DESIGNING AUTHENTIC INDUSTRY-ENGAGED ASSESSMENT FOR PROFESSIONAL COMPETENCE IN BUSINESS INTELLIGENCE

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ABSTRACT

Engineering programs increasingly seek to align student learning with professional practice, yet meaningful industry collaboration often exposes misalignment between academic assessment norms and workplace expectations. This paper presents a CDIO Implementation case describing the redesign of an undergraduate business intelligence course to strengthen industrial relevance while supporting student professional development. The redesign integrated semester-long, industry-inspired project work structured around team-based learning and competence-oriented assessment, emphasizing authentic data, reproducible workflows, and professional collaboration tools. A single industrial partner contributed real-world datasets, problem framing, and feedback, enabling students to engage with constraints and quality standards characteristic of professional practice. Assessment and feedback were redesigned to balance team performance with individual contribution through visible artifacts (e.g. version control activity) and structured reflection, addressing persistent challenges related to workload, accountability, and fairness. Evidence from iterative course evaluations, student reflections, graduate feedback, and industry partner input indicates increased student engagement, improved coherence across learning activities, and clearer alignment between assessment criteria and professional expectations. At the same time, the collaboration revealed tensions between academic tolerance for developmental errors and industry demands for reliability and trustworthiness, highlighting the importance of explicitly preparing students to communicate differently with academic and professional audiences. The paper reflects on these tensions and outlines design principles for industry-engaged CDIO courses, including expectation alignment early in the course, sustained use of a shared industrial context, and assessment practices that foreground professional standards without sacrificing formative learning space. The case offers transferable insights for CDIO programs seeking to leverage industrial collaboration as a catalyst for student professional development through innovative assessment and feedback.

KEYWORDS

Industry collaboration, professional competence, assessment and feedback, team-based learning, CDIO Standards: 5, 7, 8, 11

INTRODUCTION AND MOTIVATION

Engineering education increasingly emphasizes alignment between academic learning and professional practice. Within this agenda, CDIO integrates disciplinary knowledge with personal, interpersonal, and system-building competencies enacted in realistic engineering settings (Malmqvist et al., 2022). In parallel, industry expects graduates to handle authentic data, collaborate effectively, justify methods, and deliver credible, reproducible outputs.

Despite broad agreement on these goals, tensions persist between academic assessment practices and professional standards. In higher education, assessment often functions developmentally: students are encouraged to explore, iterate, and learn from error. By contrast, professional evaluation foregrounds data provenance, limitations, reproducibility, stakeholder relevance, and the business implications of uncertainty–sometimes more than mastery of specific algorithms. These differences surface most clearly in industry-engaged courses where academic norms meet workplace expectations and where credibility and trust become explicit evaluation criteria grounded in industry expectations of reliable, decision-supporting analysis, assessed through reproducibility, transparency, and the justification of analytical choices. This aligns with authentic assessment, which emphasizes realistic tasks, explicit criteria, and feedback that supports improvement toward professional performance (G. Wiggins, 1998).

Business Intelligence (BI), spanning data analysis, information systems, and organizational decision support, provides a revealing context for examining these tensions. Practitioners must combine sound analytical method with professional judgment, transparency about assumptions and limitations, and effective communication with non-technical stakeholders. This paper reports a redesign of a BI course to strengthen industrial relevance through competence-oriented assessment and sustained collaboration with an industry partner. We analyze how assessment and feedback support professional competence development in this context and reflect on resulting tensions, trade-offs, and transferable design principles for CDIO-aligned programs.

COURSE AND INDUSTRY CONTEXT

BI is a 6 ECTS elective for advanced undergraduate and early graduate students in Industrial Engineering and adjacent programs. The course typically enrolls 10–15 students working in two larger teams and runs over one semester in five thematic two-week modules followed by a capstone project. A single industry partner contributes authentic data and domain framing and has participated across two consecutive offerings, enabling comparison of coherence and professional relevance.

