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Live Case Studies in Industrial Engineering Education for Experiential Learning and Authentic Assessment

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Abstract

Live case studies are widely used in higher education to support active learning; however, their pedagogical potential is often limited by weak integration with learning theories and assessments. This research-to-practice study examines the systematic design of live case studies by integrating Kolb's experiential learning cycle (ELC) and authentic assessment (AA) principles. This paper presents a framework that conceptualises live cases as the learning context, ELC as the learning process, and AA as evaluative logic. The framework is illustrated through a case study of an undergraduate Quality Management module in industrial engineering at a Mexican university, involving 31 final-year students. The study is design-oriented and illustrative, aiming to demonstrate framework enactment rather than evaluating causal effectiveness. Using a case study methodology, the instructional design and enactment were documented using the ADDIE model. Data were obtained from educational artefacts, assessment results, and student feedback surveys. The findings suggest that aligning teaching and assessment activities with the ELC stages and the AA principles effectively supports learning trajectories. This support covers experience, reflection, conceptualisation, and application. Live case studies enabled the integration of multiple assessment methods around shared organisational problems and supported personalised learning through students' case selection. This study contributes a design logic and operational framework for distributing authentic assessment across Kolb's experiential learning stages within live case pedagogy. Rather than offering statistical generalisation, the framework serves as a foundation for adaptation and research, emphasising transferability across disciplines, educational levels, and delivery modes. Limitations are acknowledged regarding the conceptual scope, methodological design, and empirical context.

Keywords: authentic assessment; experiential learning; educational innovation; higher education; instructional design; live case studies

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1. Introduction

This research-to-practice study focuses on the design and implementation of live case studies in higher education, particularly in industrial engineering. Live case studies are a prominent pedagogy in business, management, and design education, reflecting a shift from instructional models to learning grounded in active, contextual, and practical engagement. This approach responds to the recognition that students learn more effectively when they "actively process knowledge, skills, and attitudes" in realistic environments rather than

through passive lecture-based methods (Biggs & Tang, 2015; Elam & Spotts, 2004; Freeman et al., 2014). Live cases enhance realism by situating learners in authentic interactions with organisations and stakeholders and exposing them to professional practice conditions (Markulis, 1985; McWilliams & Nahavandi, 2006).

An example of a live case study in industrial engineering education involves students working with local businesses to experience operational challenges. Students engage with organisations to observe processes and activities, define problems, analyse root causes, propose improvements, and reflect on organisational implications under real-world constraints.

Research shows that live case studies yield positive learning outcomes, including a better understanding of theoretical concepts, the development of transferable skills such as communication and teamwork (Gentry, 1990; Roth & Smith, 2009), and increased student engagement (Fredricks et al., 2004; McWilliams & Nahavandi, 2006). However, several gaps persist in the conceptualisation and design of live-case pedagogy. First, the literature rarely examines live cases through the lens of explicit learning theory. Although experiential learning (EL) is cited to justify live case approaches (Elam & Spotts, 2004; Gentry, 1990), studies prioritise descriptive accounts of implementation rather than theory-driven design (Garrido-Lopez et al., 2018; Roth & Smith, 2009). EL frameworks, particularly Kolb's experiential learning cycle (ELC), (A. Y. Kolb & Kolb, 2018; D. A. Kolb, 1984), are often referenced but seldom systematically operationalised in live cases.

Second, while scholars emphasise transferable skills and student engagement, assessment practices for live case studies remain inconsistent. Authentic assessment (AA) principles are rarely systematically integrated into live-case designs (Gulikers et al., 2004; Wiggins, 1990). Consequently, assessment practices often default on traditional grading approaches that inadequately capture reflective processes, ethical reasoning, and context-sensitive judgement (Boud & Falchikov, 2006).

Third, existing research on live case studies primarily describes pedagogical initiatives rather than developing transferable and theory-informed design frameworks. Although these accounts provide valuable insights, they limit the development of coherent and replicable models for curriculum integration (Garrido-Lopez et al., 2018; Roth & Smith, 2009).

Furthermore, research on live cases and experiential and authentic learning in industrial engineering education is limited, underscoring the need for advancements in the discipline (Salinas-Navarro et al., 2025). Some examples across sub-disciplines, such as operations, supply chain, and quality management, emphasise the need to link real-world challenges with in-classroom activities to enhance practical, reflective, and authentic learning (Gutiérrez-Martínez et al., 2021; Salinas-Navarro et al., 2022, 2024a).

Consequently, these gaps reveal a key research problem: while live case studies have demonstrated pedagogical value, their design remains largely descriptive and under-theorised, with assessment practices often misaligned with their experiential intent. To address this problem, this study was guided by the following research question:

> *How can live case studies be impacted by integrating Kolb's experiential learning cycle with authentic assessment principles to strengthen active learning in higher education?*

To explore this question, the study advances a design proposition: that systematically integrating Kolb's ELC (A. Y. Kolb & Kolb, 2018; D. A. Kolb, 1984) and AA principles (Ashford-Rowe et al., 2014; Villarroel et al., 2019; Wiggins, 1990) into live case pedagogy can create more coherent and assessable learning experiences. This integration translates into concrete design decisions, such as structuring student tasks to explicitly move through the stages of Kolb's cycle and using assessment methods—like reflective journals and applied reports—that evaluate not just the final output but the quality of reasoning, reflection, and theory–practice integration at each stage. The proposition functions as a conceptual and heuristic guide for enquiry and instructional design rather than as a statistically

testable hypothesis (Aken, 2004; Wang & Hannafin, 2005), guiding the development of the framework and the interpretation of findings in an illustrative educational case.

Using a qualitative case study methodology, this study examines how the proposed framework operates within an undergraduate industrial engineering module. Rather than pursuing empirical generalisation or causal verification, it seeks to enhance transferability by articulating a theoretically grounded design logic and analysing its enactment in context (Flyvbjerg, 2006; Yin, 2009). The case provides a structured account of how live case pedagogy, EL processes, and AA principles can be integrated into instructional and assessment design. In doing so, the study contributes a design logic and operational framework for distributing authentic assessment across Kolb's experiential learning stages within live case pedagogy, illustrated through a case study in an undergraduate engineering module.

The remainder of this paper is organised as follows. Section 2 provides the theoretical background on live cases, EL, and AA, and presents an integrated framework. Section 3 outlines the case study methodology. Section 4 presents the results demonstrating the framework's application in an operations management module. Section 5 discusses the findings, implications, limitations, and future research. Section 6 concludes by addressing the research question and highlighting the key contributions to experiential pedagogies.

2. Theoretical Background and Framework

This section develops a theoretical foundation by examining the intersection of live case studies, EL, and AA in pedagogy. These perspectives were synthesised into an integrative framework for designing and evaluating live case studies in higher education settings.

2.1. Live Case Studies as a Pedagogical Approach

Case-based learning (CBL) is an instructional approach in higher education that situates learning within realistic problem scenarios. Traditional case studies present structured accounts of organisational or professional situations, requiring students to analyse information, apply concepts, and propose solutions. This approach has been widely adopted in business and management and increasingly in engineering education, where it supports developing critical thinking, problem-solving, and professional reasoning skills (Hmelo-Silver, 2004; Lavi & Marti, 2023).

In undergraduate engineering education, CBL has been shown to foster creative and critical thinking by engaging students with complex, ill-structured problems that require integrating technical knowledge and contextual judgement (Lavi & Marti, 2023). Compared to lecture-based instruction, case-based approaches encourage active engagement, collaborative analysis, and theory–practice integration, aligning with broader shifts towards student-centred and experiential pedagogies (Freeman et al., 2014).

Traditional case studies often rely on predefined scenarios with known outcomes and controlled information. While such cases can scaffold analytical reasoning, they may limit students' exposure to uncertainty, evolving constraints, and stakeholder interactions. In response, variations in CBL have emerged that emphasise authenticity and direct engagement with real-world contexts.

Live case studies represent one such variation and can be understood as a pedagogical extension of CBL, shifting the locus of learning from retrospective analysis to real-time engagement with ongoing organisational situations. Rather than functioning as discrete teaching techniques, live case studies serve as structured pedagogical approaches in which learning unfolds through direct interaction with dynamic and evolving problem contexts (Culpin & Scott, 2012). Unlike traditional cases, live cases engage learners in unresolved, information-poor situations that approximate professional practice and require them to navigate ambiguity, stakeholder perspectives, and incomplete data (Elam & Spotts, 2004).

Originally proposed to address critiques of conventional cases—such as artificiality, detachment from consequences, and limited urgency—the live case approach embeds students within authentic organisational timelines and interactions (Markulis, 1985). Through collaboration with organisational actors, learners move from detached analysis towards participatory engagement, interpreting emerging information, and exercising professional judgement in uncertain contexts. Subsequent research reinforces this conceptualisation: live case studies have been framed as experiential pedagogy grounded in student–organisation collaboration (Elam & Spotts, 2004), positioned within EL as applied problem solving (Roth & Smith, 2009), and recognised for surfacing ethical tensions and contextual complexity not present in simulated cases (McWilliams & Nahavandi, 2006).

Across disciplines, live case studies function as pedagogical design choices that shape learning processes, student roles, and instructional responsibilities (Markulis, 1985; Murray, 1991; Neubert et al., 2020). Their educational value stems from embedding uncertainty, stakeholder interaction, and responsibility in learning design. When effectively facilitated, live cases create environments in which knowledge remains provisional, solutions are contested, and learning occurs through interaction rather than transmission (Bhatti et al., 2023).

Live case pedagogy also closely aligns with the principles of authentic learning. Authentic learning environments are characterised by ill-structured problems, sustained enquiry, and evaluative judgement (Villarroel et al., 2019; Wiggins, 1990). By situating learners within evolving constraints and meaningful consequences, live case studies require the integration of disciplinary knowledge, contextual reasoning, and interpersonal skills (Charlebois & Foti, 2017; Neubert et al., 2020).

Despite these strengths, the literature has identified persistent challenges. Live case studies are resource-intensive and require coordination with organisational partners while managing unpredictable learning trajectories (Markulis, 1985; Neubert et al., 2020). Without appropriate scaffolding, students may experience cognitive overload in complex contexts (Moon, 2013). Moreover, although live cases are frequently justified EL rhetoric, their instructional design often lacks explicit theoretical articulation, leading to imbalances among experience, reflection, and conceptual integration (Beard & Wilson, 2013; Roth & Smith, 2009).

Overall, live case studies emerge as powerful yet demanding pedagogical approaches, whose effectiveness depends on intentional alignment with learning theory and assessment principles. This observation motivates the need for a systematic framework that integrates live case pedagogy with EL processes and AA, as developed in the following sections.

Instructors adopting live cases must move beyond providing access to organisations and instead scaffold student engagement to prevent immersion from becoming mere activity. This can be achieved by embedding structured reflection points throughout the case timeline and requiring students to justify analytical decisions against theoretical concepts, transforming experience into learning. Such design choices shift the focus from exposure to structured experiential engagement, creating conditions for the learning cycle elaborated in the next section.

2.2. Structuring Live Case Learning Through Kolb's ELC

Kolb's ELC is a key framework for understanding learning through experience (A. Y. Kolb & Kolb, 2018; D. A. Kolb, 1984). The ELC presents learning as a continuous cycle of four stages: concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC), and active experimentation (AE). Learning occurs as learners move through these stages, transforming their experiences into embedded knowledge.

