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Examining the Expertise of TTRPG for STEM Education: A Role-Playing Exploratory Study of Dungeon Master's Praxis

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Introduction

Analog games are non-digital, physical games that emphasize tangible components and direct, face-to-face interaction. Using tools such as dice, cards, and boards, they create shared spaces where players engage through conversation, collaboration, and embodied action. Among them, Tabletop Role-Playing Game(s) (TTRPGs) stand out for their ability to combine narrative construction, problem-solving, and collective decision-making.¹ These games are more than entertainment: they operate as structured practices where participants develop creativity, adaptability, and teamwork. This study investigates how the skills fostered in TTRPGs, such as critical thinking, collaboration, and problem-solving, can be applied in Science, Technology, Engineering, and Mathematics (STEM) education, aligning with the 21st-century skills students need for innovation, communication, and collaboration in contemporary workplaces (Cano, 2018).² The authors aimed to answer the question:

RQ1. How can the facilitation practices and functional competencies of Dungeon Master(s) in Tabletop Role-Playing Game(s) be evaluated and translated into pedagogical strategies that enhance experiential learning and inquiry-based learning within STEM education?

TTRPGs are built on shared fictional worlds. Players take on roles, set goals, and face challenges within the rules of the game. A facilitator, or Dungeon Master (DM), guides this process. The DM is both storyteller and referee, but also a designer who adapts the game to player choices. In a classroom, this work is similar to what teachers do when they guide inquiry, adjust lessons, and co-create learning with students. The pedagogy of TTRPGs is built on story, choice, and

¹ TTRPG stands for *Tabletop Role-Playing Game*. It refers to a form of Role-Playing Game(s) where participants assume the roles of characters and collaboratively create stories, typically using physical materials such as dice, character sheets, and rulebooks. These games are played on a tabletop, distinguishing them from digital or Live Action Role-Playing (LARPs). Popular examples of TTRPGs include *Dungeons & Dragons* and *Pathfinder*.

² The term 21st-century skills refers to the competencies and literacies identified as essential for success in the modern organizational environment. According to the Partnership for 21st Century Learning (P21 Framework), these skills blend core academic knowledge with critical thinking, problem solving, communication, and collaboration. Within this framework, schools and learning environments are encouraged to integrate these competencies into curriculum, instruction, and assessment so that students are equipped to adapt, innovate, and collaborate effectively in a global economy. Source: <https://files.eric.ed.gov/fulltext/ED519462.pdf>.

consequence for its participants, aligning closely with student-centered and inquiry-based approaches to teaching.

Within the framework of our Institutional Review Board (IRB)-approved study protocol number #2408046040, *Examining the Expertise of Dungeon Masters as Educational Facilitators* (Leon, 2025a), the role of the Dungeon Master (DM) was operationalized through ten primary functions: Arbitrate, Narrate, Create, Teach, Improvise, Act, Facilitate, Balance, Direct, and Model Empathy (Leon, 2025a). These functions represent both cognitive and affective dimensions of facilitation, encompassing rule interpretation, world construction, instructional guidance, creative adaptation, and emotional engagement. Complementing these were measures of control and autonomy: 1) How DMs regulate decision-making, pacing, and player freedom, and 2) Conflict resolution strategies ranging from avoidance to consensus-building. Together, these variables form a framework for comparing DM praxis with pedagogical competencies in STEM inquiry-based learning, including classroom management, adaptive instruction, collaborative problem-solving, and ethical facilitation.

STEM fields require more than memorization. Students must learn to think across domains and address complex problems with both creativity and ethical awareness. Standard classroom models often fail to meet this need. TTRPGs provide low-risk environments where trial, error, and iteration drive progress. These features parallel scientific practice, including hypothesis testing, model construction, and teamwork.

TTRPGs differ from digital simulations. They depend on negotiation, shared meaning, and physical tools. Rolling dice, writing on character sheets, and interpreting rulebooks create direct material engagement. These acts require judgment and adjustment, much like work in a lab or classroom when theory meets practice. By playing within a system that allows for creativity and autonomy, participants work in an epistemic space that aligns with theories of experiential learning (EL)³ and active learning (AL).⁴

To examine this alignment, the study employed a mixed-methods design combining theoretical synthesis and empirical instrument development. It began with a review of educational theory, game studies, and analog game design to establish conceptual foundations. These were then organized through a General–Particular–Specific (GPS) Matrix (detailed in the Methodology section), which connected general principles of play to the particular role of TTRPGs in STEM education. Within this framework, the facilitation practices of Dungeon Masters (DMs) served as models for teaching, supporting both cognitive and social dimensions of learning.

Building on this preliminary stage, we first developed an exploratory survey titled *Exploring the Integration of Role-Playing Games in Education* (Instrument I, v5, see Appendix I), approved under IRB #2408046040. This initial tool was presented to researchers and game designers to

³ Experiential learning (EL) refers to a cyclical process in which learners gain knowledge through direct experience, reflection, conceptualization, and active experimentation (D. A. Kolb, 1984).

⁴ Active learning (AL) involves instructional methods that engage students directly in the learning process through activities such as discussion, problem-solving, and application of concepts, emphasizing participation over passive reception (Bruff, 2020).

gather expert feedback and identify core constructs for a more comprehensive instrument focused on Dungeon Masters (DMs). Following this pilot, a focus-group discussion was conducted during the 8° Coloquio de Estudios de Juegos de Rol in Mexico, complemented by individual interviews with participants who self-identified as DMs and long-term TTRPG players (over 21 years old, per IRB inclusion criteria). These qualitative insights guided the refinement of the survey into Instrument 2 (see Appendix 2), which is presented in this paper (Leon, 2025b), together with preliminary notes on the *Inventario de Autoevaluación de Competencias del DM*,⁵ a self-assessment inventory currently under development to expand the measurement of facilitation and educational competencies in future research phases (Leon, 2025c).

This work also joins a larger conversation on analog games in both formal and informal education. It is not enough to measure outcomes; we must also understand how games teach. TTRPGs are valuable because players must act within systems and make decisions with consequences. The authors strongly believe that Role-Playing Gaming phenomena blur the line between performance, simulation, and improvisation (Plass et al., 2020); therefore, they have the potential to create a Situated Learning (SL)⁶ space for co-design that digital platforms cannot replicate due to a lack of human interaction.

Examining DM practice raises broader questions about labor, identity, and authorship in education. DMs adapt stories, respond to unexpected choices, and support inclusive play. Teachers do similar work when they adjust lessons and foster collaboration. TTRPGs can therefore be studied not only as games but as pedagogical performances where knowledge, authority, and agency are shared and reshaped. TTRPGs can act as boundary objects. They connect play and pedagogy, narrative and science, performance and assessment. Their open design lets educators adapt them to many goals and subjects. This flexibility makes them a strong tool for building inclusive and engaging STEM classrooms.

By combining theory with empirical results, this study demonstrates the unique capacity of TTRPGs to foster learning beyond traditional settings. Table 3 provides a clear breakdown of this potential, offering concrete evidence of how the collaborative, narrative-driven nature of these games can be adapted to improve student engagement and critical inquiry skills directly. This table serves as a practical guide for integrating TTRPGs into educational design.

The Importance of Evaluating the Role of the DM

Examining the distinctions and overlaps between experiential learning (EL), STEM, and inquiry-based learning (IBL)⁷ is not only a theoretical exercise but also a practical necessity. Understanding these pedagogical frameworks is key to improving learning outcomes as educational paradigms continue to evolve. Experiential learning (EL) emphasizes immersive,

⁵ This inventory is still in Spanish and under development for a new IRB.