DESIGN FRAMEWORK AND ALIGNMENT WITH CDIO

The course redesign adopts a CDIO-inspired approach in which assessment and feedback function as developmental mechanisms guiding students toward professional standards rather than serving as terminal checks of attainment. While prior CDIO work has examined challenges in assessing interpersonal competencies in project courses–using peer assessment or logbooks (Hansen & Sindre, 2023; Huet et al., 2008; Junaid et al., 2018)–there has been comparatively less attention to how such practices interact with industry-facing expectations of credibility and trust in sustained collaborations.

Professional competence in a CDIO perspective

Professional competence is understood as the integrated ability to analyze open, data-rich problems, locate and critically evaluate information, and collaborate effectively under realistic constraints. This aligns with the CDIO Syllabus 3.0 emphasis on personal, interpersonal, and system-building competencies alongside disciplinary knowledge (Malmqvist et al., 2022).

To operationalize these competence goals, the redesign used the LOUIS (Learning Outcomes in University for Impact on Society) competence framework (Aurora Universities Network, 2022). LOUIS structures broad competences into observable elements at increasing levels of proficiency. In this redesign, it was used to make competence expectations explicit and to support prioritization: rather than addressing a wide range of competences simultaneously, a small number of key domains (e.g. critical thinking, information literacy, and teamwork) were selected and reinforced across the course. This focus enabled clearer alignment between learning outcomes, activities, and assessment within an authentic project context (Biggs & Tang, 2015).

Learning, assessment, and feedback design principles

The redesign is organized around three principles that structure collaboration, guide method use, and ensure that feedback supports progressive improvement.

Team-Based Learning as structure: TBL provided the organizational backbone, with each module moving through preparation, readiness assessment tests, team application, and individual reflection (iRAT, tRAT, tAPP, iREF; following standard TBL terminology) (Fink, 2013; Michaelsen et al., 2004; Sibley & Ostafichuk, 2014). The team application phase (tAPP) involved collaborative analysis of authentic, industry-inspired data.

Problem- and experience-oriented learning: Activities were framed as open-ended, data-intensive problems in a sustained industrial context, drawing on problem-based and experiential learning (Barrows, Tamblyn, et al., 1980; Bruce & Bloch, 2012; Kolb, 2014). This continuity enabled students to refine analytical approaches rather than repeatedly onboarding to new datasets.

Assessment-as-development: Assessment prioritized reliability, transparency, and reproducibility while retaining space for formative learning (Hansen & Sindre, 2023). Version-control artifacts and code reviews supported traceability, and rubrics aligned with the selected LOUIS domains were reused across modules to make quality criteria explicit (Biggs & Tang, 2015; G. P. Wiggins & McTighe, 2005).

Pedagogical mechanisms and tooling choices

Figure 1 provides an overview of the course structure and interaction between modules, reflection, and the capstone project.

Preparatory materials and method overviews were assigned outside scheduled class time, reserving contact time for application, discussion, and feedback (flipped classroom; (Tucker, 2012)). Within each TBL module, individual readiness activities (iRAT) required students to propose context-specific uses of analytical methods, while team readiness discussions (tRAT) consolidated approaches prior to team application (tAPP).

