Journal of Systemics, Cybernetics and Informatics (2025) 23(7), 77-94
https://doi.org/10.54808/JSCI.23.07.77

Engaged Immersive Learning: An Environment-Driven Framework for Higher Education Integrating Multi-Stakeholder Collaboration, Generative AI, and Practice-Based Assessment

Atsushi YOSHIKAWA
College of Science and Engineering, Kanto Gakuin University, Yokohama, 236-8501, Japan
Graduate School of Management, GLOBIS University, Tokyo, 102-0084, Japan

ABSTRACT

This paper proposes Engaged Immersive Learning (EIL), a new framework designed to address the passivity, lack of context, and one-way communication that often characterize lecture-centered higher education. The argument begins by examining the contributions and limitations of Problem/Project-Based Learning (PBL) and STEM/STEAM education. While these approaches have enhanced self-directed learning and creativity through problem-based inquiry and interdisciplinary collaboration, they retain structural challenges: tasks are frequently designed within the classroom, activities tend to remain short-lived, assessment relies on faculty-defined institutional standards, and multi-stakeholder collaboration often remains superficial. Drawing on Kolb's experiential learning, Mezirow's transformative learning, Akpan's social constructivism, and Lave and Wenger's concepts of Legitimate Peripheral Participation (LPP) and Communities of Practice (CoP), the study proposes design principles for EIL. It further introduces Generative AI (GenAI) as a catalyst that supports, rather than replaces, human collaboration. EIL consists of four elements: (1) an environment-driven learning space in which students are immersed for extended periods in real-world contexts where multiple stakeholders (e.g., corporations, government, citizens) interact; (2) a participation trajectory in which students' roles and responsibilities expand gradually in line with LPP; (3) a dialogue design that positions GenAI as a "buddy" that sometimes errs but offers heterogeneous perspectives; and (4) practice-based assessment structured around external outcomes, stakeholder perspectives, and transformative change. Case studies from a single university illustrate that EIL can generate outcomes beyond the classroom—such as international conference presentations and forms of societal implementation—enabling employers and public officials to evaluate students in terms of "would I want to work with this person?", and treat identity shifts as explicit learning outcomes. The paper also identifies remaining challenges concerning sample size and duration, the reliability and validity of assessment rubrics, equity of access, ethics and governance in GenAI integration, and the tension between scalability and faculty workload. EIL is therefore positioned not as a finished model but as a set of design principles to be adapted to the specific contexts of different universities and regions.

Keywords: Engaged Immersive Learning (EIL); Problem- and Project-Based Learning (PBL); STEM/STEAM education; Legitimate Peripheral Participation (LPP); Communities of Practice (CoP); Generative Artificial Intelligence (GenAI); multi-stakeholder collaboration; practice-based and authentic assessment; Work-Integrated Learning (WIL).

1. INTRODUCTION

Higher education has faced growing societal pressure to provide increasingly advanced specialization. As disciplines have become more fragmented, curricula have evolved into "siloed" structures in which subjects are taught in isolation. This has created a serious educational problem: graduates often struggle to apply their acquired knowledge in real-world settings.

In response, Problem-Based Learning (PBL) was developed as an approach that enables collaborative groups, supported by a facilitator, to work on complex, ill-structured problems through cycles of inquiry and reflection. PBL was introduced to address at least five interrelated issues in higher education: (1) the fragmentation of knowledge and the lack of application skills; (2) the need to shift from passive to active learning; (3) rapid social change and increasing student numbers; (4) the need to integrate theory and practice; and (5) a move away from memory-centered learning towards the development of problem-solving and critical thinking skills [1], [2].

Empirical studies of PBL suggest that learning deepens when students apply knowledge in practice rather than simply acquiring it in the abstract. Project-based learning (hereafter also abbreviated as PBL, without a strict distinction) extends this logic from "problems" to "projects." It aims not only at knowledge acquisition but at the integrated development of knowledge, skills, and dispositions through engagement with real-world projects. Typical designs involve sustained problem solving, planning, problem formulation, and the application of mathematical or scientific concepts to authentic situations [1].

In both forms of PBL, students are expected to develop a stronger sense of purpose—asking "Why are we learning this?"—and to increase their intrinsic motivation and engagement. However, even with a focus on intrinsic motivation, existing research suggests that the results remain limited[3].

To address this unresolved issue, recent work has explored the potential of STEM/STEAM education (hereafter referred to simply as STEAM) to enhance intrinsic motivation. Cheng et al. [4], for example, implemented a STEAM programme that adopted PBL methodology while setting an artistic goal of "designing a musical instrument." By embedding PBL within a STEAM framework that combines divergent and convergent thinking, their design aimed to complement and strengthen PBL and reported increased intrinsic motivation among participants. Other studies also indicate that STEM activities that do not explicitly adopt PBL can nonetheless be experienced as engaging and motivating.

Through such innovations, PBL and STEAM have opened promising pathways for addressing the weaknesses of highly specialized, lecture-centered education while preserving disciplinary depth. Yet important challenges remain. As long as students work primarily on problems defined by teachers, a fundamental shift in motivation is unlikely. Even where teachers provide authentic problems, sustained motivational change in PBL settings appears to require that tasks are perceived as valuable and that students are granted autonomy and opportunities for choice [5]. Beyond motivation, misalignments persist between the values emphasized in university assessment and those that matter in workplaces and communities; students can remain trapped in the assumption that “good grades” automatically translate into “being useful in society” [6]. In addition, studies of PBL and STEAM repeatedly point to difficulties in collaboration: relationships with external stakeholders often remain short-term or superficial, despite the language of partnership and engagement [7], [8].

These developments and remaining issues are summarized in Table 1.

Table 1 The PBL to STEAM Transition and Its Challenges

Educational Approach	Challenges Addressed	Remaining Challenges
Lecture-based		Disconnect between theory and practice, student passivity
PBL	Integrating theory and practice to apply to real-world problems, fostering a self-directed learning attitude	Motivation, assessment methods, stakeholder collaboration
STEAM	Integration of academic disciplines for practical application, Cultivating creativity to tackle emerging challenges	Motivation remains partial, learning is ad hoc

PBL is designed to develop problem-solving skills, addressing predefined challenges under teacher supervision. STEAM broadens capabilities by integrating analytical and creative practices, fostering an interdisciplinary perspective across multiple domains within the classroom. Consequently, it employs methods from easily connectable fields. Both PBL and STEAM produce outcomes, but they inherently lean toward ease of implementation, creating structural limitations. They particularly fail to fully address three interrelated needs: (1) Environment-driven learning spaces—where engaging practices exist and stakeholders or the subject matter itself provide diverse perspectives; (2) Sustained immersion—where learners produce outputs intermittently over weeks or semesters, receiving iterative feedback; (3) Practice-based assessment—involving stakeholder-specific evaluations, such as external metrics like customer value, academic acceptance, or policy adoption.

To address future challenges, this study proposes that experiential learning[9] , transformative learning[10] , social constructivism[11] , and Legitimate Peripheral Participation (LPP)[12] can be useful. Experiential learning enables authentic challenges and structured reflection to trigger deep learning. Transformative learning generates shifts in perspective that occur when assumptions are challenged through real-world constraints. Social constructivism posits that knowledge acquired by learners arises more from participation in communities and dialogic processes. Combined with LPP, this leads to a transformation from identity formation through participation in professional practice to becoming an agent with knowledge that enables proactive action. Designing LPP is particularly crucial in higher education. Novices first glimpse pathways into low-barrier professional groups accessible to anyone, tackle authentic yet low-risk tasks, and gradually transition to more central roles as guidance diminishes and participation becomes self-directed. Applied at the university-society interface, students become not merely "passive learners" or "customers," but are drawn into activities, gradually becoming active participants. Moreover, communities are not singular but overlapping, allowing participation as new members in multiple groups. This process itself becomes the opportunity to gain social acceptance (legitimate membership) during university years, where students are recognized by stakeholders like corporations as "legitimate members to work with”. This further naturally fosters the development of responsibility, ethics, and compliance—qualities often difficult to acquire otherwise.

Under this concept, we propose Engaged Immersive Learning (EIL) as an environment-driven framework. It is a learning model designed so that learning and growth emerge from the environment itself— —by placing students within society or in small-scale projects with real authenticity for a reasonably long period, where they solve genuine challenges alongside the adults present. EIL is defined by four mutually complementary design elements:

- Environment: Construct spaces where real-world multi-stakeholders—such as corporations, local governments, and citizens—interact. This allows problems to emerge from multiple directions, and learning manifests contextually rather than through scripted curricula.
- Immersion: Encourages long-term participation spanning weeks to semesters (problem discovery → discussion → outline creation → construction → external review → delivery). While not necessarily linear, this enables improvement and the discovery of new challenges.
- AI Buddy: Use generative AI as a friend. Position AI as a friend who, like humans, "says things that aren't always accurate." While leaving a trace, bounce solution ideas off it and receive new information. Verifying information and ensuring ethical compliance remains the responsibility of humans[13]–[15].
- Practice-Based Evaluation: Combines academic standards with stakeholder assessments to demonstrate value beyond the classroom.

The remainder of this paper reviews related research and theoretical foundations in section 2, defines the problem and designs the EIL framework in section 3, presents the implementation in section 4, evaluates EIL in section 5, and concludes with future directions in section 6.

2. RELATED WORK

2.1 PBL

PBL has demonstrated certain achievements, with reported improvements in autonomy, teamwork, critical thinking, and decision-making skills.

For example, Table 2 summarizes five approaches related to PBL: problem-based learning, project-based learning, task-based learning, case-based learning, and service learning.

Barrows classified PBL into six types in medical education[16]. First, he identified four educational objectives: ① Structuring Clinical Knowledge (SCC) applicable in clinical (practice) contexts, ② Clinical Reasoning Process (CRP), ③ Self-Directed Learning (SDL), and ④ Motivation to Learn (MOT). The weighting of these four objectives varies across different PBL types. The six types of PBL are as follows: Lecture-based cases (lecture and case), Case-based lectures (from pre-cases to lectures), Case method (discussion using cases), Modified case-based (stepwise cases like SMP/PMP), Problem-based (presenting an initial image for free inquiry), Closed-loop / iterative PBL (repeating inquiry → self-directed learning → reapplication to the problem). Regardless of the PBL classification, challenges exist, such as assessments becoming memory-focused like traditional classroom settings, or the problems themselves being designed to be solvable like standard classroom exercises. Furthermore, research indicates that closed-loop PBL, which requires repetition, is costly and difficult to implement despite its proven effectiveness. Nevertheless, they demonstrate a common finding: students learn more deeply when they actively define and solve problems, rather than merely listening.

