Bridging Theory and Practice in Engineering Technology Education: A Hybrid and Simulation-Based Approach for Adult Learners

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Bridging Theory and Practice in Engineering Technology Education: A Cross-Case Framework for Hybrid and Simulation-Based Learning for Adult Learners

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Abstract

Engineering technology programs increasingly serve adult learners, working professionals, and military-affiliated students who require flexible pathways without losing the applied laboratory rigor central to engineering technology education. This paper presents a cross-case instructional framework for bridging theory and practice through two complementary models: a hybrid Electrical Engineering Technology (EET) laboratory model using alternating online simulation and onsite laboratory blocks, and a fully online Nuclear Engineering Technology model using scenario-based reactor simulation. The framework is grounded in adult learning theory, experiential learning, collaborative learning, and simulation-based education. It is aligned with ABET Engineering Technology Accreditation Commission (ETAC) student outcomes related to applying knowledge, conducting experiments and interpreting data, using modern tools, communicating effectively, functioning on technical teams, and demonstrating professional responsibility. Because the EET hybrid model is scheduled for implementation in 2026, this manuscript is positioned as a design-and-evaluation framework rather than a completed outcomes study. The paper describes the design principles, course structures, student activities, assessment artifacts, delivery challenges, and planned evaluation strategy. Particular attention is given to how simulation can prepare learners for authentic technical decision-making while preserving evidence of hands-on or practice-oriented competence. The contribution is a replicable framework and assessment plan that can guide engineering technology programs seeking to modernize laboratory and applied learning experiences for non-traditional learners while remaining accountable to ABET ETAC outcome expectations.

Keywords: engineering technology education; adult learners; military-affiliated students; hybrid laboratories; simulation-based learning; ABET ETAC; experiential learning; workforce readiness

1. Introduction

Engineering technology programs occupy a distinctive space between traditional engineering education and applied technical preparation. Their value depends not only on conceptual understanding, but also on students' ability to use tools, interpret measurements, troubleshoot systems, communicate results, and operate within realistic technical constraints. These outcomes are especially important in electrical and nuclear engineering technology, where laboratory and simulation-based experiences provide the bridge between theory and professional practice [1], [2].

At the same time, engineering technology programs increasingly serve adult learners, working professionals, and military-affiliated students. These students often bring valuable technical experience, but they also face constraints related to employment, family responsibilities, duty schedules, geographic location, and time zone differences. Traditional laboratory models built around frequent fixed meeting times can create barriers for these learners. However, fully removing physical or practice-oriented laboratory experiences risks weakening the applied identity of engineering technology programs.

This paper responds to that tension by presenting a cross-case instructional framework for hybrid and simulation-based engineering technology education. The framework is illustrated through two course designs. The first is a hybrid EET model in which asynchronous online learning and guided Multisim-based circuit simulation are paired with bi-weekly onsite laboratory sessions focused on instrumentation, measurement, prototyping, teamwork, and troubleshooting. The second is a Nuclear Engineering Technology model in which an HTML-based pressurized water reactor (PWR) simulator supports fully online scenario-based laboratory experiences focused on operations, diagnostics, safety reasoning, and leadership communication.

The purpose of this manuscript is not to report completed learning gains from the EET hybrid model, which is scheduled for implementation in 2026. Instead, the paper presents a design-and-evaluation framework that specifies how the two models are structured, how they support adult learners, how they align with ABET ETAC student outcomes, and how effectiveness will be evaluated through direct and indirect evidence. This framing directly addresses the challenge of presenting an implementation design before complete outcome data are available.

The contribution of the paper is threefold. First, it identifies a common instructional framework that connects hybrid laboratory learning and fully online simulation-based learning across engineering technology contexts. Second, it operationalizes ABET ETAC-aligned outcomes through observable student artifacts, including simulation files, laboratory reports, scenario briefings, troubleshooting records, team products, and reflections. Third, it provides implementation guidance and a planned evaluation strategy for programs seeking to preserve applied rigor while expanding flexibility for non-traditional learners.

2. Theoretical Foundations

2.1 Adult Learning and Andragogy

Adult learning theory provides an appropriate foundation for engineering technology course design because adult learners often need self-direction, flexibility, relevance, and visible connections between coursework and professional advancement. Knowles and colleagues emphasize that adults bring prior experience to learning, prefer problem-centered activities, and are motivated when learning connects directly to life and work roles [3]. These principles are particularly relevant for working and military-affiliated engineering technology students, many of whom have operational or technical experience but need formal academic structures to connect practice with analysis.

