Board games as experiential micro-simulations: Modeling competency development in project management education

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***Abstract*— As workplaces become increasingly complicated, a new type of teaching and learning needs to emerge that can effectively combine theory with skill development in HE. Much attention has been paid to the way in which game-based learning has developed in the context of digital simulation, and yet the vast majority of existing research focuses on that medium while not actually addressing board games from a conceptual and empirical perspective. The purpose of this study is to define how board games can be understood as experiential microsimulations that can provide a formally structured method for developing structured skills in project management education. This study is based on experiential learning theory and frameworks for competency-based education, and we will conduct an empirical study to test a conceptual model that explains the relationship between board game-based learning, cognitive activation, strategic decision-making, collaborative behaviors, and risk-based reasoning, and, ultimately, how these activities improve project management skills. The study adopts a quantitative explanatory research design; specifically, a structured questionnaire distributed to participants at the end of playing an educational board game intervention conducted within a fourth year Industrial Engineering Project Management course. Reliability, Pearson correlation, and bootstrapped regression-based mediation testing methods were used to analyze the data from the survey. The findings of this research indicate that the use of board games has proven to be an effective way of creating structured experiential ecosystems for engaging students cognitively and in cooperative processes, and that these two processes will in turn significantly predict the acquisition of competencies. Additionally, the results of the research will provide evidence of the mediation effects of active engagement mechanisms with respect to the creation of professional skill development through the experiential learning process. Through theory, this study extends and builds upon simulation theories (micro-level) and their use in non-digital gaming environments (micro-level) by providing a theoretically grounded model of game-based (non-digital) experiential learning, as well as providing action-oriented information for curriculum design that incorporates structured experiential micro-simulations into management education. Additionally, the results of this study generate future areas for longitudinal and cross-contextual research regarding competency-based innovation in higher education.**

***Keywords*— Board game–based learning; experiential micro-simulations; project management education; competency development; active learning; higher education innovation.**

I. INTRODUCTION

Due to advancements in technology, systemic risk, and the high level of complexity in projects, professional environments are rapidly evolving; and consequently, demands and requirements are much greater than they have ever been before for higher education institutions to provide education through structured competency development versus creating knowledge. In disciplines such as Industrial Engineering (IE) and Project Management (PM), students are expected to demonstrate their ability not only to learn and understand theoretical constructs, but also have the skills to make and apply decisions, coordinate and collaborate with others, and develop adaptive strategies when dealing with uncertainty. Traditional lecture-based learning methods do not sufficiently address how to develop applied competencies in these areas, instead continuing to focus primarily on the cognitive aspects of learning without addressing the experiential aspects of learning. Over the past two decades, active-learning pedagogies have become a more widely recognized and established way to teach alternative methodologies to passive or non-active forms of instruction. Numerous studies in both cognitive science and educational psychology have shown substantial increases in learning outcomes when students actively reflect, interact with, and apply the material they are learning [1], [2], [3]. Further, Kolb's Experiential Learning Theory [4] supports or reinforces this theory; that experiential learning occurs when there is a cycle of experiencing, reflecting, conceptualizing, and experimenting with an experience. In the context of this pedagogical change, game-based learning has become an attractive approach to implement experiential education in a structured environment [5].

The existing body of research regarding game-based learning is centered on the use of digital simulations and serious games with the aim of increasing motivation, engagement and knowledge retention [6], [7], [8]. Non-digital board games, however, have been less well explored conceptually and empirically than their digital counterparts. Board games have been shown to foster social interaction, encourage collaboration and support the development of a strategic mentality [9], [10], yet research on board games has largely been descriptive in nature and has very little robust theoretical modeling on how

these mechanisms lead to formally developed competencies in the project management profession [11]. Few studies to date explicitly recognize board games as simulations of real-world systemic project dynamics and, therefore, do not investigate the role of board games in micro-scale pedagogical ecosystems.

As noted previously, the gap between theoretical education and practical application of required competencies in project management education is one of the most pronounced in the educational realm. The ability for students of project-based disciplines to manage constraints, allocate resources, assess risk and coordinate multiple stakeholders in an unknown environment requires an understanding of how the competencies they are developing within their project management education is progressing. Competency frameworks within project management have shifted towards an emphasis on not just the development of technical competencies, but also the development of behavioural and contextual competencies, including leadership, communication and adaptive reasoning. A deficiency in pedagogical models outlining the means in which experiential tools contribute systematically to competency development also exists even though the overarching trends in education have shifted toward competency-based education.

