- Require a short written handoff after each role rotation.
- Mid-semester, require a leadership self-assessment and teammate feedback.
- End-of-term, require a reflection report connecting outcomes to expectations, ground rules, conflict navigation, participation, and execution routines.

Minimum evaluation data for adopters

Collect three points aligned to implementation: baseline student inputs, the team expectations worksheet used in the early stakeholder meeting, and end-of-term reflections on routines, decision-making, conflict navigation, and participation. These sources support descriptive claims about feasibility and perceived impact without asserting causality.

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