Thomas evaluated project-based learning (PBL). He proposed filtering PBL using the following five criteria: ① Centrality (core to the curriculum) ② Driving question ③ Constructive investigations (knowledge-building inquiry) ④ Autonomy (learner self-direction) ⑤ Realism (authenticity beyond the school setting). However, he also noted PBL's challenges in formulating questions and its tendency toward insufficient authenticity. On the other hand, it demonstrates that when students engage in long-term, realistic projects, learning occurs through the process of planning, constructing, and presenting outcomes.[17] .

Blumenfeld et al. emphasized the use of computer games and simulations. They proposed "authentic tasks" that enhance interest, value, and a sense of mastery to achieve both "doing" and "learning," along with the appropriate introduction of technology to increase student agency. These facilitate access to information, support the learning process, and assist in creating products. This approach is said to have increased motivation for both students and teachers.[18]. While emphasizing the importance of integrating simulations and games into PBL, they also point out that it can tend to lean too heavily toward "Doing," which can interrupt the deepening of learning.

Herreid criticizes overly simplified PBL for often devolving into lightweight tasks like textbook chapter exercises, advocating instead for narrative-driven learning. He defines PBL's essence as authenticity and inquiry rooted in stories. When adapted into context-appropriate case studies, students analyze relatable examples, making abstract knowledge more memorable.[19] .

Bringle et al. promoted service learning using a similar approach, though they did not label it PBL. In this model, students apply knowledge gained in the classroom to the local community, creating social impact while learning. It is not that students cannot engage in experiential activities without skills; rather, activities are designed to connect prior learning with service. However, with service, challenges often arise early on, and the short duration of such activities is considered a limitation.

Table 2 Organizing Problems Solved Through PBL

Type of PBL	Definition and Characteristics	Benefit	Challenges
Problem-Based Learning	Students independently investigate academic and clinical problems, acquire knowledge, and devise solutions	Improved self-directed learning skills Strengthening problem identification and analysis skills	Limited exposure to the real world Difficulty gaining an interdisciplinary perspective
Project-Based Learning	A learning approach where students engage in real projects over an extended period and collaboratively produce outcomes	Acquisition of practical skills Development of teamwork and project management skills	Building relationships with businesses and society requires time and effort
Challenge-Based Learning	A learning approach where students start with local issues or social problems and propose solutions with a view toward social impact.	Cultivating Social Contribution Awareness Promoting Innovative Thinking	If tasks are not appropriately set, motivation may weaken.
Case-Based Learning	A learning method that connects theory and practice through analysis and discussion using real-world cases.	Integration of Theory and Practice Strengthening Decision-Making Skills	Overemphasizes deep analysis of real-world cases.
Service-Learning	A learning model that integrates volunteer activities in local communities and society into education. Achieves both learning and social contribution through practical experience.	Two-way learning with the community Fostering a sense of social responsibility	High operational burden in program management Difficulty in academically evaluating outcomes

As a method to overcome the "passivity, lack of context, and one-way nature" inherent in lecture-centered classes, PBL has pursued problem-based inquiry, self-directedness, and connection to real-world issues[17], [18], [20]. Notably, Barrows explicitly defined PBL's design variables and educational goals (reasoning, self-regulation, knowledge structuring), theorizing learning outcomes difficult to achieve through lecture-based methods[16]. However, as implementation expanded, criticisms emerged, such as "PBL in name only" and "assessment skewed toward knowledge"[17], [19] .

2.2 STEAM

As demonstrated above, while PBL has significantly addressed the shortcomings of lecture-based education, challenges remain. Here, we examine STEAM, which has evolved while building upon the PBL format. STEAM addresses real-world challenges, problems requiring multiple perspectives, and tasks involving design thinking. Table 3, the STEAM model contributes to enhancing practical, collaborative, and creative skills. However, it also faces challenges such as weaknesses in external collaboration, high demands on teachers for coordination and expertise, and a tendency toward ad-hoc evaluation.

Looking at specific examples, Jolly discussed instructional design that addresses real-world challenges by integrating S, T, E, and M through the Engineering Design Process (EDP)[21]. Within this framework, Jolly emphasizes six key points for effective STEM education: ① Selecting compelling challenges, ② Explicitly defining the EDP and designing projects aligned with "quality standards," ③ Intentionally including diverse learners, ④ Fostering team collaboration, ⑤ Utilizing technology authentically, not just for simulation, ⑥ Ensuring assessment evaluates not only understanding or problem-solving but also the extent of student engagement.

Additionally, while an organization, the National Math & Science Initiative (NMSI) has outlined the benefits of PBL under the title "How Project-Based Learning Transforms STEM Education," organizing them as a shift away from passive learning, improved long-term retention and academic performance, enhanced problem-solving and collaboration skills, and a more positive learning attitude[22]. Furthermore, they assert that PBL will revolutionize STEM teaching, highlighting the effectiveness of combining PBL with STEM.

Amanova et al. conducted a systematic review, defining STEAM as an interdisciplinary approach integrating art into STEM, emphasizing creativity, design thinking, and communication skills. However, they report that STEAM repeatedly faces challenges: (1) insufficient interdisciplinary expertise among teachers, (2) complexity in curriculum design, and (3) non-standardized assessment of learning outcomes.

Mahmud et al. conducted a systematic review of STEM and Service-Learning (SL) in higher education. While demonstrating the growing scope of efforts to balance social contribution and learning, they pointed out the difficulty of conducting academic evaluations regarding program operational burdens and outcomes. They also noted challenges in generalizing case studies and data insufficiency[23] .

Bettencourt et al. used constructivist grounded theory to theorize how 45 STEM undergraduate students and graduates "Choose, Navigate, and Integrate" challenges. These findings indicate that steps to cultivate interdisciplinary thinking through these three stages are crucial. However, since interdisciplinary activities simultaneously advance both knowledge consolidation and problem-solving, institutional and structural support—such as scheduling and advising—is also necessary.

The European Commission states that, as an industry, it is crucial to enhance both the quantity and quality of STEM talent across the entire EU, strengthen industry-academia education collaboration, and develop "skills intelligence."[24]. This is not only to address declining academic performance but also because STEM is expected to provide talent for industries poised for future growth. However, it also notes that there is still a shortage of personnel capable of delivering STEM education, namely teachers.

Furthermore, while IGE does not explicitly state STEAM, it emphasizes interdisciplinary learning, real-world challenges, industry-government collaboration, communication, and other foundational professional skills. Semantically, it encourages designs that incorporate the A (Arts/Design/Communication, etc., encompassing creativity, expression, ethics, and social connections) into STEM[25]. This approach aims to holistically cultivate skills, knowledge, and competencies to meet the needs of industry and society.

Table 3 Organizing Problems Solved Through STEAM

Type of STEM/STEAM	Definition and Characteristics	Benefits	Challenges
Project-Based STEM Education	Student teams solve real-world engineering challenges and address problems through the design process (EDP). Projects involve collaboration with local communities and businesses.	Acquisition of practical skills Enhanced Teamwork Skills Strengthening problem-solving abilities	Challenges in establishing and maintaining partnerships with companies Standardizing evaluation criteria is a challenge Requires high levels of expertise from teachers
STEAM Education Programs	Integrating Art into STEM, emphasizing creativity, design thinking, and communication skills. An interdisciplinary approach including visualization, storytelling, and ethical consideration	Fostering creativity and design thinking Enhances communication skills Expand interdisciplinary perspectives	Methodologies for integrating art remain unclear Teachers often lack interdisciplinary expertise Complex assessment methods

Service-Learning STEM	Integrates community service activities with STEM learning. Simultaneously achieves learning outcomes and social contribution by addressing societal challenges such as environmental issues, public health, and educational support.	Fostering social contribution awareness Addressing real-world challenges Strengthening community partnerships	Heavy burden of project management Difficulty in measuring academic outcomes Ensuring Sustainability Also a Challenge
Interdisciplinary STEM Programs	Systematically integrating multiple STEM fields to cultivate interdisciplinary thinking in students through three stages: selection, exploration, and integration. Developing problem-solving capabilities in complex fields such as biomedicine and renewable energy.	Fostering integrated, boundary-crossing thinking Enhancing complex problem-solving abilities and the capacity to translate across disciplinary "languages" Strengthening career adaptability, networking, and sense of belonging	Cultural friction due to schedules and disciplines; significant burden on guidance and coordination. Difficulty evaluating comprehensive learning; effects often manifest with a time lag. Challenges in maintaining large-scale multi-departmental and external collaborative relationships
Integrated STEM with Industry	Build long-term partnerships with companies and government agencies to integrate practical skills and academic knowledge through internships, mentoring, and joint research.	Gaining practical experience Improving employment rates and career satisfaction Acquiring the latest technologies and industry trends	Challenges in establishing and maintaining relationships with companies Balancing academic and practical aspects Lack of widespread adoption

STEAM integrates not only science and mathematics but also design thinking, offering solutions to challenges in creativity and communication that PBL alone left unaddressed. However, research also indicates that STEAM tends to be short-term, often failing to achieve sufficient effectiveness, and there is a tendency for it to remain confined within subject units.

Ultimately, while PBL/STEAM significantly addressed the weaknesses of lecture-based teaching, it has not yet achieved a design where students engage proactively, multiple stakeholders interact within an environment resembling real-world challenges, and projects are of sufficient duration— —to be evaluated by each stakeholder.

2.3 Legitimate Peripheral Participation (LPP)

While PBL and STEAM have focused on transforming individual learners' skills and motivation, Legitimate Peripheral Participation (LPP) locates the essence of learning in the very process of social interaction through which such transformation occurs.

Whereas learning was traditionally viewed as a process of knowledge acquisition and accumulation within the individual mind, Lave and Wenger [12], drawing on ethnographic research with West African tailors, Yucatan midwives, and butchers, argued that learning is not fundamentally about "knowledge transfer." Rather, it consists in the progressive deepening of participation within a Community of Practice (CoP). In this view, learners are positioned not as "novices" but as "participants" who are granted legitimacy—the right to become full members of the community.

