Enhancing Graduate Student Learning and Engagement through Graduate Industry-Integrated Internship Courses: Problem-Based Learning Approaches

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Abstract

Full Paper: This study investigates how the Graduate Role-Playing Internship Course impacts students' academic learning, professional identity development, and particularly their ill-structured problem-solving skills, as well as course engagement and self-efficacy related to professional tasks, which are key objectives of PBL [1]. We developed a two-semester curriculum simulating an internship experience that students might gain by working in a company within an academic setting. In the course, students act as intern engineers, while instructors serve as program managers, and students eventually assume leadership roles. The course employs PBL using real-life scenarios in a cleanroom micro/nano fabrication laboratory, providing hands-on experience to acquire the knowledge, skills, and abilities necessary for industry. We conducted individual interviews and a focus group interview with all students to examine their engagement, role perceptions, and problem-solving processes.

The findings indicate that students became immersed in their assigned roles and came to perceive themselves as intern engineers rather than students. Through this role immersion, students developed a strong sense of professional accountability. Grounded in this accountability, they voluntarily expanded their problem space during problem framing, actively adopted iterative problem-solving processes, and engaged in decision-making and justification based on professional standards and answerability. As a result, they were able to engage more effectively in ill-structured problem-solving processes. These findings suggest that role-playing internship courses may, in some respects, provide learning experiences that are as effective as, or potentially more effective than those offered by traditional internship settings.

Introduction

Problem-based learning (PBL) is widely recognized as an effective pedagogical approach in engineering education because it promotes critical thinking, problem-solving, collaboration, and professional communication skills [2]. A defining feature of PBL is student engagement with authentic, practice-based problems that reflect the complexity and uncertainty of real-world engineering work. These problems are often ill-structured, meaning they are not clearly defined and do not lead to a single correct solution. Instead, learners must determine relevant information, define the problem space, and decide which strategies and skills are required to address the situation [3]. Through sustained engagement with such problems, PBL supports deeper learning processes that extend beyond technical knowledge to include professional judgment.

Despite its potential, PBL in engineering education is sometimes implemented in limited and fragmented ways. In some courses, PBL is confined to a small portion of the curriculum embedded within otherwise traditional lecture-based structures [4]. When PBL lacks continuity and authentic context, students may experience reduced motivation and engage only superficially with problem-solving tasks. Research indicates that effective PBL requires clearly defined roles for both students and instructors, as well as learning environments that resemble professional practice [5]. Without these elements, students may have fewer opportunities to meaningfully engage with ill-structured problems and connect learning to real-world engineering contexts.

To address these limitations, this study examines a Graduate Role-Playing Internship Course as an alternative instructional model for graduate engineering education. Although role-based learning approaches are not limited to graduate education, this approach was applied in a graduate engineering course because graduate students are closer to professional practice and face higher expectations for autonomy, professional judgment, and decision-making.

Rather than treating PBL as a discrete instructional strategy, the course embeds student-centered PBL and role-playing across the entire learning experience. The course is designed as a bounded system in which students operate within a simulated industrial "company," assume professional roles, and engage in ongoing problem solving under the guidance of instructors acting as supervisors. By situating learning within an organizational context, the course provides sustained exposure to engineering practices and creates a setting well suited for in-depth qualitative examination of a contemporary educational phenomenon [6].

Within this internship-style learning environment, students regularly encounter ill-structured problems that resemble those faced by practicing engineers. These problems emerge through hands-on microfabrication activities, including cleanroom protocols, wafer fabrication, and etching processes, where uncertainty, constraints, and trade-offs are inherent. Students collaborate, make decisions with incomplete information, justify technical choices, and adapt strategies through iterative experimentation and reflection. Consistent with Jonassen's characterization of ill-structured problem solving, learning in this context involves generating solutions, refining problem definitions, and developing professional judgment over time [3].

Guided by a qualitative multiple-case study design, this research explores graduate students' experiences within the Graduate Role-Playing Internship Course, focusing on how participation in a role-based PBL environment shapes their problem-solving processes and professional thinking. By examining multiple cases within a bounded course context, the study aims to generate contextualized insights into how graduate engineering students engage with ill-structured problems when PBL is implemented as a course-wide framework rather than a limited instructional activity [6]. The study also explores how students experience responsibility and decision-making while engaging with ill-structured problem solving. Therefore, the study is guided by the following research question: How does the Graduate Role-Playing Internship Course impact graduate students' problem-solving skills within a PBL environment?

