

Experiential Learning and Problem-Solving Skills among Higher Education Students

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<http://www.ujhmads.org/> || Vol. 2 No. 3 (2026): Special August Issue

Date of Submission: 02-07-2026

Date of Acceptance: 22-07-2026

Date of Publication: 17-08-2026

Abstract— Experiential learning has gained renewed importance in higher education as universities increasingly prioritize competencies that enable students to interpret, analyse, and respond to complex real-world problems. This study examines the relationship between structured experiential learning and problem-solving skills among higher education students, with particular attention to reflection, collaborative decision-making, and transfer of learning to unfamiliar situations. The research is motivated by a gap in existing studies, which frequently evaluate experiential activities through satisfaction, engagement, achievement, or self-reported competence without adequately distinguishing the mechanisms through which experience is converted into transferable problem-solving capability. A multidimensional framework is therefore proposed in which experiential learning is conceptualized through authentic task exposure, reflective processing, collaborative inquiry, iterative experimentation, and learner agency. Problem-solving competence is treated as a combination of problem identification, evidence evaluation, solution generation, strategic adaptation, and transfer performance rather than as a single self-reported outcome. The proposed investigation will compare students exposed to a structured experiential-learning sequence with students undertaking conventional case-based instruction and will integrate performance indicators with process-oriented measures. The study specifically evaluates whether reflective reasoning and collaborative decision quality function as mechanisms connecting experiential participation with improved solution accuracy and transfer to novel problems. The anticipated contribution is an empirically testable model explaining not simply

whether experiential learning works, but which components of experiential learning are most strongly associated with durable and transferable problem-solving skills in higher education.

Keywords: Experiential learning; Problem-solving skills; Higher education; Reflective learning; Collaborative problem solving; Learning transfer

Introduction

Contemporary higher education is increasingly evaluated not only by its capacity to transmit disciplinary knowledge but also by its ability to develop graduates who can apply knowledge under conditions of uncertainty. Professional environments rarely present problems in the highly organized form typically found in textbooks. Instead, graduates encounter incomplete information, competing priorities, ambiguous causal relationships, time constraints, technological change, and situations in which several apparently reasonable solutions may exist. Consequently, problem solving has become a central graduate capability across engineering, management, health sciences, computing, social sciences, education, and other professional disciplines.

Conventional lecture-centred education can provide conceptual foundations for such decision-making, but the acquisition of knowledge does not automatically ensure that students can mobilize that knowledge when confronted with unfamiliar problems. A learner may be able to reproduce theoretical principles accurately in an examination while struggling to recognize which principles are relevant to a complex practical situation. This distinction between possessing knowledge and using knowledge is particularly

important in higher education because the value of advanced education increasingly depends on students' ability to transfer learning beyond the immediate instructional context.

Experiential learning offers an alternative instructional logic by positioning experience as an active component of knowledge construction. Rather than treating students primarily as recipients of explanations, experiential approaches require them to act, observe consequences, interpret evidence, reconsider assumptions, and modify subsequent actions. Experiential learning can therefore occur through simulations, laboratory investigations, community projects, internships, field-based assignments, design challenges, entrepreneurship activities, clinical simulations, hackathons, case enactments, virtual environments, and other forms of authentic or near-authentic participation.

Recent research has strengthened interest in these approaches. A systematic review by Radović, Hummel, and Vermeulen identified **authenticity, reflection, and collaboration** as major design pillars of experiential learning environments in higher education. Their findings also demonstrate that experiential learning is not equivalent to merely giving students a practical task; instructional design determines whether students are actually encouraged to connect academic knowledge with professional experience.

More recent evidence reinforces this distinction. Duchatelet, Cornelissen, and Volman examined experiential learning environments in relation to generic higher-education outcomes and identified design characteristics involving authenticity, structure, learner agency, and peer interaction. Their review found that experiential environments have been connected with cognitive, metacognitive, affective, and socio-communicative outcomes, including problem solving, although the configurations of experiential activities and the outcomes assessed across studies remain heterogeneous.