In live case studies, the ELC provides a valuable framework for structuring learning in dynamic contexts. As established in Section 2.1, live case pedagogy exposes learners

to unresolved problems characterised by uncertainty and evolving constraints. Kolb's framework organises this exposure into a learning process by combining experience with reflection, conceptual integration, and experimentation. Thus, the ELC addresses a key limitation of live case pedagogy: the focus on immersion without an adequate learning structure or scaffolding.

The CE stage aligns with live case studies, as students engage with realistic organisational challenges and decision-making. However, the literature notes that experiential pedagogies often overemphasise this stage, equating participation with learning (Beard & Wilson, 2013). EL must not be confused with practical work or learning through experience (Offerman & Sonnemans, 1998). In live cases, this can lead to task-driven engagement, where learners focus on outputs rather than critically examining their experiences and learning.

Therefore, the RO stage is central to converting experience into learning. Reflection enables learners to examine their assumptions, outcomes, and complex situations in the learning process. Despite their importance, reflective processes are often unsupported in EL design, particularly in fast-paced contexts (Moon, 2013). Without scaffolding for the development of higher-order thinking skills, reflection becomes superficial rather than analytically meaningful (Bloom, 1973, 1986).

Through AC, learners connect their reflections to theoretical constructs and conceptual frameworks. This stage is critical in higher education, where learning aims include conceptual understanding and knowledge transfer. However, critics argue that ELC can further oversimplify theory–practice relationships, suggesting a linear progression that does not reflect how learners engage with knowledge (Fenwick, 2001; Miettinen, 2000). In live cases, students may intermittently draw on theory rather than through a defined, straightforward "conceptualisation" phase.

The final stage, AE, involves testing ideas, refining strategies, and applying conceptual insights to new situations. In live case pedagogy, this stage may take the form of revised recommendations, iterative decision-making, or adaptive responses to changing organisational conditions. While this aligns well with the applied nature of live cases, the ELC's cyclical representation can underplay the contextual constraints that shape learners' experimentation in real-world settings (Bergsteiner et al., 2010).

Broadly, several critiques of Kolb's ELC are relevant to live case studies. First, the model has been criticised for its individualistic focus on personal cognition while neglecting social interaction and institutional context (Fenwick, 2001; Miettinen, 2000). This is significant in live cases, where stakeholder dynamics shape learning. Second, the ELC's normative sequencing may not reflect the nonlinear nature of learning in complex environments (Bergsteiner et al., 2010; A. B. Kayes et al., 2005; D. C. Kayes, 2002). Finally, the framework risks becoming prescriptive rather than reflective (A. Y. Kolb & Kolb, 2009). These limitations reinforce the need to integrate EL with assessment and pedagogical structures, rather than relying solely on the learning cycle.

Despite limitations, the ELC remains valuable when used heuristically rather than deterministically. The ELC functions as a pedagogical tool that helps instructors identify imbalances, such as an overemphasis on activity over reflection or theory, without assuming a linear progression through stages. When treated as a sensitising framework, the cycle does not prescribe how learning unfolds but supports educators in designing opportunities for experience, reflection, conceptual engagement, and action across a complex learning environment (Bergsteiner et al., 2010). In this study, Kolb's ELC served as a conceptual scaffold for structuring live case pedagogy—operationalised through design choices such as recursive assessment cycles and structured reflection (see Section 3.2 for draft submissions and iterative feedback on reports, and Section 4.4 for implementation).

To illustrate conventional versus live-case-based approaches: a traditional proxy-based assessment might ask students to calculate statistical process control limits from a dataset or analyse a textbook case with relevant information presented. In contrast, a live-case assessment required students to determine what data to collect from a real restaurant's operations, justifying their choice based on the process and quality problem identified. This embeds cognitive challenge and realism, transforming assessment from a decontextualised calculation exercise into a situated professional judgement task that engages multiple stages of the learning cycle.

By acknowledging ELC limitations and using it as an organising framework rather than a rigid sequence, this study positions EL as an adaptable design resource. This provides a foundation for examining how assessment practices support learning across cycle stages, as discussed in the following section.

2.3. Operationalising Authentic Assessment in Live Case Studies

AA has emerged as a significant paradigm in higher education assessment, emphasising tasks that reflect the complexity, ambiguity, and performance demands of real-world professional contexts (Ashford-Rowe et al., 2014; Gulikers et al., 2004; Wiggins, 1990). In contrast to traditional assessments that prioritise recall, decontextualised problem solving, or standardised testing, AA seeks to evaluate students' capacity to apply knowledge, exercise judgement, and integrate disciplinary understanding in meaningful situations.

Central to AA is the principle that assessment should mirror the epistemic and practical demands of professional practice. This includes engaging learners in ill-structured tasks, requiring justification of decisions, and making evaluative criteria explicit (Boud & Falchikov, 2006; Gulikers et al., 2004). Rather than treating assessment as a terminal measurement event, AA positions it as an integral component of the learning process, fostering evaluative judgement and self-regulated learning.

In engineering education, AA aligns with professional competencies, including systems thinking, ethical reasoning, contextual awareness, and communication skills beyond procedural knowledge. As engineering problems are complex and situated, assessment approaches that capture reasoning under constraints are particularly relevant. AA provides a conceptual lens for evaluating learning within live case contexts.

Building on these principles, this study positions AA as a necessary analytical lens for evaluating learning in live case studies, particularly when the learning outcomes involve judgement, reflexivity, and context-sensitive decision-making. While live case pedagogy is widely recognised for enabling authentic learning experiences, the existing literature offers limited guidance on how assessments can be systematically designed to preserve, rather than dilute, this authenticity. Consequently, assessments often remain misaligned with the epistemic demands of live cases.

Drawing on Villarroel et al. (2019), this study adopts realism, evaluative judgement, and cognitive challenge as the core principles of AA. Rather than treating these principles as abstract descriptors, this study operationalises them through alignment with Kolb's ELC, thereby translating pedagogical intent into assessable learning processes. This alignment provides a coherent basis for designing assessment practices that capture learning as situated, iterative, and provisional.

Realism is conceptualised not simply as a resemblance to professional contexts, but as the preservation of complexity, uncertainty, and constraints within assessment tasks. Live case studies inherently offer ill-structured organisational problems; however, this potential is realised only when assessments resist simplification and artificial closure. Within Kolb's ELC, realism is most salient in the CE stage, where learners engage directly with organisational actors, incomplete data, and evolving decision environments. By

requiring students to justify decisions under changing conditions, assessment designs extend realism beyond the task context to the decision's consequences, thereby reinforcing learning as situated rather than deterministic.

Evaluative judgement is operationalised as students' capacity to justify decisions, assess quality, and reason in the absence of definitive solutions. This capability is central to live case studies, in which competing interpretations and stakeholder interests preclude a single, correct answer. Within the ELC, evaluative judgement emerges through the RO and AC. Reflection enables learners to interrogate assumptions and consequences, whereas conceptualisation connects these insights to disciplinary theory. Assessment practices that foreground justification and theoretical reasoning, therefore, shift the emphasis from correctness to judgement quality, aligning assessment more closely with professional evaluative demands.

Cognitive challenge is defined as the requirement to integrate theory, evidence, and contextual reasoning across multiple learning stages. Live case studies naturally introduce cognitive challenge through ill-defined problems and competing priorities; however, assessment practices can inadvertently neutralise this challenge through overly prescriptive criteria. This study positions cognitive challenge as spanning all stages of the ELC: complexity is encountered in experience, analysed through reflection, structured through conceptualisation, and tested through action. Assessment designs that distribute challenge across these stages foreground adaptive reasoning and reflexivity, rather than discrete task performance.

Taken together, realism, evaluative judgement, and cognitive challenge form an integrated framework for assessing learning in live case studies when aligned with EL processes. Isolated assessment practices risk underutilising case realism, marginalising reflection, or fragmenting cognitive demand. Therefore, the following section proposes an integrative framework that systematically aligns live case pedagogy, EL, and AA to address these limitations through a coherent assessment system.

2.4. An Integrative Framework for Designing and Assessing Live Case Studies

This study proposes an integrative framework for systematically conceptualising and operationalising live case studies by aligning the pedagogical context with EL and AA. The framework addresses a key limitation: live case studies often lack sufficient learning structures or alignment with assessments. The framework positions pedagogy, learning theory, and assessment as interdependent elements of a coherent instructional system.

From a pedagogical perspective, live case studies provide authentic learning contexts with real organisational challenges, constraints, and stakeholder interactions. These contexts are framed by assignment briefs aligned with learning objectives, describing ill-structured problems that acknowledge uncertainty and allow multiple solutions. Briefs may ask students to advise organisations facing competing priorities, preserving complexity through real problem solving and task design that resist simplification.

Within this pedagogical context, Kolb's ELC functions as a scaffold for learning and assessment. CE operates through students' engagement with live cases, such as direct observation, interaction with organisational representatives, or the collection and analysis of real data. These activities serve as evidence of the learning process. RO involves reflective activities that require students to examine their decisions, identify their assumptions, and evaluate their outcomes. To avoid superficial reflection, prompts must link reflections to specific case events and results, and articulate learning outcomes.

AC can be operationalised through assessment components that explicitly engage with theory. AC includes theoretical examinations and reflective journals in which students define key constructs and evaluate their relevance to case studies. Students may explain

how operations management models inform their analysis and reflect on the limitations of organisational contexts. This maintains cognitive challenges by integrating theory and practice. AE can be operationalised through applied components of live case assignments and reflections on future actions. Students may revise their recommendations based on feedback, explore alternatives, or describe how learning informs similar professional situations, thereby completing the ELC.

AA principles connect learning processes to assessment practices through evaluative logic. Assessment tasks should mirror professional conditions, rather than simplified academic exercises. Evaluative judgement operates through rubrics and reflective tasks that make quality criteria explicit, while students justify their decisions and evaluate their approaches. Assessment emphasises the quality of reasoning over mere correctness. Cognitive challenges are distributed across the assessment components rather than concentrated in a single task or tool. For instance, theoretical exams assess conceptual understanding, live cases evaluate applied reasoning, and reflective journals capture judgement and professional meaning-making.

Crucially, this study views live case study assessment as a system of complementary instruments, rather than a single mechanism. Assignment briefs establish authentic contexts, rubrics clarify standards, examinations assess understanding, and reflective activities make learning visible to students. These elements allow educators to evaluate learning throughout the experiential cycle.

This perspective adopts a non-linear and non-prescriptive stance. Learning is not assumed to progress linearly through the experiential cycle, nor are educators required to enforce a rigid sequence. Instead, it recognises recursive movement between experience, reflection, conceptualisation, and action, with assessments capturing learning trajectories rather than endpoints. Live cases are design-oriented and focused on transferability rather than empirical exhaustiveness, providing a structured logic that aligns with case pedagogy, EL, and AA.

Figure 1 presents the integrative framework, depicting live case pedagogy as the contextual layer, Kolb's ELC as the process layer, and AA principles as the evaluative layer within a unified instructional system (Salinas-Navarro et al., 2024b, 2024c). The live case context situates students in authentic organisational challenges shaped by stakeholder interaction and constraints. Kolb's ELC structures engagement through recursive movement across experience, reflection, conceptualisation, and action, while AA—realism, evaluative judgement, and cognitive challenge—serves as a cross-cutting dimension. The operational layer shows how assignment briefs, examinations, reflective journals, collaborative activities, and instructional artefacts enact this alignment. These components interact iteratively, translating pedagogical intent into teaching and learning. Table 1 provides examples of how this framework is operationalised. This table serves as a generative tool for educators; reading across a row shows how a pedagogical intention translates into an assessment method and illustrative task, providing a template for module design. The table aligns each ELC stage with its AA principle and concrete assessment methods with examples.