Ill-structured Problem Solving

Ill-structured problem solving involves engaging with complex and ambiguous situations in which goals, constraints, and acceptable solutions are not clearly defined but must be interpreted, negotiated, and refined through practice. These problems are embedded in specific social, cultural, and material contexts, requiring learners to construct understanding in action as they interact with people, tools, and institutional arrangements rather than applying decontextualized rules [3]. In STEM education, ill-structured problem-solving places learners in open-ended situations that resemble real-world challenges and allow for multiple viable solutions rather than a single correct outcome. These tasks require students to work with uncertainty, draw on prior knowledge, and revise their thinking as conditions evolve [3]. Unlike well-structured textbook problems, ill-structured problems involve incomplete information and demand judgment, interpretation, and decision-making. When supported through appropriate guidance, engagement with such problems can enhance conceptual understanding, creativity, and mastery-oriented learning; however, poorly structured tasks or limited instructional support may heighten frustration and discourage sustained engagement [7].

Problem-based Learning (PBL)

This research is situated in the context of PBL, an instructional approach that centers learning on authentic, often complex problems, requiring students to identify their own learning needs, collaborate, and apply knowledge to realistic situations rather than passively receiving information through lectures [7]. By engaging learners in sustained inquiry, PBL emphasizes active participation, self-directed learning, and the integration of theory and practice. When appropriately scaffolded, PBL can support engagement, motivation, and the development of problem-solving skills; however, insufficient support may lead some learners to experience uncertainty or cognitive overload, particularly as they are accustomed to more traditional instructional formats [8].

Despite positive evidence, PBL does not always yield the intended outcomes when problems lack authenticity or when roles and responsibilities are insufficiently structured [5], [9]. In such conditions, students may engage only superficially and treat PBL activities as disconnected assignments. To strengthen the authenticity and clarify roles, this study proposes a role-based course.

Role-playing in Higher Education

Role-playing has emerged as a valuable active pedagogical approach in higher education, particularly in response to demands for more effective and engaging learning strategies. Contemporary educational contexts emphasize teaching methods that foster student participation, interaction, and reflection as core components of meaningful learning [10]. Within this shift, role-playing simulation activities are recognized as a versatile instructional strategy across disciplines, offering opportunities to engage with complex, practice-oriented learning experiences [11], [12]. By assuming defined roles within simulated systems, students apply theoretical knowledge while developing transferable skills such as leadership, coordination, communication, and decision-making [10]. These simulations replicate professional contexts, enhancing engagement and support deeper learning through experiential participation.

Role-playing is recognized as an effective pedagogical strategy in STEM education, particularly within open and authentic learning environments that support the development of students' STEM identity and interest in STEM careers. Such environments enable learners to see themselves as capable contributors who can apply STEM knowledge to real-world problems and societal decision-making [13], [14]. Through role-playing, students adopt discipline-specific roles and engage in simulated scenarios that mirror professional practices, allowing them to apply knowledge while navigating complex challenges. Role-playing provides structured opportunities to rehearse decision-making and communication in realistic settings and supports the development of teamwork, problem-solving, and communication skills while highlighting the collaborative nature of professional work [13], [14], [15]. Across STEM disciplines, role-playing promotes experiential learning that strengthens professional identity and readiness for future careers.

Methods

Research design: This study employed a qualitative multiple-case study design to examine graduate students' experiences with student-centered PBL and role-playing in an internship-style engineering course. A case study approach was appropriate because the research aimed to conduct an in-depth examination of a real-world, contemporary phenomenon within clearly defined boundaries, using rich, detailed data collected over time from multiple sources [6]. Specifically, the study explored how students engaged in ill-structured problem solving within a PBL environment and how these experiences shaped their learning processes and professional thinking. In this research, each student interview (four students) and the focus group interview (FGI) were treated as separate cases, as each captured distinct individual and group level experiences, perceptions, and reflections related to role-playing and problem solving within the course.