In the framework presented here, adult learning principles shape both course models. Content is modular, preparation activities are asynchronous where possible, tasks are organized around authentic technical problems, and assessments require learners to connect simulations, data, decisions, and professional communication. The goal is not simply to make courses more convenient, but to make flexibility compatible with rigor.

2.2 Experiential Learning and Reflective Practice

Experiential learning theory frames learning as a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation [4]. Engineering technology laboratories naturally support this cycle when students predict system behavior, test those predictions, interpret discrepancies, and refine their reasoning. However, the cycle can be weakened when laboratory time is compressed or when students arrive unprepared. The hybrid EET model distributes the experiential cycle across online and onsite activities: simulation and prediction occur before the onsite lab, physical measurement and troubleshooting occur during the lab, and integrated reports require reflection afterward.

The nuclear simulation model similarly uses experiential principles by placing learners in realistic operational scenarios. Students make decisions, observe system responses, interpret trends and alarms, and communicate conclusions. Reflection is built into scenario reports, debriefs, and leadership-style briefings so that learners do not merely manipulate a simulator, but also analyze their reasoning and decision quality.

2.3 Collaborative, Situated, and Simulation-Based Learning

Collaborative learning theory emphasizes that learners develop understanding through interaction, shared tasks, and coordinated problem-solving [5]. Situated learning further suggests that professional knowledge is learned most meaningfully when learners participate in authentic practices that resemble the contexts where knowledge will be used [6]. These ideas support the design of team-based laboratory activities, shared technical artifacts, scenario briefings, and role-based problem-solving.

Simulation-based education is especially valuable when systems are complex, expensive, dangerous, or difficult to access. In engineering technology education, simulation can provide repeated practice, safe exploration of faults, visualization of hidden system dynamics, and preparation for physical or operational tasks [7], [8]. However, simulation alone does not automatically produce practical competence. It must be guided, assessed, and connected to authentic performance expectations. The framework therefore treats simulation as a bridge to practice rather than as a generic substitute for practice.

3. Related Work and Motivation

3.1 Hybrid and Online Laboratories

Research on engineering laboratories suggests that hands-on, simulated, and remote laboratories support different learning objectives. Reviews of laboratory modalities indicate that virtual and remote labs can support conceptual understanding and procedural learning, but practical skill development, experimental judgment, and exposure to real-world non-idealities require careful attention [7], [8]. This distinction is particularly important for engineering technology programs, where laboratory competence is closely tied to workforce readiness.

Hybrid laboratories can address this tension when online activities are not treated as replacements for physical practice, but as preparation for more efficient and meaningful hands-on work. In the EET case, Multisim-based activities require students to predict circuit behavior, explore parameter variation, and prepare measurement plans before arriving in the onsite lab. The onsite sessions then focus on instrumentation, wiring discipline, measurement technique, component variation, safety, and troubleshooting.

3.2 Simulation in High-Risk and Operational Domains

Simulation has long been used in domains such as aviation, medicine, and nuclear operations because it allows learners to practice rare, high-risk, or complex scenarios without exposing people or systems to unacceptable danger [9]. Nuclear engineering technology education is particularly well suited to simulation because many authentic plant behaviors cannot be reproduced safely or economically in a conventional classroom. A PWR simulator can expose students to operational trends, abnormal conditions, diagnostic reasoning, and team communication demands that mirror professional expectations.

3.3 Need for an Engineering Technology Framework

While project-based, simulation-based, and hybrid instructional models are well established, engineering technology programs need frameworks that explicitly preserve applied rigor for adult and military-affiliated learners. The present framework is intended to help programs move beyond the simple question of whether a lab is online, onsite, or hybrid. Instead, it asks what type of practice is being developed, what evidence students produce, how that evidence maps to ABET ETAC outcomes, and what delivery risks must be managed.

4. Cross-Case Instructional Framework

The framework is organized around five design principles that apply across both the hybrid EET and nuclear simulation cases. These principles are intended to make the models transferable to other engineering technology programs while allowing local adaptation to discipline, equipment, accreditation needs, and student population.