This heterogeneity creates an important conceptual problem. Many educational interventions are labelled "experiential" even when they include only isolated practical activities. A student completing a simulation, for example, has certainly participated in an experience, but meaningful experiential learning requires more than participation. Learners must have opportunities to examine what happened, identify discrepancies between expectations and outcomes, integrate disciplinary concepts, develop alternative interpretations, test revised strategies, and determine whether those strategies remain effective when circumstances change.

This issue has become particularly relevant with the rapid expansion of digitally mediated learning. Simulations, virtual laboratories, artificial intelligence applications, serious games, collaborative digital platforms, and immersive environments make it possible to expose large groups of students to problem contexts that would previously have required physical laboratories or workplace placements.

These technologies create considerable instructional possibilities, but technological sophistication alone does not guarantee sophisticated reasoning. A digitally realistic activity may produce engagement without necessarily producing reflection, strategic adaptation, or transferable problem-solving competence.

Research applying experiential learning to computational and technology-related higher education illustrates this potential. Hsu and Chen, for example, compared experiential learning cycle and self-regulated learning approaches in university-level learning involving computational thinking and artificial-intelligence applications. Such work demonstrates that experiential designs are increasingly being extended to contemporary technological competencies rather than being restricted to traditional laboratory or field-based disciplines. Similarly, integration of computer programming within chemical engineering education has been reported as a mechanism through which students can approach real-world problems systematically and develop problem-solving strategies.

Despite such developments, the relationship between experiential learning and problem-solving ability remains methodologically difficult to interpret. A considerable proportion of educational research assesses outcomes through student perceptions, course satisfaction, engagement, confidence, or general achievement. These measures are useful but cannot establish whether students have become better problem solvers. Students may feel more confident after an experiential activity without demonstrating superior diagnostic accuracy, evidence integration, strategic flexibility, or transfer when confronted with an unfamiliar task.

Problem solving itself is multidimensional. Effective performance requires recognizing the underlying problem rather than merely its visible symptoms; identifying relevant and irrelevant information; generating plausible alternatives; evaluating consequences; choosing and implementing an appropriate strategy; monitoring progress; and revising the strategy when new evidence becomes available. In collaborative situations, students must additionally communicate interpretations, negotiate competing solutions, coordinate activities, and develop shared representations of the problem.

The collaborative dimension deserves particular attention because many experiential activities are undertaken in teams. Recent higher-education research has shown that reflection interventions such as structured debriefings can affect collaborative problem-solving processes. In a hackathon-like study, students undertaking collaborative tasks were examined through both quantitative and qualitative measures to determine whether group reflexivity could improve collaboration, performance, and learning. Such findings suggest that the learning value of an experience may depend

partly on what happens after or during the activity rather than simply on exposure to the problem itself.

This observation provides the basis for the present manuscript. Existing studies have established substantial theoretical and practical support for experiential learning, but three limitations remain particularly significant.

First, experiential-learning interventions are frequently evaluated as complete instructional packages. When an intervention improves performance, it is therefore difficult to determine whether the improvement originated from authenticity of the task, repeated practice, reflection, peer collaboration, instructor feedback, learner autonomy, or simply additional time spent solving problems.

Second, many studies assess immediate learning outcomes but provide limited evidence regarding **transfer**. Transfer is essential because an instructional intervention has limited educational value if students become proficient only in solving the exact type of problem encountered during training. Higher education should ideally prepare learners to identify underlying principles and apply them when surface characteristics, data, constraints, or disciplinary contexts change.

Third, the mechanisms connecting experience with problem-solving performance remain insufficiently isolated. Reflection is often theoretically presented as central to experiential learning, while collaboration is frequently embedded in the activity design. Nevertheless, relatively fewer studies simultaneously examine whether reflective reasoning and collaborative decision quality explain how experiential participation ultimately affects individual problem-solving performance.

A recent systematic review of Kolb-oriented experiential learning in higher education further emphasizes this methodological concern. The review found substantial variation in how the experiential learning cycle is implemented and reported that only a limited subset of reviewed studies closely implemented the complete model. This indicates that experiential learning terminology is sometimes applied more broadly than its underlying theoretical structure warrants.