Research context: The study was conducted in a graduate-level engineering course offered at a major public university in the southwestern United States during the Fall 2025 semester. The course was structured to simulate an industry internship experience through student-centered problem-based learning and role-playing. It was designed to mimic an industrial work environment, with instructors assuming the role of "bosses" and students assuming leadership and professional roles within a simulated "company." The students participated in 50-minute classroom lectures and three-hour practical laboratory sessions twice per week, along with additional practical laboratory hours. They took on roles as engineers and interns, while the instructor functioned as a supervisor or "boss," reflecting an authentic workplace structure. Course activities emphasized hands-on microfabrication tasks, including cleanroom protocols, wafer fabrication, and etching processes.

The problems addressed in the course reflected ill-structured situations commonly encountered in professional practice, where challenges were presented as complex scenarios rather than clearly defined tasks [3]. The project was determined by the instructors but informed by real-world industry needs and representative semiconductor fabrication challenges. These activities require students to collaborate, make decisions under conditions of uncertainty, and justify technical choices. Unlike traditional classroom problems with predetermined solutions, these tasks required students to define the problem, identify relevant information, and determine appropriate technical approaches. Rather than relying on traditional lecture-based instruction, the course emphasized PBL supported by experimentation, trial and error, and reflective practice.

Participants: In the Fall 2025 course, four students were enrolled, and all four students participated in this research. All participants were master's students affiliated with graduate engineering programs, including chemical engineering, electrical engineering, mechanical engineering, and computer science/electrical engineering. All four participants completed individual interviews, and three also participated in a FGI at the end of the semester.

Data collection: Data were collected through semi-structured individual interviews via Zoom and one FGI conducted in a classroom. The interviews explored students' experiences with ill-structured problem solving, decision-making processes, learning from failure, collaboration, and perceptions of professional responsibility within the role-playing course environment. The FGI provided an opportunity for participants to collectively reflect on shared experiences, compare perspectives, and generate group-level insights related to the course design. Interview protocols consisted of open-ended questions and allowed flexibility to probe emerging themes.

The unit of analysis comprised two related but distinct components: (a) individual interviews, which captured students' personal experiences and perspectives, and (b) the FGI, which reflected group-level interactions and shared meaning-making processes. Treating individual and group data as complementary units enabled a more nuanced understanding of how learning unfolded across both personal and collective dimensions within the same instructional context. Sample individual interview questions included: "Can you describe a time when you faced a difficult or unexpected problem during the course, and how you approached solving it?", "How did your team make decisions when multiple solutions were possible?", and "Did participating in this course change how you perceived your role or responsibilities compared to a typical class?" In addition, through focus group questions, participants were asked to reflect on their team and individual experiences related to course projects, including their problem-solving experiences and decision-making processes.

Data analysis: Data analysis followed a theory-informed qualitative coding approach. An initial coding scheme was developed a priori based on existing frameworks related to ill-structured problem solving and instructional design theory. A structured codebook using a binary coding scheme (0 = absent, 1 = present) was developed to guide the analysis. Each individual interview and the FGI were treated as separate analytic cases, and each code was marked as present if the construct appeared clearly at least once within a case, or absent if it did not or was too ambiguous to support coding. Additional inductive coding and analytic notes were subsequently employed to capture emergent patterns not fully represented in the initial framework. Each individual interview transcript and the focus group transcript were analyzed iteratively through repeated readings to ensure depth and accuracy of interpretation. Through this iterative process, analytic decisions were made through comparison during coding, and the initial a priori codes were refined over time based on patterns observed in the data. Theoretical frameworks on key constructs such as ill-structured problem solving guided both the development of code definitions and the interpretation of themes, which were documented in the codebook.

To enhance analytic rigor, coding was conducted independently and then compared across cases. Discrepancies were discussed until consensus was reached, resulting in a refined codebook. The inter-rater agreement for final coding exceeds 96% based on binary coding, indicating a high level of consistency in code application. Analytic patterns were developed through cross-case analysis, allowing patterns to be identified across individual and group data while preserving contextual detail.

Researcher positionality and trustworthiness: The four authors bring complementary backgrounds in STEM education, instructional design (ID), human resource development (HRD), and mechanical engineering. Two authors served as co-instructors of the course; however, they were not involved in conducting interviews or in the coding and analysis of the data. All interviews and analytic procedures were conducted independently by the first and second authors to minimize potential bias associated with instructional roles. This separation of instructional and analytic responsibilities enhanced the trustworthiness of the findings. Additional strategies to strengthen rigor included prolonged engagement with the data, iterative coding, cross-case comparison, analytic consensus-building, and triangulation across individual and group data sources [16].

