

BOARD GAME-BASED LEARNING: FROM COGNITIVE PROCESSES TO ASSESSMENT

BOARD GAME-BASED LEARNING: DAI PROCESSI ALLA VALUTAZIONE



Double Blind Peer Review

Citation

Tinterri, A., di Padova, M., & Pelizzari, F. (2025). Board game-based learning: from cognitive processes to assessment. *Giornale italiano di educazione alla salute, sport e didattica inclusiva*, 9(1).

Doi:

<https://doi.org/10.32043/gsd.v9i1.1360>

Copyright notice:

© 2023 this is an open access, peer-reviewed article published by Open Journal System and distributed under the terms of the Creative Commons Attribution 4.0 International, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

gsdjournal.it

ISSN: 2532-3296

ISBN: 978-88-6022-509-2

Andrea Tinterri
Università Digitale Pegaso
andrea.tinterri@unipegaso.it



Marilena di Padova
Università di Foggia
marilena.dipadova@unifg.it



Federica Pelizzari
Università Cattolica del Sacro Cuore
federica.pelizzari@unicatt.it



ABSTRACT

Board Game-Based Learning (bGBL) has gained increasing attention as an innovative approach to foster active engagement and holistic cognitive development. However, integrating board games into effective practice is challenging, partly because of the lack of an established instructional framework. By integrating Anderson & Krathwohl's taxonomy into bGBL design, this contribution focuses on how specific game mechanics can target higher-order thinking skills, aligning gameplay dynamics with established instructional frameworks. This allows effective implementation of bGBL strategies, in-game and around-game assessments, and real-time calibration of the learning process. These findings indicate the potential of bGBL to advance pedagogical practices, supporting teachers in creating immersive, evidence-based environments that align cognitive objectives with meaningful evaluation.

Il Board Game-Based Learning ha guadagnato sempre più attenzione come approccio innovativo per promuovere l'impegno attivo e lo sviluppo cognitivo olistico. Tuttavia, l'integrazione dei giochi da tavolo in una pratica efficace è difficile, in parte a causa della mancanza di un quadro didattico consolidato. Integrando la tassonomia di Anderson e Krathwohl nella progettazione del bGBL, questo contributo si concentra sul modo in cui specifiche meccaniche di gioco possono indirizzare le abilità di pensiero di ordine superiore, allineando le dinamiche di gioco con quadri didattici consolidati. Ciò consente un'implementazione efficace delle strategie bGBL, delle valutazioni in-game e around-game e della calibrazione in tempo reale del processo di apprendimento. Questi risultati indicano il potenziale del bGBL per far progredire le pratiche pedagogiche, supportando gli insegnanti nella creazione di ambienti coinvolgenti e basati sull'evidenza che allineano gli obiettivi cognitivi con una valutazione significativa.

KEYWORDS

Board Game-Based Learning; Game mechanics; Assessment; Anderson & Krathwohl's Taxonomy; Innovative Instructional Design.

Board Game-Based Learning; Meccaniche di gioco; Valutazione formativa; Tassonomia di Anderson e Krathwohl; Progettazione didattica innovativa.

Received 30/04/2025

Accepted 27/05/2025

Published 20/06/2025

Introduction

In recent years, Board Game-Based Learning (bGBL) has gained increasing relevance in educational contexts, establishing itself as an innovative teaching methodology capable of combining active participation, situated learning, and the development of transversal skills (Gee, 2003; Lave & Wenger, 1991; Wiggins & McTighe, 2005). The deliberate use of board games in school and training environments differs from general recreational approaches due to its ability to structure regulated, narrative, and collaborative learning environments in which students take an active role in the construction of meaning (Abt, 1970; Boller & Kapp, 2017; Vygotsky, 1978).

Despite the growing popularity of educational experiences that integrate board games, there is still a significant gap in terms of evaluation: indeed, there is no shared and structured framework that allows the cognitive and pedagogical effects of bGBL to be systematically and reliably measured (Arnab et al., 2015; Shute, 2011). Many evaluation practices are still incidental, impressionistic, or focused on secondary dimensions (e.g. liking, participation), neglecting the possibility of observing evidence of learning in relation to explicit and measurable objectives (Plass et al., 2015; Romero et al., 2012). Moreover, such practices often fail to consider the specific interplay between game mechanics and learning outcomes, which is essential for effective instructional design (Salen & Zimmerman, 2004; Engelstein & Shalev, 2019).

To address this need, this paper proposes an integrated evaluation model for board game-based learning, based on a theoretical triangulation between:

1. Anderson & Krathwohl's (2001) taxonomy, which is useful for classifying the cognitive processes activated during the game and aligning them with learning goals (Biggs, 1999).
2. the R-I-Z-A model (Trinchero, 2018; Trinchero, 2017), which allows mapping of executive functions through the descriptors of representation, interpretation, activation zone, and self-regulation.
3. Le Boterf's (1994, 2000) competence construct, which integrates the dimensions of knowledge, know-how, and interpersonal skills, and emphasises the importance of situated and contextualised learning (Le Boterf, 2006; Jonassen, 1999).

The aim is to provide a theoretical-operational tool that can guide teachers, educators, and researchers in the design and conscious evaluation of bGBL activities, enhancing both the observable in-game evidence and the around-game

reflective practices, and making visible the link between game mechanics, cognitive processes, and skill construction.

1. Theoretical Framework

To build an effective and well-founded evaluation system for Board Game-Based Learning (bGBL), it is necessary to refer to an integrated theoretical framework that allows us to map, observe and interpret what happens in ludic-educational contexts. Three models contribute to defining a coherent and articulated perspective: Anderson and Krathwohl's taxonomy of cognitive processes, the R-I-Z-A neuroeducational model and Le Boterf's construct of competence.