Building on the framework shown in Figure 1, this section outlines the methodological approach used to illustrate its application (Section 3). This work used a case study to demonstrate how live case pedagogy, EL processes, and AA were operationalised within an undergraduate quality management module, as presented in Section 4. Section 5 later revisits this architecture, illustrating how the ADDIE model was used as a reporting lens for its enactment rather than as a competing theoretical framework.

Table 1. Operationalising the Integrative Framework: Alignment of Live Case Pedagogy, Experiential Learning, and Assessment Methods (own elaboration).

Framework Dimension	ELC Stage	Authentic Assessment Principle	Assessment Methods and Tools (Indicative, Non-Exhaustive)	Illustrative Examples
Live case context (pedagogical environment)	Concrete Experience (CE)	Realism	Assignment briefs; live case tasks; client briefs; project charters; problem-framing reports	Students advise a real organisation facing competing strategic priorities using incomplete data, documenting constraints and uncertainties rather than producing a single "correct" solution.
Learning through reflection	Reflective Observation (RO)	Evaluative judgement	Reflective journals; learning logs; reflective essays; audio/video reflections; critical incident reports	Students analyse decisions made during the live case, identify assumptions, evaluate outcomes, and consider alternative interpretations linked to specific events or interactions.
Theory–practice integration	Abstract Conceptualisation (AC)	Cognitive challenge	Theoretical examinations, applied exams, concept-mapping tasks, analytical essays, and conceptual sections of reflective journals	Students explain how disciplinary models inform their case analyses and critically assess their limitations when applied to real organisational contexts.
Application and adaptation	Active Experimentation (AE)	Realism; cognitive challenge	Applied assignments; practical examination components; scenario analyses; design proposals; simulation-based tasks	Students revise their recommendations in response to feedback, test alternative strategies, or develop future scenarios based on evolving case conditions.
Learning quality evaluation and standards	Across CE–AE	Evaluative judgement	Assessment rubrics; marking criteria; exemplars; peer-assessment rubrics; self-assessment checklists	Rubrics articulate criteria for reasoning quality, decision justification, theory and context integration, and responsiveness to constraints, rather than correctness alone.
Learning process visibility	Across CE–AE	Cognitive challenge; evaluative judgement	Reflective journals; portfolios; process reports; learning narratives; design logs	Students documented how their understanding evolved through experience, reflection, conceptualisation, and action, including the implications for future professional practice.

Table 1. *Cont.*

Framework Dimension	ELC Stage	Authentic Assessment Principle	Assessment Methods and Tools (Indicative, Non-Exhaustive)	Illustrative Examples
Feedback and iteration	Across CE–AE	Cognitive challenge	Formative feedback cycles; draft submissions; peer feedback; tutor consultations; feedforward activities	Students receive feedback on interim work, revise their thinking, and demonstrate learning through iterative improvement rather than through a one-off submission.
Assessment coherence	Whole framework	Realism; evaluative judgement; cognitive challenge	Integrated assessment system combining multiple instruments	Assignment briefs, exams, rubrics, reflections, and feedback mechanisms function together to capture learning outcomes and processes across the experiential cycle.

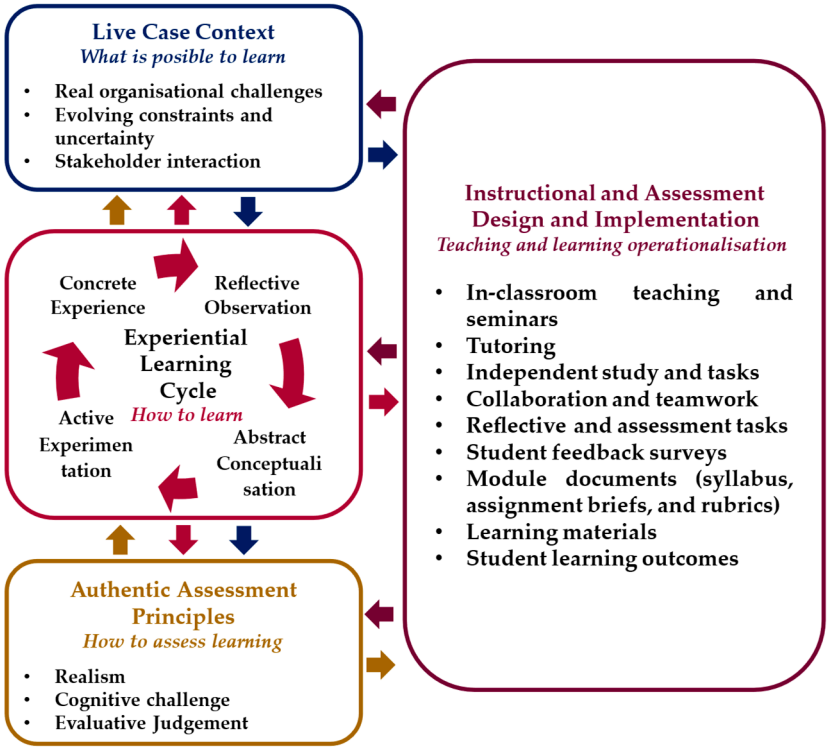


Figure 1. Integrative Framework for Live Case Studies (own elaboration).

3. Methodology

This study adopts a qualitative case study design with descriptive quantitative elements (aggregated assessment data and survey summaries) to illustrate how the framework developed in Section 2 can be operationalised in an educational setting. Case study research is well-suited to examining contemporary pedagogical phenomena in their natural contexts, particularly where the phenomenon and context are intertwined, and the aim is analytical insight rather than statistical generalisation (Crowe et al., 2011; Flyvbjerg, 2006; Yin, 2009). The qualitative dimension guided artefact analysis and thematic interpretation, while quantitative summaries were used descriptively to contextualise patterns in student engagement and performance.

Consistent with a design-oriented, transferability-focused approach, the purpose of the case is not hypothesis testing, but to examine how the proposed framework functions in practice and to derive theoretically informed insights from its enactment. Accordingly, this study followed an exploratory and descriptive design aligned with design-oriented educational research and documented the implementation of the proposed framework rather than testing causal relationships (Tharenou et al., 2007; Timans et al., 2019). Emphasis is placed on analytical insight and transferability, supported by a rich contextual description that enables readers to assess the framework's relevance to comparable educational contexts (Yin, 2009).

In addition to the integrative pedagogical framework presented in Section 2, this study draws on the ADDIE instructional design model (Analysis, Design, Development, Implementation, and Evaluation) as a reflective and organisational lens for documenting the instructional process (Branson, 1978; Molenda, 2003). Unlike Kolb's ELC, which conceptualises learning processes and AA principles guiding evaluation, ADDIE is a structural model for planning, enacting, and reviewing instructional design. Its role here is methodological and documentary, not theoretical, ensuring transparency in operationalising the live case framework within the module.

The research process (see Figure 2) involved several key steps: (i) crafting the research question (RQ), (ii) establishing the conceptual framework, (iii) defining the case context and pedagogical design, (iv) collecting data through a live case study, (v) organising and analysing the data, and (vi) reporting and discussing the findings (Tharenou et al., 2007; Timans et al., 2019). The primary objective was to explore how live case studies can be integrated with EL and AA principles in the case study context.

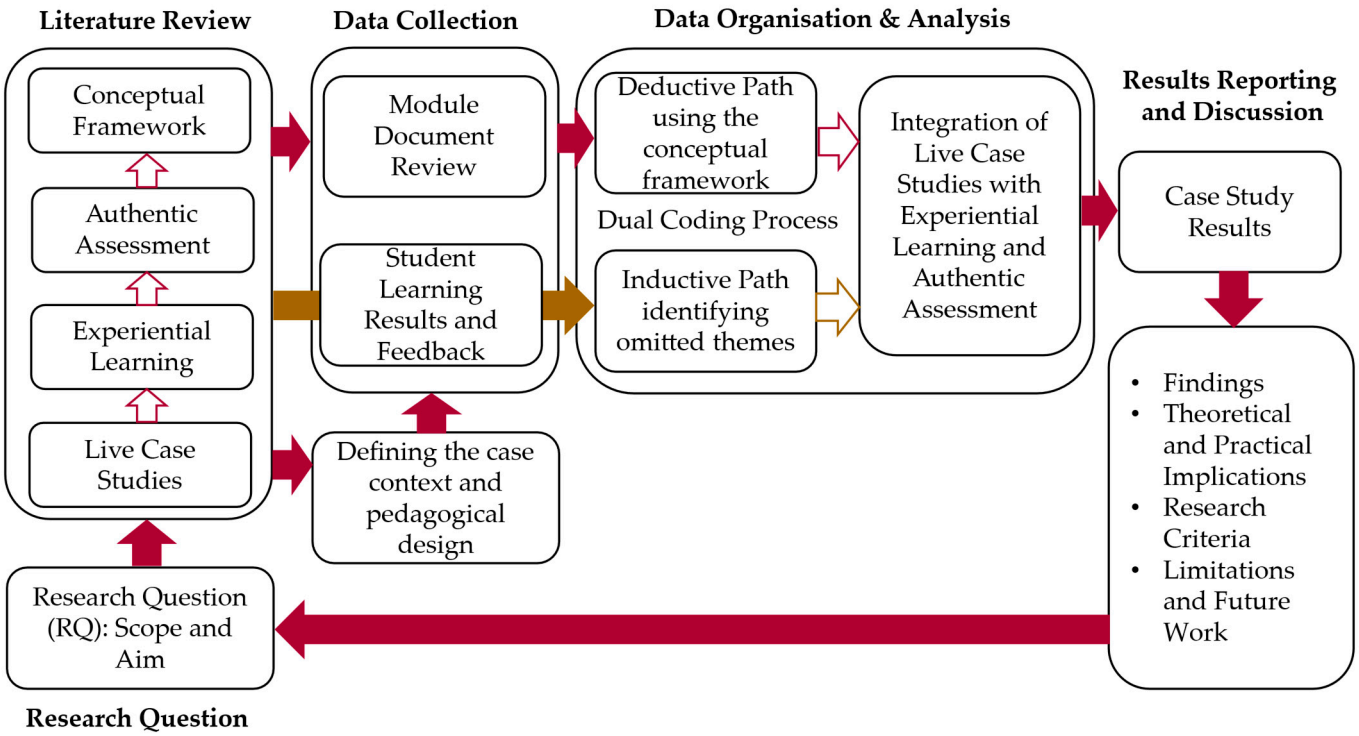


Figure 2. The Research Process of Integrating Live Case Studies with Experiential Learning and Authentic Assessment (own elaboration).

3.1. Case Context and Educational Setting

The case study was conducted within an undergraduate Quality Management module for Industrial Engineering and Design and Innovation students at a Mexican university. The module covers core quality management concepts and tools, including process mapping, improvement methodologies, root-cause analysis, continuous improvement, and quality management systems, which are foundational in engineering education.

Live case study pedagogy was embedded as a central instructional approach to complement traditional instruction, reflecting an emphasis on authentic learning in the curriculum. The students engaged with quality-related challenges from external micro and small enterprises, selected based on their research interests and data access. These challenges were ill-structured and dynamic, requiring students to analyse processes, identify quality issues, and propose improvements under realistic constraints.