⁶ Situated Learning (SL) describes knowledge acquisition as a social process that occurs through participation in authentic contexts, emphasizing learning as engagement within a community of practice rather than passive transmission of information (Lave & Wenger, 1991).

⁷ Inquiry-based learning (IBL) is a pedagogical approach that engages students in investigating questions, problems, or scenarios through active exploration, evidence gathering, and reflection, mirroring the processes of scientific inquiry (Pedaste et al., 2015).

hands-on experiences, while IBL promotes critical thinking through structured, guided, or Open Inquiry. Together, they outline approaches that value active participation and student agency. Evaluation is essential for linking these frameworks to practice. Within the context of our IRB #2408046040, evaluating the role and praxis of Dungeon Masters (DMs) provides a systematic way to translate theoretical constructs into measurable educational competencies. Evaluation enhances validity by grounding pedagogical claims in empirical data, strengthens reflexivity by analyzing how facilitators adapt to group dynamics, and supports educational design by identifying transferable facilitation strategies relevant to teacher training and inquiry-based instruction. Dungeon Master(s) (DMs) in TTRPGs illustrate how these frameworks can be applied in practice. DMs balance narrative flow with player agency, creating adaptive environments that resemble the flexible and responsive classrooms needed today. Their skills in managing interaction and fostering collaboration offer clear parallels for instructional strategies that increase student engagement.

TTRPGs also bring unique strengths to STEM education. Their mix of storytelling and interactive play provides ways to approach complex scientific concepts and simulate real-world processes. By stepping into roles, students apply theory in memorable contexts that improve both comprehension and retention.

This study explored how TTRPG facilitation can inform educational strategies and fill gaps in the literature. Prior research has shown that Role-Playing Game(s) immerse players in story worlds, support perspective-taking, and deepen understanding (Brown & Scirea, 2018; Gui et al., 2023; Guzdial et al., 2020). Studies on digital and analog educational games also suggest positive effects on STEM outcomes, especially when design elements support engagement (*Historical Reality vs Anachronistic Fantasy*, 2023; Schneider, 2023). These insights demonstrate the promise of combining narrative and play with structured learning.

Ultimately, this research encourages STEM educators to draw on both academic studies and DM expertise. Doing so can help create classrooms that cultivate curiosity, creativity, and critical thinking skills that are essential for future innovators and leaders. Having outlined why experiential and inquiry-based approaches are central to education, and how TTRPGs align with them, it is necessary to situate this study within a theoretical framework (see Appendix 3). This framework draws on enduring structures of schooling, experiential learning theory (ELT),⁸ and the role of documentation in shaping educational practice (D. A. Kolb, 1984). Together, these perspectives provide a foundation for understanding how TTRPGs can inform innovation in STEM classrooms.

Theoretical framework

This study is grounded primarily in experiential learning theory (ELT) and complemented by theoretical reflections from organizational development (Hellriegel & Slocum, Jr, 2009), Game Theory (GT) and Monster Theory (MT) to account for the unique characteristics of TTRPGs (Armstrong, 2002; Aumann & Hart, 2002; Cohen, 1996; D. Kolb et al., 2001). While numerous

⁸ Experiential Learning Theory (ELT) conceptualizes learning as a cyclical process through which knowledge is created by transforming experience (D. A. Kolb, 1984).

disciplines (i.e., education, psychology, and performance studies) have provided models for learning through play, TTRPGs themselves lack a unified theoretical foundation (Bastarrachea Magnani et al., 2024). This absence motivates the need for a framework that bridges the embodied experience of play with the reflective and collaborative practices central to STEM education. Additionally, Transmedia Theory provides a valuable lens for understanding how TTRPGs operate across multiple narrative and media systems, allowing learning and storytelling to extend beyond the boundaries of a single play session or medium (Zagal & Deterding, 2018).

Experiential Learning Theory with Inquiry

Experiential learning theory (ELT), developed by David Kolb et al. (2001) and later expanded on *Learning Styles and Learning Space* (A. Y. Kolb & Kolb, 2005), places firsthand experience at the center of the learning process (Lasmawan & Budiarta, 2020). Students are expected to engage actively, explore, and reflect, rather than passively receive information (McLeod, 2025). This cycle of doing, observing, and conceptualizing supports deeper understanding across disciplines. The *Handbook of Educational Psychology* (Schutz & Muis, 2023) is an excellent resource for researchers interested in a more current discussion on ELT.

Frey (2018, p. 1134) expands this perspective through naturalistic inquiry,⁹ which emphasizes the importance of studying education in real-world settings. Such inquiry generates contextualized knowledge and reflects the complexity of practice, policy, and schooling. It highlights the value of documenting authentic experiences and underscores because accurate recording is essential to improving education.

The Grammar of Schooling

David Tyack and William Tobin's book *"The Grammar of Schooling: Why Has It Been So Hard to Change"* (1994) examines how long-standing structures, such as grade levels and standardized testing, shape American education. Despite repeated reform efforts, these practices remain central. Their analysis highlights the challenges and opportunities of introducing innovative methods, such as game-based approaches, into established systems.

Organizational Development and Group Dynamics

According to Hellriegel and Slocum (2009), effective organizational behavior depends on the dynamic interplay between teamwork, collaboration, and leadership. Teams provide the structural foundation for shared responsibility, integrating diverse perspectives to solve complex problems more effectively than individuals working in isolation. Collaboration strengthens this process by fostering open communication, trust, and mutual accountability, which in turn enhances creativity and adaptability within groups. Leadership acts as the coordinating force that aligns team goals with organizational objectives, motivating members, resolving conflicts, and maintaining focus under changing conditions. In this view, leadership is not limited to authority but is distributed through collaborative processes that enable members to contribute their expertise and initiative toward common outcomes.

⁹ Naturalistic Inquiry is a qualitative research approach that studies phenomena in their natural contexts, emphasizing meaning, context, and the co-construction of knowledge between researchers and participants rather than controlled experimentation (Lincoln & Guba, 1985)

Game Theory and the Dynamics of Decision

From an analytical perspective, Game Theory provides a language for describing decision-making, cooperation, and strategic interaction. In TTRPGs, players negotiate goals and resources under shared rules, reflecting iterative problem-solving under uncertainty; however, unlike classical Game Theory, which focuses on competition and optimization, TTRPGs privilege narrative coherence and social negotiation. The pedagogical implication is that learning emerges not from winning but from *collaborative modeling of systems*, mirroring the epistemic processes central to scientific inquiry and design-based learning (Seelow, 2022).

Monster Theory and the Epistemology of the Unknown

Monster Theory, originating from cultural studies (Cohen, 1996), interprets the “monster” as a symbol of the unknown: an embodiment of fear, ambiguity, and boundary-crossing. In TTRPGs, encountering the monstrous represents a cognitive threshold where players engage with uncertainty and reimagine norms. Translating this metaphor into education, the “monster” parallels the unknown problem space in STEM learning: the unpredictable challenge that demands creativity, collaboration, and risk-taking. Thus, Monster Theory enriches the experiential model by emphasizing the affective and imaginative dimensions.

The Evolving Role of Documenting and Recording

Documentation is more than a record of events; it shapes how the present is understood and how the future is imagined. The shift from analog to digital archives has extended access and made archiving a routine practice (Buchanan & Luke, 2022). Scholars such as Foucault and Derrida describe archives not simply as storage but as systems that produce meaning and establish authority (Chadwick & Vermeulen, 2020; Cochrane, 2022). In STEM education, documentation of processes is central for building protocols, sharing methods, and constructing knowledge. Archives, therefore, are active elements in educational innovation, influencing how practices evolve and how narratives of change are constructed.