Anderson and Krathwohl's (2001) taxonomy represents a significant evolution of Bloom's (1956) famous taxonomy, introducing a two-dimensional structure that allows for a more detailed analysis of learning. The two axes that make up the taxonomy are

- The cognitive process axis, which articulates six progressive levels: remembering, understanding, applying, analysing, evaluating, creating.
- The knowledge axis, which is subdivided into: factual, conceptual, procedural, and metacognitive.

This cross-referenced structure allows you to design and evaluate educational activities that are not limited to mere memorisation, but that promote more complex forms of thinking, such as critical evaluation or the creation of innovative solutions.

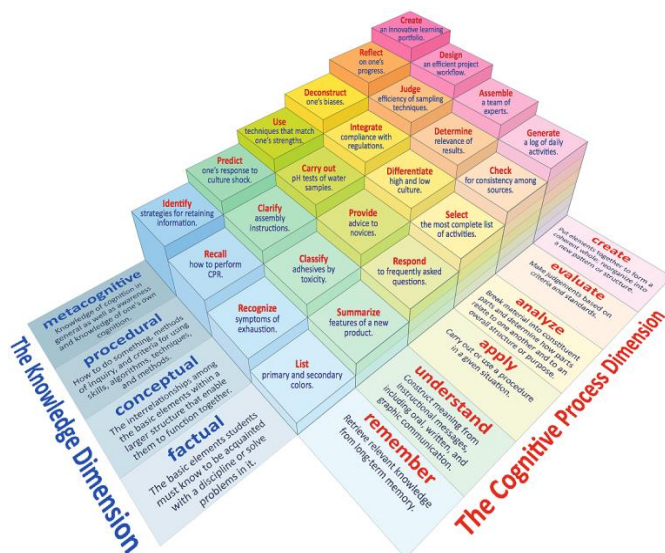


Figure 1. Anderson & Krathwohl Taxonomy (2001)

When applied to board-game-based learning, the taxonomy provides a robust interpretative framework for analysing what cognitive processes are activated during the game and what types of knowledge they are based on. For example, during a cooperative resource management game, a student may: remember rules or past events to make decisions (procedural knowledge); analyse the moves of other players to build a shared strategy (high-level cognitive process); evaluate alternatives to optimise the use of resources (critical thinking); create a new combination of actions to solve an unprecedented problem.

The effectiveness of bGBL depends on its ability to engage students in these higher forms of thinking. However, for this potential to translate into meaningful and measurable learning, instructional designers must be able to map the expected cognitive processes *ex ante* and develop observable indicators to detect them during and after the game-based activity.

In this sense, the A&K taxonomy is not just a classification tool, but a design model that allows educational objectives, game dynamics and evaluation tools to be aligned within a logic of didactic coherence (Biggs, 1999).

This first dimension is accompanied by the R-I-Z-A model, a useful conceptual framework for analysing and evaluating cognitive and executive functions in complex educational contexts, including play activities. The model is divided into four basic descriptors:

1. Resources: refers to the knowledge, skills, abilities, attitudes, and emotions that a student possesses or can access.
2. Interpretation: active decoding of information and adaptation to context.
3. Activation zone: potential space for experimentation between the known and the learned.
4. Self-regulation: the ability to consciously monitor, correct and terminate one's own actions.

The R-I-Z-A model, developed in the field of neuroeducation, allows us to describe what happens "inside" learning when a subject is engaged in activities that require attention, cognitive control, adaptation, and reflection.

In board game-based learning, these descriptors are useful for mapping the executive functions stimulated by the game and making them visible to the educational observer. For example, consider a competitive game based on risk management and bluffing: to play the game effectively, the learner must

To play the game effectively, the student must: represent the rules and objectives of the game by translating them into a mental map; interpret his opponents' moves and indirect communicative signals; activate his proximal development zone by

trying new strategies never tried before; self-regulate by avoiding impulsive actions, correcting mistakes and planning with flexibility.

The model is therefore particularly useful for structuring observation grids, checklists and evaluation rubrics that go beyond "external" performance and focus on internal thought processes and cognitive control.

Trincherò also suggests that R-I-Z-A should be seen not only as a diagnostic tool but also as a training tool: asking players to reflect on how they have represented, interpreted, explored and self-regulated their game experience activates forms of metacognition and strategic awareness that are central to any authentic learning process.

Completing the picture, the concept of competence proposed by Guy Le Boterf represents a fundamental reference for understanding the integrated and situated nature of expert performance. According to Le Boterf (1994, 2000), competence is not limited to the mere acquisition of knowledge or isolated skills, but results from the articulation of three inseparable dimensions:

1. *Savoir*: theoretical and conceptual knowledge.
2. *Savoir-faire*: operational know-how, i.e. the ability to act effectively in concrete situations.
3. *Savoir-être*: interpersonal skills, understood as attitudes, professional behaviour, and relational dispositions.

This perspective is rooted in the idea of situated learning (Lave & Wenger, 1991), whereby skills are not automatically transferred from one context to another, but are constructed and manifested within social and cultural practices.

Applied to the context of board game-based learning, Le Boterf's model allows us to interpret the game experience as an ecological space of competence, in which the subject: mobilises previous knowledge (*savoir*), acts strategically in complex and dynamic situations (*savoir-faire*), assumes roles, respects rules, cooperates and negotiates with other actors (*savoir-être*).