The module was delivered in the autumn term (August–December 2025), with 48 h of direct instruction (two 1.5-h sessions per week over 16 weeks) and 6 h of weekly independent study. A total of 31 undergraduate students were enrolled, providing a setting to examine the framework's operationalisation in practice.

The selection of this module for the case study was purposeful. Prior iterations had used live cases but lacked a coherent pedagogical and assessment framework, limiting their capacity to structure learning processes and make outcomes assessable (see, for instance, Salinas-Navarro & Rodríguez Calvo, 2020). This limitation became the catalyst for the

current design, which intentionally integrates Kolb's ELC and AA principles to create a more structured and assessable learning experience.

This module was selected as an information-rich and analytically relevant case (Flyvbjerg, 2006), not because it was representative in terms of learning outcomes, but because it enabled the design, enactment, and examination of the proposed integrative framework. In qualitative case study terms, the module functions as an instrumental case, selected to exemplify and refine a design-oriented framework rather than to represent a broader population of instructional contexts (Stake, 1995). The case serves illustrative and developmental purposes, allowing for the exploration of how live case pedagogy can be systematically structured and assessed. In line with qualitative case study logic, the aim was to generate analytical insights into pedagogical design processes rather than support empirical generalisation from the case (Yin, 2009).

3.2. Instructional and Assessment Design

Within the case study methodology, the live case study functioned both as a teaching strategy and as an empirical setting through which the proposed framework was intentionally designed and enacted. The instructional and assessment design of the *Quality Management* module was informed by the framework developed in Section 2.4, aligning live case pedagogy, EL processes, and AA to support learning while generating evidence that can be further analysed. Rather than introducing additional research instruments, the study relied on naturally occurring teaching and assessment artefacts, consistent with qualitative case study approaches that prioritise contextual validity.

The live case study was structured around three assessed reports: two individual assignments focused on problem identification and analysis, followed by a group-based project to design a quality management system. In addition, students completed a reflective journal with three entries linking quality management concepts to their application in practice and future professional development, and a written examination that assessed conceptual understanding and theory–practice integration. All assessment methods were supported through rubric unpacking sessions and exemplification of expected performance levels to clarify evaluative criteria.

These components represent distinct yet interconnected moments of engagement with real problems and produced naturally occurring artefacts that document how applied reasoning, theory–practice integration, decision making, and reflection were supported through the instructional design. Collectively, these artefacts defined the temporal and analytical boundaries of the case and enabled a longitudinal illustration of how the learning processes were structured and supported across the module.

The use of multiple assessment components supported a coherent within-case contrast of how the different elements of the framework were operationalised over time. In this way, the instructional and assessment design operationalised the proposed framework in Section 2 and structured the empirical basis for the case study research, as summarised in Table 2.

Consistent with the illustrative and design-oriented purpose of the case, these artefacts are interpreted as evidence of framework enactment and instructional coherence, rather than as measures of learning effectiveness or impact on outcomes. As outlined in Section 3.1, the purpose of the case study was to provide an analytical illustration rather than empirical validation.

Table 2. Operational Alignment between Live Case Study Design, Assessment, and Framework Components (own elaboration).

Pedagogical Elements	Live Case Study Design	Assessment Methods	Empirical Evidence for Case Study
Live case pedagogy (context)	Engagement with real micro and small enterprises	Individual live case reports	Contextual descriptions, process selection, problem statements (consistently strong across all reports)
Experiential learning—CE	Initial immersion and data gathering	Individual report (problem identification)	Evidence of experiential engagement and problem framing (ubiquitous, demonstrating successful authentic context enactment)
Experiential learning—RO	Structured reflection on decisions and outcomes	Reflective journal (three entries)	Reflective narratives, evaluative judgement, and sense-making (frequent in journals, though depth varied considerably)
Experiential learning—AC	Integration of theory and practice	Written conceptual examination; journal	Conceptual understanding, theory–practice linkage (more variable, with deeper integration evident in exams and journals than in early reports)
Experiential learning—AE	Iterative solution and system design	Individual reports; group QMS project	Improvement proposals, system-level designs, and implementation logic (strength varied by team, with some showing clear iterative refinement)
AA principles	Realism, evaluative judgement, cognitive challenge	Rubrics across all assessments	Justification of decisions, handling of uncertainty, and learning progression (evident across artefacts, though most explicitly demonstrated in reflective journals and final reports)
Case-study methodology	Use of routine coursework as data	All assessment artefacts	Contrasted, naturally occurring qualitative dataset (enabled within-case comparison across multiple data sources)

3.3. Data Collection

Data collection followed the instructional and assessment design outlined in Section 3.2 and focused on the evidence generated through the Quality Management module. Data were drawn from educational artefacts, aggregated assessment outcomes, and student feedback. The primary dataset comprised student artefacts produced as part of routine coursework, including individual live case reports, group coursework, written examination responses, and reflective journals, all collected in their final submitted form.

Assessment marks were collected and aggregated to examine assessment coherence across the module and contextualise the learning experience. Individual student grades or performance were not treated as outcome variables and were not used for evaluative or comparative purposes.

Students' perspectives were gathered using two survey instruments. The first was a standard institutional module evaluation survey that provided general feedback on teaching, learning support, and the learning environment (completed by 20 of the 31 enrolled students; 65% response rate). The second was a purpose-designed survey aimed at capturing students' perceptions of the live case study experience and its contribution to the selected learning dimensions (completed by 28 of the 31 enrolled students; 90% response rate).

The purpose-designed survey was developed in alignment with the study's conceptual framework and relevant literature, with items focusing on student interest, motivation, perceived relevance to professional practice, and self-perceived development of selected competencies. The survey consisted of seven Likert-type items using a five-point scale (1 = Not at all; 5 = Extremely), structured to capture perceived interest, motivation, relevance to professional practice, and selected ABET-aligned competencies. Example items included: "How interesting was carrying out your Live Case Study learning activities?" and "How relevant was the Live Case Study to developing skills for your studies and professional practice?" The instrument was intentionally concise to minimise survey fatigue within the module context. Given the exploratory and design-oriented nature of the study and the small cohort size, the survey was not intended to be a validated measurement instrument. Content validity was addressed through conceptual alignment and instructor reviews during item development. Therefore, the results from both surveys should be interpreted as descriptive indicators of students' perceptions rather than as validated psychometric measures.

Likert-scale responses were reported descriptively to contextualise student experiences within the case setting. These results illustrate tendencies in student perceptions rather than supporting inferential claims about learning effectiveness.

3.4. Data Organisation and Analysis

The data analysis followed a theory-informed qualitative case study approach guided by the integrative framework developed in Section 2.4. The purpose of the analysis was to examine how live case pedagogy, EL processes, and AA practices were enacted and evidenced within the case, rather than evaluating individual student performance or testing causal relationships. This approach is consistent with case study research that prioritises analytical insight and contextual interpretation over statistical generalisation (Flyvbjerg, 2006; Yin, 2009).

The analysis was conducted using a combination of deductive and inductive strategies (Guest et al., 2012). First, a deductive lens was applied using the framework's core elements as sensitising concepts. Student artefacts were examined for evidence corresponding to the stages of Kolb's ELC—concrete experience, reflective observation, abstract conceptualisation, and active experimentation—as well as the principles of AA, namely,

realism, evaluative judgement, and cognitive challenge. This provided a structured basis for organising the data and ensured alignment between the analysis and the study's theoretical foundations.

The unit of analysis comprised written segments within student artefacts, including paragraphs in live case reports, reflective journals, and exam responses. Coding was done at the sentence or paragraph level, where evidence of ELC stages (CE, RO, AC, AE) or AA principles (realism, evaluative judgement, cognitive challenge) was identifiable. Passages describing engagement with organisational constraints were coded under CE and realism, while reflective passages evaluating decision quality were coded under RO and evaluative judgement.

To illustrate how overlapping codes were handled: a student's journal entry describing the challenge of collecting data in a busy restaurant ("The manager was too busy to talk, so we had to observe and infer wait times ourselves") would be simultaneously coded as CE (engagement with real context), realism (navigating authentic constraints), and cognitive challenge (adapting methods to an ill-structured problem). This approach allowed the analysis to capture the multidimensional nature of learning experiences.

Coding proceeded iteratively: initial deductive categorisation was followed by refinement through inductive thematic analysis to capture emergent patterns that were not fully anticipated by the framework. Coding was conducted by the primary researcher, who employed reflexive strategies to enhance trustworthiness, including systematic note-taking to document interpretive decisions, periodic revisiting of earlier codes against raw data to ensure consistency, and ongoing critical reflection on how prior assumptions might shape coding choices. Coding notes were maintained throughout the analysis to record interpretive decisions, category refinements, and emerging themes, thereby supporting transparency and consistency.

Second, an inductive thematic analysis was conducted to identify patterns and insights that emerged from the data beyond predefined frameworks (Braun & Clarke, 2006; Timans et al., 2019). This inductive phase enabled attention to unanticipated learning trajectories, variations in student engagement, and the coherence of assessment practices across the module. The analysis focused on cross-artefact comparison rather than individual cases, examining convergence and divergence across live case reports, group coursework, examination responses, reflective journals, and survey data.

Throughout the analysis, a within-case comparison was employed by contrasting evidence across multiple data sources, enhancing analytical robustness and supporting a holistic interpretation of how the framework was operationalised in practice. Aggregated assessment results and survey responses were used descriptively to contextualise the qualitative findings rather than as independent analytical outcomes (Garay-Rondero et al., 2019).

In summary, the analytical process iterated between the data, framework constructs, and interpretations. Analytical notes documented interpretive decisions and maintained the study's transparency. The findings are grounded in a systematic examination of the evidence and interpreted using a conceptual framework.

3.5. Results Reporting and Discussion

The results focused on the relationship between live case studies, EL, and AA. To enhance understanding and ensure clarity, the pedagogical design is described according to an adapted ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Branson, 1978; Molenda, 2003), including what to learn, how to learn, and how to assess learning. Student quotes from survey responses and written work were included, alongside descriptive statistics. These quotes reveal both positive experiences and difficulties, allowing the analysis to extend beyond mere numerical data to capture students'

experiences. The discussion highlights the integration of live case studies with Kolb's ELC and AA principles, providing insights into their theoretical and practical implications, limitations, and future research directions. Accordingly, new formulations might trigger new research questions and changes to existing theoretical and conceptual definitions, iteratively validating and testing these claims (de Zeeuw, 1996; Popper, 2008).

3.6. Ethical Considerations and Methodological Scope

This study adhered to ethical standards for educational research. Ethical approval was obtained in accordance with institutional guidelines. Data were obtained from routine teaching with voluntary student participation and anonymised responses. Ethical considerations regarding consent, confidentiality, and data protection were followed. The study used existing assessment artefacts and posed no risk to participants. Methodological trustworthiness was supported through transparent documentation, theoretical alignment, and the use of multiple sources. Validity was enhanced through within-case comparisons of assessment artefacts and student feedback (Leung, 2015; Vahl, 1997). Reliability was supported through systematic coding and theme convergence (Leung, 2015; Vahl, 1997). Transferability was supported by a rich contextual description of the educational setting, allowing readers to judge the relevance of the findings to comparable contexts (Drisko, 2025; Vahl, 1997).

Given its exploratory nature, this study contributes by providing a theoretically grounded framework that can inform future research and practice (de Zeeuw, 1996). As no comparisons or control groups were included, causal or broader inferences or claims could not be made. Furthermore, reliance on a single case and voluntary survey data limits statistical generalisability, as it does not provide automatic, probability-based, universal, or truthful applications in similar circumstances (Drisko, 2025). Therefore, the results are indicative and require replication in other contexts to evaluate their applicability. Future research could extend this design-oriented approach by pairing artefact analysis with targeted interviews or think-aloud protocols to illuminate how students make decisions, interpret constraints, and integrate theory during live case engagement.