To tackle this issue, researchers have recently begun studying the pedagogical district and proposing structured learning scenarios that include experiential and reflective elements. Some authors argue that innovation and competency acquisition are enhanced when students work collaboratively in dynamic decision-making environments requiring iterative problem-solving. However, little research has been conducted on the use of this framework for project management education using tangible, non-digital simulation methods [12].

This study builds on experiential learning theory, simulation-based educational practices, and literature on competency development to conceptualise board games as experiential micro-simulations. Unlike electronic media-based simulations; board games create a physical, co-present environment with resource limitations and a specific set of rules. The learners must then come together to make sense of uncertainty as well as negotiate how to develop a strategy and make decisions in sequence. The use of structured environments simulates key elements of an actual project environment on a smaller scale and allows for safe experimentation and an appropriate level of complexity.

This document shows how using board games to learn has value not just as an engaging way of learning but as a structured design of micro simulation environments that can activate essential factors (i.e., cognitive activation, strategic decision-making ability, collaborative dynamics, risk-based reasoning) related to developing competencies in project management education. These four factors contribute to developing competencies within project management.

To validate how the above factors lead to developing competencies in project management, this research developed and tested a conceptual model (using an empirical approach) of how board games can be used within an industrial engineering project management course for fourth-year students. By integrating theoretical modeling and empirical validation, this research aims to support the understanding of how to use non-digital games as a form of experiential learning beyond simply describing them.

The objectives for this research include:

Conceptualizing board games as experiential micro-simulations in post-secondary education

Creating a theoretically based model to illustrate the mechanisms through which board games develop competencies in project management.

The goal of this research is to develop and test a conceptual model through empirical research in the context of an industrial engineering project management course. The empirical research will enable the integration of empirical and theoretical evidence to improve the understanding of non-digital game-based learning to be more than just a description, but to provide a structured explanation.

The objectives of this research are:

1. To understand how board games can be viewed as experiential micro-simulation in the context of higher education.
2. To build a theoretical model that explains how board games support project management competency development.
3. To test the model through empirical research in a real classroom setting.

By meeting the three research objectives, this research makes three contributions to the research literature: (a) it furthers our understanding of experiential learning theory by viewing board games as a micro-simulation ecosystem; (b) it advances the body of research in competency-based education through the development of a theoretical model that explains the mediating effects of experiential engagement on professional skills development; and (c) it provides practical insights for curriculum designers looking for structured, innovation-based pedagogical tools in management education.

II. LITERATURE REVIEW

A. Experiential Learning and Active Pedagogical Transformation

Competency-based higher education has been greatly impacted by the theory of experiential learning and constructivist viewpoints. Kolb's Experiential Learning Theory [4] states that we learn through a cycle of experiencing something as well as observing what we did, thinking about it in conceptually, and then trying out what we just created. Learning is the active creation of new meaning by interacting with structured activities rather than passively accumulating information.

Constructivist theory supports this notion by stating that knowledge is built by the learner via interaction, experimentation, and problem-solving in context . This requires a shift from linear models of instruction to interactive learning environments and ecosystems that promote cognitive activation and metacognitive reflection.

Active learning techniques have been shown to increase student performance, retention of knowledge, and student engagement by an order of magnitude over traditional lecture-based methods [1], [2], [3], [13]. In particular, when it comes to

management and engineering education, experiential learning opportunities better equip students for success in complex work environments as they develop reasoning and decision making skills.

Recent studies into pedagogical innovation have illustrated that, through the use of structured experiential scenarios that have been created for the purpose of developing higher-order cognitive skills, students can assess and evaluate their experiences at advanced levels as described by the taxonomy of Bloom. Abdessadak & al. have proposed a new framework for assessing innovation-driven skill development based upon their findings demonstrating that when students participate in engaged and dynamic learning environments, they achieve the highest levels of the taxonomy, including the analytic, evaluative, and creative stages. Their research further indicates that when students experience structured experiential contexts, they will not only learn through engagement but will transform their competencies via a continual process of interaction and reflection on their collaborative experiences [12].

While experiential learning theory lays a foundation, it is somewhat limited in its ability to explain how specific pedagogical mechanisms can use tools to replicate the simulation processes associated with the systemic dynamics of the real world. This limitation defines a need for further integration with simulation-based learning theories.

B. Simulation-Based Learning and Micro-Level Pedagogical Ecosystems

Simulation-based learning is well established as a tool that connects theory and practice within disciplines that require professional competency [7], [14]. Simulations provide learners with an opportunity to experiment, make choices and see the results of their choices in a safe environment with no real-world consequences[15].