Table 1. Cross-case design principles for hybrid and simulation-based engineering technology learning

Design Principle	Meaning in the Framework	Example Evidence
Authentic technical task	Students engage in tasks that resemble professional practice rather than isolated academic exercises.	Circuit build and measurement records; PWR scenario decisions; technical briefings
Simulation as bridge to practice	Simulation prepares, extends, or safely substitutes for selected technical	Multisim predictions; PWR trend logs; parameter studies

	experiences while remaining connected to authentic performance expectations.	
Observable student artifacts	Learning is assessed through artifacts that make reasoning, collaboration, and performance visible.	Lab reports; scenario reports; troubleshooting logs; team debriefs
Adult-learner flexibility with structure	Courses provide asynchronous access and predictable schedules without weakening deadlines, expectations, or rigor.	Readiness quizzes; modular content; scheduled lab blocks; asynchronous simulator activities
ABET ETAC-aligned assessment	Activities are designed to produce evidence for student outcomes related to application, experimentation, tools, communication, teamwork, and professionalism.	Outcome rubrics; skills checks; report scoring; team evaluations

As shown in Table 1, the two cases differ in modality but share a common logic. Both models begin with structured preparation, move students into authentic technical activity, require production of evidence artifacts, and include reflection or debriefing. This shared structure is what makes the two examples part of a unified framework rather than two unrelated course descriptions.

5. Case Study 1: Hybrid Electrical Engineering Technology Model

5.1 Course Context and Goals

The hybrid EET model is designed for an Applied Electronics course in an engineering technology curriculum. The course focuses on analog circuit analysis and laboratory practice, including resistive networks, RC transients, operational amplifier circuits, filtering, frequency response, and sensor interfacing. Course goals include applying circuit theory, using simulation tools, operating laboratory instrumentation, analyzing differences between predicted and measured behavior, and documenting results in a professional format.

5.2 Online Simulation and Preparation

The online portion of the model uses asynchronous modules that include short readings or lectures, worked examples, guided Multisim activities, and readiness quizzes. Students construct or modify circuits in simulation, generate predicted values, explore parameter changes, and identify expected measurement points. Each simulation task includes prompts that require students to compare theoretical calculations with simulated results and to prepare hypotheses for possible discrepancies during physical measurement.

This structure is intended to improve the quality of onsite time. Rather than spending the first portion of the physical lab introducing concepts or debugging avoidable setup issues, students arrive with a schematic, predicted values, expected waveforms, and a preliminary measurement plan. The simulation artifacts become a bridge between conceptual understanding and bench practice.

5.3 Bi-Weekly Onsite Laboratory Sessions

Onsite laboratory sessions occur every other week in extended blocks to support working students who may not be able to attend campus weekly. During these sessions, students work in small teams at lab stations equipped with power supplies, oscilloscopes, multimeters, function generators, and prototyping boards. They build the circuits previously simulated online, collect measurements, observe non-ideal behavior, and diagnose discrepancies caused by tolerances, loading, wiring errors, noise, instrument setup, or component limitations.

The onsite portion preserves applied laboratory competencies that are difficult to develop through simulation alone. Students practice safe instrument setup, disciplined wiring, calibration, waveform capture, tolerance analysis, troubleshooting strategy, and team communication. The integrated lab report requires students to reconcile analytical predictions, simulation outputs, and measured results rather than treating each activity as separate.

5.4 EET Student Activities and Artifacts

Students produce three categories of artifacts in each module. Preparation artifacts include readiness quizzes, Multisim files, annotated screenshots, predicted values, and short reflections. Laboratory artifacts include measured data, instrument screenshots, observation checklists, troubleshooting notes, and team role documentation. Integration artifacts include formal lab reports with theory-to-simulation-to-measurement comparisons, error analysis, and conclusions about the most plausible causes of discrepancy.

6. Case Study 2: Nuclear Engineering Technology Simulation Model

6.1 Course Context and Goals

The Nuclear Engineering Technology model uses an HTML-based pressurized water reactor simulator to support fully online laboratory experiences. The courses focus on reactor fundamentals, plant operations, safety systems, abnormal conditions, diagnostic reasoning, and professional communication. Because many students in this population are military-affiliated or working in technical fields, the model emphasizes asynchronous access, realistic scenarios, and structured decision-making.

6.2 PWR Simulator and Scenario Structure

The simulator presents key plant variables such as reactor power, coolant temperature, pressure, control status, alarms, and safety system responses. Students interact with selected controls, initiate scenarios, observe trends, and interpret system behavior over simulated time. Scenarios may involve normal operations, transients, equipment failures, degraded conditions, or abnormal responses requiring diagnostic reasoning.