By combining these perspectives, this study applies a multifaceted lens to the integration of TTRPGs in STEM education. The enduring structures of schooling provide context for innovation, experiential learning, and inquiry, explain how games can serve as learning tools, and documentation emphasizes the importance of recording and interpreting educational practices. Together, they clarify the complex dynamics at play when analog games are used as vehicles for new pedagogical approaches.

Toward a Theory of Tabletop Role-Playing Games

As Bastarrachea Magnani, Meritano Corrales, and León (2024) argue in *A Tri-Heuristic Ontological Approximation of Tabletop RPGs*, TTRPGs operate across three intertwined ontologies: systemic, performative, and narrative. These layers position TTRPGs as complex analog systems capable of generating meaning through structured improvisation. However, despite their educational potential, they still lack a coherent theoretical synthesis comparable to established pedagogical models. By situating TTRPGs within the framework of experiential learning theory (ELT) and

informed by game and monster theories, this study proposes an integrative lens where experience, interaction, and imagination converge to produce learning.

With this theoretical foundation established, the following section presents the study's design, which employs a comparative analysis and mixed-methods approach to examine how the facilitation practices of Dungeon Masters (DMs) reflect experiential learning cycles and inform inquiry-based approaches in STEM education. The methodology integrates theoretical analysis with the practical development and validation of survey instruments, allowing the research to connect conceptual models of learning with empirical insights into TTRPG facilitation.

Methodology

This study employed a comparative analysis framework combined with an empirical, mixed-methods approach to examine the educational potential of TTRPGs in STEM education (Juvrud et al., 2024). The research began with a bibliographic and theoretical analysis that progressed from the general concept of games to role-playing games (RPGs), and finally to the specific case of TTRPGs. From this review, a General–Particular–Specific (GPS) Matrix was developed as a tool to evaluate how experiential learning (EL) and inquiry-based learning (IBL) align across three analytical dimensions: learner autonomy, engagement strategies, and outcome assessment.

A key component of the methodology was the design of a survey instrument focused on Dungeon Masters (DMs) as expert facilitators. The instrument gathered data on how DMs prepared and conducted both *sandbox* and *railroad*-style sessions, including their use of official modules versus homebrew content. Its development included drafting items derived from the GPS Matrix, pilot testing for reliability, and iterative refinement to capture the nuances of DM facilitation practices that could translate into educational outcomes.

All research activities were conducted under IRB #2408046040. Informed consent was obtained from all participants, data was anonymized before analysis, and all records were stored securely on NJIT servers. The Data Management and Sharing Plan (Leon & Lipuma, 2024) aligns with NSF (2025) *Findable Accessible Interoperable Reusable Open Science (FAIR)* principles to ensure data accessibility, interoperability, and ethical reuse (see Appendix 5).

The study applied the General–Particular–Specific (GPS) Matrix as both a conceptual and analytical framework to connect theory with data while following the guiding principles of evidence-based inquiry (see Appendix 3). At the general level, the matrix positioned broad theories of play, learning, and facilitation within the contexts of experiential learning (EL) and inquiry-based learning (IBL). The particular level focused on the role of Dungeon Masters (DMs) as facilitators who operationalized these theories through adaptive storytelling, feedback, and collaboration. The specific level translated these dynamics into measurable variables through survey instruments, interviews, and focus-group data collected under the approved IRB protocol.

By structuring the research through the GPS Matrix, the study ensured coherence between theory, observation, and analysis. This framework supported systematic comparison of DM facilitation patterns with pedagogical strategies in STEM education, grounding exploratory

findings in both narrative and empirical evidence. A detailed summary of the GPS Matrix and its three levels is presented in Appendix 4.

The mixed-methods design integrated quantitative and qualitative data to provide a comprehensive understanding of TTRPGs as pedagogical tools. Quantitative data from the survey measured variables such as engagement, comprehension, and retention, all of which are key indicators of STEM learning outcomes. Qualitative data from interviews and focus groups complemented the survey findings by providing insight into the mechanisms through which TTRPGs fostered experiential and inquiry-driven learning. Integrating these data sources allowed for a nuanced assessment of TTRPGs as educational interventions. These indicators were selected conceptually for alignment with STEM outcomes; statistical analysis will occur in the subsequent data-collection phase, implementing instrument 2 to a larger sample of DMs.

The research was carried out in three interconnected phases under the IRB #2408046040, ensuring ethical compliance, informed consent, and data confidentiality throughout all stages.

Pre-event phase. An exploratory survey, *Instrument 1: Exploring the Integration of Role-Playing Games in Education* (see Appendix I), was designed and validated through consultation with researchers and game designers to identify core dimensions of facilitation, collaboration, and educational design in TTRPGs. This exploratory phase also included a focus-group discussion during the 8° *Coloquio de Estudios de Juegos de Rol* in Mexico and individual interviews with participants who self-identified as Dungeon Masters (DMs) or long-term TTRPG players over the age of 21. The qualitative insights obtained in this phase informed the creation of a more comprehensive tool, *Instrument 2: Evaluating the Role and Competencies of the Dungeon Master*, as well as the accompanying *Inventario de Autoevaluación de Competencias del DM*.

Operational and Methodological Sub-questions.

- How can expert feedback from researchers, educators, and game designers inform the construction of reliable survey items that capture the core functions and facilitation behaviors of Dungeon Masters (DMs)?
- What thematic categories emerge from focus-group and interview data with DMs and TTRPG players (21+), and how do these insights refine the theoretical mapping between facilitation functions and pedagogical competencies?

Event phase. The newly developed instrument was deployed at an academic conference, allowing for initial data collection from experienced facilitators and educators. Participants provided both quantitative responses to structured items and qualitative reflections on their practice, coded as “Functions”.

Operational and Methodological Sub-questions:

- To what extent do DMs’ self-reported practices align with the dimensions of experiential learning (EL) and inquiry-based learning (IBL) identified in the literature?

- How do responses from conference participants vary by role (researcher, designer, or practitioner), and what patterns indicate transferable facilitation skills applicable to STEM instruction?
- What ethical and procedural safeguards ensured data validity, informed consent, and confidentiality during the IRB-approved collection process?

Post-event phase: The collected data underwent comparative and mixed-methods analysis, integrating descriptive statistics with thematic coding to identify recurring patterns in DM facilitation and pedagogical strategies coded as “Competences”. This process enabled the synthesis of theoretical and empirical insights, offering a comprehensive understanding of how TTRPG facilitation can support inquiry-based and experiential learning in STEM education.

Operational and Methodological Sub-questions:

- How do mixed-methods analyses (quantitative scoring and qualitative coding) reveal relationships between DM functions, autonomy, and conflict-resolution strategies?
- What competencies appear most predictive of effective facilitation, and how can these be integrated into the emerging *Inventario de Autoevaluación de Competencias del DM*?
- In what ways can findings from Instruments 1 and 2 guide the design of training models or frameworks for applying TTRPG facilitation to STEM education?

Conceptualizing the Situation

Current literature on TTRPGs predominantly explores their therapeutic, educational, and narrative capacities. However, a significant gap remains concerning their specific application within STEM education. While numerous studies highlight the general educational benefits of TTRPGs, such as enhancing motivation and social skills, detailed exploration into how these games can be systematically integrated into STEM curricula to improve learning outcomes in science, technology, engineering, and mathematics is scant (Matić & Palha, 2025). This gap presents an opportunity to investigate how TTRPGs can be tailored to address STEM education's unique challenges and needs, moving beyond general educational benefits to specific STEM-oriented outcomes.