Assessment reliability was supported through detailed criterion-referenced rubrics with explicit performance descriptors for each grade band (see Appendix B for an illustrative extract) (Table A2). As the module was delivered and marked by one tutor, formal inter-rater reliability statistics (e.g., percentage agreement, Cohen's κ, or Cronbach's α) were not applicable. Consistency was reinforced through predefined criteria, grading scales, alignment with learning outcomes, and systematic application of standards across submissions. While this approach supports internal consistency, future implementations with multiple instructors could incorporate inter-rater reliability measures to strengthen evaluative robustness.

Building on the methodology described in Section 3, the following section presents the case study results organised within the framework developed in Section 2. The results demonstrate the integration of live case pedagogy, EL, and AA into practice. The results describe how learning and assessment practices unfolded, using multiple sources of evidence to illustrate the framework's application.

4. Results

This section presents the case study results as an analytical account of how the proposed instructional model linking live case pedagogy, EL, and AA was enacted in an undergraduate Quality Management module. Rather than evaluating learning effectiveness or testing causal relationships, the results illustrate how instructional design decisions, learning activities, and assessment practices were aligned in practice across the module.

As discussed in Section 3, the ADDIE model is used here as a reporting structure to organise the presentation of the instructional design and its enactment. Table 3 summarises the module's instructional design, and the following subsections describe each ADDIE stage in detail. Evidence was drawn from naturally occurring teaching and assessment artefacts, aggregated assessment outcomes, and student feedback. Quantitative summaries are reported descriptively to contextualise student engagement and achievement within this learning experience, rather than to support empirical generalisation or claims about its impact.

Accordingly, the results are intended to be illustrative rather than confirmatory. They demonstrate how integrating live case studies, Kolb's ELC, and AA principles can be coherently operationalised in a real educational setting. The analytical value of the case lies in making the design logic visible and transferable, enabling readers to judge the framework's relevance and adaptability to other contexts.

4.1. Analysis

The analysis phase examined the learner profile and curricular requirements of the Quality Management module delivered to 31 final-year undergraduate students in the Industrial Engineering and Design and Innovation Engineering programmes. The students had no prior background in quality management, and this was their first exposure to quality-related concepts. The instructional design emphasised progressive scaffolding through applied learning activities.

The module aims to enable students to design a quality management system (QMS) to support competitiveness and value creation, and develop their ability to apply quality management principles to exceed customer expectations and address quality problems in organisations.

The learning outcomes focused on students' cognitive and applied competencies. Students were expected to (i) apply quality management principles, particularly ISO 9001 and ISO 26000; (ii) analyse processes for quality challenges; (iii) design quality improvement solutions; and (iv) reflect on theory–practice integration. Attitudinal outcomes emphasised the selection of appropriate quality improvement tools for organisational issues.

The content progressed from foundational concepts to system applications, covering quality dimensions, continuous improvement, statistical tools, root cause analysis, service quality, Six Sigma, metrology, and ISO 9000 systems. The define, measure, analyse, improve, and control (DMAIC) method was established as the fundamental problem-solving tool. Topics were presented through case studies that linked concepts to their practical applications.

Key constraints included 48 h of scheduled instruction (two 1.5-h sessions per week over 16 weeks) and 6 h of weekly independent study. Notably, this module was taught in English, as Spanish is the official and most widely spoken language in Mexico. These constraints informed the adoption of live case studies as a central strategy for integrating learning into real organisational contexts.

Recurring themes across artefacts included process inefficiencies in operations, inconsistencies in customer feedback, and limited quality control mechanisms in micro and small enterprises. Reflective journals emphasised both the difficulty of translating quality principles into resource-constrained environments and the value of theoretical models for navigating such contexts. These patterns confirm the realism of live cases while revealing students' initial cognitive gap in translating abstract concepts (such as DMAIC) into messy, real-world settings. This gap was not a design flaw but an intentional feature—creating conditions for concrete experience (CE) from which structured learning could unfold through subsequent reflection and conceptualisation.

Table 3. Integrated Instructional Design of the Quality Management Module (own elaboration).

ANALYSIS (A): Identifies learner characteristics, contextual constraints, learning objectives, and content scope to inform the module's instructional design.
• Final-year engineering students (n = 31) • No prior background in operations or quality management • Learning objectives: applied quality management and systems • Constraints: 48 contact hours + independent study
DESIGN (D): Aligns learning outcomes, pedagogy, and assessment methods into a coherent instructional and assessment structure.
• Live case studies as core pedagogy enhanced with the ELC and AA principles • Learning outcomes mapped to assessments • Blended sessions + fieldwork • Assessment structure and weighting ○ Live case reports (10% + 15%) ○ Conceptual exam (15%) ○ Group QMS project (40%) ○ Reflective journal (20%)
DEVELOPMENT (D): Produces the instructional materials, assessment instruments, and support resources required to enact the designed learning experience.
• New assignment briefs and rubrics • Support materials (slides, videos, guides, cases) • Social responsibility principles and QMS integration as a group live case • Problem solving at increasing depth in two individual live cases • Reflective journal entries for conceptual integration, real-world application, and critical reflection
IMPLEMENTATION (I): Enacts the instructional design through facilitated live case activities, fieldwork, and instructional support in real organisational contexts.
• Live cases in real local businesses • Sectors: food service, manufacturing, services, and retail • Fieldwork: visits, interviews, observations, and surveys • Facilitated sessions + on-demand tutoring • Individual and group work
EVALUATION (E): Reviews instructional design effectiveness using assessment outcomes and student feedback to inform reflection and iterative improvement.
• Aggregated assessment results • Institutional module survey • Live case-specific competency survey • Iterative improvement of instructional design

4.2. Design (D): Alignment of Learning Outcomes, Live Case Pedagogy, and Assessment Structure

The design phase translated learning objectives into a coherent instructional structure using live case studies. Learning outcomes were mapped to activities and assessments to ensure alignment between instruction, engagement, and evaluation.

Live case studies served as the core pedagogical approach within a blended educational structure, comprising sessions, consultation tutoring, draft submissions, checklists, and independent fieldwork. Dedicated sessions introduced case studies, provided clarifications during development, and supported the final integration. In addition, similar support sessions were provided for reflective journals and group coursework, maintaining alignment across assessments.

The assessment comprised complementary tasks, weighted by scope and complexity. Two individual live case reports addressed problem solving using the DMAIC method with increasing depth. The first report on defining and measuring product and service quality problems, covering time, cost, customer satisfaction, and sustainability issues, contributed 10% of the total marks. The second report on quality tools for problem analysis, countermeasure development, and control contributed 15%. These reports engaged students in organisational contexts and increased their cognitive demand.

A written conceptual examination, accounting for 15%, assessed students' understanding of quality management concepts, frameworks, and tools throughout the module. The examination emphasised application and interpretation rather than memorisation, ensuring that EL was grounded in disciplinary theory and supported the abstract conceptualisation of the subject matter.

The final group coursework live case, in which students designed a quality management system for a local business in line with ISO standards, accounted for 40% of the assessment. This weighting reflected the assignment's integrative nature, requiring systems thinking, collaboration, and the synthesis of theoretical and applied learning.

Finally, an individual reflective journal (20%) was designed to make the learning process explicit and to assess students' integration of concepts, real-world applications, and critical reflection. The marking criteria emphasised depth of reflection, application of concepts, integration of ideas, organisation, and use of academic sources. Table 4 presents the pedagogical elements of the live case integrative framework in the Quality Management module. A consolidated overview of the alignment between learning outcomes, EL phases, AA principles, and assessment instruments is provided in Appendix A (Table A1).

Table 4. Pedagogical Elements of Live-Case Integrative Framework in the Quality Management Module (own elaboration).

ELC Stage	Authentic Assessment Principle	Assessment Methods and Supporting Activities	Description
Concrete Experience (CE): Live case contexts	Realism	Individual live cases (problem definition and measurement) Group live cases (problem definition and measurement)	Problem definition and measurement, according to the DMAIC problem-solving method for quality improvement, in local small business companies.
Reflective Observation (RO): Learning through reflection	Evaluative judgement	Individual live cases (problem analysis) Group Live Cases (problem analysis) Reflective journals (reflective section)	Root cause analysis of problems using the DMAIC problem-solving method for quality improvement. Links to professional practice and transdisciplinary applications were also identified.

Table 4. *Cont.*

ELC Stage	Authentic Assessment Principle	Assessment Methods and Supporting Activities	Description
Abstract Conceptualisation (AC): Theory–practice integration	Cognitive challenge	Individual live cases (problem improvement) Group Live Cases (problem improvement) Reflective journals (conceptual section) Conceptual written examination	Development of countermeasures for problems using the DMAIC problem-solving method for quality improvement. Conceptual comprehension to bridge quality management theories and countermeasure design.
Active Experimentation (AE): Application and adaptation	Realism; cognitive challenge	Individual live cases (improvement proposals) Group live cases (improvement proposals) Reflective journals (application section)	Students develop implementation, follow-up, and control plans, analyse potential risks, and discuss implications for business practice.

The design phase established the architecture for distributed assessment across ELC stages. The weighting structure (no component exceeding 40%) departed from prior iterations that relied heavily on final projects, reflecting the framework's principle that learning should be assessed recursively rather than at a single endpoint.

4.3. Development (D): Creation of Learning Materials, Assessment Instruments, and Support Resources

The development phase focused on producing the module materials, assessment instruments, and support resources. Assignment briefs, rubrics, and supporting materials were developed to align with live case pedagogy and learning outcomes.

Assignment briefs were created for each assessment component, including live case reports, a group quality management system project, a reflective journal, and a written examination. The briefs outlined the objectives, deliverables, and requirements while maintaining an open-ended case enquiry. Live case briefs presented problems as ill-structured and context-dependent, acknowledging that multiple valid solutions exist. The reflective journal brief required entries that covered conceptual explanations, practical applications, implications, reflections, and connections to future professional practice.

Assessment rubrics and checklists ensured evaluation consistency. The rubrics emphasised depth of analysis, application of quality management, integration of ideas, justification of decisions, and effective communication. Assessment weightings evaluated learning across experience, reflection, conceptualisation, and application. These criteria operationalised AA while allowing for professional judgement. The assessment structure supported progressive learning and aligned with the ELC stages.

Supporting learning resources, including presentations, videos, checklists, study guides, and traditional case studies, were also provided to scaffold student engagement. These materials introduced quality management tools and supported class discussions, helping students interpret and apply concepts in their contexts.

The development process aligned the materials with the module's progression to ensure coherence between instruction and assessment. This phase translated the design into concrete artefacts that supported implementation and research. Table 5 summarises the assessment elements of the live-case framework.

A key insight was that assessment instrument quality—particularly rubrics articulating criteria for justification rather than correctness—directly influenced how students approached live case work. Early submissions showed that when rubrics emphasised decision justification, students devoted more attention to explaining their reasoning, demonstrating evaluative judgement operationalisation.

Table 5. Assessment Elements of the Live-Case Integrative Framework in the Quality Management Module.