LPP comprises three interrelated elements:

1. Legitimate: Newcomers are granted access to the community's resources—tools, information, and the expertise of senior members. They are recognized not as outsiders but as prospective experts.
2. Peripheral: Participation begins at the periphery, where the risk of failure is low and the expert's overall approach can be observed, rather than at the center, where responsibility is high and tolerance for error is limited. This arrangement allows newcomers to master tasks incrementally while developing a sense of the whole.
3. Participation: Beyond observation, learners take on an active role within the community's practices.

Through this trajectory from periphery to center, learners undergo not only skill acquisition but also an "identity transformation"—a shift in self-definition from "learner" to "practitioner." This reframing of learning as identity change is central to addressing challenges that PBL and STEAM have left unresolved.

Wenger [26] extended LPP theory by shifting attention from the apprenticeship model—a longitudinal process in which newcomers gradually become veterans—to the structure of the Community of Practice itself and the identity formation that occurs within it. He reconceptualized learning as a process of "negotiation of meaning," arising from the interplay between "reification" (the creation of artefacts, concepts, and narratives) and "participation." This framework reframes PBL and STEAM as components of a broader "social learning system," illuminating how knowledge is generated and shared within organizations.

A related line of research highlights the value of membership in multiple communities. Akkerman and Bakker [27] describe this as "Boundary Crossing," whereby learners generate new knowledge by moving across community boundaries rather than remaining within a single practice. This perspective is essential for addressing complex, real-world problems that span disciplinary and organizational borders.

2.4 Learning Theory

Kolb proposed Experiential Learning Theory (ELT), suggesting adult learning requires four stages: 1) Concrete Experience (CE): Actually doing something (practice), 2) Reflective Observation (RO): Reviewing what happened and observing it from multiple angles (reflection), 3) Abstract Conceptualization (AC): deriving principles or theories from observations (lesson learning/modeling), and 4) Active Experimentation (AE): testing that theory in new situations (retrial). He posits that people learn through repeated cycles of these four stages[9]. However, this cycle requires "realistic and challenging projects," not textbook exercises. It is through experiencing cognitive dissonance—recognizing that "I tried, but it didn't work"—that learners interpret the situation themselves and generate their own hypotheses (= abstract concepts).

While Kolb explained "how we learn from experience (the process cycle)," Mezirow focused on "what it means for adults to undergo profound change (rewriting the framework of meaning)" and proposed Transformative Learning Theory[10]. Within this framework, Mezirow posited that the transformation of one's "Frame of Reference"—that is, changing one's interpretation of the world itself—constitutes adult learning. According to this theory, within groups composed solely of individuals sharing the same background, shared premises (unspoken rules and common sense) prevent individuals from questioning "Why did I think that? (Is the premise correct?)" and thus, such doubts never arise. Only when diverse external perspectives enter does one realize that one's common sense was not universal truth, but merely one prejudice. Thus, others become essential.

In the context of science education, Akpan et al. go beyond Piaget's personal constructivism (individuals constructing knowledge in their minds) and advocate for social constructivism based on Vygotsky's theory: "knowledge is constructed through social negotiation and agreement." Based on this theory, learning is not "processing within an individual's mind" but "the very process of participating in and dialoguing with a community."

The learning Kolb, Mezirow, and Akpan seek involves high cognitive and emotional costs: "abandoning familiar ways, tackling uncertain challenges, and re-examining one's deep-seated beliefs." Consequently, people tend to default to familiar methods. To counter this tendency, I proposed utilizing generative AI (LLMs).This approach stems from positioning generative AI not as a replacement for human collaboration, but as an enabler that makes collaboration function effectively. Research verifies the impact of generative AI on the quality of student dialogue and the depth of self-reflection, demonstrating that AI functions not merely as an information provider, but as a "discussion partner offering a different perspective."

3. PROBLEM DEFINITION AND APPROACH TO RESOLUTION

3.1 Problem Setting

As seen in the previous section, PBL and STEAM have been used to change lecture-based teaching methods, which tend to be passive, abstract, and one-way instruction from the teacher. PBL allows for a shift to active learning starting from a "problem/project," within a meaningful learning context, enabling students to engage in collaborative activities. However, challenges remain: tasks are often designed within the classroom, limiting student agency; they can become short-term events; and assessment tends to stay confined to the classroom. STEAM aims to incorporate the Engineering Design Process, engage with authentic subjects through community or industry partnerships, and foster interdisciplinary creativity. Yet barriers persist, such as collaboration with stakeholders and increased workload for educators.

In summary, these developments leave four structural challenges, which I label P1-1 to P1-4 for later discussion. P1-1 concerns the continuity and depth of inquiry: rather than being sustained over time, problem-solving activities are often compressed into short-term projects, making it difficult for students to revisit and deepen their understanding of the issues they encounter [28]. P1-2 addresses the fact that both problem definition and evaluation tend to remain confined within the classroom. Problems are typically pre-set by instructors, and grading follows uniform, institution-wide criteria, even though different stakeholders would frame the same situation – and judge its value – in very different ways. P1-3 refers to the erosion of motivation and agency when task setting is teacher-led and deliverables are predetermined; under these conditions, students have little room to exercise autonomy and easily slip back into a passive stance. Finally, P1-4 captures the mismatch between the skills demanded by society (for example, negotiating with stakeholders or engaging in evidence-based decision-making) and the skills that instruction actually cultivates.

3.2 Solutions

For the challenges outlined in P1-1 through P1-4, Kolb proposed a cycle of Experience → Reflection → Conceptualization → Re-engagement. This cycle effectively addresses P1-1 by enhancing learning from case studies. According to Mezirow et al., critical reflection and reframing promote deeper consideration for P1-1 to P1-3. Akpan et al. suggest that creating social meaning and its associated artifacts can help mitigate interdisciplinary friction, addressing P1-3 and P1-4.

Even when Kolb’s experiential cycle, Mezirow’s transformative learning, and Akpan’s social constructivism are incorporated, further limitations remain. First (P2-1), concrete approaches for engaging multiple stakeholders are often unclear. Second (P2-2), there is still a lack of valid, stakeholder-specific assessment criteria that would allow companies, policymakers and citizens to evaluate student work from their own perspectives. Third (P2-3), problem-setting continues to be dominated by teachers, which restricts opportunities for self-directed activities in which students identify and pursue problems that matter to them.

To address this, consider the following ideas: Incorporate peripheral activities such as introductory lectures that introduce the types of challenges typically encountered after graduating and entering society, or simple company training programs organized by businesses. Through these, students can experience such challenges at university. This allows them to identify problems within companies that employees themselves do not directly tackle but are recognized as issues—problems they discover using their own capabilities (and precisely because they discover them themselves, they can envision potential solutions). In the process of solving these problems, they engage with multiple stakeholders, produce some form of output, and thereby gain access to new information. This approach incorporates the LPP/CoP framework, focusing not on knowledge acquisition but on the "process of identity transformation through becoming a member of a Community of Practice (CoP)." In other words, by combining Kolb, Mezirow, Akpan with LPP/CoP, the legitimacy inherent in LPP primarily addresses P2-1 and P2-2, while peripheral participation mainly resolves P2-3.

Nevertheless, the following issues remain with Kolb, Mezirow, and Akpan:

P2-4: It involves high cognitive and emotional costs—abandoning familiar methods, tackling uncertain challenges, and re-examining one's deep-seated beliefs.

Consequently, during the transition from Concrete Experience (CE) to Reflective Observation (RO), learners may skip genuine reflection and rush directly to Active Experimentation (AE). At the stage of Critical Reflection (CR), the fear of questioning deeply held values can lead them to avoid open debate. During social negotiation, they may smooth over disagreements, resulting in superficial consensus or groupthink. Drawing on social learning theories, Zhou et.al position Generative AI (GenAI) as a catalyst for overcoming this "learning inertia[29]" by providing a persistent, low-risk dialogue partner that injects heterogeneous perspectives into collaborative work[30]. Building on their insight, this paper assumes that even when LPP/CoP-based project designs are in place, typical sources of friction—such as limited access to experts, newcomers' reluctance to speak up, and emotional resistance to change—can be mitigated when GenAI functions as a catalyst that keeps reflection and dialogue in motion.

3.3 Design of Engaged Immersive Learning

3.3.1 Basic Concept of EIL

To fundamentally resolve the remaining challenges outlined in Sections 3.1-3.2 (P2-1 to P2-4), a fundamental redesign of the learning environment itself is necessary. The Engaged Immersive Learning (EIL) proposed in this paper integrates Kolb's Experiential Learning Cycle, Mezirow's Transformative Learning, Akpan's Social Constructivism, and Lave and Wenger's Legitimate Peripheral Participation (LPP)/Communities of Practice (CoP), while further incorporating Generative AI (GenAI) as a catalyst to enable these theories. This design philosophy aims to simultaneously resolve the aforementioned challenges (Table 4).

EIL is defined as follows:

> *It is an educational model where students continuously immerse themselves in real-world environments where multiple stakeholders interact. They learn based on practical evaluation criteria (problem-solving ability, decision-making capacity, value creation), utilize generative AI as a "buddy," and achieve learning through spontaneous discovery within an environment-driven learning design.*

The novelty of EIL lies not in "learning programs" or "teaching methods," but in the "design of the learning environment itself, involving multiple stakeholders. "Traditional PBL/STEAM education followed a model where university instructors set problems and students responded to them. In contrast, EIL aims for a structure where learning naturally deepens. This is achieved by having real stakeholders—such as corporations, government, and local communities—bring their own challenges with independent discretion. Students are gradually drawn into this multi-layered stakeholder environment as "peripheral participants."