For example, in a collaborative game where players have to solve a complex problem under pressure, competence is expressed in the ability to combine analytical thinking, time management, effective communication and team spirit in a way that is consistent with the conditions imposed by the game situation. It is not just about 'winning' but about adapting, reflecting, negotiating, and learning together. Evaluating skills in a bGBL activity therefore requires tools that can capture this three-dimensional nature: multi-level observation rubrics, reflection diaries, peer feedback and narrative debriefing moments can make visible the process through which skills emerge and consolidate.

2. Game mechanisms and cognitive processes: between transparency and strategic activation

In the context of Board Game-Based Learning (bGBL), the challenge is not only to design engaging game experiences, but also to construct assessment tools that are valid and consistent with the skills activated (Jonassen, 1999; Mislevy et al., 2014). In this sense, the relationship between game mechanics, or mechanisms (Engelstein and Shaleev, 2019), and cognitive processes is central to instructional design and assessment. Game mechanisms represent the rules, dynamics, and actions that structure players' interactions with the game system, while cognitive processes correspond to the mental operations elicited by these interactions, as described in Anderson & Krathwohl's (2001) taxonomy.

Unlike video games, in which the rule system is encoded in the software and often remains opaque to the player, board games have a fundamental characteristic: mechanical transparency. In digital games, outcomes may depend on hidden variables—random number generators, backend algorithms, or undocumented constraints—making it difficult to establish a clear cause-effect relation (De Freitas & Oliver, 2006; Gee, 2007). This opacity may enhance immersion or complexity, but it limits opportunities for cognitive meta-reflection (Spires et al., 2011; Iten & Petko, 2016). In board games, by contrast, the rule system is explicit, shared, and visible: every player knows the conditions shaping the game and can observe the consequences of their actions in real time (Andreoletti & Tinterri, 2023). This rule visibility facilitates deeper understanding of system dynamics and encourages learners to reflect upon decisions, outcomes, and strategies (Salen, 2017).

This transparency has important educational implications, especially in contexts where games are used as models of complex systems, turning play into a reflective and cognitive environment (Petty, 2009; Egenfeldt-Nielsen, 2005). Examples such as *Pandemic* or *Photosynthesis* demonstrate how clearly defined mechanics can simulate ecological, social, or epidemiological systems, allowing players to explore interconnected variables and consequences through active participation (Rooney, 2012).

To this structural quality is added the pedagogical function of game mechanics as cognitive activators. Theoretical models such as the LM-GM framework (Arnab et al., 2015) or the modded educational game design workflow (Abbott, 2018) allow for the linking of game mechanics and learning mechanics, facilitating a systematic reading of player dynamics and their alignment with learning goals. Mechanics such as resource management, bluffing, negotiation, design, and collaborative storytelling are not merely functional elements, but experiential structures

intentionally designed to stimulate complex thinking (Garris et al., 2002; Van Eck, 2006). In board games, every rule and mechanic are enacted by the player: the mechanic becomes the medium, shaping both performance and cognition.

However, to avoid summative or impressionistic evaluations, assessment must move beyond mere performance checklists and embrace the gradual, situated, exploratory, and reflective nature of playful learning (Shute & Ventura, 2013; Annetta, 2010). From a constructivist perspective, competence is built over time: it evolves through experimentation, error, and meaning negotiation—leading eventually to stable mastery (Barab et al., 2005). Game mechanics support this path from exploration to mastery, making the construction of knowledge and skills observable and intentional (Schell, 2014).

Trinchero (2014) provided a detailed analysis of how different game mechanics activate distinct cognitive processes, based on empirical observation and the classification of tasks used in computerized games for cognitive enhancement. His research demonstrated that strategic, cooperative, and exploratory game formats tend to elicit higher-order cognitive operations such as exploring, selecting, planning, and controlling—all of which are closely related to executive functions like inhibitory control, working memory, and cognitive flexibility (Kolb, 1984). These mechanics often require the player to assess available options, anticipate future states of the game, coordinate with other players, and regulate decisions over time, making them particularly valuable for fostering metacognitive awareness and strategic reasoning. By contrast, more procedural or linear games, often centered on repetitive tasks or predictable sequences, are typically associated with recognising, executing, and repeating. These actions correspond to lower levels in Anderson & Krathwohl's (2001) taxonomy, such as remembering and applying, and are useful when the instructional goal involves skill automation, routine task performance, or initial exposure to content. While such games may seem less cognitively demanding, they can play a key role in scaffolding learning and supporting students with low prior knowledge or special learning needs (Mayer, 2014; Moreno & Mayer, 2007).

This distinction has critical implications for the intentional design of educational board games. The mapping between specific game mechanics and cognitive processes allows educators and designers to align the structure of play with pedagogical objectives, ensuring that the learning experience is not only engaging, but also measurable and goal-oriented. As Wouters and van Oostendorp (2017) suggest, integrating cognitive taxonomies into game design enhances the instructional transparency of the game and supports a constructivist approach to learning design, enabling players to progress from concrete operational behaviours

to more abstract and reflective thinking through structured game experiences. Certain game mechanics stand out for their ability to activate complex cognitive levels and support articulated learning processes. Cooperative, narrative, and variable-structure mechanics—such as Variable Player Powers and Narrative Choice—frequently engage the higher-order levels of Anderson and Krathwohl’s taxonomy (Evaluate and Create). These mechanisms foster dynamics of shared reflection, meaning negotiation, and collaborative problem-solving, making them especially effective in educational settings focused on the development of critical thinking and transversal competencies.