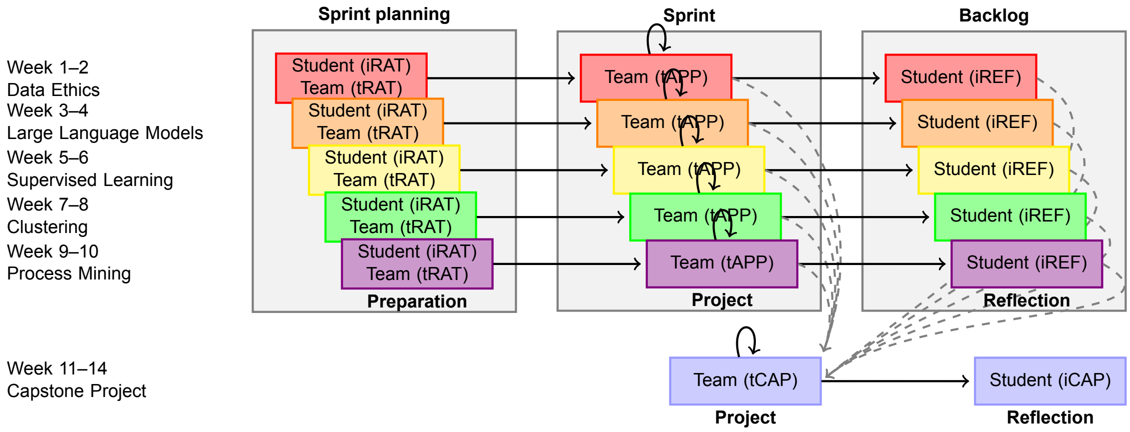

Figure 1. Course flow illustrating the structure of thematic team-based learning modules and their integration into the capstone project. Each module includes preparation (iRAT/tRAT), team application (tAPP), and individual reflection (iREF). Reflections serve as forward-oriented notes and backlogs that inform the capstone project (tCAP), supporting continuity, iteration, and professional competence development across the semester.

GitHub Classroom was adopted as the primary collaboration environment, reflecting common professional practice. The platform supported version control, peer review via pull requests (PRs), and reproducibility, enabling assessment to recognize both team outcomes and individual contributions through observable work traces. PRs provide a mechanism for proposing, reviewing, and discussing changes to a shared codebase, commonly used in professional software and data workflows. Ingimundardóttir (2026) provides a detailed account of how PR-centric workflows function as assessment architecture within this structure.

Each two-week module was aligned with agile development practices (Schwaber & Beedle, 2001). Planning activities in tRAT functioned as lightweight sprint planning, tAPP as execution, and individual reflection (iREF) as a structured retrospective. Reflection was forward-oriented: students documented unresolved issues, methodological limitations, and improvement ideas that they revisited during the capstone project.

Course flow and iterative integration

The course flow integrates five thematic TBL modules into a final capstone project (Figure 1). Each module comprises preparation (iRAT/tRAT), team project work (tAPP), and individual reflection (iREF). Dashed connections indicate how both team outputs and individual reflections contributed to the capstone project (tCAP). The capstone project functioned as a sustained integrative task in which teams revisited and consolidated insights, feedback, and unresolved issues from earlier modules, enabling assessment and reflection to accumulate toward professional standards rather than reset between tasks.

By explicitly carrying insights, constraints, and unresolved questions forward into the capstone, the course avoided treating assessment tasks as isolated events. Instead, assessment and feedback accumulated across modules, reinforcing learning as an iterative, developmental process aligned with professional practice.

Alignment with CDIO standards

The redesigned course aligns with CDIO Standards in several ways. Standard 5 (Design–Implement Experiences) is addressed through semester-long, industry-inspired project work that requires students to design analytical approaches and implement reproducible solutions. Standard 7 (Integrated Learning Experiences) is reflected in the intentional integration of professional competencies with BI methods within a sustained industrial context. Standard 8 (Active Learning) is operationalized through TBL modules, flipped preparation, and in-class application requiring reasoning, collaboration, and decision-making. Finally, Standard 11 (Learning Assessment) is addressed by competence-aligned rubrics, artifact-based accountability, and iterative feedback loops that balance formative learning with professional expectations. Together, these elements position assessment and feedback as central drivers of development toward professional standards in a CDIO-aligned project-based course.

COURSE REDESIGN: ASSESSMENT AND FEEDBACK ARCHITECTURE

This section outlines how assessment and feedback were reconfigured to function as developmental mechanisms supporting professional competence, rather than primarily summative evaluation. The redesign is informed by qualitative evidence from two course iterations with a single industry partner, drawing on observations, reflections, and partner feedback. The following subsections detail the key elements of this assessment architecture.

From assessment as measurement to assessment as development

We adopted a developmental view of assessment, in which criteria and feedback guided progression toward professional standards over time. The final rubric was introduced early and reused formatively with scaled weight across project modules, allowing students to rehearse expectations while retaining space for revision. Early exploration and errors were acceptable if recognized, documented, and addressed. Rubrics covering analytical soundness, transparency, reproducibility, and stakeholder relevance were applied consistently across modules and the capstone so that feedback accumulated across modules through explicit revisiting and resolution of prior comments, rather than fragmenting across tasks, with detailed rubric design and application discussed in Ingimundardóttir (2026). Version-control histories and pull-request records provided concrete evidence of whether and how teams responded to feedback between iterations.