Findings and Discussion

Immersion in the role-playing setting: This research aims to understand how the role-playing internship course influenced students' ill-structured problem-solving skills. Through individual interviews and the FGI, it was observed that students' perceptions of both the instructor and their own roles shifted over time. In other words, students intentionally reframed both the instructor and the course environment as components of a workplace setting rather than a traditional classroom. This shift in perception reflects students' active engagement in redefining the learning context rather than passively accepting a traditional instructional setting.

This perception change may not have happened automatically or immediately. Instead, it appeared to develop gradually and required deliberate effort over time; however, it eventually occurred for all students. The repeated emphasis by the instructor on the role-playing concept of the course during the early period of the class appears to have helped students accept and become immersed in the internship role play. Through repeated reinforcement, students gradually internalized internship expectations and began to engage with course activities through a workplace-oriented lens.

> It's weird because I know that he is effectively my professor, but I'm trying to treat this as much as myself as an internship, so I'd like to look at him as my boss. Sometimes I feel like it always doesn't come across it just because I'm always asking questions, which isn't something you would do to a boss, but I definitely make it a point to try and to see it that way. […] Dr. Pleil (instructor) is making it very clear that you treat this like a job where

> he’s essentially your boss. And when you don’t know how to do something in your place of work, you go and ask your boss, and they give you an answer. They don’t scold you for not knowing something or anything like that (Nick, FGI).

This intentional role immersion shaped how students interpreted interactions, sought guidance, and navigated uncertainty, which are critical components of ill-structured problem solving in professional contexts.

Professional accountability-Effects of immersion in role-playing: The more students identify themselves as interns and team members within a workplace-simulated project, the more they internalize professional accountability. This is a salient and interesting phenomenon observed in this course.

Professional accountability is defined as a structure in which an actor is expected not only to fulfill their responsibility (the obligation to perform) but also to explain and justify their decisions and implementations to a forum of professional peers and superiors. This justification must be based on reasoned grounds and professional standards [17], [18]. Thus, professional accountability goes beyond simple responsibility for one’s work; it is significantly enhanced by a sense of ownership, which provides the initiative for one's tasks.

Previous research argues that professional accountability can be enhanced by various constructs, such as social interaction, trust, the expertise level of the forum, and clear roles and expectations [19]. In this research, we did not intentionally manipulate these components. We simply provided the role of an intern engineer in a simulated workplace. Interestingly and unexpectedly, students demonstrated high levels of professional accountability. By the mere assumption of being an intern, students readily accepted the roles and expectations of an engineer. This indicates that students formed "felt accountability": a psychological state in which the actor believes their work and decisions will be assessed based on professional standards by experts [19].

> ... when it is time to submit your submissions, like assignments, or any work report or other things. So, I do it very carefully, like I'm submitting to my company's boss, otherwise they'll fire me from the job. So, I made it very clear at that time. It's not like class assignments. So, I try to do it in a more professional way. […] In a traditional class, we do just homework and all other stuff they're giving us, but here in every week we have to submit weekly report what we did in this whole week, what we learned, and then if any project done, then we have to submit, okay, what is the project, how did we do this, all the steps, what types of problem like we did or what type of mistake we did in the lab and how we solved that lesson learned and what is the like expected work in the upcoming week. So, this is how it differs from other courses. Like in other courses, it's just like regular things, but here you have to keep them updated. Even if you fail to complete your work, you have to give them updated like, okay, because of this I didn't

> complete my work. Yeah, it's fine. You can complete it in the next week, but still you have to submit why you failed or why you got stuck. (Leo, FGI)

As shown in Leo's interview, students re-identify assignments as required "deliverables" rather than mere homework. This change of perception leads students to view their work as their own responsible tasks, helping them understand the practical consequences of their results.

This shift is also influenced by the structure of the course assignments, which are based on a workplace setting (e.g., weekly reports and status updates). These reports require students to explain and justify their decisions, delays, and even failures, as well as their successes. This *answerability* (the perceived obligation to explain and justify one's conduct [17]) reminds students that they are not passive learners but active and responsible engineering interns.