Each scenario includes a pre-lab brief, operational objectives, guided prompts, data collection requirements, and a post-scenario explanation. Students document observations, explain the relationship between control actions and system response, and communicate recommendations in written or recorded briefings. The simulator allows students to experience complexity and consequence in a low-risk environment.

6.3 Nuclear Technology Student Activities and Artifacts

Nuclear technology students produce scenario reports, trend interpretations, alarm response explanations, diagnostic notes, team briefings, and leadership-style recommendations. In capstone or advanced activities, teams may be assigned complex scenarios with interacting failures and must diagnose the situation, propose a plan of action, and justify decisions using simulator evidence. These artifacts support assessment of systems thinking, communication, safety reasoning, and professional judgment.

7. Comparison of the Two Course Designs

Table 2 summarizes the relationship between the two cases. The table is included not simply to list features, but to show how different modalities can serve a common instructional purpose. The EET model preserves physical laboratory practice through concentrated onsite sessions, while the nuclear model uses simulation to represent operational environments that cannot be safely or practically reproduced for students. Both models use simulation to make technical reasoning visible and to support adult learners through structured flexibility.

Table 2. Comparison of the two engineering technology course designs

Dimension	Hybrid EET Model	Nuclear Technology Simulation Model	Shared Instructional Purpose
Primary modality	Asynchronous online modules plus bi-weekly onsite laboratories	Fully online scenario-based simulator laboratories	Flexible access with structured technical expectations
Core tool	Multisim and physical bench instrumentation	HTML-based PWR simulator	Simulation-supported technical reasoning
Authentic practice	Circuit construction, measurement,	Plant operations, diagnostics,	Practice with realistic technical constraints

	troubleshooting, instrumentation	abnormal condition analysis	
Adult learner support	Predictable onsite blocks; online preparation; guided templates	Asynchronous simulator access; flexible scenario completion	Reduced schedule barriers while maintaining rigor
Assessment artifacts	Simulation files, readiness quizzes, lab reports, practical skills checks	Scenario reports, trend analyses, recorded or written briefings	Observable evidence of analysis, communication, and professional judgment
Primary risk	Missed onsite sessions; uneven preparation; tool access	Simulator realism; engagement in asynchronous work; limited physical equipment exposure	Need for scaffolding, clear rubrics, and triangulated evidence

The comparison in Table 2 also clarifies why the paper uses a cross-case framework. The models should not be judged by whether they use the same technology or meet in the same modality. Instead, they should be judged by whether they create authentic tasks, generate assessable evidence, support adult learners, and align with program outcomes.

8. ABET ETAC Outcome Alignment and Assessment Strategy

A major purpose of the framework is to ensure that flexible delivery remains accountable to engineering technology outcomes. The models are aligned with ABET ETAC student outcomes associated with applying knowledge, conducting experiments and interpreting results, using modern tools, communicating effectively, functioning on teams, and demonstrating professional responsibility [1]. Table 3 translates those broad outcomes into student evidence that can be collected in the two cases.

Table 3. ABET ETAC outcome alignment and evidence artifacts

ABET ETAC-Aligned Outcome Area	Hybrid EET Evidence	Nuclear Simulation Evidence	Assessment Method
Application of knowledge to broadly defined technical problems	Circuit calculations; simulation predictions; design decisions	Scenario diagnosis; parameter interpretation; systems reasoning	Rubric-scored problem analysis and explanation

Experimentation, data analysis, and interpretation	Measured data; instrument screenshots; discrepancy analysis	Simulator trend data; abnormal event analysis	Lab report or scenario report rubric
Use of modern tools	Multisim files; oscilloscope and instrumentation use	Browser-based PWR simulator; data plots	Tool-use checklist and artifact review
Communication	Integrated lab reports; graphical results; team debriefs	Written reports; recorded briefings; leadership recommendations	Communication rubric
Teamwork and leadership	Lab team roles; peer feedback; troubleshooting notes	Team scenario analysis; capstone briefings	Peer and instructor evaluation
Professional responsibility and safety	Safe lab practices; documentation discipline; ethical data reporting	Safety culture reasoning; operational decision justification	Observation checklist and reflection rubric

The assessment strategy uses both direct and indirect evidence. Direct evidence includes rubric-scored lab reports, simulator scenario reports, practical skills checks, troubleshooting records, readiness quizzes, and team deliverables. Indirect evidence includes student surveys, mid-course feedback, end-of-course evaluations, confidence ratings, and reflective prompts. For the EET pilot, where feasible, completion rates, lab scores, practical skills performance, and withdrawal patterns will be compared descriptively to prior traditional sections. These comparisons will be interpreted cautiously because they are contextual benchmarks rather than controlled causal evidence.