Other mechanisms, such as Prisoner’s Dilemma, Deduction, Voting, and Trading, directly engage executive functions, as they require players to mediate between individual choices and group objectives, balancing interests, risk, and anticipation of others’ actions. These mechanics activate self-regulation, planning, and cognitive flexibility, making them valuable for enhancing metacognitive and decision-making skills.

Economic and competitive mechanisms, such as Trading and Auction, specifically train skills related to strategic application and systemic analysis, prompting players to evaluate resources, opportunities, and trade-offs in relation to dynamic goals. These mechanics promote an operational understanding of complex models, with interesting implications in economic, civic, or environmental education. Finally, some low-threshold mechanics, such as Pattern Movement and End-Game Bonuses, are particularly suited to activating basic cognitive levels (Remember, Apply), and can be effectively used in the initial phases of a learning path or with heterogeneous groups. However, with intentional design, these mechanisms can also be scaled up toward higher cognitive objectives, for instance by combining them with strategic, narrative, or cooperative dynamics that broaden their educational potential. In the following table, we outline how some common game mechanisms can be associated with specific cognitive processes as defined by Anderson & Krathwohl:

Game Mechanic	Remember	Understand	Apply	Analyze	Evaluate	Create
STR-02 Cooperative Games	✓	✓	✓	✓	✓	✓
TRN-09 Simultaneous Action Selection	✓	✓	✓	✓	✓	
ACT-02 Action Drafting	✓	✓	✓	✓	✓	
ACT-12 Variable Player Powers	✓	✓	✓	✓	✓	✓
ACT-18 Narrative Choice	✓	✓	✓	✓	✓	✓
RES-08 Prisoner's Dilemma		✓	✓	✓	✓	
RES-15 Voting	✓	✓	✓	✓	✓	
VIC-01 Victory Points from Game State	✓	✓	✓	✓		
VIC-06 End-Game Bonuses	✓	✓	✓	✓	✓	
UNC-01 Betting and Bluffing		✓	✓	✓	✓	
UNC-04 Hidden Roles	✓	✓	✓	✓	✓	
UNC-12 Deduction	✓	✓	✓	✓	✓	✓
ECO-02 Trading	✓	✓	✓	✓	✓	✓
AUC-01 Open Auction	✓	✓	✓	✓	✓	
MOV-03 Pattern Movement	✓	✓	✓	✓		

Table 1. Correlation between some game mechanics and cognitive processes (Anderson & Krathwohl)

It is important to remember that game mechanisms do not act in isolation: the combination and sequence between them produce emergent cognitive effects. Furthermore, the processes activated vary according to the player's profile, experience, and educational background. For this reason, it is useful to cross-reference this table with the R-I-Z-A model and with indicators of situated competence to construct more complex evaluation matrices.

3 -The rationale for applying the R-I-Z-A model to board games

As previously mentioned, Trincherro (2006, 2012, 2017) devised the R-I-Z-A model as a tool to unpack how learners exercise their competence, defined, according to the framework of situated learning, as “being able to act effectively in a specific situation” (Trincherro, 2012, p.35). The situation described is an “open problem” (ivi, p.37), that is, problems that can be interpreted in multiple ways or where not all information is given, that allow multiple solutions (some better than others) and require critical reflection for interpreting and acting accordingly.

The definition of competence expressed through the R-I-Z-A model is strictly linked to another pedagogical notion, that of experiential learning circles (CAE): the idea that effective learning happens through a continued alternance of direct experience, through which the learner acquires new information about the world, and moments of systematic and controlled reflection about the experience (Trincherro, 2017).

Games, and board games specifically, represent an ideal learning environment for the acquisition of competence as defined by Trincherro as they both offer open problems to the player/learner, and allow repeated cycles of experience and reflection through gameplay. A key notion of board games is that of *agency* (Andreoletti and Tinterri, 2023). In short, game rules define a set of actions by the player(s), which in turn can influence how the game develops. The possibility to influence the outcome of the game through the action of the player is the most distinctive characteristic of games, which separate them from other media and, crucially, is the foundation of the powerful potential of games for learning. Indeed, by constantly adjusting to player actions and providing immediate feedback on the results of said actions, games represent a dynamically evolving open problem with a certain number of possible solutions (restricted by game rules), some of whom are better than others as they advance the player(s) closer to the victory condition.

Thus, board games fulfil the requisite of being open problems, as they allow all the processes identified in the R-I-Z-A model (Table 2):

Elements (Structures of:)	Properties of an open problem (Trinchero, 2012)	Properties of board games	Example (chess)
Interpretation	The problem can be read in more than one way The problem has information missing and/or needs discriminating useful and less useful information	Board games present the player with game states (the combination of the game components and their relationships defined by game rules) from which information is extrapolated	Players “read” the game state of a chessboard by analysing the pieces present on the board, their position, and the spatial relationships between pieces.
Action	The problem allows different solutions, each with specific strengths and weaknesses	Players can usually choose between a set of actions to perform; the game rules specify which actions are allowed	Based on their reading of the game state, players move one of their pieces according to the rules. Some moves are better as they give an advantage (or a bigger advantage) over others
Self-regulation	The reflection on one’s own action encompasses the adequacy, efficiency, and effectiveness of the strategies used.	The game state changes dynamically according to the player moves. Thus, players can assess the adequacy (is the move legit?), efficiency (was this the best move	After their moves (and their opponents’ reaction), players can gauge whether their move had the intended effect by analyzing how the

		available?) and effectiveness (does this move makes me closer to winning?) of their actions	game state has changed.
--	--	---	-------------------------

Second, games are experiential learning circles in that they allow repeated cycles of interpretation-action-reflection during gameplay. The nature of board games often makes this repeated cycle explicit: most board games are played in *turns* and/or *rounds*, a set of repeated actions, defined by the game rules, that occur multiple times during gameplay until a victory (or loss) condition is reached (a concept also known as *game loops*). In these games, it is easy to parse the moments dedicated to interpreting the game state, acting, and reflecting upon the choices made. But even in games that don't have turns or are played in real time (such as *Dobble* or *e-mission*) such moments can be easily identified.