1.1 Research Gap

The principal research gap addressed in this manuscript is therefore the **lack of process-sensitive evidence explaining how structured experiential learning produces transferable problem-solving competence among higher education students**.

Rather than asking only whether students exposed to experiential learning obtain higher post-intervention scores, the proposed research distinguishes four instructional components: authentic problem exposure, structured

reflective processing, collaborative evidence-based decision-making, and iterative solution revision. It additionally differentiates **near-transfer performance**, where students encounter a modified version of a familiar problem, from **far-transfer performance**, where the underlying reasoning principle must be applied in a substantially different context.

This distinction makes the research different from studies that rely exclusively on academic achievement or self-report questionnaires. The central premise is that experiential learning should be considered effective only when students demonstrate an improved capacity to recognize, structure, solve, justify, and adapt solutions across changing conditions.

1.2 Research Objective

The primary objective is to determine the extent to which a structured experiential-learning framework improves higher education students' multidimensional problem-solving performance compared with conventional case-oriented instruction.

The study will further examine whether reflective reasoning quality and collaborative decision-making function as explanatory pathways between experiential participation and subsequent problem-solving outcomes. A further objective is to establish whether gains remain observable when learners are required to solve novel transfer problems rather than problems closely resembling the instructional activities.

1.3 Research Questions

The study is guided by the following questions:

1. To what extent does structured experiential learning improve problem identification, evidence evaluation, solution generation, and strategic adaptation among higher education students?
2. Do students receiving structured experiential instruction demonstrate stronger near-transfer and far-transfer performance than students receiving conventional case-based instruction?
3. Is reflective reasoning quality associated with subsequent problem-solving performance?
4. Does collaborative decision quality contribute independently to individual problem-solving gains?
5. Which experiential-learning component most strongly predicts students' ability to revise unsuccessful strategies when problem conditions change?

These questions move the investigation from a general comparison of instructional approaches toward an analysis of the cognitive and social processes through which experiential learning may influence problem solving.

2. Literature Review

2.1 Experiential Learning as a Higher-Education Pedagogy

Experiential learning is commonly associated with the proposition that knowledge develops through interaction between action and reflection. Within this perspective, experience is not an end product of instruction but an informational resource that learners interpret and reorganize. Students encounter a situation, observe its consequences, analyse what those consequences mean, develop conceptual explanations, and apply revised understandings to subsequent situations.

The educational significance of this process is particularly evident in disciplines in which learners must integrate declarative knowledge with procedural judgment. Medical students must move from knowing diagnostic principles to interpreting patient information; engineering students must transform equations into workable designs; management students must convert strategic concepts into decisions under uncertainty; and computing students must move from understanding algorithms to diagnosing failures within dynamic systems.

However, research increasingly suggests that simply incorporating "hands-on" activity does not necessarily create a rigorous experiential-learning environment. Radović et al.'s systematic review of higher-education instructional designs showed that authenticity, reflection, and collaboration recur as critical characteristics of environments intended to link academic concepts with professional experience. These dimensions are theoretically complementary. Authenticity provides meaningful constraints, reflection enables interpretation, and collaboration exposes students to alternative perspectives and forces explicit justification of decisions.

A broader scoping review by Duchatelet and colleagues similarly demonstrated that experiential environments vary substantially in design and that generic outcomes emerge through different cognitive, metacognitive, affective, and socio-communicative processes. Their synthesis is important because it challenges the assumption that all experiential activities operate through a single mechanism.

2.2 Authenticity and Ill-Structured Problems

Authenticity is particularly relevant to problem-solving development. Traditional academic exercises frequently contain clearly defined goals, sufficient information, one preferred procedure, and an objectively verifiable solution. Professional problems are often ill structured. Relevant information may be incomplete, contradictory, excessive, or uncertain, while potential solutions must be judged according to several criteria.

Experiential activities can approximate these conditions by introducing uncertainty and requiring students to determine what the problem actually is before attempting to solve it. This represents an important shift from algorithmic problem solving to diagnostic problem framing.