The majority of current simulation research examines the learning that can occur from the use of digital simulations and serious games [6]. The majority of the research on the effect of simulations has established that students who have engaged in simulation-based activities have increased levels of motivation, systems thinking, and strategic thought processes. However, research on the use of digital simulations has tended to disconnect learners from the tactile characteristics of the learning environment as well as from the social characteristics associated with physical co-presence when they are playing simulation-based games in a non-digital format (e.g., playing a board game).

The characteristics that describe the way in which board games are structured are similar to the way that most project management practices occur. These characteristics include:

-Explicit rules;
-Resource limitations;
-Sequential decision-making;
-Dynamic feedback loops; and
-Competitive or cooperative interactions.

Existing literature that has examined board games within post-secondary education primarily uses descriptive methods to study the degree of engagement and enjoyment with participation in board games rather than focusing on the structural role of board games as a type of simulated learning environment (micro-simulated ecosystems).

Understanding the similarities between the structural characteristics of board games and project management practices allows for the extension of simulation theory to include micro-learning environments that can be used to enhance the understanding of project management. Within micro-simulated ecosystems,social interaction, spatial orientation, and systemic reasoning must be part of the process of learning within the constraints of project management; therefore, project management learners will be able to learn how to allocate resources, assess risk, manage stakeholders, and strategically adapt to changes in a project in the same way that they would develop their skills in a real project life cycle.

This conceptualization is consistent with innovation-focused pedagogical models emphasizing repeated experimentation and flexible decision making and can be seen in terms of how board games act as sources of motivation and also as a site for the activation of systems-like structures providing support for the development of professional competencies.

C. Competency Development in Project Management Education

Competency-based education continues to be one of the primary paradigms of education in management and engineering curricula. Competency-based education is more than just gaining knowledge; it involves bringing together cognitive, behavioural, and contextual capabilities to be successful in the workplace. In Project Management, the competencies in a competency model typically include: Technical Competencies (as in planning, scheduling, and budgeting): Behavioural Competencies (as in communicating, leading, and working within a team): Contextual Competencies (as in input froming other students, the leader of the team, and creating a winning strategy for your team): The current world of project management has become characterized by volatility and uncertainty. Traditional pedagogical approaches do not provide students with the opportunity to experience or support the totality of the system in the classroom in way that would replicate to students the complexity of a real-world project. Pedagogy based on innovation research suggests that developing competencies is strengthened when learners are placed in environments similar to the complexity of outside world but where learners feel safe. Structured Innovation experiences have increased the transfer of on-target skills to students by enhancing their capacity to solve problems using collaborative creativity and strategic problem-solving.

All board games inherently contain specific characteristics which require players to: - Interactively interpret changing limitations; - Coordination of actions in conditions of uncertainty; - Balancing strategic long-term plans with short term tactical decisions; - Adapt and deal with unexpected changes in systems. The processes and behaviors of project management follow these same dynamics; therefore the conceptualization of board games as experiential micro-simulations provides a conceptual framework for understanding how they serve to develop competencies in a systematic way.

D. Integrating Experiential Learning, Simulation, and Competency Theory

This research proposes a theoretical integration of experiential learning theories, simulation learning theories, and competency

development frameworks, to formalize how board games can be used in education and achieve pedagogical goals.

Through an experiential lens, board games create an experiential basis for stimulating reflection, activating reflective learning cycles.

Through a simulation lens, board games simulate project process dynamics that occur within project environments at a micro level.

From a competency lens, board games initiate cognition and collaboration, thereby integrating collaborative elements of the project process and supporting the activation of adaptive reasoning.

Research has shown that while there is theoretically a good deal of overlap among these three theories, there is little empirical research that explicitly tests these relationships, particularly in non-digital environments, and within the field of project management.

The basis of this study's theoretical integration leads to the fundamental hypothesis of the study:

Board games serve as experiential micro-simulators that initiate both cognitive and collaborative activities, and ultimately increase the likelihood that project managers develop structured project management competencies.

In the next section, a conceptual model is developed using the framework developed through the integration of the three theories, and that will allow for the formulation of hypotheses that can be empirically tested.