In addition, students demonstrate a strong awareness of forum expertise and professional consequences. Leo perceives that the forum (the boss) will examine his work through the lenses of expertise and professional standards rather than typical academic criteria. He situates himself within a professional context where failing to meet these standards can lead to significant consequences, such as *being fired*. This perception transforms the assignment into a professional task, fundamentally enhancing the students' professional accountability by making the perceived risks and standards feel authentic.

Interestingly, we also observed a potential downside of deep role immersion. In Leo's comments, he stated, "I'm submitting to my company's boss, otherwise they'll fire me from the job." While termination solely due to a missed report submission would be unlikely in most real-world workplace settings, this remark suggests that Leo may have simplified or exaggerated the relationship between professional responsibility and its consequences. Such heightened perceptions of negative outcomes may introduce unnecessary psychological pressure during the learning process.

Based on this evidence and interpretation, it is evident that students developed robust professional accountability toward their work. Furthermore, this role-playing internship course suggests the capacity to provide more practice opportunities beyond real-world internships. In real-world workplace settings, student interns often perform as assistants/ demonstrate supportive roles rather than leading core projects. In such assistant roles, answerability and responsibility for project outcomes are typically attributed to team leads or senior members rather than the interns. This can dilute an intern's professional identity, accountability, and agency.

In contrast, this course positions students to co-lead projects. This setting blocks the "feeling of immunity" often caused by the diffusion of responsibility. Instead, it provides sole answerability, leading students to fully embrace the responsibility and consequences for all their decisions and results.

Expansion of problem space: This research aims to investigate the effects of the internship role-playing course on problem-solving. We observed that students' problem space expanded during the problem-solving process while they were working on their projects, meaning that students broadened cognitive boundaries within which a problem solver searches for causes and solutions.

When students internalized their identity as intern engineers in a workplace setting and undertook ownership of their projects, a natural expansion of the problem space occurred. As discussed in the previous section, in the ill-structured problem-solving process it is critical to frame a problem, which involves defining the boundaries and conditions of the task [3]. In traditional college courses, students frequently perceive problems as "well-structured", assuming there is a single correct answer. Consequently, they aim to precisely follow textbook instructions or course instructors. When the problem remains unresolved or unexpected challenges emerge, students often narrow their inquiry to personal performance, framing the issue as, "What did I miss compared to the course notes?"

In contrast, this course enabled students to review the whole process rather than focusing solely on individual tasks. This shift appears to be primarily driven by the exercise of agency, rooted in students' ownership of the project. By identifying themselves as the key agents responsible for the project's success or failure, students appear to have moved beyond merely repeating prescribed procedures and actively sought to resolve issues and achieve results. This sense of agency appears to have expanded their focus from checking fragmented individual tasks to examining the process as a whole.

> I think something that really helped was during our first project we were doing, I'm going to use this a lot like photolithography because it's a really important process in semiconductor manufacturing. But we discovered that our structures were not as sharply etched as we were hoping for them to be. And we all came to the conclusion that it was due to the photo masks that we had, because the photo mask has a polarity to it that interacts with the photolithographer. So, if it's not sharp or if it's reversed or if the mask is upside down, it causes light scattering. So, your image that gets transposed onto your silicon wafer doesn't come out as sharply defined. So, we were able to come to that conclusion pretty much amongst ourselves, me and the team. So that is when I felt like my intuition and problem solving and critical thinking really improved because normally, I wouldn't have really known why our structures didn't come out properly or things like that. I would have just assumed we over etched or something to that accord, as opposed to it being an intrinsic problem from a mask that we're using. (Nick, Individual Interview)

Nick's interview clearly illustrates how he exercises agency within the project. He admits that, previously, he would have "just assumed" the failure was due to a simple error like over-etching and would have moved on without further investigation. This reflects a typical behavior in traditional classroom settings, where learners prematurely halt their exploration by attributing problems to their own lack of skill or minor procedural mistakes.

However, in this project, Nick shared the initiative for problem-solving with his teammates ("me and the team"). Because he felt a profound responsibility for the outcome, he did not settle for superficial guesses. His remark, "Normally, I wouldn't have really known," paradoxically suggests that his intense ownership, the determination to uncover the root cause, was the very force that drove him. This psychological driver led him to investigate the physical principles of the process, such as mask polarity and light scattering, and ultimately resulting in successfully resolving the problem by expanding the problem space from an individual scope to the entire process.