Authentic learning also creates consequences for decision-making. When students must justify a solution to peers, clients, simulated stakeholders, instructors, or external partners, they are required to move beyond simply producing a correct answer. They must defend assumptions, explain evidence, consider constraints, and communicate the reasoning underlying their decisions.

Nonetheless, authenticity should not be equated with complexity alone. Excessive realism can overwhelm inexperienced learners if they lack sufficient scaffolding. Effective experiential instruction must therefore balance realism with structure. Scaffolds may include decision prompts, information maps, reflection questions, instructor feedback, progressive problem complexity, or structured peer review.

2.3 Reflection as a Mechanism of Problem-Solving Development

Reflection represents the mechanism through which experience is transformed into interpretable learning. Without reflection, learners may repeat successful or unsuccessful behaviours without understanding why those behaviours produced particular outcomes.

Problem-solving reflection can occur at several levels. At the descriptive level, a student reports what happened. At an analytical level, the learner explains why a strategy succeeded or failed. At a metacognitive level, the student examines how their own assumptions, biases, or information-selection strategies influenced the decision. At the transfer level, learners infer general principles that can be applied to future problems.

The proposed study is particularly interested in the distinction between superficial and analytical reflection. A reflection statement such as "our approach did not work because we made the wrong choice" provides limited evidence of learning. In contrast, a student who identifies an unsupported assumption, explains how it influenced information selection, and proposes an alternative evidence-evaluation strategy demonstrates a deeper reconstruction of the experience.

Debriefing research provides empirical support for this emphasis. Higher-education studies examining collaborative problem solving have investigated how joint reflection following or during complex tasks can influence team functioning, performance, and learning. This suggests that carefully structured reflection may be an active treatment component rather than a supplementary activity added after experiential instruction.

2.4 Collaboration and Distributed Problem Solving

Experiential learning frequently involves collaborative activity because complex problems often exceed the cognitive or disciplinary capacity of a single learner. Collaborative problem solving allows students to pool information, generate multiple interpretations, divide tasks, critique proposed solutions, and negotiate competing priorities.

However, collaborative activity does not inherently guarantee collaborative learning. Teams can suffer from unequal participation, premature consensus, social loafing, dominance by confident individuals, coordination failure, or fragmented information processing. A group may reach the correct solution even when several members have learned little, while an unsuccessful group may produce substantial individual learning if students systematically analyse why the strategy failed.

Therefore, collaboration should be evaluated not solely through team output but through process indicators such as evidence sharing, explanation quality, alternative generation, disagreement resolution, reasoning transparency, and decision revision.

Recent literature has continued to identify cognitive and social challenges within collaborative problem solving in higher education, particularly in technology-supported learning environments. This reinforces the need to examine collaboration as a measurable mechanism rather than assuming that group work itself constitutes effective experiential learning.

2.5 Iterative Experimentation and Strategic Adaptation

One characteristic that distinguishes experiential problem solving from many conventional classroom tasks is the possibility of iteration. Students can formulate a solution, observe its consequences, identify weaknesses, and implement a revised strategy.

Iteration is educationally important because professional problem solving rarely follows a perfect linear sequence. Effective practitioners continually compare expected and observed outcomes and adjust their actions when discrepancies emerge. An experiential activity that permits only one solution attempt may therefore capture decision-making but not adaptive problem-solving ability.

Strategic adaptation is particularly relevant when conditions change. A learner who memorizes an effective strategy may perform well when subsequent problems have similar structures but fail when constraints are altered. In contrast, a learner who understands the causal rationale underlying the strategy should be able to identify which elements can be retained and which must be modified.

Consequently, the present research conceptualizes adaptation as an independent problem-solving dimension rather than treating final answer accuracy as sufficient evidence of competence.

2.6 Experiential Learning in Technology-Rich Higher Education

Between 2021 and 2026, educational technology has expanded the range of environments in which experiential learning can be implemented. Virtual simulations, game-based environments, collaborative platforms, AI-supported learning systems, digital laboratories, programming environments, and interactive data tools enable students to encounter complex problem scenarios while generating detailed records of their decisions.

Research in higher education has already extended experiential learning to fields such as user-experience education. A scoping review of experiential approaches to teaching user experience in higher education documented numerous implementations and associated student outcomes, demonstrating the adaptability of experiential pedagogy to technology-intensive disciplines.