III. CONCEPTUAL MODEL AND HYPOTHESES DEVELOPMENT

A. Board Games as Experiential Micro-Simulations

Within project management education, board games may be considered an experiential micro-simulation of project management. Unlike traditional teaching/learning tools, board games are created as structured, rule-based systems — simulating real-world project dynamics (e.g., resource constraints; sequential decision-making; uncertainty; and interpersonal interactions).

In this micro-environment, students are actively involved in the learning process and, therefore, as they interact and navigate the shifting constraints and shared goals of the overall game, they are mirroring many of the critical elements that exist within project ecosystems (e.g., the necessity for coordination, anticipation of risk, evaluation of trade-offs, and adaptive planning).

Using Kolb's (1984) experiential learning theory, Freeman et al.'s (2014) active learning research, and Abdessadak & Reklaoui's (2024) innovation-focused pedagogical frameworks to support this premise, we contend that, in addition to experiential engagement through the board games, the use of board game-based micro-simulation will activate a series of mediating mechanisms that facilitate the development of professional competencies through an experiential learning process [4], [12].

B. Mediating Mechanisms of Competency Development

Instead of simply assuming that there is a direct link between board games and the development of competencies, this research suggests that the connection happens through four interrelated mediating mechanisms:

Cognitive Activation

Board games activate analytical thought processes, as well as deep thinking and reflective thought. The processing and continuously evolving scenarios with ongoing adjustments to strategy creates higher order cognitive engagement from students [16].

Strategic Decision-Making Capability

While playing a board game, players are required to develop a plan, prioritize tasks and adapt their plan according to limits. Meetings in the iterative decision-making-feedback model created by board game play reflects meeting processes occurring in project management activities, enhancing students' abilities to think strategically.

Collaborative Dynamics

Most board games require players to negotiate with others, coordinate their activities with others and distribute roles among themselves with others. By virtue of the social interactions required for board game play, players will develop their teamwork capabilities, communication abilities and capacity to solve problems collectively.

Risk-Based Reasoning

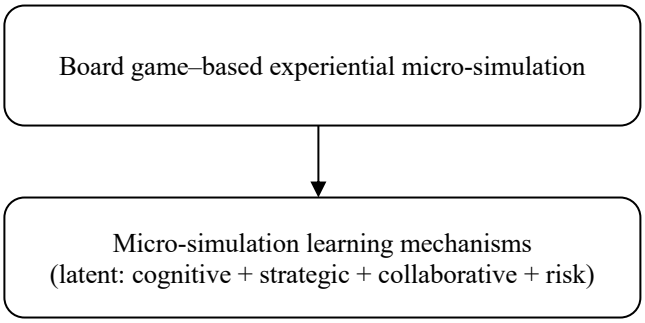
Due to the uncertainty related to gameplay (i.e., hidden information, probabilistic events and changing constraints), students learn to evaluate risk and weigh alternative approaches when they make decisions, thus enhancing their ability to apply risk-based reasoning.

These four mechanisms represent a cohesive model of how experiential microsimulations function to create professional competencies through a set of internal processes (See Figure 1).

C. Project Management Competency Development

The term “project management competency development” means acquiring together all of the cognitive, behavioural, and contextual (i.e., how to apply what you have learned), needed to execute projects successfully. These areas include abilities such as strategic alignment, problem-solving, communication skills, and risk management.

In the competency-based education system, learners acquire skills by applying the knowledge that they have learned to multiple environments with both dynamic (constantly changing) and constraint (limited information) conditions. Therefore, experiential processes for stimulating cognitive, strategy-related, and collaborative reasoning, as well as reasoning about risk, will contribute positively to competency development [17].



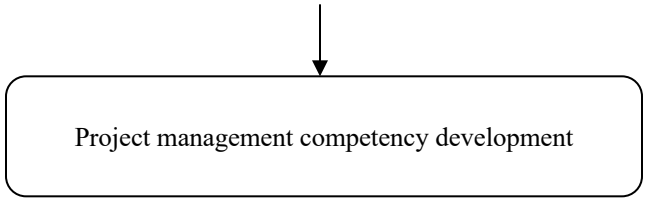


Figure 1: Structural Model of Micro-Simulation Learning Mechanisms and Project Management Competencies

Aligned with the adopted mediating model, the following hypotheses are proposed:

H1: Board game–based experiential micro-simulations positively influence Micro-Simulation Learning Mechanisms (MSLM).

H2: Micro-Simulation Learning Mechanisms (MSLM) positively influence project management competency development.

H3 (Mediation): MSLM mediates the relationship between board game–based experiential micro-simulations and project management competency development.