Iterative problem solving and learning from failure: Iterative processes are central to ill-structured problem solving [3]. In this course, students with enhanced professional accountability and ownership appeared to change how they perceived failure in their work. Instead of treating failure as meaningless time spent in a single, isolated process, students began to perceive failure as an opportunity to generate additional data and insights. Experiences of failure prompted students to treat mistakes as learning moments and use them to advance their projects.

> Another thing that I could think of was before working on those little chips, we had like giant wafers and we would etch them inside a giant bath. And the results were not as, how do I say that, were not as favorable as that one chip that we had. So, it was a process, well, working backwards, figuring out, oh, wow, why, does that process yield this and how do we improve it? And basically, after a bunch of discussions and looking up resources, we figured out like, oh, yes, well, our wafer didn't work because it's either the was, the bath was dirty, the concentration was wrong, or something happened in the process step. So, we kind of figured out a way to pivot away from that and like, yes, maybe we could just dice up the wafer into little chips and use it in a new bath and see how it goes. And as you see from yesterday, the results from that were a lot more, let's say, a lot better than what we had before. So, but yeah, basically figuring out how to fix issues with processes inside the clean room. I think that's what I learned the most. (Garry, Interview)

Garry’s interview clearly shows that students engage in problem solving through an iterative process. When the team experienced failure (etching failure in a giant bath), team members together analyzed possible causes for the failure, such as a dirty bath, incorrect concentration, or other issues in the etching process. Based on this analysis, they decided to dice up the wafer and apply different combinations of solutions in parallel in order to identify more optimal outcomes. In this iterative problem-solving process, the team used a “working backward” approach, meaning that they attempted to confirm and refine the process by examining the results. This reflects a relatively high level of iterative problem solving.

During this process, students also recognized that iteration through failure was effective not only for problem solving but also for their learning.

> I feel you almost learn more in a mistake than you do doing it successfully on the first go around. (Nick, FGI)

This type of iterative process typically requires more time and more deliberate effort in the short term than a traditional, straightforward approach. However, students appeared to adopt the iterative process intuitively and with minimal conscious effort. One possible reason for this pattern is students' enhanced professional accountability. Students perceived failure as a necessary component for continuous engagement or improvement rather than as an individual mistake or something that could be ignored. This perception can support iterative processes such as re-identifying problems, searching for alternative solutions, and engaging in repeated testing and feedback. This may stem from the belief that their work and decisions would be reviewed based on professional standards [19].

Decision-making and justification: In ill-structured problem solving, there is no single correct answer. Since such problems have multiple possible solutions, problem solvers must consider which option is most appropriate given the situation [3]. Therefore, it is important to consider trade-offs and provide justification based on incomplete information.

In the anecdote Garry mentioned above, the project team considered various possible causes of failure. They generated alternative solutions, discussed these options, compared them by weighing trade-offs, and ultimately decided to dice up the wafer and examine the results. This sequence represents a typical ill-structured problem-solving process. During this process, the team analyzed the issues collaboratively and justified both their solutions and decision-making processes, reflecting an effective approach to decision-making and justification [20]. In this course, there is no evidence of instructor intervention in this process. Instead, students appeared to fully own and lead the decision-making process, which was grounded in their sense of professional accountability, particularly their answerability for decisions and outcomes.

Summary and Conclusion

In summary, this research adopted the graduate role-playing internship course in order to implement PBL as a course-wide immersive learning framework and investigated how this course impacted graduate students' problem-solving process. Figure 1 summarizes the relationships among role immersion, professional accountability, and the observed changes in students' ill-structured problem-solving processes.

Within the course, students gradually became immersed in their assigned roles and situations. This immersion did not occur immediately at the beginning of the course. Instead, through the students' deliberate efforts to engage with the assigned roles and workplace context, students increasingly accepted and internalized the role-playing setting. Through this process, students came to perceive themselves as intern engineers who actively participate in projects and, in doing so, developed a clear sense of professional accountability, which is consistent with the conceptualization of felt accountability in the previous research [19]. With this enhanced professional accountability, students expanded their problem space during ill-structured problem solving, moving beyond narrow task execution toward broader problem framing, as described in prior research on ill-structured problem solving [3]. In addition, they intuitively and voluntarily adopted iterative problem-solving processes, which often require more time and effort in the short term [3], [20]. Students generated multiple possible causes and solutions, compared trade-offs among alternative approaches, and justified their decisions in professional terms [3], [20]. They also reflected that these experiences were highly effective for both their learning and project execution.