Table 4 EIL Challenge Resolution Matrix

Challenge	Traditional PBL/STEAM	EIL Solution Direction
P2-1: Unclear Stakeholder Engagement Methods	Teachers select and manage a limited number of stakeholders	Multiple stakeholders participate with independent discretion. Universities focus solely on designing the "space and time"
P2-2: Lack of Stakeholder-Specific Valid Assessment	Primarily classroom-based assessment (graded by instructors)	Companies may evaluate based on efficiency, policymakers on implementation feasibility, citizens on social value, etc.
P2-3: Problems to be solved are teacher-set and lack autonomy	Teachers preset problems	Stakeholders bring real-world challenges; students transition from peripheral observation to central roles
P2-4: High cognitive and emotional cost of abandoning familiar methods	Refuge in relationships and discussions with like-minded individuals	Conversations with diverse stakeholders and AI buddies constantly provide "heterogeneous perspectives"

3.3.2 Four Design Elements of EIL

EIL consists of the following four complementary design elements(Figure 1):

① Environment: A space where multi-layered stakeholders intersect

It builds a multi-layered environment where companies, local governments, civic groups, research institutions, and others bring real projects together—not merely "university-industry collaboration."

- Multidimensionality of Problems: Even in the same situation, different stakeholders interpret challenges differently. For example, companies may have problems they face but don't directly address. Solving these may not offer economic benefits but could benefit service users, meaning multiple legitimate values coexist simultaneously. This inherent complexity of the real world is embedded within the learning environment.

- Situated Learning Manifestation: Within this complex environment, as students engage in real actions, "what should be learned" naturally becomes apparent. In other words, learning objectives are not fixed in advance as a syllabus but are dynamically generated according to the situation.
- Loose Coupling: This is a crucial element. Universities focus on designing "time" and "space," while maximally respecting the independent discretion and ingenuity of companies and stakeholders. This enables innovative learning liberated from many constraints.
- Media Diversification: Combining multiple media—face-to-face, online, hybrid—minimizes geographical and temporal constraints, creating an environment where more stakeholders can participate.

② Immersion: Sustained Participation Over Weeks to Semesters

Whereas PBL/STEAM often devolves into "short-term projects within a unit," EIL promotes deep immersion through long-term participation spanning at least several weeks to an entire semester.

- Hierarchy of Participation: Newcomers initially engage peripherally—listening to lectures, observing projects, or attending events. As teams advance project challenges and engage with companies, they gradually transition to more central roles (phased participation). Through this process, newcomers develop an identity as "community members," naturally cultivating responsibility and ethical awareness.
- Iterative Feedback and Redesign: Rather than linear progression (problem discovery → planning → execution → completion), students experience the true meaning of "learning by doing" through an iterative cycle: implementation → external stakeholder review → learning → refinement → new problem discovery → reimplementation. This corresponds to executing Kolb's experiential learning cycle not merely through individual reflection, but within dialogue involving multiple stakeholders.
- Visible Output Production: By generating concrete outputs (prototypes, policy proposals, reports, etc.) at each stage, students perceive in real-time that "their actions are impacting the real world." This naturally fulfills the three fundamental psychological needs of "competence," "autonomy," and "relatedness," sustaining intrinsic motivation (P2-3)[31], [32].

③ AI Buddy: Enabling Generative AI as a Collaborative Explorer

Position generative AI (LLMs) as a "partner" to act as a catalyst for overcoming learning inertia. This means actively involving AI at each stage of the learning process, rather than treating it merely as a "tool" or "knowledge search engine."

- Provider of Heterogeneous Perspectives: AI possesses different logical structures and knowledge patterns than humans, breaking students out of groupthink and fixation on single thought patterns. Questions like "AI said this, but is it true?" naturally trigger critical thinking.
- Positioning as a "Fallible Partner": Large Language Models (LLMs) are known to hallucinate (generate information that isn't factual). EIL incorporates this limitation as a "learning opportunity." Students develop the awareness that "AI suggestions require verification," naturally cultivating critical literacy skills essential in modern society: how to judge the authenticity of information and how to integrate multiple sources. This verification process becomes collaborative misinformation verification, strengthening group critical thinking [33]–[35] .
- Promoting Reflection: Through dialogue with AI, students re-examine questions like "What assumptions are we making?", "Are those assumptions truly justified?", and "What might be visible from another perspective?" This functionalizes Mezirow's concept of "transformative critical reflection" within the framework of AI dialogue[10], [34] .
- Implementation of Continuous Support: The AI Buddy is available throughout all stages of the learning process, including brainstorming, data analysis, literature summarization, and idea feasibility assessment. Crucially, the final judgment and responsibility always remain with the human (student team).

④ Practice-Based Assessment: Introducing the Value of Multiple Stakeholders

Instead of traditional "in-class grading," we implement a multidimensional assessment combining practical outcomes, academic understanding, and evaluations from multiple stakeholders.

- Incorporating stakeholder metrics:
  1. Customer Value: Whether a company can actually adopt this solution, etc.
  2. Academic Acceptance: Whether faculty members perceive that "this learning experience deepened conceptual knowledge or fostered theoretical understanding," etc.
  3. Policy Implementability: Policy makers assess whether the learning can be explained to citizens and whether there are institutional challenges.
  4. Social Acceptance: Community members assess whether the learning genuinely contributed to solving their challenges and whether it is trustworthy.
- Transparent Evaluation and Immediate Feedback to Students: Feedback from multiple stakeholders is immediately communicated to students, bridging the gap between "university grades" and "real-world value." Students gain a multi-perspective understanding of "what they contributed," fostering a sense of accomplishment and social efficacy, which sustains intrinsic motivation.
- Multidimensional Output Formats: Outcomes take diverse forms beyond mere "reports" or "presentations," including academic papers, international conference presentations, policy proposals, and provision of measured data. This fosters outcomes meaningful to each stakeholder.

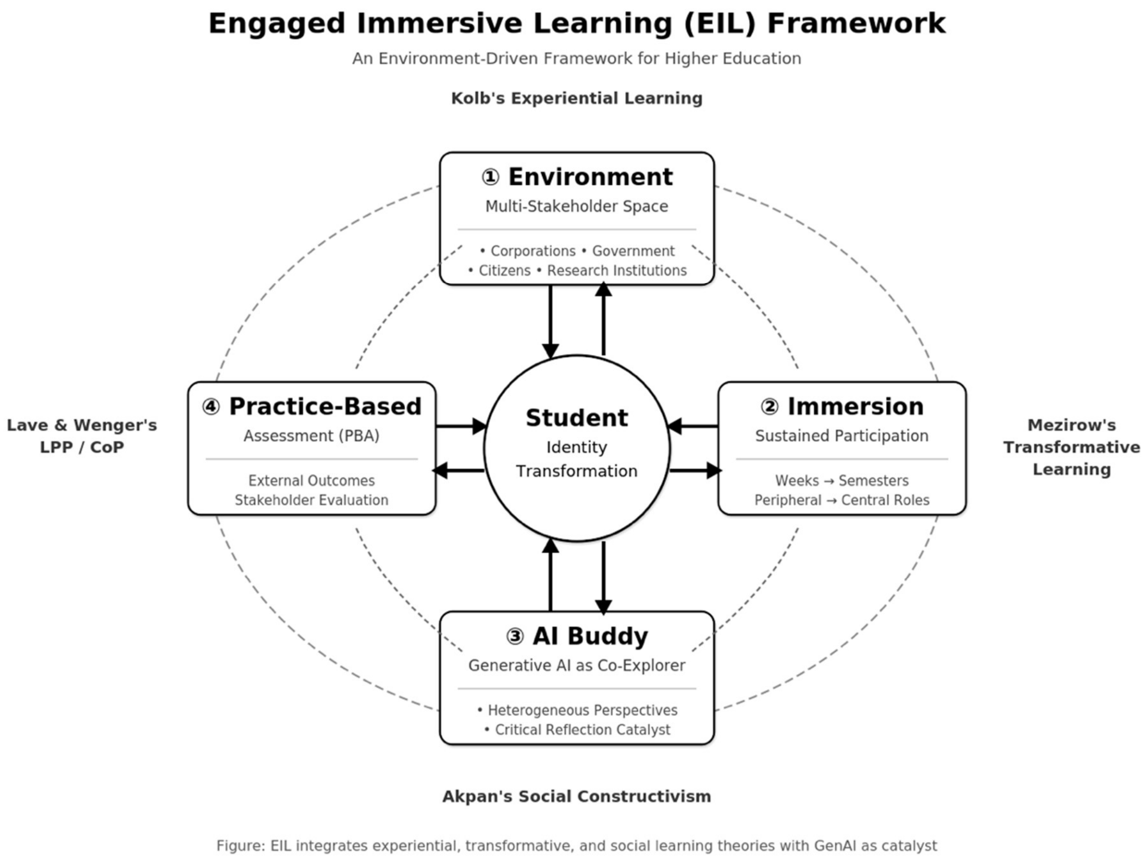

Figure 1 Concept of EIL

3.3.3 Operationalizing LPP/CoP in EIL

EIL operationalizes PBL/STEAM by integrating Lave & Wenger's Legitimate Peripheral Participation (LPP), loosely engaging multiple stakeholders.

Traditionally, LPP was conceived for learning within "single professional communities," such as artisan apprenticeships or medical training. However, addressing societal challenges requires learning within "overlapping multiple communities" where diverse professional domains and interests intersect.

EIL achieves (Table 5) this through the following methods:

- Building Plural "Legitimacy": Students hold multiple identities—as "university students" attending lectures, "participants" in events, "members" in projects, and "young professionals" consulting with working adults. Within each identity, students are recognized as "legitimate" members by their respective stakeholders.
- Transition to Progressive Centrality: Initially, students start as "observers" or "information gatherers" (peripheral participation). Through accumulating small successes and building trust with stakeholders, they gradually ascend to more central roles (proposer → decision-maker → project leader). Following this process, they also become "teachers" to juniors. These processes represent the transformation of the student's identity from "learner" to "practitioner," embodying the very "trajectory" described by Wenger, where the student's self-definition fundamentally shifts from "learner" to "practitioner."
- Boundary Crossing: By moving between multiple communities (course participants, project members, researchers), students encounter different "ways of doing things," "technical terms," and "values," acquiring the ability to integrate them [27], [36]. This process fosters "integrative thinking" and "contextual adaptability," qualities difficult to achieve within a single academic discipline.