IV. Methodology & materials

A. Research Design

This research employs a quantitative explanatory design to assess whether board-game based experiential micro-simulations can assist with the development of project management competencies through the Micro-Simulation Learning Mechanisms (MSLM). The data for this analysis comes from a cross-sectional survey that was collected at the conclusion of a structured educational intervention integrating board games into a project management curriculum.

The data collection method corresponds to the competency-based education assessment of the acquisition of perceived skills and learning mechanisms after the experience of using experiential learning techniques.

B. Research Context & Sample

This study took place within a fourth-year Industrial Engineering program over a 48-hour period of project management instruction. The course structure was organized into three main phases:

1) Theory (planning projects; risk management; and coordinating stakeholders);
2) board-game based experiential exercises;
3) reflective debriefings.

Board games were chosen to model project-related characteristics such as; resource allocation; uncertainty; collaboration; and strategic planning.

The sample for this analysis consisted of 23 students representing the total student population in the course. This small sample size but full population makes it a census-based study as opposed to random sampling.

Though N=23 may seem small compared to N=100+ typical research proportions, it is the entire population of students enrolled in this course, thus making this a study based on the census or complete enumeration of the subjects rather than a probabilistic sample. Bootstrapping methods for exploratory mediation analysis have been shown to be appropriate for use with small samples provided the effect sizes are large. Given the present study's observed significant effect sizes (β=0.71 and 0.79), the minimum sample size needed to achieve sufficient statistical power is greatly reduced than it would otherwise be to conduct the analysis. In addition, the use of bootstrapping procedures (5,000 resamples) will produce robust confidence interval estimation, thus alleviating any limitations presented with the usage of small-N parametric testing. Future research should attempt to replicate these results with larger and/or more diverse samples [18], [19].

C. Measurement Instrument

Data Collection was accomplished via self-administered (i.e., person completing questionnaire) structured questionnaire that was given at the end of the course. The instrument consists of three major sections: Perception of the board game-based experiential micro-simulation; Micro-Simulation Learning Mechanisms (MSLM); and Project Management Competency Development. Each item was answered using a five-point Likert scale, where (1) means Strongly Disagree and (5) would be Strongly Agree. The questionnaire items were developed from: (a) Experiential Learning Literature, (b) Active Learning Research, (c) Innovation Oriented Pedagogy Frameworks, and (d) Project Management Competency Frameworks. The instrument was reviewed for clarity and face validity prior to its distribution.

D. Micro-Simulation Learning Mechanisms (MSLM) – Latent Construct

The Micro-Simulation Learning Mechanisms (MSLM) construct represents the total experiential learning process that occurred through gameplay. The construct is factorized into four dimensions representing distinct learning constructs:

- Cognitive Activation
- Strategic Decision-Making
- Collaborative Dynamics
- Risk-Based Reasoning

The four dimensions of MSLM were assessed using a number of indicators (multiple items) For example:

1. Cognitive Activation

- *"The gameplay stimulated me to think critically in a deep way".*

- *"The gameplay made me continually assess multiple strategies"*

2. Strategic Decision-Making

- "The gameplay provided me with the ability to develop a strategic plan".

- "The gameplay required me to adjust my decision making due to changes in the game"

3. Collaborative Dynamics

- "The gameplay enhanced my sense of teamwork and coordination"

- "Successful teamwork and communication within the team was key to winning"

4. Risk-Based Reasoning

- "The gameplay required me to anticipate possible risks"

- "The gameplay provided me with the ability to assess tradeoffs between two uncertain outcomes"

The four dimensions of MSLM were combined into a single index representing the latent construct of Micro-Simulation Learning Mechanisms.

The Project Management Competency Development (Dependent variable) construct is composed of four variables that measure students' perceptions of the acquisition of project management competencies. Students generated a cumulative rating of their perceived gains on four project management skills as follows:

- *Strategic Planning Skill*
- *Team Coordination Skill*
- *Problem Solving Under Constraints Skill*
- *Risk Management Awareness Skill*

Example indicator statements include:

- "My project management skills have improved as a result of the activities."

- "I have gained confidence in my ability to manage complex project situations."

- "The course has increased my skills for coordinating project activities."

The measuring structure of the constructs examined in this study is illustrated in Figure 2. The illustration depicts Micro-Simulation Learning Mechanisms (MSLM) as an underlying concept with four constituent dimensions, which include cognitive activation, strategic decision-making capability, collaborative dynamics, and risk-based reasoning. These dimensions are the major experiential processes that are generated by engaging in micro-simulation activities based on board games. Collectively, they form the overall mechanism through which experiential learning takes place.