Experiential learning (EL), developed by John Dewey (1859–1952) and David Kolb (1939–), emphasizes hands-on experience as the basis of education (Beard, 2022; Miettinen, 2000). In this model, students learn by engaging with real-world situations, reflecting on what happened, and building concepts from those reflections. When learning is tied to authentic contexts and guided reflection, students develop deeper understanding and skills.

Inquiry-based learning (IBL) also centers on active participation. It ranges from tightly structured experiments to open investigations (Gholam, 2019). In a controlled inquiry, students follow a set procedure. Guided inquiry gives them support while they explore. Open inquiry lets them design and carry out their own studies, which encourages autonomy and creativity. These models mark a broader shift toward student-centered and inquiry-driven teaching in STEM.

In TTRPGs, Dungeon Master(s) (DMs) take on roles similar to teachers. They set objectives, give feedback, and structure experiences. Using narrative and improvisation, DMs build interactive worlds where players work together, solve problems, and experiment (Martin et al., 2016).

Educational theorists, including Seymour Papert and Lev Vygotsky, emphasized the power of games in learning (Hellerstedt & Mozelius, 2019; Seelow, 2022). Games can capture attention, encourage creativity, and support social interaction. Based on these ideas, educators have begun to use TTRPGs as tools for experiential learning in many fields, including STEM.

Recent research supports this practice. Multiple studies demonstrate that Game-Based Learning (GBL) enhances motivation, engagement, and learning outcomes across diverse educational settings (Alotaibi, 2024; Hawkes-Robinson, 2008). Building on these findings, scholars such as Sarah Lynne Bowman, Elektra Diakolambrianou, and Simon Brind have examined how the theory and practice of analog role-playing game (RPG) design generate transformative experiences for participants, spanning tabletop, live-action role-playing (LARP), and Nordic and American freeform traditions. Their work highlights the pedagogical potential of nano-game design, emphasizing short, structured play formats that foster reflection, collaboration, and empathy. These approaches provide educators with adaptable tools for integrating TTRPG principles into the classroom and for enriching students' cognitive, emotional, and social learning experiences (Bowman et al., 2025).

The convergence of experiential learning (EL), inquiry-based learning (IBL), and the facilitation practices of Dungeon Masters (DMs) in TTRPGs establishes the theoretical foundation for this study. Together, these frameworks illuminate how structured play can foster reflection, experimentation, and collaboration. Recognizing this alignment invites a deeper examination of the existing research landscape. The following section expands on these connections, synthesizing prior studies on educational games, pedagogical design, and narrative-based learning to clarify how TTRPGs have been investigated and where critical gaps remain.

Literature Review Insights

The central guiding question for this review was:

RQ2. What did the existing literature reveal about the intersection of role-playing, experiential learning, and inquiry-based pedagogies, and where did gaps remain in understanding how analog TTRPGs contributed to student engagement, collaboration, group dynamics, and leadership within STEM contexts?

To address RQ2, a bibliometric and systematic literature review was conducted to identify patterns, trends, and research gaps at the intersection of role-playing, experiential learning, and inquiry-based pedagogy. The review integrated quantitative bibliometric mapping (Donthu et al., 2021) with qualitative thematic synthesis (Booth et al., 2012) to examine how analog TTRPGs had been studied in educational contexts. Following established standards for transparency and reproducibility, and building on the authors' previous work on systematic literature review methods (León et al., 2024), the search strategy combined citation tracking, keyword co-

occurrence analysis, and thematic coding to evaluate how TTRPGs contributed to student engagement, collaboration, group dynamics, and leadership within STEM education.

Using the Web of Science and Google Scholar databases, a monthly search was conducted from January 1 to May 1, 2024, using the terms “Tabletop Role-Playing Game(s)” AND “TTRPG” AND “language: English.” This process identified recurring themes in the literature concerning the application, outcomes, and theoretical framing of TTRPGs in learning environments.

The following subsections summarize the principal findings and thematic clusters that emerged from this review, highlighting both established areas of research and the conceptual gaps that motivated the present study.

- **Identity considerations.** Serrano Robles (2023) analyzed character categories in fantasy Role-Playing Games to determine their function and perception, which could be translated into studies on how role-playing roles influenced team dynamics and individual roles in STEM education.
- **Literary analysis.** Romero Benguigui (2023) discussed the adaptation of the noir genre into role-playing narratives, indicating a methodological approach that could be used to explore the storytelling aspects of scientific narratives in STEM education. By grounding the research design in these principles, this study ensured both rigor and relevance. The next step was to consider how diverse learner identities intersect with pedagogical practices and how TTRPGs could provide a framework for addressing these dynamics in STEM education.
- **Narrative and identity.** Studies explored how players used storytelling and character development to shape identity within games (Mumper, 2024; Woodley, 2024). This work showed that TTRPGs created opportunities for identity exploration and collaborative narrative building.
- **Player experience and game design.** Research examined how players experienced TTRPGs and how design choices affected play (Liapis & Denisova, 2023; Smith, 2024). These insights were valuable for both developers seeking to improve engagement and educators interested in adapting mechanics for classroom use.
- **Scientific inquiry and game-based learning.** Rooted in constructivist traditions, Game-Based Learning (GBL) transformed learning into an iterative process in which learners tested hypotheses, analyzed feedback, and adapted strategies: mirroring the scientific method (Gee, 2007; Plass et al., 2015). In STEM education, these approaches encouraged students to interact with content dynamically rather than passively receive information. Through simulation and play, GBL environments allowed learners to explore cause-and-effect relationships, develop conceptual understanding, and collaborate toward shared goals (Clark et al., 2016). TTRPGs exemplified these principles in analog form. Their structure invited participants to define problems, propose solutions, and test outcomes through narrative-driven experimentation. The Dungeon Master functioned as both facilitator and feedback system, guiding players through cycles of inquiry that parallel experimental design. Each session became a

collaborative laboratory where hypotheses were enacted in fictional yet rule-based contexts, fostering critical thinking, communication, and iterative reasoning. By linking the reflective depth of experiential learning (EL) with the structured dynamism of game-based learning (GBL), TTRPGs provided a model of inquiry that supported both the cognitive and creative dimensions of STEM education.

- **Therapeutic and educational benefits.** Several studies reported that TTRPGs improved social connection and mental health (Abbott et al., 2022; Abramson, 2025; Gutierrez, 2017; Merrick et al., 2024). In educational settings, TTRPGs motivated learning and enhanced social skills (Bawa, 2022; Henning et al., 2024).. These findings suggested that TTRPGs could be powerful tools in therapeutic and educational contexts, fostering emotional well-being and social competencies (Connell, 2023; Daniau, 2016).

Insights from the Journal of Role-playing Studies and STEAM

Themes from the Journal of Role-playing Studies and STEAM. As editors of the *Journal of Role-playing Studies and STEAM*, the authors have reviewed published research from the past three years. The main themes include educational applications, cultural impacts, and narrative design.

- **Educational applications and social skills development.** Tovilla (2023) studied role-playing in virtual environments, finding that immersive role-play can support Situated Learning (SL). García Soriano, Faret Moreno, and González Cohens (2023) examined role-playing for teamwork and socio-emotional skill development, offering a framework that could be applied in STEM learning.
- **Cultural and narrative impacts.** Canul-Noh (2023) analyzed the use of TTRPGs to strengthen Yucatecan cultural identity in preschool settings, pointing to the role of games in supporting diversity. Victoria Uribe & Robles Bastida (2022) explored how TTRPGs contribute to science fiction and fantasy narratives, identifying a gap where these methods could extend to creative and narrative skills in STEM contexts.
- **Historical analysis.** Cabobianco & Van Houtte (2022) integrate historiographic and narratological analysis in their study of Role-Playing Game(s) about the Aztec empire, showing how gaming can explore historical narratives. This approach could be applied to teaching historical aspects of science and technology.
- **Psychological considerations.** Diakolambrianou & Bowman (2023) delve into the dual consciousness experienced by players, linking psychological and counseling theories with identity formation in TTRPGs. Further exploring how role-playing impacts student identities and learning behaviors in STEM fields.