Table 5 Characteristics of EIL and PBL/STEAM

Aspect	PBL/STEAM	EIL
Learning Driver	Teacher-defined "problem"	The Environment Itself (Diverse Stakeholders, Real-World Challenges, AI Buddies)
Participant Composition	Primarily faculty and students	Naturally incorporate students, faculty, TAs, corporate professionals, government officials, politicians, etc., as appropriate
Duration	Within a unit, several weeks to several months	One semester to multiple years
Evaluation criteria	In-class grading criteria	Multifaceted, including corporate efficiency, policy implementability for policymakers, and social value for citizens

AI's role	Support Tool (Optional)	Actively employed, serving as a learning catalyst and collaborative explorer
Form of Integration	Tight coupling	Flexible and Independent Participation (Loose Coupling)
Learning Outcomes	Problem-solving ability, collaborative skills	Integrative thinking, social adaptability, identity transformation

3.3.4 Integration of Kolb, Mezirow, Akpan, Wenger Theories and AI Catalysis

EIL integrates and operationalizes the following learning theories:

- Kolb's Experiential Learning Theory: Executes the cycle of Concrete Experience (CE) → Reflective Observation (RO) → Abstract Conceptualization (AC) → Active Experimentation (AE) through dialogue with multiple stakeholders. Whenever practical difficulties arise, students interpret the situation themselves and construct their own hypotheses.
- Mezirow's Transformative Learning Theory: Constant exposure to diverse external perspectives challenges students' "presuppositions (unspoken rules)". Through critical reflection, they realize their "common sense" was merely "one bias among many", leading to a transformation of their frame of reference.
- Akpan's Social Constructivism: Knowledge is understood not as "processing within an individual's mind," but as "a process of participation and dialogue within a community." Knowledge is constructed through negotiation and consensus among multiple stakeholders, meaning that even for the same issue, different forms of "knowledge" emerge depending on the stakeholder.
- Wenger's Communities of Practice and Trajectories: Students participating in multiple communities undergo a process of gradual transition from periphery to center, accompanied by an essential transformation of identity.

To integrate these four theories, EIL functions generative AI as a "learning catalyst." To overcome human "inertia" (fixation on familiar methods, avoidance of critical reflection, emotional resistance), AI:

1. Provides constantly accessible alternative perspectives to prevent groupthink
2. Automatically triggers critical thinking through the process of information verification
3. Serve as a neutral dialogue partner to mitigate emotional backlash
4. Amplify human interaction rather than replace it

3.3.5 Student Learning Process in EIL (Nonlinear Cyclic Model)

The student learning process in EIL consists of the following mutually complementary elements (iterative, not linear):

1. Independent Theme Selection and Problem Discovery
   Students independently select from multiple practical themes (challenges presented by companies or regions) based on their own interests. This exercise of autonomy constitutes the first stage of intrinsic motivation.
2. Critical Action Utilizing AI Buddies
   During the idea generation phase, students utilize AI as a "partner" to rapidly gather diverse proposals. Simultaneously, they scrutinize these proposals through group discussions, identifying misinformation and biases. This process constitutes collaborative misinformation verification, fostering the formation of collective intelligence[37].
3. Growth Through Collaboration with Diverse Stakeholders
   Students work on the same project teams with adults from diverse backgrounds, such as corporate professionals, politicians, teaching assistants, and faculty. Through presentations, group discussions, and peer reviews, they learn from each other. In this process, Mezirow's "critical reflection" occurs naturally, prompting them to re-examine their own assumptions and values.
4. Autonomous Feedback Loop
   At each project stage, students receive feedback from multiple stakeholders. They integrate this feedback and incorporate it into the design of the next stage. This iteration causes Kolb's learning cycle to rotate repeatedly, deepening learning in a spiral fashion.
5. Growth into Autonomous, Continuous Learners
   EIL's "loosely coupled" environment grants students high levels of freedom and flexibility. Students develop the habit of independently repeating the cycle of "choosing, questioning, and acting," rather than merely "following instructions." Failures and discomfort are also transformed into further drivers of learning through interpersonal relationships, dialogue, and interactions with AI.

3.3.6 Role Division in EIL Implementation

The success of EIL hinges on universities and companies (as well as governments and local communities) clearly defining their respective roles while collaborating under loose coupling.

The Role of Universities

- Designing "Time" and "Space": Focus on structuring semesters, determining lecture event frequency, and designing opportunities for engagement with stakeholder companies
- Ensuring Diversity: Combining multiple companies, multiple perspectives, and multiple media formats
- Quality Assurance of Learning Environments: Establishing reflection opportunities, feedback mechanisms, and consultation systems
- Promoting Cross-Boundary Learning: Supporting student mobility and learning integration across different communities

The Role of Companies, Government, and Local Communities

- Maintaining Autonomous Discretion: Bringing challenges based on independent judgment, not being "directed" by universities
- Presenting Authentic Challenges: Presenting challenges that companies and local governments genuinely want to solve, not simplified versions for universities
- Continuous Engagement: Multiple dialogues and feedback provision, not just a single guest speaker appearance

Openness to Mutual Learning: Sincerely receiving fresh perspectives and proposals from students, maintaining an attitude to expand one's own thinking

4. IMPLEMENTATION

4.1 Benefits for Universities: Why Universities Are Suited as EIL Venues

Universities play a central role in implementing EIL. However, a crucial question arises: Why should universities, rather than companies or governments, be the core of the learning environment? I will address this question while describing my practice.

The Primary Advantage of Universities: A Neutral and Trustworthy Hub

Universities are "neutral places" not dominated by a single corporation or political stance. This neutrality is crucial for the following reasons:

- Openness: Organizations from different industries and political backgrounds can participate on equal footing. Competing companies can coexist, and government agencies and private enterprises can sit at the same table.
- Credibility: Universities possess social credibility as educational institutions. Citizens and policymakers trust universities to generate and disseminate knowledge impartially.
- Tolerance for Critical Thinking: Universities foster a "culture of testing different perspectives." This enables open and rigorous debate not typically found in for-profit enterprises.

The Second Advantage of Universities: Cross-Company Network Hub

Universities can function as a "hub" connecting multiple companies, government agencies, NGOs, and research institutions.

- Serendipity and Emergence: Organizations that would not normally meet find points of contact through universities. Even if Company A and Company B are competitors, cooperative relationships can emerge within the neutral space of a university.
- Cross-Industry Collaboration: Learning across different sectors is naturally promoted. For example, expertise from entirely different fields—such as IT companies, manufacturing, agriculture, and welfare—intersects.
- Informal Network Formation: Student presentations and exchange events foster personal networks between companies. These networks later evolve into cross-industry projects.

The Third Benefit of Universities: Social Legitimacy for Human Resource Development

Universities are publicly recognized as institutions that invest in future human development.

- Acceptance of a Long-Term Perspective: Unlike companies or governments, universities are institutionally justified in investing in "long-term human development spanning four years or several years." Long-term growth is valued over short-term gains.
- A culture accepting failure: Universities foster a culture of "learning from failure." The process of trial and error itself is valued, rather than demanding perfect outcomes.
- Acceptance of diverse career paths: Universities bring together students aspiring to different paths (entrepreneurship, public service, large corporations, NGOs, research, etc.) on the same campus. This diversity itself enriches the learning environment.

The Fourth Benefit of University: Coexistence of Learners Across Generations and Backgrounds

Universities are places where learners from different generations and backgrounds coexist.

- Intergenerational Exchange: Undergraduates, graduate students, working adults, and senior students coexist in the same space. Perspectives from different life stages naturally intersect.
- Diverse backgrounds: International students, regional students, urban students, students with disabilities, and others from various backgrounds are represented.
- Accelerated Identity Formation: Within the unique university environment, students gain opportunities to reexamine "who they are." They can simultaneously experiment with multiple identities.

The University's Fifth Advantage: A Safe Environment for Social Experimentation

Universities are places where new ideas and social experiments can be tried "safely."

- Tolerance for Failure: Failure in business leads to profit loss, but failure in university is seen as "learning." This tolerance enables innovative attempts.
- Risk-mitigated innovation: Policy experiments, technological experiments, and prototypes of social innovation can be tested "experimentally" through universities.
- Knowledge Dissemination and Social Impact: Research findings and policy recommendations originating from universities carry public credibility. This enhances the societal acceptance of student activities and learning outcomes.

4.2 Stakeholder Expectations: What Companies, Students, and Faculty Expect and Should Do

To successfully implement EIL, all stakeholders involved (businesses, students, faculty) must clarify what they expect from each other and what they themselves should do. However, these expectations are sometimes conflicting and sometimes complementary. The expectations and responsibilities of the three positions are detailed below.

4.2.1 Expectations and Responsibilities of Companies

What Companies Expect

1. **Students acquire the skills companies need**

Companies view universities as "frontline bases for talent development." Specifically, they expect students to possess practical, immediately applicable skills such as data analysis, project management, and communication skills. However, companies also seek individuals who can independently identify problems and make sound judgments—not just technical skills.

2. **Developing students who can understand the world ten years from now from today's perspective**

In this era of rapid change, companies seek individuals who "understand current trends while envisioning the future." Adaptability to respond to society's rapid shifts (digitalization, ESG, AI penetration, etc.) and strategic thinking focused on the future are essential.

3. **Students who can contribute to solving real corporate challenges**

The fundamental purpose of corporate-university collaboration is to solve the company's own challenges. Therefore, companies expect student proposals to be practical solutions that can be implemented in business, not just idealistic concepts that look good on paper but are difficult to execute.

What companies should do

1. **Bring authentic challenges**

Companies must present "real challenges they currently face," not "problems simplified for university learning." This "authenticity" significantly impacts student motivation.

2. **Maintain continuous engagement**

While a single guest speaker can spark interest, it is not the only approach. Continuous engagement is also essential, including multiple dialogues, providing feedback, and participating in mid-term evaluations. This sustained engagement fosters deep learning among students.

3. **Openness to Mutual Learning**

Companies must sincerely embrace fresh perspectives and innovative ideas from students, adopting an attitude that expands their own thinking. The essence of EIL lies not in a one-way approach where "companies teach and students learn," but in a mindset of "mutual learning."

4.2.2 Student Expectations and Responsibilities

What Students Expect

1. **Finding themes aligned with their interests**

Students choose "problems they genuinely want to solve," not "assigned tasks." This proactive choice is the first step in generating intrinsic motivation.