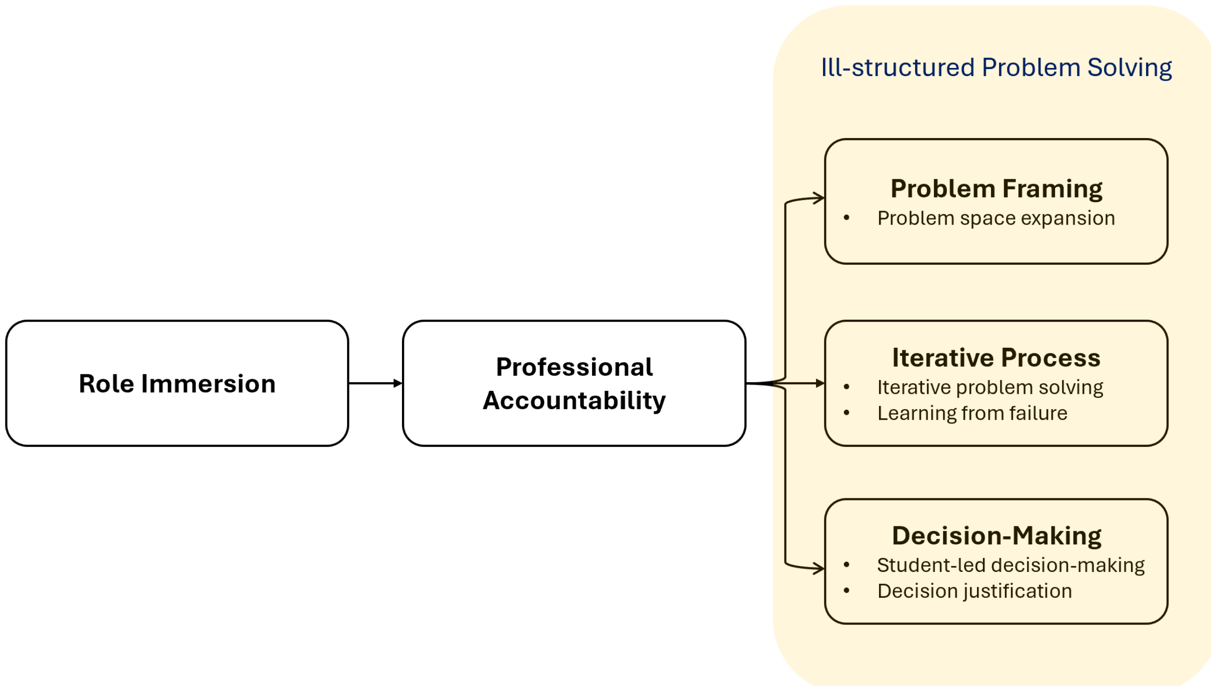

Fig. 1. Summary of findings: Role immersion, professional accountability, and ill-structured problem-solving.

The findings of this research suggest that role immersion plays a key role in fostering and practicing students' professional accountability, which in turn contributes to their engagement in ill-structured problem solving in workplace settings as well as to their learning process [3], [19]. Interestingly, this study also points to the possibility that role-playing internship courses may provide even more opportunities for practicing decision-making and responsibility for outcomes than some real-world internships. In many real-world internship settings, interns primarily perform assistant tasks, and responsibility for decisions and outcomes is often attributed to senior team members. In contrast, the role-playing internship course examined in this study positioned students to engage more directly in decision-making and to assume responsibility for the results of their work. In light of these implications, this research highlights the educational value of internship-based role-playing courses as an instructional approach in graduate engineering education [5].

Considering these findings together, future research could further examine how experiences of role immersion and professional accountability impact students' professional identity formation and the development of self-efficacy [13], [14]. In addition, future studies could explore how role-playing courses can be designed to effectively support learning while appropriately calibrating students' perceptions of responsibility and consequences, particularly in cases where role immersion may lead to exaggerated or inaccurate assumptions about workplace outcomes.

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