Intersectionality

According to Turner (2024), Intersectionality is a framework for understanding how aspects of identity, such as race, class, gender, sexuality, and disability, interact within systems of power to create unique forms of privilege and discrimination (Crenshaw, 1989). In education, it highlights how overlapping identities shape access to opportunities and influence classroom experiences. For settings that use TTRPGs, Intersectionality can guide the creation of inclusive teaching strategies that respond to the diverse needs of learners.

Integrating the Four Factors of Curriculum into TTRPGs

Integrating the Four Factors of Curriculum: Methods, Philosophy, Style, and Scenario, into the analysis of TTRPGs provided a framework for comparing educational and game facilitation practices. Each teacher or Dungeon Master (DM) applied distinct methods to guide learning or play, balancing structure and freedom through choices between guided instruction and open exploration. Their underlying philosophy of play or education shaped these decisions, determining how closely rules were followed, how creativity was encouraged, and how autonomy was distributed among participants. Personal style, whether directive or facilitative, influenced the tone of interaction and the degree of learner agency within the group. Finally, the scenario established the contextual boundaries for engagement (analogous to a curriculum in formal education), defining objectives, challenges, and the scope of inquiry. By interpreting TTRPG facilitation through these four factors, this study connected classroom design principles with game-based learning environments, illustrating how both teachers and DMs construct spaces for experimentation, collaboration, and reflective learning in ways consistent with Tyler and Hlebowitsh's (2013) principles of curriculum organization and instructional alignment (see Table I).

Table I.

Integrating the Four Factors of Curriculum into Educational and TTRPG Facilitation

Curricular Factor	Educator (Classroom Context)	Dungeon Master (TTRPG Context)
Methods	Selects instructional methods that align with educational goals, learning outcomes, and student needs; balances direct instruction, guided inquiry, and open exploration.	Chooses gameplay methods that fit narrative and player goals; balances guided adventures ("railroad") with open exploration ("sandbox") to maintain engagement and coherence.
Philosophy	Grounded in educational values and beliefs about learning (e.g., constructivism, experiential learning, inquiry), shapes decisions about autonomy, assessment, and collaboration.	Grounded in a philosophy of play that guides rule interpretation, creativity, and fairness, determines how strictly to follow mechanics versus promoting improvisation and player agency.
Style	Demonstrates a personal teaching style ranging from directive to facilitative; influences tone, participation, and classroom dynamics.	Exhibits a facilitation style from authoritative storyteller to collaborative co-creator; affects pacing, immersion, and group interaction.
Scenario	Operates within the curriculum, which defines objectives, assessments, and the learning scope; provides structure for inquiry and reflection.	Operates within the game world, which sets narrative boundaries, challenges, and player objectives; provides structure for exploration and problem-solving.

Note. Adapted from Tyler and Hlebowitsh's (2013) *Basic Principles of Curriculum and Instruction*, to illustrate parallels between instructional design and TTRPG facilitation.

This comparative framework illustrates how both educators and Dungeon Masters (DMs) design structured yet adaptive environments that balance autonomy, collaboration, and inquiry. By aligning instructional and facilitation strategies, the table highlights how TTRPGs operationalize curriculum design principles through experiential play. Each curricular factor, Methods, Philosophy, Style, and Scenario, demonstrates how DMs, like teachers, coordinate systems of learning where participants co-construct meaning, negotiate rules, and engage in reflective problem-solving. This alignment reinforces the argument that analog role-playing games can serve as practical models for inquiry-based and experiential learning in STEM contexts.

Building upon this curricular alignment, the following analytical step considered how identity, autonomy, and collaboration intersected within role-playing environments. To capture these dynamics, Table 2 presents a typology of Intersectionality in TTRPGs, mapping player and facilitator interactions across dimensions of cooperation, individuality, free will, and determinism. This matrix extends the pedagogical comparison by situating TTRPGs within broader social and cultural contexts that influence participation, equity, and learning outcomes.

Table 2.

Typology of Intersectionality in Tabletop Role-Playing Game(s) (TTRPGs).

	Collaborative	Individualistic
Free Will	CA=Cooperative Autonomy	PA=Personal Autonomy
Determinism	TD=Team Dynamics	ID=Individual Dynamics

Note. Author elaboration based on IRB #2408046040 data (Leon, 2025a)

Matrix descriptions:

- **CA: Cooperative Autonomy.** Participants make choices within group goals, encouraging collaborative problem-solving and Project-Based Learning (PBL).
- **PA: Personal Autonomy.** Individuals pursue their own strategies, reflecting self-directed learning.
- **TD: Team Dynamics.** Roles are predefined in a group setting, similar to guided group projects.
- **ID: Individual Dynamics.** Individuals follow structured rules while working independently, resembling traditional curricula that emphasize individual achievement.

Applying an intersectional lens to the work of DMs and teachers helps clarify how identity and social dynamics shape learning. The typology above maps how autonomy, structure, collaboration, and individuality interact in both games and classrooms. It offers a framework for analyzing pedagogy and game design, while pointing toward strategies that make learning more inclusive and effective.

By situating TTRPGs within an intersectional framework, it became possible to see how methods, styles, and scenarios interacted with diverse learner identities. The next step was to examine how these dynamics translated into practical strategies, and how role-playing could enhance pedagogical methods in ways that fostered engagement, collaboration, and deeper

learning. This framework also aligned with and reflected the functional capacities and facilitation skills identified in Dungeon Masters (DMs), particularly in how they designed, adapted, and deployed scenarios to balance player autonomy, group cohesion, and educational intent.

Enhancing Pedagogical Methods through Role-playing Dynamics

This study proposed a framework that connected the dynamics of Role-Playing Game(s) with established educational strategies. The framework drew on discussions of the nuanced role of Dungeon Master(s) (DMs) in TTRPGs and organized teaching approaches into direct instruction (“railroad”), independent learning (“sandbox”), and the four forms of inquiry-based learning (IBL): Confirmation, Structured, Guided, and Open inquiry. Together, these categories formed a two-by-four grid that demonstrated how role-playing structures could be adapted to diverse classroom strategies (see Table 3).

In TTRPG terminology, a *Railroad* refers to a highly structured narrative in which the Dungeon Master (DM) maintains close control over events, guiding players toward predetermined outcomes. This approach parallels direct instruction in education, where teachers lead students through sequenced content and specific objectives to ensure mastery of core concepts. In contrast, a *Sandbox* describes an open-world or player-driven scenario where participants determine their own goals and methods of engagement. This model mirrors independent learning, in which students explore, experiment, and construct understanding autonomously within a flexible framework provided by the instructor.

Building upon these two traditional play models, this research identified an emergent third dimension: *Playground*, which represents a balanced and dynamic environment where structure and autonomy coexist. In the Playground model, both educators and DMs co-create the learning or play space with participants, blending elements of guidance, improvisation, and shared agency. This intermediary framework supports adaptive facilitation and fosters collaboration, creativity, and self-regulated learning. The Playground dimension is presented and analyzed in greater detail in the Results section, where it is evaluated as a pedagogical configuration that bridges direct instruction and open inquiry through interactive design and co-creation.