2. **Understanding how their learning applies to the real world**

Students expect that their university learning extends beyond "grades" and "credits" to connect with "real-world value." In other words, they seek the experience of having their work recognized by stakeholders and implemented.

3. **Receiving evaluation from multiple perspectives**

Students seek evaluation from multiple perspectives—not just "grades from instructors"—but also assessments like "Is this valuable from a corporate viewpoint?" and "Is this trustworthy from a citizen's perspective?" This multifaceted evaluation provides clues about how their learning is perceived socially.

What Students Should Do

1. **Proactively selecting challenges and defining problems**

Students should not merely follow assigned tasks but take responsibility for deciding "what they want to pursue from multiple options." After selection, they must also possess the ability to reexamine "what is the essence of this task?" and "what is the fundamental problem to be solved?" and redefine the problem themselves.

2. **Develop the ability to think and judge independently**

Develop the habit of "making judgments for themselves in uncertain situations," rather than merely "memorizing given answers." While they receive information from AI and stakeholders, the final judgment rests with them.

3. **Building diverse relationships and engaging in continuous dialogue**

Students must proactively build relationships and engage in ongoing dialogue with people from diverse backgrounds, such as corporate professionals, faculty, teaching assistants, and citizens. This very process of "relationship building" becomes an indispensable competency even after entering society.

4.2.3 Expectations and Responsibilities of Faculty (University)

Faculty Expectations

1. **Faculty want to support students in learning autonomously and continuously**

Faculty members wish to move beyond the traditional "teach and evaluate" model toward a new role of "preparing the environment and promoting students' autonomous learning." However, they must ensure this support does not become "hands-off" and that appropriate scaffolding (support) is provided.

2. **Faculty want to enable students to achieve deep learning experiences**

Faculty aspire to create learning experiences that transform students' identities and foster insights through engagement with society, rather than merely completing superficial assignments. This aligns with the principles of Mezirow's transformative learning and Lave & Wenger's Legitimized Peripheral Participation (LPP).

3. **We want to increase points of contact with society while maintaining educational quality**

Educators strive to ensure that incorporating social practice does not compromise the academic rigor of education. In other words, they aim to achieve both "practicality" and "academic rigor."

What Faculty Should Do

1. **Designing time and space**

Faculty transition from "conductors" to "stage designers." They focus on structuring the semester, determining the frequency of stakeholder lectures, and designing face-to-face, online, and hybrid environments, while minimizing intervention in the content of individual projects.

2. **Ensuring and Coordinating Multiple Stakeholder Participation**

Faculty must devise ways to secure and sustain participation from multiple stakeholders, such as corporations, government, and NGOs. They also serve as coordinators to ensure the expectations of different stakeholders do not conflict.

3. **Evaluate student learning outcomes and provide feedback**

Faculty must aggregate evaluations from multiple stakeholders and provide appropriate feedback to students. They should also visualize "what drove student growth" and leverage this insight to improve the overall program quality.

4. **Re-examining their educational beliefs**

Educators should avoid assumptions like "traditional lectures are outdated" or "PBL is new." Instead, they must continuously question "the purpose of education" and "what students should learn."

4.3 Overall Framework for EIL Implementation

While section 3 detailed EIL's theoretical design principles, this section outlines the concrete implementation framework. EIL implementation is based on loose coupling: "the university designs time and space, while multiple stakeholders participate with independent discretion." This philosophy aims for a flexible structure that maximizes participants' autonomy and ingenuity, rather than traditional tight coupling (rigid control).

The overall structure of EIL implementation consists of the following three layers:

Layer 1: Environment Design Layer
The university provides the "learning environment." Specifically, this includes lecture events during the semester, opportunities for stakeholder engagement, and the integration of multiple media formats such as in-person, online, and hybrid. The university's role is limited to "designing space and time," minimizing directives and management regarding individual stakeholders' participation methods or task content.

Second Layer: Stakeholder Participation Layer
Companies, local governments, civic groups, investors, research institutions, etc., independently bring "challenges their organization or municipality genuinely wants to solve." Multiple participants are required, each providing distinct perspectives (e.g., companies focus on efficiency, governments on policy feasibility, citizens on social value). This very diversity enriches the learning environment.

Third Layer: Student Learning Experience Layer
Students immerse themselves in an environment where multiple stakeholders interact, gradually transitioning from "peripheral participants" to "central participants." Through this process, students acquire multiple identities and develop the ability to integrate different "methods," "terminology," and "values." The AI Buddy functions as a companion available throughout this entire process.

These three layers represent an interactive process, not top-down control. A cycle emerges where student activities prompt new questions for stakeholders, and stakeholder feedback deepens student learning.

4.4 Practical Implementation of Loosely Coupled Design

4.4.1 What is Loose Coupling?

The defining feature of EIL is its loose coupling of participants, not tight coupling. This is not merely lax management but a strategic design based on the following principles:

1. **Clarifying and Limiting the University's Role:** The university acts not as a "conductor" but as a "stage setter." It focuses on structuring the semester, determining the frequency of lecture events, and designing opportunities for interaction with stakeholder companies, without intervening in the content of individual projects.
2. **Respecting stakeholder autonomy:** Companies and governments bring challenges based on independent judgment, not university "instructions." These challenges are not "simplified versions for the university" but genuine issues their organizations actually face.
3. **Flexibility in Participation:** When multiple companies participate, competitors may sometimes coexist in the same environment. Alternatively, multiple companies may collaborate on a single theme. This flexible combination consistently provides participants with new learning opportunities.
4. **Acceptance of Innovation and Serendipity:** Rather than "planning everything in advance," we expect "unexpected learning" and "new collaborations" to emerge from participants' free interactions. This aligns with Jobs' concept of "connecting the dots"[38], which theorizes that much innovative learning arises from unplanned serendipity.

4.4.2 Operational Patterns in Practice

Specific operational patterns for implementing loose coupling are as follows:

Pattern A: Regular Lectures and Workshops
Universities frequently host lectures or workshops inviting multiple stakeholders (in practice, about once a week; see Figure 2). This flexible cadence naturally sustains students' intrinsic motivation.

(a) Lecture (b) Workshop

(c)Workshop activities (d) Workshop presentation

Figure 2 Examples of classes and workshops by external lecturers

For example, a politician delivers a lecture on "Challenges in Modern Elections," followed by a Q&A session and proposals from students. Through this process, students directly experience the "disconnect between theory and practice" and begin to spontaneously consider how to apply their university learning.

Pattern B: Formation of Theme-Based Project Teams (PBL)
Multiple stakeholders bring different challenges, or students identify challenges from the corporate field based on their own interests and abilities (see Figure 3). At this point, mixed teams composed of students, faculty, and stakeholders are formed.

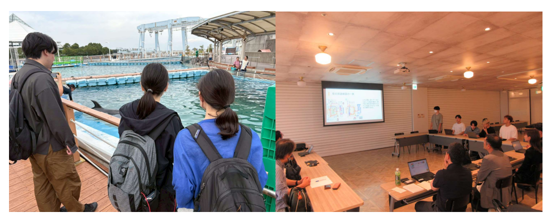

Figure3 Project Activity Scene

In this process, the university provides a "project matching platform," but the management and evaluation of individual projects after matching are led by the involved stakeholders and student teams. University faculty members remain in an "advisory" role, avoiding excessive intervention.

Pattern C: Collaboration with Multiple Stakeholders
This may be a derivative of Pattern B, but it can also involve bringing in other companies during the project execution process. While permission from the original client company is required, the university facilitates the matching, and students also participate. For example, this could involve another company joining the technical aspects of a project with the theme "We want to understand the commercial flow."

In this case, the university's role is to provide a "matching platform." Students manage the process while proposing solutions.

5. EVALUATION

5.1 Approach to Evaluation

Evaluation in EIL can be considered a form of authentic assessment. Simultaneously, it extends traditional authentic assessment into "practice-based evaluation" by incorporating external indicators such as adoption, utilization, academic acceptance, and policy implementation.

Evaluation in EIL centers not on "quantitative input indicators" like course completion rates or test scores, but rather on how much students "broke out of their shells" (changes in identity or behavior), how well outcomes connected to real-world settings (e.g., international conference presentations, employment by companies or municipalities), and whether they became individuals external stakeholders would want to work with. This evaluation perspective aligns with discussions on "authentic assessment" and Work-Integrated Learning (WIL), which aim to measure transferable skills and employability through tasks resembling real-world practice and collaboration with stakeholders.

Recent higher education research indicates that authentic assessment—evaluating through "practice-like tasks," "collaboration with external stakeholders," and "public presentations"—is effective for developing 21st-century skills and employability.

In the Work-Integrated Learning (WIL) field, reports indicate that projects in collaboration with companies and field-based assignments enhance the visibility of employer-sought competencies and improve employability. Consequently, the focus of assessment is shifting from "earning credits" to "competencies applicable after graduation."

EIL assessment incorporates these trends, placing core emphasis on practice-based indicators such as "real-world deliverables," "external dissemination," and "qualitative evaluation by stakeholders," rather than merely internship hours.

Based on these discussions, EIL refers to this approach as Practice-Based Assessment and employs three interrelated axes of evaluation.

The first axis, the external outcomes axis, focuses on results that extend “beyond the university”. It includes outcomes such as oral or poster presentations at international and domestic conferences, acceptance of work in peer-reviewed proceedings, the adoption of student proposals by companies, local governments or NGOs (for example through pilot implementations or use as internal or policy documents), and public events or citizen-facing reports and online dissemination. Research on authentic assessment in higher education suggests that student poster conferences and public presentations can function as effective assessment occasions that simultaneously foster professional competence, self-efficacy and an emerging expert identity[39]. In the field of sustainability education, practice-based program evaluations – in which students evaluate their own programs – have similarly been shown to measure critical thinking and social competencies at the same time.

The second axis, the stakeholder perspective axis (“would we want to work with them?”), captures employability as seen from the standpoint of companies and organizations. In EIL, corporate professionals and government officials consider whether students can understand the context of the company or municipality and redefine challenges (problem-setting and situational awareness), engage in dialogue and consensus building with diverse stakeholders (collaboration and communication), and take initiative and responsibility rather than waiting for instructions (autonomy and sense of responsibility). Work-Integrated Learning (WIL) employer surveys report[40] a high likelihood of hiring students who have gained WIL experience within their own organizations and highlight “ behavior in the field”, “problem-solving ability” and “communication” as core factors in hiring decisions. EIL systematically collects this qualitative feedback through rubrics and interview records and treats concrete cases where employers felt “this person is promising” (e.g. offers of employment, continuation of long-term internships, participation in joint research) as important outcomes.