The model also identifies Project Management Competency Development as an outcome variable. This represents the student's perceived competence in acquiring core project management competencies and will be represented by a number of competency indicators, including (but not limited to) abilities related to strategic planning, teamwork and coordination, problem-solving, and awareness of risk.

Thus, the arrangement of the constructs in this manner demonstrate how many experiential learning processes are combined to form one latent mechanism (MSLM) that represents the totality of experiential learning dynamics that occur during gameplay. Additionally, project management competency development has been conceptualised as a multidimensional outcome measure that combines cognitive, collaborative, and strategic competencies required to be successful in project-based environments.

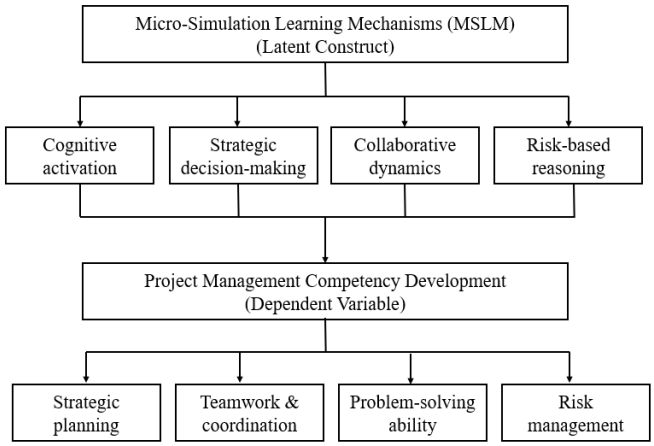


Figure 2. Measurement Structure of Micro-Simulation Learning Mechanisms and Project Management Competency Development

E. Data Analysis Plan

Due to the limited sample size N=23, a strong but simple analysis plan was developed.

The analytical strategy consisted of four definable steps:

- Descriptive statistics to check the distribution and central tendency of the data set.
- Reliability analysis conducted using Cronbach's alpha coefficient to determine whether the constructs have internal consistency.
- Construct aggregation was carried out to create composite indices for MSLM & competency development.
- Mediation analysis through regression-based modelling with bootstrapping to assess for an indirect relationship.

Bootstrapping was also used within this stage as a means to improve parameter estimation reliability and to reduce the effects of small sample size on the statistical findings. All statistical hypotheses were tested at a 5% level of significance. This methodology allows for testing the theory of mediation while still maintaining statistical robustness considering the small size of the sample.

V. RESULTS

A. Descriptive Statistics

Descriptive statistics of the principal constructs (Table 1), indicates students had large amounts of experiential micro-simulations, activated learning mechanisms and competency development. The overall mean scores for all constructs, as measured by a 5-point Likert scale, had means greater than 4.0;

demonstrating a solidly positive response towards the intervention.

Table 1. Descriptive Statistics

Construct	Mean	SD
Board Game–Based Micro-Simulation	4.36	0.51
Micro-Simulation Learning Mechanisms (MSLM)	4.28	0.47
Project Management Competency Development	4.41	0.49

B. Reliability analysis

Cronbach's alpha was used to evaluate the measurement scales and results suggest that all of the constructs have satisfactory reliability.

Overall scores of the micro-simulation learning mechanisms (MSLM) construct yielded a high internally consistent score measured by Cronbach's Alpha (0.87); therefore, the various types of experiential learning that occurred during play may be defined as being highly reliable. The project management competency development construct received a reliability score of 0.84 on Cronbach's Alpha, suggesting that the project management competency developmental indicators have strong reliability in measuring student self-perceived competency acquisition.

Since both Cronbach's Alpha scores are higher than the conventional threshold of 0.70, it is concluded that all of the measurements of these constructs in the study have reliable measures and all measurement items consistently tap into their respective constructs.

C. Correlation Analysis

A Pearson correlation analysis was performed in order to test the correlation between the main variables used in this study. The correlation coefficients for all constructs were positive, statistically significant ($p < .01$), and also presented strong intercorrelations. For example, BG-MBS had a strong correlation with MSLM ($r = .71$; $p < .01$) and MSLM had an even stronger correlation with PMCD ($r = .79$; $p < .01$). There was also order correlation between BG-MBS and PMCD ($r = .65$; ($p < .01$)). Together, these findings provide initial support for the mediated relationship that is subsequently tested.