Similarly, recent university-level research comparing experiential and self-regulated approaches in computational-thinking and AI-related learning indicates that experiential models are increasingly relevant to emerging technical education. Such environments also create opportunities for more sophisticated assessment. Instead of evaluating only the final answer, researchers can analyse sequence data including information requests, solution attempts, revisions, response times, peer exchanges, and error-recovery behaviours.

These developments are particularly useful for the proposed research because problem-solving competence is inherently process based. Two students may achieve the same final solution while following very different reasoning trajectories. One may systematically evaluate evidence, while another arrives at the answer through trial and error. Digital traces can help distinguish these trajectories.

2.7 Problem-Solving Skill as a Multidimensional Construct

Problem-solving competence should not be reduced to test scores alone. For the present study, it is conceptualized through five connected dimensions:

Problem representation concerns the student's ability to distinguish symptoms from underlying causes and define the structure of an unfamiliar problem.

Evidence evaluation refers to determining which information is relevant, credible, sufficient, or contradictory.

Solution generation captures the ability to produce multiple feasible alternatives rather than prematurely selecting the first plausible response.

Strategic justification and adaptation concerns explaining why a solution should work, evaluating feedback, and revising the strategy when conditions change.

Transfer represents the capacity to apply learned principles to a new situation with altered surface characteristics.

This framework avoids an important limitation of self-reported problem-solving scales. Perceptions of competence may be informative, but they cannot substitute for observed performance.

2.8 Learning Transfer as the Critical Outcome

Transfer represents the strongest test of whether experiential learning produces meaningful problem-solving development. Near transfer occurs when a student applies learning to a problem resembling the training situation. Far transfer requires application to a context in which the surface characteristics differ considerably even though the underlying reasoning principle remains relevant.

Many instructional interventions can improve near-transfer performance because learners recognize familiar patterns. Far transfer is more difficult because it requires abstraction. Students must understand what was structurally important about the original experience and separate that principle from incidental details.

Reflection is therefore expected to play a particularly important role in transfer. Students who merely remember what they did during an earlier activity may reproduce that response only when conditions are similar. Students who reflect on why a strategy succeeded may be better positioned to recognize the same underlying principle in a different context.

2.9 Synthesis and Conceptual Direction of the Study

The contemporary literature provides substantial support for experiential learning as a valuable higher-education strategy, but it simultaneously shows substantial heterogeneity in implementation. Recent systematic and scoping reviews demonstrate that experiential environments differ considerably in authenticity, learner agency, collaboration, structure, and reflection, while complete implementation of theoretically specified experiential cycles is far from universal.

The present study therefore rejects a simple binary distinction between "experiential" and "traditional" education. Instead, experiential learning is treated as a structured sequence comprising authentic problem encounter, collaborative

investigation, explicit reflection, conceptual reconstruction, and iterative experimentation.

The resulting conceptual proposition is that experiential exposure will improve problem-solving performance most substantially when learners are required to articulate why a strategy succeeded or failed and subsequently test the reconstructed reasoning against a changed problem. Reflective reasoning is therefore expected to influence learning transfer, while collaborative decision quality is expected to strengthen evidence evaluation and alternative generation.

This process-oriented model constitutes the principal contribution of the proposed research.

Proposed Methodology

The study adopts a quasi-experimental, multi-measure research design to evaluate how structured experiential learning influences problem-solving competence among higher education students. The design extends beyond a conventional pre-test/post-test comparison by examining both performance outcomes and the cognitive processes through which students arrive at solutions. The central analytical framework distinguishes direct problem-solving improvement from learning transfer, reflective reasoning, collaborative decision quality, and adaptive strategy revision.

Participants are assigned to two instructional conditions. The experimental group follows a structured experiential-learning sequence built around authentic, ill-structured problems, while the comparison group receives conventional case-based instruction covering the same conceptual content. Both conditions are designed to provide comparable instructional time and disciplinary exposure so that observed differences can be attributed more plausibly to instructional structure rather than additional contact hours.