The third axis, the transformation axis, focuses on students’ inner transformation. Drawing on transformative learning theory, EIL examines whether participants have “broken out of their shells” by analyzing changes in their assumptions and role perceptions in pre- and post-program reflection essays or interviews, by introducing Transformative Learning Outcomes (TLOs) that ask “What kind of practitioner are you becoming?” rather than merely “What did you learn?”, and by tracing how students come to articulate shifts in identity – for example, from “university student” to “startup member”, “citizen researcher” or “policy proposer”. Recent higher education research proposes formulating learning outcomes as TLOs that explicitly specify “what kind of person one has become” rather than simply “what one knows”, and emphasizes the importance of designing and evaluating identity development as a distinct outcome[41].

5.2 Specification of Evaluation Indicators

Table 6 summarizes the EIL evaluation rubric implemented in this study. It presents a practice-based evaluation framework comprising three broad categories: (1) External Outcomes Axis (academic/social external outcomes), (2) Stakeholder Axis (employability/collaborative skills, measured by "would you want to work with them?"), and (3) Transformative Axis (transformative learning and identity shifts on the learner side). The External Outcomes Axis was evaluated using three items: "Practical Impact," "Sustainability and Scalability," and "Academic/Professional Acceptance." The Stakeholder Axis was evaluated using two items: "Stakeholder Value" and "Multi-Stakeholder Collaboration," while the Transformation Axis was evaluated using Transformative Learning Outcomes (TLOs), with the quality of evidence and accountability assessed under the "Evidence & Accountability" category. This is because TLOs involve qualitative observation, which is also considered a vital form of evaluation.

Table 6 Evaluation Rubric

Dimension	Level 1 – Limited	Level 2 – Developing	Level 3 – Effective	Level 4 – Transformative
1. Practical Impact	Deliverables are shared with stakeholders only.	Stakeholders use deliverables primarily as reference information.	Deliverables hold value as concrete Proof of Concept (PoC) and are positioned for experimental use in practice.	They have the impact to trigger new projects or initiatives.
2. Stakeholder Value	While beneficial for student learning, the direct value for stakeholders is limited.	Stakeholders acknowledge the deliverables as beneficial but perceive issues with their usefulness and feasibility.	Regarding the deliverables, stakeholders report that they helped them rethink or solve their own challenges.	Stakeholders have proposed future collaboration and next steps, and expressed interest in hiring students.
3. Multi-stakeholder Collaboration	Single stakeholder or multiple stakeholders involved, but one-way communication.	Multiple stakeholders are involved, but participation is fragmented.	Multiple stakeholders participate, discuss challenges, and collaboratively create shared deliverables.	Stakeholders establish a joint decision-making process, and students are treated as legitimate participants within the practice community.
4. Sustainability & Scalability	Positioned as a one-off event with no concrete plans for feedback.	Some ideas regarding continuation or reuse of deliverables are mentioned.	Concrete plans exist for ongoing use, and resources for further development have been identified.	There are plausible scenarios for scaling the approach or applying it elsewhere, and it appears feasible to reach proof-of-concept level.
5. Evidence & Accountability	Data and other information have only been collected and not systematically documented as evidence.	Data, references, and materials exist, but the relationship between claims, evidence, and alternatives is unclear.	Claims, evidence, alternatives, and risks are systematically documented.	In addition to Level 3, the provenance log is systematically organized, enabling audit, reanalysis, and reuse for educational and research purposes.
6. Scholarly & Professional Uptake	Results remain within the university; no attempts have been made to share them with professional or academic communities.	Informal presentations are made to academic and professional audiences.	Part of the research is invited to professional and academic forums.	The research is adopted in academic and professional fields.

Based on our established evaluation criteria, all six items are currently rated Level 3. As TLOs, we observe increasing instances where participants—though not all—engage critically with information and consider causality. However, transforming the framework itself or proactively taking initiative remains unachieved.

6. CONCLUSION AND FUTURE CHALLENGES

6.1 Summary of This Research

This section presented a new design framework called Engaged Immersive Learning (EIL), following an analysis of the contributions and limitations of PBL and STEAM in addressing the challenges of passivity, lack of context, and one-way communication inherent in lecture-centered higher education.

Section 2 demonstrated that while PBL and STEAM have significantly advanced traditional instruction in aspects like self-direction, collaboration, connection to real-world challenges, and creativity, they still retain structural constraints such as "tendency for challenges to be designed within the classroom," "relatively short duration," "dependence on instructor evaluation," "fragile external partnerships," and "non-standard assessment."

Section 3 reformulated these challenges as P1-1 to P1-4 and P2-1 to P2-4. It then discussed how much could be resolved and where limitations remained, drawing on Kolb's experiential learning, Mezirow's transformative learning, Akpan's socioconstructivist science education theory, and Lave & Wenger's Legitimate Peripheral Participation (LPP) and Communities of Practice (CoP). As a result, four unresolved issues were identified: (1) unclear allocation of roles and responsibilities in multi-stakeholder environments, (2) lack of appropriate evaluation criteria for each stakeholder, (3) teacher dependency in problem setting and weak intrinsic motivation, and (4) high cognitive and emotional costs associated with deep reflection and frame transformation.

In response, this paper has proposed Engaged Immersive Learning (EIL) as an environment-driven framework built around four design elements: (1) environment, (2) immersion, (3) an AI buddy, and (4) practice-based assessment.

EIL is characterized by introducing a catalyst into learning processes that have traditionally relied on human resources and emotional costs. It does this by operationalizing LPP/CoP within a multi-stakeholder environment while positioning generative AI as a "co-explorer."

Furthermore, Sections 4 and 5 demonstrate through practical examples that EIL can: (1) generate external outcomes (conference presentations, societal implementation) extending beyond the classroom; (2) provide a framework for employers and administrative staff to evaluate students from the perspective of employability ("would you want to work with them?"); and (3) explicitly treat identity shifts as outcomes from the perspective of transformative learning. Supporting these points, this paper features a practice-based assessment framework comprising external outcomes, stakeholders, and transformation, operationalized as a six-item rubric.

6.2 The Relationship Between Recently Emphasized Multi-Stakeholder Collaboration and WIL Research

In recent years, the framework integrating the three missions of universities (education, research, and social contribution) has been evolving beyond a bilateral relationship between a single university and a single "regional partner" toward a multi-stakeholder network (MSN) comprising multiple stakeholders.de Groot et al. point out that even in networks involving diverse stakeholders, a university-centered mode, where universities tend to monopolize resources and decision-making, remains dominant[42] . In contrast, the novelty of this study's EIL lies in its intentional design of a collaborative structure closer to a polycentric-collaborative mode. This is achieved by limiting the university's role to "designing time and space" and sharing task definition, evaluation, and decision-making with external stakeholders. Consequently, each stakeholder continues to cooperate, and the number of participating companies is increasing.

Furthermore, Curto-Reverte et al. emphasize that the success of Work-Integrated Learning (WIL) depends on learning agreements, theory-practice integration, multiple forms of assessment, and stakeholder collaboration[43]. EIL aligns with these principles while reinterpreting the multi-stakeholder environment not as "external organizations to the university" but as LPP/CoP units. It positions students not as "clients" but as "new members," thereby transitioning from a dualistic debate to a seamless environment. Furthermore, EIL's Practice-Based Assessment incorporates stakeholder value (recruitment interest, invitations to collaborative research, internal use) as an evaluation axis alongside university learning outcome metrics. This provides a concrete response to the "research-practice gap" and "real impact" issues highlighted by Dwivedi et al.[7] .

6.3 Limitations of This Study

This study has several limitations and challenges for future research.

First, the scope of empirical evidence. The EIL practices addressed in this paper are based on cases from a specific university and specific courses, with limited sample size and duration. Large-scale quantitative analyses or long-term follow-up studies, as seen in existing research on PBL, STEAM, or WIL, were not conducted. Future research should validate EIL's effectiveness through longitudinal studies spanning multiple programs and years, or quasi-experimental designs with comparison groups.

Second is the issue of the reliability and validity of the assessment framework. This paper proposed a rubric consisting of three axes and six assessment items as Practice-Based Assessment. However, its reliability (inter-rater agreement) and validity (correlation with external standards) have only been explored at this stage. Particularly for the transformation axis, the development of an assessment tool linked to Transformative Learning Outcomes (TLOs) is required. Moving forward, the rubric must be refined through application to courses at other universities and in other disciplines, followed by psychometric validation.

Third is the issue of access and equity. As emphasized in WIL and multi-stakeholder collaboration research, opportunities to participate in practice are often unevenly distributed among students, potentially leading to exclusion based on socioeconomic background, disability, language, etc. EIL also risks creating disparities in participation opportunities and learning experiences due to relationships with external partners, students' time constraints, and access to GenAI environments. Moving forward, it is necessary to consider participation requirements, support measures, and hybrid online/in-person designs from an inclusion perspective.

Fourth, there are ethical and governance issues associated with GenAI integration. Recent reviews on GenAI acknowledge its potential for learning support and engagement enhancement while repeatedly highlighting concerns regarding academic integrity, fairness, and assessment reliability[44], [45]. While AI buddies in EIL are premised on human verification and compliance, numerous institutional-level issues remain unresolved: alignment with university-wide policies and IT infrastructure, relationships with AI detection tools, and accountability to students. Moving forward, operational guidelines for EIL must be developed in step with international discussions on assessment frameworks integrating GenAI.

Fifth, scalability and faculty burden pose challenges. Existing research consistently reports that building and maintaining multi-stakeholder environments incurs high coordination costs, increasing burdens on faculty and coordinators. For EIL to scale, institutional infrastructure development is essential, including university-level organizational design (e.g., liaison offices or intermediary support units), standardization of partnership agreements, and establishment of online collaborative platforms.