The planned evaluation will address four questions: (1) Do simulation-based preparation activities improve students' readiness for applied tasks? (2) Do students produce evidence of ABET ETAC-aligned outcomes at acceptable levels? (3) Do adult and military-affiliated learners perceive the models as flexible without being less rigorous? (4) What implementation barriers affect access, engagement, and consistency?

9. Delivery Challenges and Mitigation Strategies

Reviewers of early versions of this work emphasized the importance of discussing delivery challenges rather than presenting the models as frictionless. The framework therefore includes explicit attention to technology access, student readiness, attendance, faculty workload, simulation realism, and assessment consistency.

9.1 Technology Access and Readiness

Students may have uneven access to computing resources, software, bandwidth, or prior experience with simulation tools. Mitigation strategies include browser-based tools where possible, early technology readiness checks, software setup guides, short demonstration videos, template files, and low-stakes practice tasks before graded activities.

9.2 Engagement During Asynchronous Work

Asynchronous flexibility can create engagement gaps if students delay preparation or treat online work as optional. The framework addresses this through readiness quizzes, required simulation artifacts, checkpoints before onsite labs or scenario submissions, and explicit connections between preparation artifacts and later performance tasks.

9.3 Onsite Attendance and Lab Capacity

The hybrid EET model depends on attendance during extended onsite sessions. Working students may still face conflicts related to employment, family responsibilities, or travel. Mitigation strategies include predictable lab calendars, rotating cohorts when enrollment exceeds bench capacity, limited open-lab make-up opportunities, and alternative assignments only when they preserve the same core outcomes.

9.4 Faculty Workload and Consistency

Hybrid and simulation-based models can increase faculty workload if activities, rubrics, and feedback routines are not standardized. Mitigation strategies include shared templates, common rubrics, calibration among instructors, reusable simulation files, structured debrief prompts, and selective review of representative artifacts rather than exhaustive review of every data point.

9.5 Authenticity and Assessment Validity

Simulation realism can vary, and students may overgeneralize simulator behavior if limitations are not discussed. The framework requires students to identify assumptions, compare expected and observed behavior, and reflect on what simulation can and cannot represent. Assessment validity is strengthened by triangulating tool artifacts, reports, skills checks, team evaluations, and reflections.

10. Implementation Guidance for Instructors

10.1 Start with the Evidence, Not the Modality

Instructors adapting this framework should begin by identifying the evidence they need students to produce for course and program outcomes. Only after those outcomes are clear should they decide which activities belong online, onsite, or in simulation. This prevents hybrid design from becoming a scheduling decision disconnected from learning goals.

10.2 Use Templates and Repeated Routines

Adult learners benefit from clear expectations and predictable routines. The framework recommends templates for simulation submissions, lab reports, scenario reports, troubleshooting logs, and reflections. Repeated routines allow students to improve over time rather than learning a new submission format for every activity.

10.3 Scaffold Technical Tools

Simulation and laboratory tools should be introduced progressively. Early activities should emphasize basic navigation, measurement setup, and interpretation. Later activities can introduce ambiguity, faults, and open-ended decision-making. This staged approach reduces cognitive overload while still moving students toward authentic practice.

10.4 Make Reflection Actionable

Reflection should not be a generic paragraph added after the real work. Reflection prompts should ask students to identify discrepancies, justify decisions, explain what evidence changed their thinking, and describe what they would do differently in a professional setting. These prompts help connect experience to conceptual understanding and professional judgment.

11. Discussion

The two cases demonstrate that flexibility and rigor do not have to be opposing goals in engineering technology education. The hybrid EET model uses simulation to prepare students for concentrated hands-on practice, while the nuclear technology model uses simulation to create authentic operational scenarios that would otherwise be inaccessible. In both cases, the key design move is to connect simulation, practice, evidence, and reflection into a coherent learning cycle.