Industry-engaged project structure

A key element of the assessment architecture was the use of a shared, industry-inspired project context spanning the entire semester. A single industry partner provided an authentic dataset and participated in problem framing, milestone discussions, and final presentations. Students were free to augment the provided data with additional sources, but all work remained anchored in the same organizational and analytical context.

This design choice addressed two recurring challenges observed in earlier course iterations: repeated onboarding to unrelated datasets and weak coherence between modules. By maintaining a stable context, students could progressively deepen their understanding of the domain, refine analytical approaches, and revisit earlier assumptions as new methods were introduced.

Assessment requirements emphasized reproducibility and traceability. All analyses were developed in shared repositories, and deliverables consisted not only of reports and presentations, but also of executable code and documented workflows. This structure mirrored professional expectations in data-intensive work and reinforced importance of credible, transferable results.

Industry feedback emphasized trustworthiness and usability, making visible how even minor analytical flaws can erode confidence–a clear contrast to academic tolerance for developmental error that students learned to navigate.

In parallel, the partner emphasized a preference for receiving the final deliverables in a GitHub-based format, reflecting their familiarity with working in that environment. For professional audiences, a concise slide deck summarizing key insights, assumptions, and business implications was considered the most useful final product, with the option to explore the underlying codebase in the repository if the results appeared promising. By contrast, the more extensive technical report was produced primarily to satisfy academic assessment requirements, ensuring transparency of methods and providing the instructor with sufficient detail to evaluate attainment. This distinction further highlighted how professional and academic audiences value different forms of evidence, documentation, and communication.

Balancing team performance and individual accountability

Team-based project work was central to the course, mirroring professional practice in BI. However, team assessment introduces well-known challenges related to unequal contribution, free-riding, and perceived unfairness, as widely recognized in CDIO project courses (Huet et al., 2008). Rather than relying solely on peer grading or individual exams, the redesign adopted a dual assessment strategy.

Team deliverables were assessed collectively with respect to analytical quality, coherence, and professional relevance. In parallel, individual contribution was assessed through visible artifacts generated during project work, including version-control activity, code reviews, and documented design decisions. Structured individual reflection complemented these artifacts by requiring students to articulate their contributions, uncertainties, and learning needs.

This approach allowed individual accountability to be supported without fragmenting team outcomes. Students reported that this transparency clarified expectations and reduced uncertainty about how their individual efforts were recognized within the team context.

Feedback loops and iterative learning

Feedback was integrated at multiple levels and stages of the course. Instructor feedback focused on methodological soundness, alignment with competence criteria, and progression across modules. Peer feedback occurred primarily within teams, through code review and collaborative problem-solving, and across teams during selected review moments.

Throughout the semester, the instructor served as the primary point of contact, emphasizing methodological and implementation aspects, while industry input was concentrated at key milestones and emphasized domain relevance and decision context. This separation of roles made differences in evaluation criteria explicit and required students to adapt their communication to distinct stakeholders.

Individual reflection (iREF) functioned as a forward-oriented practice: students documented unresolved issues, limitations, and improvement opportunities that were revisited during the capstone. This is consistent with CDIO approaches to reflection as professional practice rather than retrospective reporting (Junaid et al., 2018). As illustrated in Figure 1, these reflections formed a personal backlog that students returned to during the capstone, enabling feedback from earlier modules to inform later design decisions.

Industry feedback was gathered through discussions of intermediate results and final presentations, informing expectations across iterations. It was interpreted in relation to professional competence, emphasizing justification of analytical choices, clear communication of assumptions and limitations, and credible, decision-supporting results. In contrast to academic tolerance for developmental imperfection, industry feedback foregrounded trustworthiness, clarity, and usability, requiring students to adapt their work and communication accordingly.