6.4 Conclusion: Significance and Outlook of EIL

This paper proposes Engaged Immersive Learning (EIL), an environment-driven framework, by synthesizing the challenges addressed by PBL and STEAM, the gaps that remain, theories from Kolb, Mezirow, Akpan, and LPP/CoP, and learning design catalyzed by GenAI. EIL attempts to bridge university education and social practice through: (1) long-term participation in real multi-stakeholder environments, (2) role design based on legitimate peripheral participation, (3) reflection and visualization of thinking using AI buddies, and (4) Practice-Based Assessment integrating external outcomes, stakeholder evaluations, and transformative learning.

However, EIL should be understood less as a finished "model" and more as "design principles" to be customized according to each university's and region's context. The case presented in this paper is merely one prototype. Moving forward, it is necessary to pilot EIL across diverse fields, diverse student groups, and diverse local communities, comparing and analyzing its successes and failures to clarify under what conditions EIL functions effectively or struggles to do so.

Finally, a word on GenAI. As GenAI transforms higher education and assessment into a "wicked problem," universities must confront not "how to ban AI," but "what kind of practitioners do we want to cultivate in a society where AI is a given?" EIL offers one response to this question, connecting environment, immersion, practice, and transformation. It is hoped this paper will serve as a foundation for discussions in designing higher education for the GenAI era, building upon PBL and STEAM.

7. REFERENCES

[1] C. E. Hmelo-Silver, “Problem-based learning: What and how do students learn?,” *Educ. Psychol. Rev.*, vol. 16, no. 3, pp. 235–266, 2004.

[2] A. A. Greenspan, G. S. Goldberg, and K. L. Hamilton, “Problem-based learning and digital platforms in medical education,” *Front. Educ.*, vol. 10, no. 1631337, Sept. 2025.

[3] L. Wijnia, G. Noordzij, L. R. Arends, R. M. J. P. Rikers, and S. M. M. Loyens, “The effects of problem-based, project-based, and case-based learning on students’ motivation: A meta-analysis,” *Educ. Psychol. Rev.*, vol. 36, no. 1, Mar. 2024.

[4] L. Cheng, M. Wang, Y. Chen, W. Niu, M. Hong, and Y. Zhu, “Design my music instrument: A project-based science, Technology, Engineering, Arts, and Mathematics program on the development of creativity,” *Front. Psychol.*, vol. 12, p. 763948, 2021.

[5] M. Uğraş, “The effects of STEM activities on STEM attitudes, scientific creativity and motivation beliefs of the students and their views on STEM education,” *Int. Online J. Educ. Sci.*, vol. 10, no. 5, 2018.

[6] P. Bora, “Students’ Learning Motivation in Mathematics Learning: It is Effects on Students’ Learning Approaches on Surface Approach of Learning and Deep Approach of Learning,” *IJRISS*, vol. 11, no. 6, pp. 2890–2901, May 2025.

[7] Y. K. Dwivedi *et al.*, “‘Real impact’: Challenges and opportunities in bridging the gap between research and practice – Making a difference in industry, policy, and society,” *Int. J. Inf. Manage.*, vol. 78, no. 102750, p. 102750, Oct. 2024.

[8] L. A. Pace, L. V. Markić, F. Sammut, I. D. Miles, and N. Balic, “ The role of multi-stakeholder collaborations in integrating university missions: Experience of six universities in Europe,” *Eur. J. Educ.*, vol. 60, no. 4, Dec. 2025.

[9] D. A. Kolb, *Experiential learning: Experience as the source of learning and development*. United States: FT press, 2014.

[10] J. Mezirow, “Transformative learning,” *Challenging Educational Theories*, p. 319, 2015.

[11] B. Akpan and T. J. Kennedy, Eds., *Science education in theory and practice: An introductory guide to learning theory*, 2nd ed. Cham, Switzerland: Springer International Publishing, 2025.

[12] J. Lave and E. Wenger, *Situated learning: Legitimate peripheral participation*. Cambridge university press, 1991.

[13] K. Conrad and S. Kamperman, “Building critical AI literacy: An approach to generative AI,” *Thresholds in Education*, vol. 48, no. 2, pp. 142–158, 2025.

[14] E. Mollick and L. Mollick, “Assigning AI: Seven approaches for students, with prompts,” *arXiv [cs.CY]*, 12-June-2023.

[15] D. R. E. Cotton, P. A. Cotton, and J. R. Shipway, “Chatting and cheating: Ensuring academic integrity in the era of ChatGPT,” *Innov. Educ. Teach. Int.*, vol. 61, no. 2, pp. 228–239, Mar. 2024.

[16] H. S. Barrows, “A taxonomy of problem-based learning methods,” *Med. Educ.*, vol. 20, no. 6, pp. 481–486, Nov. 1986.

[17] J. W. Thomas, “A review of research on project-based learning,” *J. Technol. Educ.*, vol. 13, no. 1, pp. 1–44, 2000.

[18] P. Blumenfeld, E. Soloway, R. Marx, J. Krajcik, M. Guzdial, and A. Palincsar, “Motivating project-based learning: Sustaining the doing, supporting the learning,” *Educ. Psychol.*, vol. 26, no. 3, pp. 369–398, June 1991.

[19] C. F. Herreid, “The death of problem-based learning?,” *The journal of college science teaching*, vol. 32, no. 6, pp. 364–366, 2003.

[20] B. Barron *et al.*, “Doing with understanding: Lessons from research on problem- and project-based learning,” *The Journal of the Learning Sciences*, vol. 7, pp. 271–311, July 1998.

[21] A. Jolly, *STEM by design: Tools and strategies to help students in grades 4-8 solve real-world problems*, 2nd ed. London, England: Routledge, 2024.
[22] National Math & Science Initiative, "How Project-Based Learning Transforms STEM Education," National Math & Science Initiative, Sept. 2025.
[23] S. N. D. Mahmud and N. K. Ismail, "STEM service learning in higher education: A systematic literature review," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 20, no. 12, p. em2549, Dec. 2024.
[24] EUROPEAN COMMISSION, "A STEM Education Strategic Plan: skills for competitiveness and innovation," 03-May-2025.
[25] National Science Foundation, "Innovations in Graduate Education (IGE)," National Science Foundation, NSF-24-529 Solicitation, 2024.
[26] E. Wenger, *Communities of practice: Learning, meaning, and identity*. Cambridge university press, 1999.
[27] S. F. Akkerman and A. Bakker, "Boundary crossing and boundary objects," *Rev. Educ. Res.*, vol. 81, no. 2, pp. 132–169, June 2011.
[28] M. Gibbons, C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, and M. Trow, *The new production of knowledge: The dynamics of science and research in contemporary societies*. London, England: SAGE Publications, 1994.
[29] M. Tripsas and G. Gavetti, "Capabilities, cognition, and inertia: evidence from digital imaging," *Strategic Manage. J.*, vol. 21, no. 1011, pp. 1147–1161, Oct. 2000.
[30] X. Zhou and L. Schofield, "Using social learning theories to explore the role of generative Artificial Intelligence (AI) in collaborative learning," *J. Learn. Dev. High. Educ.*, no. 30, Mar. 2024.
[31] R. M. Ryan and E. L. Deci, "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being," *Am. Psychol.*, vol. 55, no. 1, pp. 68–78, Jan. 2000.
[32] K. A. Miller, E. L. Deci, and R. M. Ryan, "Intrinsic motivation and self-determination in human behavior," *Contemp. Sociol.*, vol. 17, no. 2, p. 253, Mar. 1988.
[33] J. Pow and J. Fu, "Developing digital literacy through collaborative inquiry learning in the web 2.0 environment – an exploration of implementing strategy," *J. Inf. Technol. Educ. Res.*, vol. 11, pp. 287–299, 2012.
[34] C. Jia, A. Y. Lee, R. C. Moore, C. H.-S. Decatur, S. X. Liu, and J. T. Hancock, "Collaboration, crowdsourcing, and misinformation," *PNAS Nexus*, vol. 3, no. 10, p. pgae434, Oct. 2024.
[35] O. Westlund, V. Belair-Gagnon, L. Graves, R. Larsen, and S. Steensen, "What is the problem with misinformation? Fact-checking as a sociotechnical and problem-solving practice," *Journal. Stud.*, vol. 25, no. 8, pp. 898–918, June 2024.
[36] S. F. Akkerman and A. Bakker, "Learning at the boundary: An introduction," *Int. J. Educ. Res.*, vol. 50, no. 1, pp. 1–5, Jan. 2011.
[37] J. Surowiecki, *The wisdom of crowds: Why the many are smarter than the few, and how collective wisdom shapes business, economies, societies, and nations*. Doubleday., 2004.
[38] S. Jobs, "Connecting dots," presented at the Commencement address, Stanford University, 12-June-2005.
[39] D. Sims, C. Swales, and D. Aitken, "Student poster conferences as a formative, authentic, inclusive and sustainable assessment practice," *Clin. Teach.*, vol. 22, no. 2, p. e70050, Apr. 2025.
[40] P. Sattler and J. Peters, "Work-integrated learning and postsecondary graduates: The perspective of Ontario employers," Higher Education Quality Council of Ontario, Toronto, 2012.
[41] M. D. Duerden and J. C. Rowan, "Transformative Learning Outcomes: Shifting Learning Outcome Conversation from Assessment Design Outcome Conversation from Assessment Design," *International Journal of Teaching and Learning in Higher Education*, vol. 35, no. 1, pp. 186–194, 2023.
[42] L. de Groot, F. A. Demeijer, M. Zweekhorst, and E. Urias, "Multi-stakeholder networks in the higher education context: a configurative literature review of university-community interactions," *J. High. Educ. Policy Manag.*, vol. 47, no. 4, pp. 490–508, July 2025.
[43] A. Curto-Reverte, M. C. Peguera-Carré, H. Cobos-Rius, and C. Vidal-Marti, "The role of work - integrated learning in the European Higher Education Area: A systematic review," *Rev. Educ.*, vol. 13, no. 3, p. e70114, Dec. 2025.
[44] N. J. Francis, S. Jones, and D. P. Smith, "Generative AI in higher education: Balancing innovation and integrity," *Br. J. Biomed. Sci.*, vol. 81, p. 14048, 2024.
[45] S. Powell and R. Forsyth, "Generative AI and the implications for authentic assessment," in *Using Generative AI Effectively in Higher Education*, 1st Edition., London: Routledge, 2024, pp. 97–105.