The framework also clarifies how ABET ETAC-aligned outcomes can be supported in non-traditional formats. Rather than assuming that an onsite lab automatically produces rigor or that an online simulator automatically produces flexibility, the framework asks whether students are producing valid evidence of applied knowledge, tool use, experimentation or diagnostic reasoning, communication, teamwork, and professional responsibility.

The lack of completed EET pilot data is a limitation, but it is also the reason the paper emphasizes a prospective evaluation plan. The strongest immediate contribution is the explicit design structure and assessment strategy. After the 2026 implementation, future work can report measured outcomes, compare sections more formally, and refine the framework based on student performance and feedback.

12. Conclusion and Future Work

This paper presented a cross-case framework for bridging theory and practice in engineering technology education for adult, working, and military-affiliated learners. The framework was illustrated through a hybrid EET model combining online circuit simulation with bi-weekly onsite laboratories and a fully online Nuclear Engineering Technology model using a PWR simulator for scenario-based learning. Both models are grounded in adult learning, experiential learning, collaborative learning, and simulation-based education.

The revised framework directly addresses common concerns about hybrid and simulation-based technical education by specifying ABET ETAC outcome alignment, observable student artifacts, delivery challenges, and a planned evaluation strategy. Future work will implement the EET pilot, collect direct and indirect evidence, compare outcomes to historical traditional sections where feasible, and refine the framework for broader use across engineering technology curricula.

Appendix A. Outcome Measures and Instruments

Table A1 provides a detailed evaluation plan for the framework. The table is intentionally placed in the appendix so that the main manuscript remains readable while still providing reviewers and future adopters with a concrete assessment structure.

Table A1. Outcome measures and instruments for the hybrid and simulation-based engineering technology framework

Outcome Domain	What is Measured	Instrument or Indicator	Evidence Source	Collection Frequency	Notes on Interpretation
Preparation and readiness	Whether students complete prerequisite conceptual and simulation work before applied tasks	Readiness quiz score; simulation submission; pre-lab reflection	LMS, Multisim files, simulator logs	Each module or scenario	Used to identify whether online work supports later performance
Technical analysis	Whether students apply theory to predict and explain system behavior	Calculation accuracy; prediction quality; diagnostic explanation	Lab reports, scenario reports	Each major assignment	Quality of reasoning matters more than answer accuracy alone
Experimentation and interpretation	Whether students collect, interpret, and explain data appropriately	Measurement accuracy; discrepancy analysis; trend interpretation	Instrument data, screenshots, simulator data	Each lab or scenario	Includes physical measurement in EET and operational data interpretation

					in nuclear courses
Modern tool use	Whether students use simulation and technical tools competently	Simulation file quality; tool-use checklist; instrumentation setup	Multisim, bench checklist, PWR simulator	Each module; selected skills checks	Tool use is assessed as a means of analysis, not as button-clicking
Troubleshooting and diagnostic reasoning	Whether students identify likely causes of unexpected behavior	Fault isolation task; troubleshooting notes; scenario diagnosis	Lab notebooks, reports, simulator responses	Per unit or selected milestones	Emphasis is on evidence-based reasoning and plausible alternatives
Communication	Whether students communicate technical findings clearly and professionally	Report rubric; briefing rubric; graphical presentation quality	Written reports, recorded briefings, plots	Per assignment and end of course	Assesses clarity, evidence use, organization, and audience awareness
Teamwork and leadership	Whether students contribute to coordinated technical work	Peer evaluation; role documentation; team debrief quality	Peer surveys, instructor notes, team artifacts	Midterm and end of course	Interpreted in relation to role expectations and team context
Professional responsibility and safety	Whether students demonstrate safe, ethical, and responsible practice	Safety checklist; data integrity expectations; safety reasoning prompts	Onsite observations, reflections, scenario reports	Each onsite lab or relevant scenario	Includes physical safety in EET and safety culture reasoning in nuclear technology
Adult learner access and persistence	Whether the model supports flexibility without reducing rigor	Attendance, completion rates, withdrawal patterns, workload survey	Institutional data, LMS, student surveys	Midterm and end of course	Compared descriptively to prior sections where feasible

Student perception and confidence	Whether learners perceive the model as useful, flexible, and rigorous	Confidence ratings; open-ended survey items; reflection prompts	Mid-course and end-of-course surveys	Midterm and end of course	Used for improvement, not as sole evidence of effectiveness

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