Table 2. Correlation Matrix

Variable	**1**	**2**	**3**
1. Micro-Simulation	—		
2. MSLM	0.71**	—	
3. Competency Development	0.65**	0.79**	—

Specifically, there is a very strong positive correlation between board game-based micro-simulation (BG-MBS) and micro-simulation learning mechanisms (MSLM) ($r = 0.71$, $p < 0.01$). This supports that engaging in experiential gameplay activities is very much associated with activating one or more of the four cognitive, strategic, collaborative, and risk-taking learning processes. Additionally, MSLM had a strong positive correlation with project management competency development (PMCD) ($r = 0.79$, $p < 0.01$) indicating that the use of these learning mechanisms is closely associated with students' perception of having developed the necessary project management skills.

Also, there was a positive correlation found between micro-simulation (MS) and PMCD ($r = 0.65$, $p < 0.01$). Overall, these results provide initial empirical support for the pathways theorized in the conceptual model and warrant now conducting the regression analysis in order to assess the hypotheses for this study.

D. Hypothesis Testing

Regression analyses were performed to analyze the mediating relationship between micro-simulation, MSLM, and competency development.

Step 1: The Effect of Micro-Simulation on MSLM (H1)

Micro-Simulation Learning Mechanisms are positively impacted by experiential micro-simulation in the form of a board game.

$\beta = 0.71$, $p < .001$

$R^2 = .50$

This provides support for H1.

Step 2: The Effect of MSLM on Competency Development (H2)

Project Management Competency Development is positively impacted by Micro-Simulation Learning Mechanisms.

$\beta = 0.79$, $p < .001$

$R^2 = .62$

This provides support for H2.

Step 3: Mediation Analysis (H3)

The above two analyses of Micro-Simulation and MSLM as predictors of Competency Development yield the following information:

The direct effect of Micro-Simulation decreases to a non-significant level.

The direct effect of MSLM remains significant.

The bootstrapped indirect effect (5,000 samples) is as follows:

Bootstrapped Indirect Effect = 0.56

95% Confidence Interval [.31, .79]

Since the confidence interval does not include zero, the mediation effect is significant. Thus, H3 is also supported.

Results suggest that board game-based experiential micro-simulation has a significant effect on activating micro-simulation learning mechanisms. Based on this evidence, these mechanisms also serve as a strong predictor of the development of project management competencies. The relationship between board game micro-simulation and the development of competencies is fully mediated by micro-simulation learning mechanisms (MSLM) thus demonstrating that board games don't create competency directly but that structure learning mechanisms developed through using board games will translate into the development of professional skills through the experience of the learner.

VI. Discussion

This article's research was focused on how using board game-based experiential micro-simulations in higher education can facilitate the development of project management competency. The empirical evidence indicates that the way in which board game-based learning can contribute to the development of project management competencies is primarily through activating micro-simulation learning mechanisms (MSLM).

In other words, the results of this study revealed that using board game-based experiential micro-simulations improves the activation of experiential learning mechanisms. The strength of the correlation between micro-simulation activities and MSLM indicates that environments created by playing board games encourage deeper cognitive engagement, more complex strategic reasoning, more effective collaborative interaction, and greater creativity in assessing risk. This is consistent with Kolb's (1984) experiential learning theory that states that learning occurs through an individual's active participation in structured experiences and not through passive acquisition of knowledge. Additionally, previous research has shown that active learning environments promote increased levels of student engagement and higher-order cognitive processing [4].

The findings demonstrate that Micro-Simulation Learning Mechanisms are a strong predictor of the development of project management abilities. This result underscores the need for building competencies through internal learning, specifically as it relates to the way in which experiential activities lead to the acquisition of skills. While board games do not appear to directly create competencies, they do create a learning environment in which students can apply their cognitive, strategic, and collaborative skills to create competencies. Additionally, this interpretation of board games as a mechanism for learning expands on previous research about the use of game-based learning, where researchers typically focus on the motivational and engaging aspects of game-based learning and ignore the structured mechanisms that facilitate the development of competencies.

Additionally, these findings are supportive of the literature concerning the use of innovation-oriented pedagogical methods.

From a learning standpoint, the findings of this study indicate that board games are not just fun activities for use in classrooms but also provide a means to structure and help students learn through experience. Using board games allows students to make decisions with constraints; negotiate strategies with other players; and adapt to changing conditions through the progression of the game. These same conditions occur for individuals who manage projects in real life where project managers are tasked with coordinating their stakeholders; managing uncertainty; and providing an appropriate amount of resources for their projects.