Depending on factors such as the player experience and the game specific mechanisms, we can identify learning cycles at a micro (concerning single actions or a limited number of actions) as well as a macro scale (spanning several turns or even a whole game). In game studies, this is often referred to as tactical decisions (where players aim to achieve short-term goals) and strategic decisions (where players plan for the long term, Braithwaite and Shachter, 2009). For instance, in *Dixit* a tactical decision might be aimed at finding an effective clue for a given card, whereas finding an effective communication strategy (like targeting details on cards or giving elliptic cues) to increase the likelihood of my card being recognized by some but not all players can be considered a strategic decision. Usually, players with less experience in a game are focused on immediate aspects, whereas, by gradually acquiring mastery of the game, they start focusing on long-term planning. Chess provide once again a compelling example, as studies showed that expert players gradually become more efficient in "reading" the game state, developing a system of routines (a phenomenon known as "chunking") of multiple moves to deploy according to both strategic and tactical needs (Gobet, Retschitzki, de Voogt, 2004). This is an important aspect to consider when using R-I-Z-A to define potential learning outcomes in bGBL as, according to the learner expertise and our planned goals, our expected learning outcomes might concern either short-term, long-term strategies, or a combination of the two. Of course, this influences instructional and assessment choices; for example, if we are interested in assessing learning at a micro scale we might examine the player turn-by-turn actions, whereas assessing

acquisition of long-term strategies might entail looking at different evidence, such as the overall score (in-game assessment) or post-game discussion (around-game assessment).

4. Mapping Top Board Games with cognitive and executive processes

To better illustrate the theoretical framework proposed, an analysis was conducted on a curated selection of board games drawn from BoardGameGeek - BGG (<https://boardgamegeek.com/>), the world's largest and most authoritative online database dedicated to tabletop games. Founded in 2000, BGG functions both as a catalogue and a community platform, aggregating detailed information, user reviews, play statistics, and rankings for over 120,000 games, including board games, card games, and role-playing games. Its rating system, based on thousands of user contributions, serves as a recognized benchmark for evaluating the quality, complexity, and popularity of games across genres (Vasconcelos et al., 2022; Rogerson, Sparrow, Gibbs, 2021; Bayeck, 2020). Using user vote, BGG categorizes games in eight types (Abstract, Customizable, Thematic, Strategy, Family, Wargames, Children, and Party games). Within this framework, we focused on the top ten highest-rated party games, a category that comprises games characterized by social interaction, accessibility, dynamic group engagement, and a lower number of game mechanisms, which made the subsequent analysis easier. The games analysed — Just One, KLASK, Telestrations, Dixit: Odyssey, Decrypto, Time's Up! Title Recall!, Camel Up (Second Edition), Codenames, Wavelength, and Secret Hitler — exemplify how even seemingly light-hearted, entertainment-oriented games naturally mobilize complex cognitive and executive processes. The identification of core mechanics associated cognitive processes, and corresponding levels of Anderson & Krathwohl's taxonomy (2001) was conducted through direct observation and evaluation by a human assessor, based on structured gameplay analysis. The selected games represent a diverse array of party games capable of mobilizing complex cognitive and executive functions through playful interaction. From the cooperative word association of Just One to the dexterity challenges of KLASK, the visual reinterpretations in Telestrations and the imaginative storytelling of Dixit: Odyssey, each game invites players into dynamics of inference, deduction, risk management, or strategic negotiation, as seen in titles like Decrypto, Codenames, Camel Up, Wavelength, and Secret Hitler. Even seemingly simple formats, such as Time's Up! Title Recall!, reveal deep layers of cognitive engagement, confirming the potential of party games as fertile contexts for activating higher-order thinking skills. The mechanical structures of these games

emphasize features such as communication limits, targeted clue-giving, hidden information management, collaborative negotiation, and risk-based decision making, all of which closely align with the activation of higher-order cognitive operations as categorized by Anderson & Krathwohl's taxonomy (2001)—particularly analysing, evaluating, and creating.

Table 3 Results of the human evaluator's analysis

Game	Mechanisms	Description	Related cognitive processes	Taxonomy level
Just One	Communication limits	Games may limit players from communicating with one another openly. These restrictions can be absolute as they relate to certain specific pieces of information, or they may restrict certain types of communication, such as speaking.	Exemplifying	Understand
	Team-based game	Players coordinate their actions to achieve a common win condition or conditions. Players all win or lose the game together.	Inferring	Understand
KLASK	Dexterity	Action/Dexterity games often compete players' physical reflexes and co-ordination as a determinant of overall success.	-	-
	Real Time	There are no turns. Players play as quickly as possible, subject to certain constraints, until the game or phase is completed.	-	-

Telestrations	Paper and pencil	Players draw a picture, and other players guess what the picture is intended to depict.	Interpreting	Understand
	Real Time	There are no turns. Players play as quickly as possible, subject to certain constraints, until the game or phase is completed.		
Dixit: Odyssey	Storytelling	players are provided with conceptual, written, or pictorial stimuli which must be incorporated into a story of the players' creation	Interpreting	Understand
	Targeted Clues	A player gives clues that they want some, but not all, players to guess.		
	Voting	Players vote on whether a proposed action will occur or not.		
Decrypto	Targeted Clues	A player gives clues that they want some, but not all, players to guess.	Inferring	Understand
	Team-based game	Players coordinate their actions to achieve a common win condition or conditions. Players all win or lose the game together.		