Assessment Elements (ELC Stage)	Authentic Assessment Principle	Assessment Methods	Description
Learning quality evaluation and standards (across CE–AE)	Evaluative judgement	Individual and group live cases	Rubrics and checklists articulated the criteria for assessing disciplinary problem solving, quality improvement, and systems development.
Learning process visibility (across CE–AE)	Cognitive challenge; evaluative judgement	Reflective journals (all sections)	Students bridged links across quality management conceptualisation, reflection, and action, including implications for future professional practice.
Feedback and iteration (across CE–AE)	Cognitive challenge	All assessment methods	Formative feedback sessions, draft submissions, checklists, and tutor consultations supported all learning tasks Students iterated improvement and learning tasks across individual and group efforts in live case contexts and tutoring support.
Assessment coherence (whole framework)	Realism; evaluative judgement; cognitive challenge	All assessment methods	Individual cases nurtured group live cases by combining individual learning into a collective team learning Live cases provided examples for reflective journals Reflective journals (conceptual section) contributed to the conceptual written examination Module syllabi, assignment briefs, checklists, and study materials align with learning outcome development, following the ELC and AA principles.

4.4. Implementation (I): Enactment of Live Case Studies and Learning Activities

The implementation phase focused on applying the instructional design through live case-study activities in the classroom. The students conducted case studies in various organisations, including restaurants, coffee shops, gymnasiums, cinemas, and manufacturing companies. These were selected based on the students' interests and data access, ensuring feasibility and diversity.

Live case studies were combined with in-class facilitation and independent fieldwork. The classes introduced expectations, methodological approaches, and guidance for case development. The instructor addressed the problem definition, quality management tools, and data interpretation, with tutoring available for analytical questions.

Moreover, students engaged with organisations by visiting facilities, observing operations, interviewing stakeholders, checking online reviews, and collecting customer feedback through surveys. These activities enabled interactions with real processes, reinforcing the experiential nature of live cases. The group work was supported by collaboration and tutoring to ensure the integration of quality management solutions.

The implementation balanced learner autonomy and support. While students managed organisational access, structured guidance ensured alignment with learning objectives. This approach accommodates diverse contexts while maintaining consistent standards.

Overall, the implementation phase operationalised live case pedagogy by embedding EL in real-world settings and providing students with facilitation and feedback to ensure consistent learning experiences.

Student-selected cases proved viable across diverse contexts—from restaurants to manufacturing—without compromising learning outcomes. However, variation in organisational access and data quality created different levels of cognitive challenge. Students with more accessible organisations progressed faster to analysis, while those facing access barriers spent more time in concrete experience (CE), suggesting case selection influences learning cycle pacing and may require differentiated scaffolding.

4.5. Evaluation (E): Review of Instructional Design Effectiveness and Learning Outcomes

The evaluation phase examined the module's instructional design effectiveness rather than student performance. The evaluation used assessment outcomes and student feedback to assess the coherence and impact of the live case-based approach, which aligned with the exploratory nature of the study.

Additionally, a summative evaluation of learning outcomes was based on assessment results across components, including case reports, examinations, quality management system projects, and reflective journals. The distribution of marks showed how effectively the assessment system supported learning across experience, reflection, conceptualisation, and application.

Finally, student perceptions were collected using two end-of-module feedback instruments: On the one hand, the institutional module evaluation survey, capturing views on learning clarity, support, and satisfaction. In contrast, a purpose-designed survey on the live case study explored students' perceptions of the pedagogy and its contribution to ABET outcome development (ABET, 2024).

- "An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors."
- "An ability to communicate effectively with a range of audiences."

The results of student achievement and both surveys are presented in Tables 6–8, which help assess the instructional design and identify areas for refinement. In addition, survey findings and assessment performance trends inform module revisions when evaluations fall below the thresholds.

Table 6. Assessment Method Survey Results (authors' elaboration).

Assessment Method	Average Mark	Standard Deviation
Live Cases (First and Second)	7.47	2.33
Live Case Group Work	8.48	2.21
Conceptual Written Examination	8.32	2.52
Reflective Journal	7.00	3.35
Final Mark	8.11 (with a 100% passing rate)	2.01

Marking Scale: 0–10, 6.0 Passing Mark.

Table 7. Module Survey Results (authors' elaboration).

Views on the Tutor and Module	Respondents (*n*)	Mean
The tutor places the course content in a professional context.	20	9.54
The tutor assesses students objectively based on the learning outcomes established at the beginning of the course.	20	9.23
The tutor uses teaching resources and strategies to support the learning of course topics.	20	9.69
The tutor helps resolve problems and/or questions related to course topics.	20	9.54
The module fosters an environment in which students can actively participate in class and express their ideas.	20	9.85

The students provided 20 of the 31 responses. Scale: 1–10, Target: 8.5+.

The reflective journal had the lowest mean score (7.0) and the highest standard deviation (3.35) among the assessments, indicating greater variability in students' performance on reflective tasks than on reports or examinations. This dispersion suggests reflective writing required advanced metacognitive articulation and theory–practice integration, posing uneven challenges across the cohort. Although most students met the passing threshold, the depth and structure of reflection varied across submissions.

Table 8. Live Case Study Survey Results (authors' elaboration).

Questions	Mean	Std Dev	Mode	*n*-Mode	Cumulative Frequency (1–2)	Frequency (3)	Cumulative Frequency (4–5)
How *interesting* was carrying out your Live Case Study learning activities?	3.82	1.04	4	13 (46.4%)	2 (7.1%)	6 (21.4%)	20 (71.4%)
How *motivating* was carrying out your Live Case Study learning activities?	3.64	1.11	4	12 (42.9%)	2 (7.1%)	6 (21.4%)	18 (64.3%)
How *relevant* was the Live Case Study to developing skills for your studies and professional practice?	3.93	1.03	4	14 (50%)	2 (7.1%)	4 (14.3%)	22 (78.6%)
Before this module, how was your ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors [1]?	3.68	0.66	4	16 (57.1%)	1 (3.6%)	9 (32.1%)	18 (64.2%)
As a result of this module, how is your ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors [1]?	4.04	0.68	4	15 (63.6%)	0 (0%)	6 (21.4%)	22 (78.6%)
Before this module, how effective were you at communicating with a range of audiences in English [1]?	4.07	0.8	4	13 (46.4%)	1 (3.6%)	5 (17.9%)	22 (78.6%)
As a result of this module, how is your ability to communicate effectively with a range of audiences in English [1]?	4.07	0.8	4	13 (46.4%)	1 (3.6%)	5 (17.9%)	22 (78.6%)

The students provided 28 of the 31 responses. Scale: 5—Extremely/Great, 4—Very/Considerably, 3—Reasonably/Moderately, 2—Slightly, 1—Not at all. [1] Module's ABET student outcomes.

Distribution patterns indicate positive student perceptions. For example, 71.4% of respondents rated live case activities as "Very" or "Extremely" interesting (ratings 4–5), while only 7.1% selected lower categories (1–2). Similarly, 78.6% rated the relevance of live case studies for professional development at levels 4–5. These frequencies suggest engagement and perceived professional value were concentrated in the upper range, despite variability in motivational responses.

Qualitative comments further illustrate students' experiences and provide insight into how the framework components were experienced in practice. One student's reflection demonstrates the integration of concrete experience with active experimentation: *"Working directly with a real company made the project feel meaningful and impactful. We had to adapt our data collection to process situations and analysis when new information emerged, which helped me understand quality management beyond textbook examples."*

This excerpt illustrates how CE (engagement with real operations) and AE (adapting to emerging information) were experienced in tandem, with the student explicitly linking this adaptive process to deeper understanding—evidence of the theory–practice integration (AC) that the framework was designed to foster.

At the same time, challenges were noted, particularly regarding the reflective journal: *"The reflective journal was more difficult than the case reports because it required an explanation of the link between theory, practice, and our professional future. It was also hard to find time to write thoughtfully with other module deadlines approaching."*

This comment highlights the cognitive load of RO and AC versus applied tasks. The student's difficulty articulating theory–practice links suggests that while the framework created conditions for reflection, the metacognitive demands of evaluative judgement were unevenly distributed across the cohort. The mention of competing deadlines highlights a

boundary condition: reflective tasks may be vulnerable to workload pressures, necessitating careful scheduling across the curriculum.

A higher standard deviation in reflective journal scores (3.35) compared with applied reports (2.33) suggests that reflective competence does not develop uniformly through experiential exposure alone. While some students demonstrated sophisticated evaluative judgement, others needed more structured support in translating experiences into reflective writing—indicating RO and AC stages may require additional scaffolding for some learners.

Together, these patterns indicate that while the live case context successfully enhanced authenticity and engagement (consistent with the framework's realism principle), the reflective articulation of learning required additional cognitive effort—a finding that reinforces the need for deliberate scaffolding of the RO and AC stages. The variability in reflective performance, rather than signalling assessment misalignment, usefully illuminates where learners face differential challenges in developing evaluative judgement.

These empirical insights, organised through the ADDIE reporting structure, provide a foundation for reflecting on the design implications and theoretical contributions of integrating live case pedagogy with EL and AA. The following section discusses these implications, addresses the study's limitations, and outlines directions for future research.

5. Discussion

5.1. Findings on the Integration of Live Case Studies, ELC, and Authentic Assessment Principles

The findings indicate that the proposed design logic and operational framework for distributing authentic assessment across Kolb's experiential learning stages within live case pedagogy supported consistency between what students were asked to learn, how learning unfolded, and how learning was evaluated. Rather than operating as separate components, live case pedagogy, EL processes, and assessment practices functioned as an interdependent system throughout the Quality Management module. This integrated configuration directly responds to prior critiques that experiential approaches are often implemented without sufficient theoretical articulation or alignment with assessment (Beard & Wilson, 2013; Roth & Smith, 2009).

First, a central finding concerns the systematic integration of teaching and assessment activities with the ELC's stages and the principles of AA. Learning tasks and assessment components were deliberately mapped onto concrete experience, reflective observation, abstract conceptualisation, and active experimentation, while simultaneously operationalising realism, evaluative judgement, and cognitive challenge. This structured integration addresses longstanding concerns that experiential pedagogies may overemphasise immersion at the expense of reflection and conceptual integration (Fenwick, 2001; Moon, 2013). By embedding assessment throughout the experiential cycle, the design mitigated the risk of equating activity with learning, reinforcing D. A. Kolb's (1984) argument that experience alone does not guarantee knowledge construction.

Second, the findings demonstrate that live case studies can serve as organising contexts for coherent assessment systems. Rather than relying on a single performance artefact, the module integrated individual reports, group coursework, reflective journals, and conceptual examinations around shared organisational problem spaces. This multicomponent structure aligns with AA scholarship, which emphasises that realism and evaluative judgement must be distributed across tasks rather than confined to isolated projects (Ashford-Rowe et al., 2014; Gulikers et al., 2004). In doing so, the framework advances the view that AA functions most effectively as a system of complementary instruments rather than a singular task (Boud & Falchikov, 2006).

Third, the case illustrates how live case pedagogy can support personalised yet coherent learning trajectories. Students selected organisational contexts based on accessibility

and interest, resulting in variations in problem scope and analytical focus. Simultaneously, shared learning outcomes and rubrics ensured evaluative consistency. This balance between individualisation and coherence echoes arguments in case-based and engineering education literature that authentic problems enhance engagement, while structured criteria maintain academic rigour (Freeman et al., 2014; Lavi & Marti, 2023). This suggests that student-mediated access to organisations can serve as a pragmatic mechanism for implementing live case pedagogy in contexts where formal industry partnerships are limited, thereby expanding accessibility and scalability in undergraduate engineering education.