The strong correlation between experiential elements and the development of competencies shows that reflection and debriefing should be conducted after completing a board game. The literature on experiential learning suggests that just because an individual has experienced something, they will not necessarily learn from it. Instead, an individual will learn from an experience if they have taken the time to reflect upon the experience and conceptualize their findings. If structured discussions occur after playing board games, it may allow players to translate their experiential knowledge into competencies that can be used on future projects.

The research presented here has three contributions to the current body of literature: first, it offers a novel perspective on how board games function for students in support of learning through hands-on experiences; second, it merges experiential learning theory with a competency-based framework to describe how working in simulation through structured gaming can help students build professional skills; and third, it builds on previous work, providing empirical support for using experimental micro-simulations in project management education where there is an ongoing divide between theory and practice.

In addition, the data reported here lend support to other researchers who are developing pedagogical models for improving innovation through experiential learning. Similarly, the current study's findings indicate that micro-simulation in board games provides users the opportunity to engage in multiple ways with the learning activities to develop competencies in project management education.

This approach also supports earlier work that showed how ingenuity and process-related skills have been developing through innovative pedagogies for engineering learners. Interactive problem-related learning situations will assist students in applying their strategic thinking, collaboration and adaptive reasoning capabilities. As a result, board gaming micro-simulations can serve as a practical implementation of this innovation-oriented model for delivering project management education.

VII. Conclusion

The purpose of this research was to determine the impact of experiential micro-simulations based on board games on the development of project management competencies within academic institutions. The objective was to create and empirically validate a mediation-based theoretical model in order to gain insight into the linkage between experiential learning experiences and the acquisition of professional competencies.

The three hypotheses were confirmed through empirical testing. Participants who used experiential micro-simulation boards games had high activation of Micro Simulation Learning Mechanism MSLM ($\beta = 0.71$, $p < .001$, $R^2 = .50$) and therefore, developed project management competencies at significant levels ($\beta = 0.79$, $p < .001$, $R^2 = .62$). Bootstrapped mediation analysis (5,000 resamples), revealed a significant indirect full mediation effect (indirect effect = 0.56, 95% CI [.31, .79]) through four experiential mechanisms of cognitive activation, strategic decision-making, collaborative dynamics and risk-based reasoning that form the structure/pathway of boardgaming to competency development by providing experiential learning exposure to boardgame experience [15].

The implications of this research are twofold. First, this research makes a contribution to the body of knowledge by bringing to light a mechanism-based understanding of board game-based experiential learning. More than traditional forms of pedagogical tools for motivation or engagement, the development of a theoretical model characterizing board games as experiential micro-simulations that are able to re-create critical dynamics of project environments extend the existing experiential learning theory; and second, provide a framework for understanding the role that non-digital game-based experiential learning activities can play in the development of competency in management education.

This article highlights how board games may be used as avant-garde educational tools in Project Management, particularly regarding the teaching of decision-making, team work, and

problem solving within simulated project limitations. If combined with a formalized pedagogical methodology, which includes an advanced preparation phase, followed by a reflective debrief phase following play (immediate post-game feedback), then an interactive learning environment will be created in which students have at least one opportunity to practice these skills before they are required to apply them to real world constraints.

There are some serious limitations to this study that should be acknowledged. The first limitation is the small size of the sample (n= 23). This sample represents a single cohort of students at one institution, thus limiting the overall ability to generalize from these results. Second, as students self-reported their competency development it is possible that they were influenced by social desirability bias; self-reports do not objectively quantify actual performance outcomes. Third, because of the absence of a control group it is not possible to draw causal inferences about the results. Quasi-experimental designs or longitudinal designs should be employed in future research to further establish causal claims. Fourth, the study used only one board game intervention to measure competency; therefore, it is still unknown whether the results of this study could be generalized to other game formats or other disciplines. Fifth, the study was designed cross-sectionally, so it cannot provide evidence of long-term competency retention; therefore, longitudinal studies are needed in the future to determine if experiential gains obtained from participating in the course outlast participation in the course itself. Finally, future research is needed to replicate and extend these findings using larger, more diverse samples across multiple institutions, different game formats, and objective measures of competency.

Overall, the study provides empirical support for the usage of experiential micro-simulation based board games in the project management educational setting. When using structured learning mechanisms that engage cognitive, strategic and collaborative abilities within a micro-simulation, it appears as though this type of pedagogical approach may have significant potential for improving competency based learning in higher education.

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