STUDENT AND INDUSTRY RESPONSES

Evidence of the impact of the redesigned assessment and feedback architecture indicates three main themes: (i) engagement and perceived relevance remained high without formal attendance requirements, reflected in consistently high attendance and active participation among current students, consistent with Freeman et al. (2007), who link engagement to a strengthened sense of belonging; (ii) early-career transfer was evident in graduates' use of reproducible workflows, collaborative problem-solving, and explicit documentation of assumptions and limitations; and (iii) industry partner feedback valued improved coherence and credibility of outputs while highlighting that small analytical flaws can undermine trust—an expectation difference we now make explicit to students. From an academic perspective, this was also reflected in increasingly ambitious, student-driven project scope, enabled by the sustained structure of the course rather than direct instructor steering.

TENSIONS, TRADE-OFFS, AND LESSONS LEARNED

Industry engagement exposed productive tensions central to the redesign. Most prominently, academic tolerance for developmental error contrasted with industry expectations of reliability and trustworthiness. Accepting developmental error proved pedagogically valuable, but it also complicated students' calibration of when exploratory imperfection was acceptable and when it conflicted with professional expectations of reliability.

Team-based assessment presented a second trade-off. Large collaborative projects supported professional skill development but heightened concerns about workload distribution and fairness. Visible artifacts and structured reflection reduced ambiguity around individual contribution, though increased transparency also amplified student sensitivity to perceived inequities.

Tooling introduced a further tension. Professional collaboration platforms enhanced authenticity and reproducibility but imposed both an initial learning burden and substantial instructor effort through ongoing review and feedback. This front-loaded investment, however, streamlined final assessment by making revisions and responses to feedback clearly visible across iterations. Relocating tool onboarding earlier in the curriculum emerged as a pragmatic adjustment to preserve realism while reducing cognitive load during complex project work.

Collectively, these lessons indicate that industry-engaged assessment requires deliberate negotiation between realism and pedagogical support. Designing explicitly for such tensions–rather than attempting to eliminate them–proved essential for maintaining both learning quality and professional credibility.

TRANSFERABLE DESIGN PRINCIPLES FOR CDIO PROGRAMS

The redesign surfaced several principles that may support other CDIO programs implementing industry-engaged, competence-oriented assessment. These principles highlight how authenticity, developmental assessment, and clear competence structures can be integrated to reinforce professional learning in data-intensive project contexts.

1. **Anchor assessment in a sustained industrial context.** Maintaining a shared, semester-long industry context supports coherence across learning activities and enables cumulative competence development, reducing fragmentation between project modules.
2. **Design assessment as a developmental process.** Align assessment criteria across formative and summative tasks so that feedback accumulates over time and guides students toward professional standards rather than functioning as isolated judgments.
3. **Make individual contribution visible within team work.** Combine team-level outputs with artifact-based indicators and structured reflection to support accountability and fairness without undermining collaborative learning.
4. **Use reflection as forward-oriented professional practice.** Frame reflection as documentation of unresolved issues and improvement opportunities that inform subsequent design decisions, rather than as retrospective self-evaluation alone.
5. **Explicitly manage academic–industry expectation gaps.** Surface differences between developmental learning tolerance and professional reliability requirements early, and prepare students to adapt quality standards and communication to audience and context.
6. **Introduce professional tooling with intentional scaffolding.** Select tools that support authenticity and reproducibility, but ensure early alignment and onboarding to prevent tool mastery from overshadowing learning objectives.

CONCLUSIONS AND FUTURE WORK

This paper presented a redesign of an industry-engaged Business Intelligence course in which assessment and feedback function as central mechanisms for developing professional competence within an authentic project context. The approach combines team-based learning, sustained industry collaboration, and competence-oriented assessment to enhance coherence and professional relevance. The redesign surfaced productive tensions between developmental learning space and workplace expectations of reliability and trust, illustrating how assessment structures and forward-oriented reflection can help students navigate these expectations.

Two targeted refinements follow from iterative delivery. First, to reduce cognitive load and keep thematic modules in focus, mastery of collaboration tooling (e.g., GitHub) will be addressed in a prerequisite course. Second, to support early collaboration and credibility, the opening session will prioritise team formation, trust-building, and exploratory engagement with the industrial context before readiness activities and application work.

Future work will examine how this revised sequencing influences team dynamics, the credibility of student deliverables, and competence development across cohorts. It will also explore how the assessment architecture can scale to additional partners and related data-intensive courses.

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BIOGRAPHICAL INFORMATION

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