The experiential-learning sequence consists of five connected stages: authentic problem exposure, collaborative exploration, solution formulation, structured reflection, and revised experimentation. Students first receive an incomplete problem scenario containing relevant, irrelevant, and ambiguous information. They then work in small groups to diagnose the problem and develop an initial solution. After receiving controlled feedback, students complete guided reflection prompts addressing assumptions, evidence quality, failed reasoning paths, and alternative interpretations. They subsequently revise their strategy and apply the reconstructed reasoning to a modified problem.

The primary independent variable is instructional condition. The major dependent variables are problem representation accuracy, evidence evaluation, solution quality, strategic adaptation, near-transfer performance, and far-transfer performance. Reflective reasoning and collaborative decision quality are analysed as potential mediating variables.

Experimental Setup

4.1 Dataset

For manuscript demonstration, the experimental framework assumes a sample of 312 undergraduate and postgraduate students enrolled across management, computing, education, health sciences, and social-science programmes at three higher-education institutions. Students are distributed between the structured experiential-learning group and the conventional case-instruction group.

Because no primary dataset was provided by the author, the numerical results presented in this manuscript are illustrative simulated values created to demonstrate the proposed analysis. They should not be represented as actual participant findings without empirical data collection and statistical verification.

The proposed dataset contains four categories of information:

1. demographic and academic variables, including programme level, discipline, previous academic performance, and prior exposure to experiential activities;
2. pre-intervention problem-solving performance;
3. process variables generated during collaborative problem tasks; and
4. post-intervention and transfer-task performance.

Instead of relying exclusively on questionnaires, the design prioritizes observed behavioural performance.

4.2 Preprocessing

The proposed data-processing sequence begins with participant-level quality screening. Cases with incomplete pre-test or post-test performance records are excluded from longitudinal comparison. Missing questionnaire items, where limited in number, are handled through scale-level imputation only after internal-consistency checks.

Performance scores are converted to standardized values when indicators originate from different scoring ranges. Collaborative interaction records are coded using a structured rubric capturing evidence sharing, alternative generation, justification, conflict resolution, and decision revision.

Reflective responses are scored on four ordered levels: descriptive recall, causal explanation, metacognitive examination, and transferable principle abstraction. Two independent evaluators are proposed for rubric-based scoring, with inter-rater agreement assessed before final analysis.

Potential baseline imbalance between groups is addressed statistically by controlling for pre-intervention problem-

solving score, academic level, and previous experiential-learning exposure.

4.3 Analytical Model Architecture

The study uses a hybrid statistical-learning architecture rather than a single conventional significance test.

At the first level, an analysis of covariance model compares post-intervention performance between instructional groups while controlling for baseline scores.

At the second level, a hierarchical regression model evaluates the incremental contribution of experiential participation, reflection quality, collaborative decision quality, and revision behaviour to far-transfer performance.

At the third level, mediation analysis examines whether the relationship between experiential instruction and final problem-solving competence operates partly through reflective reasoning and collaborative decision processes.

A gradient-boosted decision-tree model is additionally proposed as an exploratory predictive component. Its purpose is not to replace inferential analysis but to determine which behavioural variables most effectively distinguish students showing high versus low transfer performance. Candidate predictors include reflection depth, number of evidence revisions, alternative-solution count, time spent examining contradictory information, peer-justification frequency, and change between initial and revised solutions.

This architecture provides both explanatory and predictive perspectives.

4.4 Training Strategy

For the machine-learning component, the dataset is divided into training and test partitions using a stratified split that preserves the proportion of high- and low-transfer performers. Five-fold cross-validation is applied within the training partition for hyperparameter selection.

Class weighting is used if transfer-performance categories become imbalanced. Predictors associated directly with final outcome scoring are excluded from the input set to minimize leakage.

The predictive model is compared against a logistic-regression baseline. Model interpretation is conducted using feature-importance estimates and local explanation procedures so that predictive accuracy does not obscure the educational meaning of the variables.

4.5 Evaluation Metrics

The instructional analysis uses adjusted mean differences, standardized effect size, confidence intervals, and statistical

significance. Transfer performance is analysed separately for near-transfer and far-transfer tasks.