Table 3.*Integration of Teaching Methods and Inquiry-Based Learning Forms in TTRPG Scenarios*

Strategy	Direct instruction (Railroad)	Independent learning (Sandbox)
Confirmation Inquiry	A DM-guided scenario where players must solve a puzzle with a known solution, reinforcing game mechanics.	Players explore a well-known module with specific tasks but decide how to execute them.
Structured Inquiry	Players follow a specific quest line with predefined challenges, such as retrieving a known artifact.	Players are given a goal but must devise their methods to achieve it within a game world.
Guided Inquiry	A DM sets up a scenario with a problem (e.g., a village plagued by mysterious disappearances) and guides players through solving it with hints.	Players are presented with a scenario (e.g., political intrigue in a city) and must use their strategies to navigate it.
Open Inquiry	Players are involved in a campaign in which they must uncover the mystery of their origin stories, with minimal DM interference beyond setting the initial scene.	It is an entirely player-driven campaign in which the DM facilitates the world's reactions to player actions without predefined plot points.

Note. Author elaboration.

This matrix illustrates how TTRPG encounters can be tailored to match teaching approaches, ranging from DM-controlled quests to player-driven explorations. The iterative, trial-and-error process of Dungeon Mastering parallels effective pedagogy, where teachers adjust methods based on student responses. This adaptability is essential for creating learning environments that are responsive and engaging.

The potential of role-playing elements in STEM education lies in their ability to frame game-like scenarios that support collaboration and creativity (Leon et al., 2025). DMs provide a valuable model because their skills: narrative design, adaptive facilitation, and balancing autonomy with structure, mirror those required for responsive teaching. To investigate these parallels, a survey instrument was developed to document DM practices and refine them for educational application.

This transdisciplinary approach highlights the need to adapt game-based strategies carefully. When integrated effectively, TTRPG-based methods align with contemporary educational priorities that emphasize experiential, Student-Centered Learning (SCL) and offer classrooms that are both interactive and intellectually demanding.

Results and Exploratory Findings

Because this study represents the design and validation phase of a larger mixed-methods project, the results presented here should be understood as exploratory findings rather than definitive empirical outcomes. The analysis focuses on patterns that emerged from the instrument development process, pilot testing, and theoretical synthesis under IRB #2408046040. These findings illustrate how Dungeon Master (DM) facilitation practices can be modeled, evaluated, and adapted to inform experiential learning (EL) and inquiry-based learning (IBL) within STEM education.

The results section is organized around two core components. First, it summarizes the insights derived from the development, testing, and validation of the research instruments (Instruments 1 and 2), including the operationalization of the General–Particular–Specific (GPS) Matrix. Second, it interprets the conceptual and methodological relationships captured in Tables 4 and 5, highlighting how the identified facilitation competencies, such as adaptability, empathy, and collaborative leadership, align with effective pedagogical strategies in STEM inquiry.

Based on the literature review and theoretical framework, it was hypothesized that the sustained interest inherent in TTRPGs would motivate students and promote lasting engagement with STEM subjects. The findings from this study supported this hypothesis by demonstrating how the facilitation practices of Dungeon Masters (DMs) mirror essential pedagogical strategies associated with experiential learning (EL) and inquiry-based learning (IBL). TTRPGs provided experiential opportunities that allowed learners to explore complex scientific and social concepts through interactive, narrative-driven settings. These sessions enabled participants to test ideas, reflect on outcomes, and apply knowledge in practical contexts, paralleling inquiry cycles in STEM education. Through the creation and adaptation of scenarios, DMs cultivated low-risk environments for experimentation, collaboration, and iterative problem-solving.

A research protocol and a series of instruments were developed under the IRB #2408046040. The primary instrument captured how DMs planned and facilitated engaging sessions, focusing on the balance between narrative structure and player autonomy. The first phase involved testing and refining this survey with experienced DMs to ensure it accurately represented the cognitive, creative, and affective dimensions of facilitation. Once validated, the tool was adapted for use with educators to examine how DM strategies could inform classroom practice.

Through this phased approach, the study assessed whether the adaptive and interactive methods used by DMs could enrich STEM education. The analysis identified strategies that increased student motivation, supported collaboration, and promoted deeper engagement with STEM content. The results also revealed strong parallels between DM facilitation and practical instructional design, particularly in areas of feedback, adaptive management, and collaborative inquiry.

Table 4 presents the primary Research Questions (RQs) in relation to the three IRB phases, data sources, and analytical focus. It summarizes how each question guided the study and how the results addressed the central objectives of evaluating DM praxis as a pedagogical model.

Table 4.*Research Questions, IRB Phases, and Summary of Findings*

RQ	Research Question	IRB Phase	Data Source / Instrument	Preliminary Findings or Analytical Focus
1	How can the facilitation practices and functional competencies of Dungeon Masters (DMs) in Tabletop Role-Playing Games (TTRPGs) be evaluated and translated into pedagogical strategies that enhance experiential learning (EL) and inquiry-based learning (IBL) within STEM education?	All Phases	Instruments I & 2; Focus Groups; Interviews; Literature Review	DMs exhibit facilitation patterns that parallel instructional design, adaptive teaching, and formative assessment processes in STEM classrooms.
2	What did the existing literature reveal about the intersection of role-playing, experiential learning, and inquiry-based pedagogies, and where did gaps remain in understanding how analog TTRPGs contribute to student engagement, collaboration, group dynamics, and leadership within STEM contexts?	Pre-Event	Literature Review (Web of Science, Google Scholar)	Literature emphasizes digital games; analog TTRPGs remain under-theorized despite strong evidence of social and cognitive benefits.

Note. Author elaboration.

RQ1 examined how DM facilitation practices could be evaluated and translated into educational strategies. Results showed that DMs exhibited facilitation patterns parallel to instructional design, adaptive teaching, and formative assessment.

RQ2 explored what the existing literature revealed about role-playing and experiential pedagogy. The review indicated that digital games dominate current research, leaving analog TTRPGs under-theorized despite consistent evidence of cognitive and social benefits.

Table 5 expands this analysis by detailing the Operational and Methodological Sub-questions (SQ1–SQ9) that structured the data collection and analysis across the three IRB phases.

- The Pre-Event phase validated the survey through expert consultation and focus-group feedback, identifying ten core DM functions: Arbitrate, Narrate, Create, Teach,

Improvise, Act, Facilitate, Balance, Direct, and Model Empathy, as educationally relevant competencies.

- The Event phase confirmed alignment between reported DM practices and the principles of EL and IBL, highlighting improvisation, feedback, and collaboration as key pedagogical parallels.
- The Post-Event phase integrated quantitative and qualitative findings, revealing that empathy, communication, and creativity were the strongest predictors of effective facilitation. These insights directly informed the development of the *Inventario de Autoevaluación de Competencias del DM*, establishing a pathway for future validation and educator training applications.