	Deduction	Players form conclusions based on available premises.	Hypothesizing	Create
Time's Up! Title Recall!	Memory	Hidden, trackable information whose tracking gives players an advantage.	Recalling	Remember
	Team-based game	Players coordinate their actions to achieve a common win condition or conditions. Players all win or lose the game together.	Interpreting	Understand
	Communication limits	Games may limit players from communicating with one another openly. These restrictions can be absolute as they relate to certain specific pieces of information, or they may restrict certain types of communication, such as speaking.	Exemplifying	
Camel Up (Second Edition)	Dice Rolling	"Dice Rolling" is a game mechanism that can be used for many things, randomness being the most obvious.	-	-
	Roll / Spin and Move	Roll / Spin and move games are games where players roll dice or spin spinners and move playing pieces in accordance with the roll.		
	Betting and Bluffing	Players commit a stake of currency or resources to purchase a chance of winning everyone's stake, based on some random outcome like being dealt a superior set of	Inferring (predicting)	Understand

		cards or rolling a higher number.		
	Track Movement	Pieces are moved along a linear track (not necessarily straight - it may turn, curve or loop).		
Codenames	Team-based game	Players coordinate their actions to achieve a common win condition or conditions. Players all win or lose the game together.	-	-
	Communication limits	Games may limit players from communicating with one another openly. These restrictions can be absolute as they relate to certain specific pieces of information, or they may restrict certain types of communication, such as speaking.	Summarizing	Understand
	Deduction	Players form conclusions based on available premises.	Comparing/Inferring	Understand
	Push your luck	Players must decide between settling for existing gains, or risking them all for further rewards, in a game with some amount output randomness or luck. Push-Your-Luck is also known as press-your-luck.	Checking	Evaluate

	Memory	-	-	-
Wavele ngth	Team-Based Game	Players coordinate their actions to achieve a common win condition or conditions. Players all win or lose the game together.	-	-
	Targeted Clues	A player gives clues that they want some, but not all, players to guess.	Interpreti ng	Underst and
	Race	Games where the first player to achieve a key objective wins the game.	Classifyin g	Underst and

In an educational context, applying the R-I-Z-A model (Trinchero, 2018; Trinchero, 2017) provides a structured approach for integrating board games into classroom design to foster cognitive and executive skills.

To illustrate this application, Just One — a cooperative word association game — is analysed here as an example, based on a manual evaluation conducted by a human instructional designer through structured gameplay observation. Just One proves particularly effective in promoting transversal skills such as communication, critical thinking, creative problem-solving, and metacognitive awareness. Despite its accessible format, the game activates complex cognitive processes that can be systematically mapped through the R-I-Z-A framework:

R – Resources | Students activate prior knowledge, linguistic competencies, and cultural references to generate effective semantic clues.

I – Interpretation Strategies

- Students correctly analyse potential meanings of the clues proposed by peers
- Students discriminate between potential clues to avoid superposition with peers

Z – Action Strategies

- Students formulate a single strategic word balancing originality and informativeness of the clue
- Students infer common knowledge, linguistic, or cultural elements from different cues to identify the solution

A – Self-Regulation Strategies

- Students adjust their strategies according to the group's dynamics
- Students critically assess the appropriateness of their choices.

Thus, Just One emerges as a low-threshold yet cognitively rich educational tool, capable of fostering key curricular competencies such as linguistic mastery, collaborative problem-solving, and metacognitive awareness. Its iterative feedback dynamics make it particularly suitable for formative assessment and transversal skills development through playful, socially engaged learning.

5. Discussion

The definition of the reference conceptual framework, and the analysis of the selected board games against Anderson and Krathwohl's cognitive taxonomy highlights several critical insights regarding the relationship between game mechanics and learning processes.

First, it is important to note that in the constructed tables, several fields remained blank. This occurs particularly for dimensions related to affective, socio-relational, and motor skills — areas that are inherently activated by certain games but are not fully captured by Anderson and Krathwohl's cognitive framework. For instance, games like *KLASK*, which heavily rely on dexterity, rapid motor responses, and embodied interaction, fall outside the primary scope of the taxonomy, which focuses exclusively on cognitive operations such as remembering, understanding, and creating (Spiel & Gerling, 2021). Similarly, many games foster socio-emotional competencies — including cooperation, negotiation, empathy, and conflict management — yet these are not explicitly recognized within the traditional cognitive classification system. These "empty spaces" are not a flaw of the analysis but rather reveal the structural limits of using Anderson and Krathwohl's taxonomy alone to map complex, holistic learning experiences stimulated by board games. Andreoletti and Tinterri (2023) identified, in addition to cognitive engagement, three other types of player engagement with games: motivational, affective, and

sociocultural, to which physical engagement should be added. These aspects need to be included in integrated models that consider executive, affective, and psychomotor domains alongside cognitive processes when evaluating game-based learning environments (Dell'Angela et al., 2020).