Fourth, the results highlight the importance of assessment coherence over individual task sophistication. The effectiveness of the approach is derived not from any single assessment component, but from the deliberate sequencing of applied analysis, conceptual examination, and reflective integration across the experiential cycle. This observation supports critiques of fragmented assessment practices in higher education, where disconnected tasks may obscure learning trajectories (Gulikers et al., 2004). By distributing cognitive challenge and evaluative judgement across multiple components, the design reinforced the recursive and non-linear nature of EL noted by Bergsteiner et al. (2010) and D. C. Kayes (2002).

Finally, descriptive evidence from assessment outcomes and student feedback provides insights into how the integrated framework functioned in practice. Students demonstrated achievement across applied, conceptual, and reflective components, suggesting the integration of case activities, EL processes, and assessment design. Although descriptive statistics do not establish causal relationships, the patterns observed are consistent with the literature reporting enhanced engagement and perceived relevance in active and EL environments (Freeman et al., 2014; Kong, 2021). The observed improvement in self-perceived engineering design competence further aligns with calls for authentic, context-sensitive assessments in engineering education.

Uneven performance in reflective journals, including non-submissions, suggests that reflective competence does not develop automatically through experiential exposure. Although the journal activity was scaffolded through rubric-unpacking and exemplification sessions that clarified expectations and assessment criteria, grade dispersion indicates some students needed more structured support in translating experiences into reflective writing. Student feedback suggested that competing assessment deadlines across modules contributed to non-submission, indicating that workload distribution affected engagement. These observations reinforce findings that reflection requires deliberate pedagogical design and guidance rather than being assumed as a natural by-product of experiential tasks (Moon, 2013).

Taken together, these findings suggest that integrating live case studies with EL and AA principles provides a structured design logic that supports engagement, structured reflection, conceptual integration, and applied reasoning. Rather than positioning live case pedagogy as an isolated innovation, this case illustrates how intentional alignment between pedagogy, learning processes, and assessment can address persistent critiques in the experiential and case-based learning literature.

5.2. Theoretical and Practical Implications

The primary theoretical implication of this study is the conceptual integration of live case studies, Kolb's ELC, and AA principles as complementary pedagogical anchors. The findings show that live case studies provide contextual learning conditions that define learning through engagement with authentic and ill-structured organisational problems. EL theory and Kolb's learning cycle contribute a process-oriented perspective that clarifies how learning occurs through experience, reflection, conceptualisation, and action. AA principles address how learning should be evaluated by emphasising realism, evaluative

judgement, and cognitive challenge. The theoretical contribution lies in articulating how these three perspectives integrate into a conceptually unified pedagogical logic, rather than being applied in parallel or invoked rhetorically.

This integration addresses a limitation in the live case study literature: while EL is frequently cited, it is insufficiently operationalised, and assessment practices often lag behind pedagogical innovations. By positioning EL and AA as structuring mechanisms for live case pedagogy, this study advances a precise theoretical account of how live case studies support structured learning trajectories and rigorous evaluations. A key theoretical implication is reframing live case studies not as standalone teaching methods but as design contexts that require alignment with learning processes and assessment logic. This perspective contributes to broader discussions on experiential and practice-based learning by emphasising pedagogical design over instructional novelty.

This study contributes to education research literature by demonstrating the value of design-oriented frameworks. Using ADDIE as a documentation and reflection lens demonstrates how instructional design models can complement learning theories without displacing them from the learning process. This reinforces the idea that learning theories explain learning processes, whereas design frameworks support the translation of theory into practice. This study offers a methodological contribution by demonstrating how multiple frameworks can be integrated when their roles are clearly differentiated. Figure 3 illustrates the integration of the ADDIE model into the originally proposed framework, enriching the initial version.

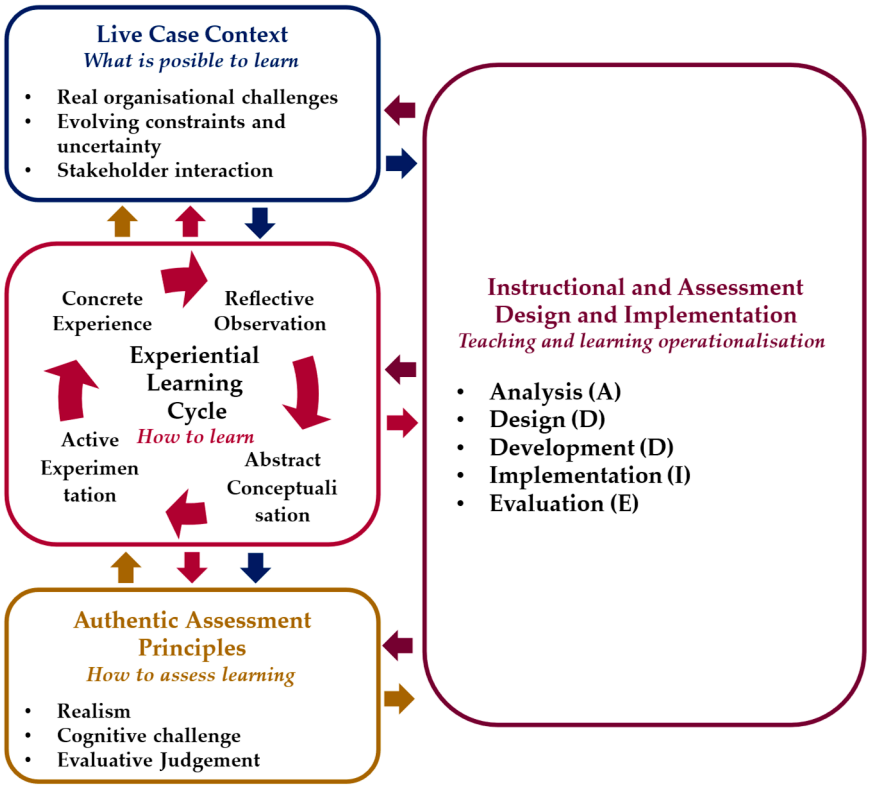


Figure 3. Integrative Framework for Live Case Studies, Revised Version, including ADDIE (own elaboration).

Figure 3 extends Figure 1 by situating the ELC–AA framework within the ADDIE instructional design cycle as a reporting and implementation lens rather than a learning theory. While Figure 1 captures core pedagogical alignment, Figure 3 shows how this

alignment can be documented and refined in practice. Instructors may adopt the ELC–AA alignment independent of ADDIE if a lighter implementation is desired.

From a practical perspective, the theoretical integration advanced in this study requires operationalisation in the field. A key practical implication is that educators should move beyond viewing live case studies as isolated projects and design them as integrated learning and assessment systems. The framework provides practical guidance for integrating live case activities with ELC stages and AA principles. It offers educators a structured approach to designing assessment sequences, selecting assessment tools, and ensuring that learning processes are visible and assessable over time.

This framework can be enacted using routine instructional and assessment artefacts, including assignment briefs, reflective journals, examinations, and group coursework. The findings suggest that effective live case implementation does not depend on highly specialised resources or formal industry partnerships, but can be achieved through student-selected cases that balance relevance, accessibility, and authenticity. This has practical implications for scalability and adoption in undergraduate contexts, particularly in institutions with limited access to external collaborators.

The case revealed several boundary conditions affecting the framework's workability. First, class size was a key factor: with 31 students, personalised tutoring and feedback were feasible, but scaling to larger cohorts would require additional resources or peer-feedback mechanisms. Second, institutional support for innovative pedagogies proved essential—particularly flexibility to design multi-component assessments rather than standardised examinations. Third, the success of student-selected cases depended on a departmental culture valuing authentic engagement over controlled comparability; programmes requiring uniform case experiences would need to adapt the model through curated partnerships. Finally, the framework assumes students' willingness to engage with uncertainty—a disposition that may need cultivation where prior learning emphasised clear answers and procedural tasks. These conditions do not diminish the framework's utility but specify contextual adaptations required for successful implementation.

Additional practical implications concern assessment design. These findings highlight the importance of treating assessment as a system of complementary components rather than a single evaluative mechanism. By distributing assessments across applied tasks, conceptual examinations, and reflective artefacts, educators can capture multiple dimensions of learning while maintaining cognitive challenge and evaluative judgement. This approach supports personalised learning pathways within a common framework, accommodating diversity in student interests and contexts without compromising intended learning outcomes.

Overall, this study makes three main contributions. First, it advances the conceptual integration of live case pedagogy, EL, and AA, clarifying their roles in higher education. Second, it provides an operational framework to guide the practical implementation of this integration through an instructional and assessment design. Third, it offers an illustrative case demonstrating how such integration can be implemented in undergraduate engineering through live case studies, thereby contributing to theory-informed pedagogy and design research.

5.3. Limitations

This study has several limitations that should be considered when interpreting its findings. These limitations relate to the conceptual scope of the framework, the study's methodological design, and the empirical context in which it was implemented.

Conceptually, the proposed framework integrates live case studies, EL, and AA into pedagogical anchors. While this integration provides coherent design logic, it does not

exhaust the theoretical perspectives that could inform live-case pedagogy. Other learning theories, such as social constructivism, situated learning, enquiry-based learning, and collaborative learning, may offer insights into collaborative dynamics, power relations, and community-based learning, which are not explicitly foregrounded in this study. The framework focuses on pedagogical and assessment alignment rather than on the broader curricular or institutional constraints that may shape the implementation of live cases across contexts.

Another limitation concerns equity, diversity, and inclusion factors not explicitly examined. The language of instruction, access to local organisations, and group dynamics may have shaped students' experiences in ways that have not been systematically analysed. Future research could explore how live case designs interact with diverse student backgrounds and resource access.

Methodologically, this study adopts a single-case design, prioritising depth and contextual richness over breadth. Although this approach supports transferability, it limits the statistical generalisability of the findings across disciplines, institutions, and educational levels without further examination. Using naturally occurring educational artefacts as primary data sources enhances validity but constrains the analysis to evidence from routine teaching activities. Consequently, certain aspects of student learning, such as informal peer interactions or unarticulated cognitive processes, may not be fully captured.

Empirically, the framework was implemented in an undergraduate engineering module with a small cohort of students. The students had no prior background in quality management, and the cases were selected based on their interest and accessibility. Although this design supported student participation and pedagogical feasibility, it introduced variability in organisational contexts and data quality, which may have influenced learning experiences across cases. For instance, the absence of a diagnostic assessment at the start of the module limits insights into how prior experience, knowledge, and skills may have shaped learning trajectories.

Finally, the evaluation of the instructional design relied on aggregated assessment results and student feedback surveys, which provided useful but partial indicators of how the learning experience unfolded within the case setting. The module evaluation and live case survey data limited the depth of the empirical assessment of learners' perceptions, as no open-ended questions were used to elicit more detailed reflections on the module or live case pedagogy. Consequently, aspects such as learning clarity, conceptual understanding, engagement, module recommendations, and potential relationships between perceptions and assessment outcomes were not examined and may warrant further investigation in future studies. In addition, the absence of longitudinal data limited insights into the longer-term impact of the live case approach on students' subsequent academic development and professional practice. Furthermore, the purpose-designed live case survey was used descriptively to contextualise student perceptions and was neither designed nor validated as a psychometric instrument, restricting its use to illustrative rather than evaluative interpretations of the data.

The study did not use inferential statistics to examine relationships between instructional design elements and learning outcomes. Survey results and assessment data were reported descriptively to contextualise learning rather than test hypotheses. Given the exploratory design, single-case context, and small cohort size, inferential testing would not have yielded robust claims. While findings show patterns consistent with the proposed design proposition, they do not support causal inferences. Future research using comparative designs, larger samples, or quasi-experimental methods could provide further validation.