Table 5.*Operational and Methodological Sub-questions*

IRB Phase	Data Source / Instrument	Analytical Focus or Preliminary Findings
Pre-Event	Instrument 1: Exploring the Integration of Role-Playing Games in Education	Expert feedback from researchers and designers refined survey language and validated ten DM facilitation functions (Arbitrate, Narrate, Create, Teach, Improvise, Act, Facilitate, Balance, Direct, Model Empathy).
Pre-Event	Focus-group discussion (8° <i>Coloquio de Estudios de Juegos de Rol</i> , Mexico) and individual interviews with self-identified DMs (21 +)	Thematic analysis revealed recurring categories: adaptive facilitation, empathy, narrative coherence, balance, and inclusive collaboration, mapped to pedagogical competencies in inquiry-based instruction.
Pre-Event	General–Particular–Specific (GPS) Matrix framework	The GPS Matrix effectively linked general play theory to specific DM praxis and measurable learning outcomes, providing a foundation for later survey operationalization.
Event	Instrument 2: Evaluating the Role and Competencies of the Dungeon Master (Conference deployment)	Quantitative results showed strong alignment between reported DM practices and key principles of experiential learning (EL) and inquiry-based learning (IBL); most DMs emphasized improvisation, feedback, and collaboration.
Event	Instrument 2 (Role-based comparison: researcher, educator, designer, DM)	Cross-group comparison indicated convergent competencies: creativity, adaptability, and group facilitation, suggesting transferability to STEM instructional contexts.
Event	IRB procedures, digital consent forms, and NJIT secure storage logs	Data-management review confirmed full compliance with ethical standards: voluntary consent, anonymization, and restricted access to identifiable data.
Post-Event	Mixed-methods dataset: Likert-scale frequency/importance ratings + open-ended responses	Correlation analysis revealed that empathy, collaboration, and improvisation positively influence consensus-based conflict-resolution strategies.
Post-Event	Cross-analysis between Instrument 2 results and draft <i>Inventario de Autoevaluación de Competencias del DM</i>	Core predictive competencies identified: communication, creativity, emotional regulation, and adaptive planning; proposed as primary dimensions for inventory validation.
Post-Event	Integrated synthesis of Instruments 1 & 2, interview data, and theoretical mapping to ELT	Findings support a training framework aligning DM facilitation cycles with Kolb's experiential learning theory (ELT), offering a replicable model for applying TTRPG methods to STEM education.

Note. Author elaboration.

The Playground Dimension

During data analysis, a new dimension, *Playground*, emerged as a conceptual bridge between the traditional railroad and sandbox paradigms used to describe facilitation and instructional design in both TTRPGs and education. While railroad structures emphasize control, sequencing, and clearly defined outcomes (akin to direct instruction), and sandbox structures promote freedom, exploration, and learner-driven discovery (similar to independent or open inquiry), Playground represents a dynamic middle ground where structure and autonomy coexist through guided co-creation.

In a Playground environment, both facilitators and participants share responsibility for constructing meaning, rules, and goals. The facilitator, whether a teacher or Dungeon Master (DM), acts as a co-designer rather than a controller or passive observer. Scenarios begin with a defined framework (narrative, objectives, constraints), but participants are invited to expand and reinterpret that framework collaboratively. This iterative interplay of design, exploration, and reflection creates a participatory learning space that fosters creativity, critical thinking, and problem-solving while maintaining pedagogical coherence.

Findings from the IRB #2408046040 supported this new dimension. Across both survey instruments and focus-group data, participants consistently described the most effective learning or play experiences as those in which the facilitator “set the stage” but allowed the group to “build the story.” This balance between facilitation and freedom reflected high levels of empathy, adaptability, communication, and collaborative leadership, core competencies identified in the *Inventario de Autoevaluación de Competencias del DM*.

The Playground model aligns closely with experiential learning theory (ELT) and inquiry-based learning (IBL) by positioning learners as active participants in meaning-making cycles. As in Kolb’s experiential cycle, players engage in concrete experience (gameplay or experimentation), reflective observation (discussion and analysis), abstract conceptualization (rule interpretation or hypothesis formation), and active experimentation (decision-making and adaptation). The facilitator supports this process by framing challenges and maintaining flow without predetermining outcomes.

Pedagogically, the Playground dimension offers a framework for adaptive learning design in STEM education. It enables instructors to maintain curricular alignment while allowing for student agency, creativity, and emergent inquiry. This model can be particularly effective for project-based or transdisciplinary learning, where exploration and reflection must coexist with measurable objectives. By blending the structure of direct instruction with the openness of inquiry, the Playground space embodies the principles of co-creation, inclusivity, and transformative learning that define both effective teaching and expert Dungeon Mastery. These exploratory findings informed practical recommendations for integrating TTRPG facilitation into STEM pedagogy.

Implications

The results demonstrated that TTRPG facilitation embodies a set of transferable competencies with direct relevance to STEM teaching and curriculum design. DMs engaged in practices that

promoted experiential inquiry, reflective problem-solving, and collaborative learning: mirroring the adaptive instruction and formative assessment emphasized in effective pedagogy. Furthermore, the emergent Playground dimension, introduced in this study, offered a novel pedagogical configuration that bridged structured (railroad) and open (sandbox) modes of learning. This hybrid environment encouraged both guidance and autonomy, aligning with current trends in inquiry-based STEM education that emphasize co-creation and student agency.

These findings suggest that integrating TTRPG principles into teacher preparation and classroom practice could enhance student engagement, foster creativity, and cultivate the collaborative and adaptive skills required in contemporary scientific and technological fields. Future research will continue to refine the DM competency inventory, extend its validation with educators, and explore its application in professional development programs and interdisciplinary learning environments.

Limitations and Open Questions

While this study outlines a strong foundation, several challenges remain in observing and analyzing TTRPGs as educational phenomena:

- **Observation without interference.** Capturing play requires documentation methods that do not disrupt the natural flow of the session. Video recording could provide rich data, but risks altering player behavior.
- **Complexity of transcription.** DMs often speak in multiple voices, alternating between characters and narration. Transcribing this accurately requires conventions that distinguish character dialogue, out-of-character talk, and narrative description.
- **Duration of sessions.** Game sessions often last five to eight hours. Documenting and analyzing such lengthy interactions demands strategies for sampling, segmenting, or coding without losing essential detail.
- **Emergent narrative vs. casual conversation.** A key challenge is distinguishing between in-character dialogue, table talk, and the evolving story. Methods must account for this fluidity to avoid oversimplification.

These limitations highlight a gap in existing research: there are few established methods for systematically observing the complexity of live TTRPG play. Future work must explore mixed approaches, such as combining video and audio capture with transcription protocols and digital analysis tools, while being mindful of ethical considerations and participant comfort.

These challenges underscore the complexity of studying TTRPGs in educational contexts. Rather than weakening the study, they point to important areas for future research and methodological innovation. With these questions in mind, the following conclusions outline the contributions of this work and the directions it opens for both scholarship and practice.

Conclusions

This study reviewed current literature on the role of TTRPGs in STEM education and used those insights to guide the design of research instruments and coding categories for future

work. Our findings suggest that adding TTRPG dynamics to classroom practice changes how students approach STEM content. Rather than memorizing facts, they adopt roles, make choices, and test ideas. These practices support engagement and help students develop lasting understanding. Looking closely at how Dungeon Master(s) (DMs) facilitate games gave us a model for how role-playing techniques might translate into more responsive teaching.

Our framework aligns with experiential and Student-Centered Learning (SCL). DM techniques (like adapting to player choices, balancing freedom with structure, and promoting collaboration) mirror what effective teachers already do. When applied in classrooms, these strategies can help students explore more deeply and solve problems more effectively. They are especially relevant in STEM, where learners must handle complex ideas and build skills they can use beyond the classroom.

A key outcome of this study is the development of a research instrument to capture effective DM practices. The tool will be tested in stages: first with researchers, then with DMs, and later with K–12 teachers. Each step will require separate IRB approval. This phased process ensures rigor and keeps the work grounded in real practice. It also creates a pathway for adapting role-playing techniques to classroom use.

We expect this research to generate evidence on the value of TTRPGs in STEM learning and to produce practical recommendations for teachers and policymakers. By showing how role-playing methods can make learning more interactive, adaptive, and inclusive, this work aims to support ongoing efforts to rethink STEM education and make it more effective.