Moreover, the manual analysis process revealed substantial methodological complexity. Conducting a rigorous mapping between game mechanics and cognitive processes requires not only familiarity with the theoretical frameworks (e.g., taxonomy, executive functions) but also specialized expertise in game design dynamics and instructional design. The human assessor must be able to deconstruct mechanics, anticipate emergent player behaviours, and interpret subtle cognitive engagements — a task that is far from straightforward, particularly when multiple skills are simultaneously activated during gameplay (Bounajim et al., 2020). For this analysis, the assessor relied on both firsthand experience on some of the games, as well as the descriptions and videos available on the BGG website; however, this is a skill-intensive and time-consuming procedure that might be too complex for teachers without specific bGBL training.

On the other side, the R-I-Z-A model allows evaluators to capture a granular description of how players activate prior knowledge, decode contextual signals, make strategic choices, and regulate their behaviour dynamically throughout the gameplay. Given this complexity, it becomes evident that educators and instructional designers could benefit from supportive digital tools capable of facilitating and partially automating the mapping process.

As a future development, we propose the creation of a dedicated chatbot: an intelligent assistant trained to recognize game mechanics, associate them with cognitive and executive processes, and suggest appropriate learning objectives and assessment strategies. Such a tool would not only streamline the instructional design workflow but also democratize access to high-quality bGBL integration, making it more feasible for teachers without specific expertise in game studies or cognitive taxonomies to intentionally design and evaluate game-based activities (Gómez Niño et al., 2024).

Conclusions

The analysis conducted in this study highlights the pressing need for a rigorous analytical model capable of explicitly defining learning objectives in the design and evaluation of Board Game-Based Learning (bGBL) experiences. While the integration of board games into educational settings has often been celebrated for

its motivational and engagement benefits, a lack of structured alignment between gameplay and cognitive development goals has limited the reliability of learning assessments. Without a clear articulation of which cognitive, metacognitive, or executive functions are expected to be activated, evaluation risks remaining incidental, impressionistic, or overly focused on surface-level outcomes such as participation or enjoyment.

In this perspective, the R-I-Z-A model proves to be particularly functional when applied to games, as it mirrors the cyclical and experiential nature of learning that occurs during gameplay. Representation, interpretation, activation, and self-regulation are not abstract dimensions but dynamic processes that players continuously engage with as they explore, test, and adapt their strategies in response to evolving game scenarios. By framing the player's experience through these lenses, R-I-Z-A allows for the systematic observation and support of learning trajectories, turning playful engagement into a fertile ground for intentional skill development.

Moreover, the study emphasizes the importance of deepening our understanding of the relationships between specific game mechanics and learning processes. Different mechanics trigger distinct forms of reasoning, problem-solving, decision-making, and reflective thought. Recognizing and intentionally leveraging these relationships is crucial for designing educational games that are not only entertaining but also pedagogically purposeful. In this regard, board games emerge as an ideal testbed: their mechanical transparency—the explicit visibility of rules and consequences—makes it possible to trace and analyse players' cognitive strategies with a level of clarity that is often unattainable in digital environments.

From a broader pedagogical standpoint, embracing board games as intentional learning tools invites a shift in educational practice: it calls for rethinking play not as a mere ancillary activity, but as a structured space for cognitive apprenticeship, situated reflection, and authentic skill construction. Games, when thoughtfully selected and integrated, become microcosms of complex systems, laboratories where learners can explore cause-and-effect relationships, test hypotheses, negotiate meanings, and confront ethical dilemmas in a safe but challenging environment.

Future research should expand this framework to encompass not only cognitive dimensions but also social, emotional, and civic competencies, exploring how different game structures can foster holistic development. Equally, empirical validation of the proposed evaluation matrices across diverse educational settings will be essential to confirm their adaptability and effectiveness. The pedagogical

challenge—and opportunity—lies in reclaiming play as a serious, evidence-based, and transformative practice for 21st-century education.

Author contributions

The paper was conceptualized and developed collaboratively by all authors, with each contributing to specific sections based on their expertise. A.T. was responsible for writing sections 3 and analysis of table n.3; M.d.P. authored section 4 and 5; F.P. authored section 1 and 2. The introduction and conclusions were developed and written jointly by the three authors.

References

- Abt, C. C. (1970). *Serious games*. Viking Press.
- Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.
- Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., de Freitas, S., Louchart, S., ... & De Gloria, A. (2015). Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology*, 46(2), 391–411.
- Bayeck, R. Y. (2020). Examining Board Gameplay and Learning: A Multidisciplinary Review of Recent Research. *Simulation & Gaming*, 51(4), 411-431. <https://doi.org/10.1177/1046878119901286>
- Biggs, J. (1999). *Teaching for quality learning at university*. Open University Press.
- Boller, S., & Kapp, K. (2017). *Play to Learn: Everything You Need to Know About Designing Effective Learning Games*. ATD Press.
- Bounajim, D., Rachmatullah, A., Boulden, D., Mott, B., Lester, J., Lord, T., Reichsman, F., Horwitz, P., Dorsey, C., & Wiebe, E. (2020). Utilizing Cognitive Load Theory and Evidence-Centered Design to Inform the Design of Game-Based Learning Environments. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 64(1), 826-830. <https://doi.org/10.1177/1071181320641192>
- Brathwaite B., Schreiber I. (2009). *Challenges for game designers*, Course Technology/Cengage Learning.
- Dell'Angela, L. et al. (2020). Board Games on Emotional Competences for School-Age Children. *Games for Health Journal*, 9(3), 187-196. <https://doi.org/10.1089/g4h.2019.0050>