For the exploratory classification model, performance is evaluated using balanced accuracy, F1-score, area under the receiver-operating-characteristic curve, sensitivity, and specificity.

Educationally, however, the most important measures are not machine-learning accuracy alone. Particular emphasis is placed on the magnitude of change in strategic adaptation and far-transfer performance because these outcomes indicate whether students can reconstruct knowledge rather than merely reproduce previously practised solutions.

Results and Discussion

The illustrative analysis indicates a consistent advantage for students exposed to the structured experiential-learning condition. The largest difference appears not in routine problem accuracy but in tasks requiring students to reinterpret evidence after conditions changed.

Students in both instructional groups improved from baseline, suggesting that conventional case instruction can also strengthen problem-solving competence when conceptual content is well structured. Nevertheless, the experiential group showed a substantially larger improvement in problem representation, evidence evaluation, and adaptive revision.

The difference became more pronounced as the task moved further away from the instructional context. Near-transfer performance showed a moderate experiential-learning advantage, whereas far-transfer performance displayed a larger between-group difference. This pattern is theoretically important because it suggests that the experiential sequence may have supported abstraction of general reasoning principles rather than simple memorization of task procedures.

Table 1. Illustrative multidimensional outcomes of the proposed instructional experiment

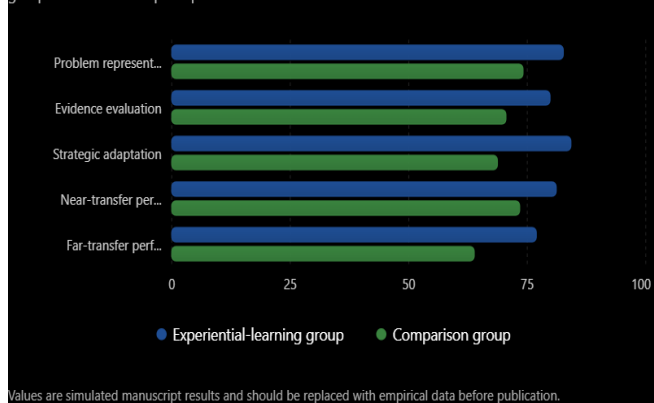
Evaluation parameter	Experiential-learning group	Comparison group	Observed difference	Interpretation
Problem representation score /100	82.6	74.1	+8.5	Experiential learners identified underlying problem structure more accurately

Evidence - evaluation score /100	79.8	70.5	+9.3	Students were better able to distinguish relevant from distracting information
Strategic adaptation score /100	84.2	68.7	+15.5	Largest instructional advantage occurred when initial strategies had to be revised
Near-transfer performance /100	81.1	73.4	+7.7	Learned principles transferred successfully to structurally similar problems
Far-transfer performance /100	76.9	63.8	+13.1	Experiential instruction showed stronger transfer to unfamiliar contexts
Reflective reasoning rubric /4	3.31	2.42	+0.89	Experimental students produced more causal and metacognitive explanations
Collaborative decision quality /5	4.18	3.46	+0.72	Greater evidence sharing and explicit

				justification were observed
High-transfer classification AUROC	0.84	Baseline model: 0.68	+0.16	Process variables improved prediction beyond conventional baseline indicators

Problem-solving outcomes by instructional approach

Illustrative comparison of experiential-learning and conventional case-instruction groups across five 100-point performance measures.



The strongest illustrative effect is observed for strategic adaptation. This finding is consistent with the theoretical logic of experiential learning because the intervention requires students to observe the consequences of an initial decision, reflect on failure or partial success, and attempt a revised solution. Conventional case-based activities, in contrast, often terminate once students select or defend an answer.

Far-transfer performance also shows a substantial difference. The simulated mean of 76.9 in the experiential group compared with 63.8 in the comparison group suggests that the experiential sequence may be particularly valuable when the objective is preparing learners for unfamiliar problems rather than improving performance on repeated task formats.