These limitations do not undermine the proposed framework but highlight the need for cautious interpretation and further research. Future studies could address these limitations

by pairing artefact analysis with semi-structured interviews or think-aloud protocols to gain insight into students' decision-making and metacognitive processes, illuminating patterns observed in their written work. Longitudinal designs could track learning outcomes beyond the module, while multi-institutional comparisons would help establish the framework's transferability across contexts. These directions point to opportunities for future research, as discussed in the following subsection.

5.4. Future Work

The findings and limitations of this study point to several avenues for future research to advance the empirical validation and refinement of the proposed framework.

First, future studies should examine the transferability and construct validity of the framework across multiple modules, disciplines, and institutional contexts. Comparative case studies in different engineering domains or educational levels would enable researchers to assess how contextual variables influence the enactment and coherence of live case pedagogy integrated with EL and AA principles. Replication across diverse cohorts would strengthen analytical generalisations and clarify boundary conditions for implementation.

Second, future research could adopt quasi-experimental or comparative designs to explore the relationships between framework-based instructional design and learning outcomes. For example, modules employing the integrative framework could be compared with modules using traditional case-based or lecture-based approaches. While maintaining sensitivity to contextual factors, such designs would allow for a more systematic examination of whether and how structured alignment across pedagogy, learning processes, and assessment influences engagement, conceptual integration, and applied competence.

Third, the reliability and validity of the assessment instruments embedded in the framework can be examined. Studies could investigate the inter-rater reliability of rubric-based evaluations, consistency of judgement across instructors, and alignment between rubric criteria and intended learning outcomes. When survey instruments are used to capture student perceptions, psychometric validation—including exploratory or confirmatory factor analysis and internal consistency measures—can strengthen claims about perceived relevance, motivation, and competence development.

Future iterations of the reflective journal component could incorporate additional scaffolding mechanisms to further support deeper reflection and higher submission rates. While rubric unpacking and exemplification sessions were implemented, structured reflective prompts explicitly linked to ELC stages, low-stakes micro-reflection tasks earlier in the semester, peer-review cycles, or staged feedback could provide incremental practice in evaluative writing. Such enhancements may strengthen students' capacity to articulate theory–practice integration and mitigate the impact of competing assessment pressures across modules.

Fourth, longitudinal research could evaluate the sustained impact of live case-based learning structured through the proposed framework. Tracking students across subsequent modules, capstone projects, internships, or early professional practice would provide insights into whether experiential and AA alignment contribute to durable professional reasoning and evaluative judgement.

The framework's adaptability could be tested by applying it to develop outcomes beyond ABET criteria while remaining within Quality Management. For instance, to target ethical reasoning, a case might present a food manufacturer deciding whether to release a batch with cosmetic defects. Students would experience the dilemma during site visits (CE), reflect on stakeholder interests (RO), engage with professional ethics frameworks like the ASQ Code of Ethics (AC), and propose a justified course of action with preven-

tive recommendations (AE), with assessment focused on reasoning quality rather than decision correctness.

Similarly, for teamwork competencies, a group QMS project would have teams conduct organisational visits (CE), engage in structured debriefs on team dynamics and conflict resolution (RO), conceptualise principles of effective collaboration (AC), and experiment with revised practices in subsequent project phases (AE), with assessment including peer and self-evaluations of collaborative processes.

Such mappings demonstrate how the integrative logic can be extended to diverse learning outcomes while maintaining disciplinary coherence.

Finally, iterative design-based research cycles can further refine the framework. By systematically implementing, evaluating, and revising the framework across contexts, researchers can generate increasingly robust design principles grounded in empirical testing and reflective adaptation. Such cycles would move the framework from an illustrative case to a field-tested design logic capable of informing broader pedagogical innovation.

Collectively, these directions suggest that the proposed framework offers a foundation for continued empirical enquiry into live case pedagogy. While the present study provides a conceptually illustrative account, further research is required to examine its reliability, validity, scalability, and long-term educational impact.

6. Conclusions

This study contributes a design logic and operational framework for distributing authentic assessment across Kolb's experiential learning stages within live case pedagogy. By approaching live case pedagogy as a design problem rather than an instructional technique, the study demonstrates how learning activities, assessment practices, and design decisions can be intentionally structured to support theoretically grounded and assessable experiential learning.

Live case studies provide contextual conditions for learning, while experiential learning theory structures the unfolding of that learning, and authentic assessment principles guide its evaluation. Integrating these perspectives enabled the design of learning trajectories that support reflection, conceptual integration, and application, rather than mere experiential exposure. The ADDIE model served as a reflective design lens to document enactment without displacing learning theory or assessment logic.

The framework does not prescribe uniform practices or claim empirical generalisation; rather, it offers a transferable design logic for structuring live case modules across educational contexts. The case illustrates that such integration can be achieved using routine instructional artefacts and student-selected organisational contexts, supporting feasibility in undergraduate engineering education.

A central design principle emerging from this study is that assessment within live case pedagogy should function as a distributed and recursive system aligned across concrete experience, reflective observation, abstract conceptualisation, and active experimentation, rather than being concentrated in a single capstone artefact. This moves beyond generic calls for constructive alignment by demonstrating how assessment can be distributed across the experiential learning cycle, capturing learning at multiple points, enabling iteration through feedback loops, and making the development of evaluative judgement visible over time.

For practitioners, this principle translates into a practical heuristic: when designing a live case module, ensure that no single summative assessment dominates the overall grade structure, and that each major task maps to at least two of Kolb's four stages and one core authentic assessment principle (realism, evaluative judgement, or cognitive challenge).

Such distribution prevents over-reliance on a single performance snapshot and reinforces the recursive nature of experiential learning.

The transferable value of this study lies not in the specific configuration of this module, but in the underlying logic of integration: aligning a live case context, Kolb's experiential learning cycle as process guide, authentic assessment principles as evaluative lens, and a distributed assessment structure. By articulating and illustrating this logic, the study provides a conceptual and practical foundation for designing live case-based learning in engineering and broader higher education settings.

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Institutional Review Board Statement: Ethical approval for this study was obtained from the Institutional Review Board of Universidad Panamericana (Reference IRB UP-CI-2026-MX-01-ING and date of approval 10 February 2026), particularly for the interview components of the research. The analysis of anonymised educational artefacts and aggregated module evaluation data was based on materials generated through routine teaching and assessment activities and did not involve intervention, experimentation, or the collection of personal or sensitive data beyond standard educational practice.

Informed Consent Statement: Informed consent was obtained from all participants involved in the interview and survey components of the study. Participation was voluntary, and respondents were informed of the purpose of the research, data use, and confidentiality procedures prior to participation. Coursework artefacts and aggregated evaluation data were analysed in an anonymised form in accordance with institutional ethical procedures and data protection regulations.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request (D.E.S.-N.). These data are not publicly available because they contain information that can compromise the privacy of academic records.

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Abbreviations

The following abbreviations are used in this manuscript:

AA	Authentic assessment
AC	Abstract conceptualisation
ADDIE	Analysis, design, development, implementation, and evaluation
AE	Active experimentation
CE	Concrete experience
EL	Experiential learning
ELC	Experiential learning cycle
QMS	Quality management system
RO	Reflective observation

Appendix A. Alignment Matrix

The matrix below illustrates the explicit alignment between the intended learning outcomes, EL stages, AA principles, assessment instruments, and observable evidence generated within the module.

Table A1. Alignment Matrix Linking Learning Outcomes, Experiential Learning Phases, Authentic Assessment Principles, and Assessment Instruments (authors' elaboration).

Learning Outcome	ELC Phase(s)	Authentic Assessment Principle	Assessment Instrument(s)	Examples of Observable Evidence
Apply quality management principles (ISO 9001, ISO 26000)	AC, AE	Cognitive challenge; realism	Conceptual written examination; Group QMS project	Accurate application of standards; contextualised interpretation of ISO clauses; integration of theory with organisational constraints
Analyse quality problems in real organisations	CE, RO	Realism; evaluative judgement	Individual live case reports (problem definition and analysis)	Structured DMAIC application; root-cause analysis; justification of decisions under uncertainty
Design quality improvement solutions	AE	Realism; cognitive challenge	Individual live case reports; Group QMS project	Development of implementation plans; risk analysis; iterative refinement of proposals
Reflect on theory–practice integration	RO, AC	Evaluative judgement; cognitive challenge	Reflective journal	Explicit articulation of assumptions; linking theoretical models to case decisions; critical evaluation of outcomes
Develop professional reasoning and decision-making	Across CE–AE	Realism; evaluative judgement	All assessment components (reports, exam, journal, QMS project)	Evidence of contextual judgement; responsiveness to feedback; adaptation of solutions across iterations

Appendix B. Assessment Rubric

Table A2. Excerpt from Assessment Rubric for Live Case Study Coursework (authors' elaboration).

Performance Level	Criterion 1: Results—Suggested Improvements, Metrics, and Challenges (35%)	Criterion 2: Discussion and Conclusions—Critical Analysis and Recommendations (35%)
Excellent (90–100)	Comprehensive, clear, justified, and well-articulated improvements resulting from the correct and coherent use of quality concepts and tools; provides a full explanation of how recommendations were obtained; justification is commendable and well-structured; includes a comprehensive and well-articulated set of performance metrics; transparent identification of challenges.	Demonstrates an in-depth understanding and thorough evaluation of quality management theories; discusses complex issues with clarity; presents strong, well-supported arguments; provides clear, actionable, and well-justified recommendations; synthesises findings coherently; highlights significant implications; and reflects critically on limitations and broader impacts.
Good (80–89)	Clear, justified, and consistent improvements resulting from the correct and coherent use of quality concepts and tools, with minor limitations; provides a comprehensive explanation of how improvements were obtained; justification is clear and well-structured; includes a well-articulated set of performance metrics; and structured identification of challenges.	Clearly demonstrates a clear understanding and adequate evaluation of theories; identifies key issues with well-supported arguments; presents justified and feasible recommendations; provides a precise summary with sound synthesis; and articulates relevant implications.
Satisfactory (70–79)	Clear and sufficient improvements resulting from the correct and coherent use of quality concepts and tools; provides a good explanation of how improvements were obtained; justification is clear but may lack depth; includes an appropriate set of performance metrics; and identifies challenges in a structured but limited manner.	Demonstrates a basic understanding and limited evaluation of theories; identifies some key issues but with limited depth; recommendations are generally practical but lack full justification; summary reflects main points but synthesis is limited; implications mentioned but not fully developed.
Passing (60–69)	Most improvements resulted from the broadly correct use of quality concepts and tools; minor errors or inconsistencies may exist; provides a reasonable explanation of how improvements were obtained; justification is adequate but limited; includes a fair set of performance metrics; and some challenges were identified.	Limited understanding and superficial evaluation; weak arguments; vague or insufficiently justified recommendations; lack of clarity or synthesis in the summary; minimal discussion of implications.
Needs Improvement (<60)	Improvements are incorrect, incoherent, or unsupported; significant errors or inconsistencies in the use of quality concepts and tools; weak or absent explanation of how improvements were obtained; unclear or incoherent justification; incomplete or inappropriate performance metrics; challenges not identified or poorly described.	Lack of understanding of relevant theories; arguments that are unsupported or incoherent; recommendations that are absent or impractical; no meaningful synthesis; no clear findings or implications.

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