The full impact of TTRPGs will only be clear after further empirical testing. Still, this study lays important theoretical and methodological groundwork. It connects educational research with practice, adds new tools for teachers, and suggests fresh ways to meet the needs of diverse learners.

Author Contributions

Cristo Leon, Ph.D. (Corresponding Author, First Author). Conceptualization, Data Curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, and Writing - Original Draft.

James Lipuma, Ph.D.. Conceptualization, Methodology, Validation, Investigation, Resources, Writing - Original Draft, and Writing - Review and Editing.

Conflict of Interest

No conflict or interest.

AI and Related Technologies

The authors disclose the use of the following digital tools and generative AI technologies in the preparation of this manuscript:

- *Power BI* Version 2.121.853.0 (April 2025) — for data visualization and analysis.
- *Grammarly* Version 2025.4.0 — for language editing and proofreading.
- *Microsoft Excel 2025* (Version 2303 Build 16.0.16227.20204) — for data organization and analysis.
- *Microsoft Word 2025* (Version 2303 Build 16.0.16227.20204) — for manuscript drafting and editing.
- *Zoom* Version 5.14.0 (April 2025) — for communication and collaborative meetings during the research process.
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Findable Accessible Interoperable Reusable Open Science

All outputs are made public through the Open Science Framework (OSF) repository¹⁰ and are referenced in the project's Data Management and Sharing Plan (DMSP) (Leon & Lipuma, 2024). Each item adheres to the FAIR principles—Findable, Accessible, Interoperable, and Reusable—and carries a CC BY 4.0 license to promote transparency, ethical data reuse, and long-term availability.

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¹⁰ Source for all files: <https://osf.io/qt7wp/files>

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Appendixes

Appendix I.

Instrument I V.5 section I

INSTRUMENT

Questions for the Researchers Survey (Google Form):

These questions will be part of the google survey for the researchers.

[Page 01]

Title of study

Recruitment Script

1.- Have you signed the Inform Consent form to Participate?

- ☐ Yes / No

Note: This is a conditional question. If the participant selects "Yes," they may proceed with the survey. If they select "No," they will be directed to the following message:

Thank you! It is not possible to participate without your consent.

[Page 02]

Inclusion/Exclusion Question: The following is an inclusion/exclusion question for the study.

2.- Are you older than 21?

- ☐ Yes / No

Note: If the participant selects "Yes," they may proceed with the survey. If they select "No," they will be directed to the following message:

Thank you for your interest in the study. Unfortunately, you do not meet the age requirement for participation.

[Page 03]

Demographic Questions

3.- Are you a researcher, designer, or student?

- ☐ Researcher / Designer / Student

4.- What is the university that you are affiliated with?

- ☐ Please specify the name of your institution.

5.- Have you played RPGs?

- ☐ Yes / No

Note. Complete instrument "00_Protocol_Summary_Report Public and Instrument I.pdf".

Source <https://osf.io/p2r8k>

Appendix 2.*08_Instrument 2 Exploring the Integration of Role section***[Page 4 – Functions of the Dungeon Master (DM)]****Instructions**

Below are standard DM functions. Indicate how frequently you perform each and how important you consider it for effective facilitation.



Function	Definition	Frequency (1–5)	Importance (1–5)
Arbitrate	Apply and interpret rules to maintain fairness and consistency.	_____	_____
Narrate	Describe scenes, characters, and events to build immersion.	_____	_____
Create	Design worlds, settings, and story elements.	_____	_____
Teach	Help players understand rules and facilitate learning.	_____	_____
Improvise	Respond creatively to unexpected player choices.	_____	_____
Act	Portray characters and convey emotion through performance.	_____	_____
Facilitate	Ensure player engagement, pacing, and group balance.	_____	_____
Balance	Adjust challenge and difficulty for fairness.	_____	_____
Direct	Guide rhythm, transitions, and focus of play.	_____	_____
Model Empathy	Encourage emotional awareness and respect among players.	_____	_____

Scales:

Frequency → 1 Never ... 5 Always

Importance → 1 Not Important ... 5 Essential

Ranking Questions

9. Select your **1st Most Important Function (Top Choice)**: *(Dropdown)*

10. Select your **2nd Most Important Function (Second Choice)**: *(Dropdown)*

11. Select your **3rd Most Important Function (Third Choice)**: *(Dropdown)*

12. Open-Ended

Are there other functions or responsibilities you believe are essential to the DM role?

Note. Complete instrument “08_Instrument 2 Exploring the Integration of Role.pdf”. Source <https://osf.io/28tpv>

Appendix 3.*Guiding Principles of Evidence-Based Inquiry*

Principle	Definition
Relevance of research questions	Research questions should significantly impact knowledge and practice and be capable of empirical investigation.
Theoretical and conceptual framework	Research should be anchored in a robust theoretical or conceptual framework that aids in interpreting and explaining the results.
Empirical data collection	The chosen research method must gather empirical data to explore the research questions.
Logical and coherent reasoning	The research process should maintain a rational and coherent flow of reasoning, with detailed accounts of procedures and analyses to ensure transparency and replicability.
Replicability of results	Results should be replicable across studies, enhancing their reliability and validity.
Dissemination of findings	Research findings should be disseminated to peers and professionals to invite further Inquiry, critique, and discussion, fostering a collaborative scientific community.

Note. According to the National Research Council (2002). Source

<http://www.nap.edu/catalog/10236>

Appendix 4.*General–Particular–Specific (GPS) Matrix Applied to TTRPG Facilitation*

Level	Focus	Application in This Study
General	Theoretical foundations of play, learning, and facilitation.	Established the conceptual link between experiential learning (EL), inquiry-based learning (IBL), and role-playing as educational practices. Defined learning as a cyclical and participatory process involving experience, reflection, and experimentation.
Particular	Role of the Dungeon Master (DM) as facilitator within Tabletop Role-Playing Games (TTRPGs).	Examined how DMs translate learning theory into practice through storytelling, adaptive management, and collaborative problem-solving. Identified ten facilitation functions: <i>Arbitrate, Narrate, Create, Teach, Improvise, Act, Facilitate, Balance, Direct, and Model Empathy</i> .
Specific	Operational instruments and empirical procedures.	Implemented through survey design, interviews, and focus-group analysis under IRB #2408046040. Generated data used to compare DM competencies with pedagogical strategies in STEM education and to develop the <i>Inventario de Autoevaluación de Competencias del DM</i> .

Note. Author elaboration based on “Modelo General Particular Específico (GPE): Una Herramienta Convergente para la Revisión Sistemática de la Literatura” (León et al., 2022).

Appendix 5.
DMSP Outputs

Title	Type	Repository	Release date	Access level	
00 IRB Protocol and Initial Survey Instrument	Text	OHSU Digital Commons	10-12-2025	Open	Actions▼
01 Public Data Report Informe Público de Datos	Text	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
02_TTRPG_Survey_Responses_Public	Dataset	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
03_TTRPG_Survey_Affiliations_frequency	Dataset	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
04_TTRPG_Survey_Categoría_Descriptiva_Porcentaje	Dataset	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
05_TTRPG_Survey_Role	Dataset	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
06_Escala de valores para las Competencias	Text	JMU Open Science Framework (OSF)	10-18-2025	Open	Actions▼
08 Second Instrument for Exploring the Integration ...	Text	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
09 Inventario de Autoevaluación de Competencias de ...	Text	JMU Open Science Framework (OSF)	10-10-2025	Open	Actions▼
RUIR Conference Presentation	Event	OHSU Digital Commons	10-10-2024	Open	Actions▼

Note. Author elaboration.