- Engelstein, G., & Shalev, I. (2019). *Building Blocks of Tabletop Game Design: An Encyclopedia of Mechanisms*. CRC Press.
- Gee, J. P. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. Palgrave Macmillan.
- Gobet F., Retschitzki J., De Voogt A. (2004). *Moves in Mind: the Psychology of Board Games*. Psychology Press, London.
- Gómez Niño, J. R., Árias Delgado, L. P., Chiappe, A., González, E. O. (2024). Gamifying Learning with AI: A Pathway to 21st-Century Skills. *Journal of Research in Childhood Education*, 1-16. <https://doi.org/10.1080/02568543.2024.2421974>
- Jonassen, D. H. (1999). *Designing Constructivist Learning Environments*. In C. M. Reigeluth (Ed.), *Instructional Design Theories and Models: A New Paradigm of Instructional Theory* (Vol. II).
- Le Boterf, G. (1994). *De la compétence: Essai sur un attracteur étrange*. Les Éditions d'Organisation.
- Le Boterf, G. (2000). *Construire les compétences individuelles et collectives*. Éditions d'Organisation.
- Le Boterf, G. (2006). *Professionnaliser: Le modèle de la compétence*. Eyrolles.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.
- Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist*, 50(4), 258–283.
- Rogerson, M. J., Sparrow, L. A., Gibbs, M. R. (2021). Unpacking “Boardgames with Apps”: The Hybrid Digital Boardgame Model. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, Article 111, 1–17. <https://doi.org/10.1145/3411764.3445077>
- Romero, M., Usart, M., & Ott, M. (2012). Can Serious Games contribute to developing and sustaining 21st century skills? *Games and Learning Alliance*, 2(2), 12–23.
- Salen, K., & Zimmerman, E. (2004). *Rules of Play: Game Design Fundamentals*. MIT Press.
- Shute, V. J. (2011). Stealth assessment in computer-based games to support learning. *Computer Games and Instruction*, 55(2), 503–524.

Spiel, K., & Gerling, K. (2021). The purpose of play: How HCI games research fails neurodivergent populations. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 28(2), 1-40.

Vasconcelos, L., Sousa, M., Ferreira, F., Pinheiro, J. (2022). COLLABORATING: modern board games and collaboratories as a tool for capacity building. *SN Soc Sci* 2, 190. <https://doi.org/10.1007/s43545-022-00472-y>

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.

Wiggins, G., & McTighe, J. (2005). *Understanding by Design* (Expanded ed.). ASCD.

Abbott, D. (2018, December). Modding tabletop games for education. In *International conference on games and learning alliance* (pp. 318-329). Cham: Springer International Publishing.

Amory, A. (2007). Game object model version II: A theoretical framework for educational game development. *Educational Technology Research and Development*, 55(1), 51–77.

Annetta, L. A. (2010). *The “I’s” Have It: A Framework for Serious Educational Game Design*. *Review of General Psychology*, 14(2), 105–112.

Barab, S. A., Gresalfi, M., & Ingram-Goble, A. (2010). Transformational play: Using games to position person, content, and context. *Educational Researcher*, 39(7), 525–536.

De Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education*, 46(3), 249–264.

Egenfeldt-Nielsen, S. (2005). Beyond edutainment: Exploring the educational potential of computer games. IT-University of Copenhagen.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33(4), 441–467.

Iten, N., & Petko, D. (2016). Learning with serious games: Is fun playing the game a predictor of learning success? *British Journal of Educational Technology*, 47(1), 151–163.

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and Higher Education*, 8(1), 13–24.

Mislevy, R. J., Steinberg, L. S., & Almond, R. G. (2014). *Design and analysis in task-based language assessment*. Routledge.

Petty, G. (2009). *Evidence-Based Teaching: A Practical Approach*. Nelson Thornes.

- Rooney, P. (2012). A theoretical framework for serious game design: Exploring pedagogy, play and fidelity and their implications for the design process. *International Journal of Game-Based Learning*, 2(4), 41–60.
- Schell, J. (2014). *The Art of Game Design: A Book of Lenses* (2nd ed.). CRC Press.
- Shute, V. J., & Ventura, M. (2013). *Stealth assessment: Measuring and supporting learning in video games*. MIT Press.
- Spires, H. A., Rowe, J. P., Mott, B. W., & Lester, J. C. (2011). Problem solving and game-based learning: Effects of middle grade students' hypothesis testing strategies on learning outcomes. *Journal of Educational Computing Research*, 44(4), 453–472.
- Van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *Educause Review*, 41(2), 16–30.
- Wouters, P., & van Oostendorp, H. (2017). Overview of instructional support in serious games. In *Instructional techniques to facilitate learning and motivation of serious games* (pp. 1–15). Springer.
- Andreoletti, M., & Tinterri, A. (2023). *Apprendere con i giochi. Esperienze di progettazione ludica* (pp. 1-203). Carocci Editore.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Prentice Hall.
- Mayer, R. E. (2014). *The Cambridge Handbook of Multimedia Learning* (2nd ed.). Cambridge University Press.
- Moreno, R., & Mayer, R. E. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, 19(3), 309–326.
- Trincherò, R. (2012). *Costruire, valutare, certificare competenze. Proposte di attività per la scuola*. Franco Angeli.
- Trincherò, R. (2014). *Il gioco computerizzato per il potenziamento cognitivo e la promozione del successo scolastico. Un approccio evidence based. Form@re - Open Journal per la formazione in rete*, 14(3), 7–24. <https://doi.org/10.13128/formare-15269>
- Trincherò, R. (2017). *Costruire e certificare competenze con il curricolo verticale nel primo ciclo* (pp. 1-143). Rizzoli Education.
- Trincherò, R. (2018). *Costruire e certificare competenze nel secondo ciclo* (pp. 1-144). Rizzoli Education.