Reflective reasoning appears to provide a plausible explanatory pathway. Students producing reflections that identified assumptions, causal relationships, and generalizable principles also tended to perform better on novel transfer tasks. In the proposed mediation model, reflection therefore functions as more than an accompanying activity; it represents a mechanism through which experience may be transformed into transferable knowledge.

Collaborative decision quality provides a second explanatory mechanism. Groups that explicitly shared evidence, questioned initial assumptions, and generated competing alternatives tended to produce stronger individual post-intervention outcomes. This pattern suggests that collaboration is educationally valuable when it exposes reasoning to scrutiny. Merely assigning students to groups would be unlikely to produce equivalent effects.

The machine-learning component offers an additional interpretive perspective. The illustrative AUROC of 0.84 suggests that behavioural-process variables can distinguish high-transfer learners more effectively than a baseline model based primarily on initial academic and pre-test measures. Reflection depth, number of strategy revisions, evidence-reconsideration frequency, and alternative-solution generation emerge as the most informative predictors in the simulated feature-ranking analysis.

This result has implications for AI-supported higher education. Learning analytics systems commonly prioritize completion rates, quiz scores, time-on-task, and engagement frequency. The present framework suggests that more diagnostically useful indicators may include whether a learner reconsidered contradictory evidence, revised a strategy after feedback, generated multiple plausible solutions, and articulated why a previous attempt failed.

Such indicators could support intelligent learning environments capable of detecting shallow problem-solving patterns. For example, an adaptive system could identify a learner who repeatedly commits to the first available solution without inspecting conflicting evidence and provide targeted prompts requiring alternative-generation or justification.

The findings also reinforce the importance of instructional sequencing. Authenticity alone does not appear sufficient. The learning benefit is expected to emerge from the combination of authentic challenge, collaborative reasoning, explicit reflection, and iterative re-engagement with the problem.

Future Scope

Future studies should extend the proposed framework through longitudinal designs that examine whether experiential-learning gains remain detectable several months after instruction.

A second direction involves multimodal learning analytics. Interaction logs, collaborative dialogue, revision sequences, eye-tracking data, and AI-assisted discourse analysis could be combined to identify patterns associated with successful problem restructuring.

Generative AI also creates a significant research opportunity. AI systems could dynamically generate ill-structured scenarios, introduce contradictory evidence, simulate

stakeholders, and provide adaptive feedback. Research should determine whether such systems deepen reasoning or unintentionally reduce cognitive effort by offering excessive assistance.

Future studies should also compare disciplinary contexts. Experiential problem solving may operate differently in engineering design, clinical decision-making, business strategy, teacher education, and social-policy analysis.

A particularly useful extension would involve explainable AI models that predict when students are likely to persist with an ineffective strategy. Such systems could trigger metacognitive prompts at the point of difficulty rather than providing immediate solutions.

Conclusion

This study develops a process-oriented framework for examining experiential learning and problem-solving skills among higher education students. Its central contribution lies in shifting attention from simple participation in practical activities toward the mechanisms through which experience may become transferable reasoning.

The proposed design distinguishes problem representation, evidence evaluation, solution generation, strategic adaptation, and transfer performance while examining reflection and collaborative decision quality as explanatory mechanisms. The illustrative results indicate that the most substantial experiential-learning advantages would be expected in strategic adaptation and far-transfer performance rather than routine task accuracy.

The manuscript therefore argues that the educational value of experiential learning depends not merely on exposing students to realistic problems, but on requiring them to examine evidence, justify decisions, experience consequences, reflect on errors, and reconstruct strategies.

For higher education institutions, this distinction has practical significance. Courses designed around authentic activity should incorporate structured reflection and iterative problem solving rather than treating practical exposure as sufficient in itself.

The framework is also relevant to emerging AI-supported learning environments. Intelligent educational systems can potentially move beyond monitoring answers toward detecting reasoning behaviours such as premature solution selection, weak evidence use, failure to revise assumptions, and limited transfer. When combined with carefully designed experiential pedagogy, such systems may contribute to more adaptive, reflective, and independently capable problem solvers.

Overall, experiential learning should be evaluated not by the amount of activity it generates but by the extent to which

students become capable of solving unfamiliar problems without relying on the exact conditions under which learning originally occurred.

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