Game-Based Learning for Autism: A Tabletop Approach to Theory of Mind

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Abstract: Theory of Mind (ToM) is the cognitive ability to recognize that others have thoughts, beliefs, and emotions different from one's own. It is essential for effective social interaction and communication. Children diagnosed with autism spectrum disorder (ASD) often experience significant difficulties with ToM, especially in perspective-taking and interpreting false beliefs, negatively impacting their social relationships and academic performance. Structured, game-based interventions have demonstrated promising results in enhancing social-emotional cognitive abilities in autistic children. This article explores the prototype design of a tabletop game titled "*Guess the Animal*," which aims to promote ToM skills in autistic children aged 7 (seven) to 12 (twelve) years old.

Keywords: Theory of mind, Autism spectrum disorder, Game-Based learning, Perspective-Taking, Universal design for learning, Tabletop games

1. Introduction

Understanding that what others think, feel, or believe is different from our own experience is a skill often taken for granted in everyday social interaction. Yet for many autistic children, this kind of perspective-taking, known as Theory of Mind (ToM), can present significant challenges. Difficulties in interpreting false beliefs or predicting others' actions may lead to breakdowns in communication, social withdrawal, or academic misunderstandings. In a foundational study, Baron-Cohen, Leslie and Frith (1985) found that only 20% of autistic children answered a classic false-belief task correctly, compared to 85% of their non-autistic peers—a striking illustration of this developmental gap.

However, such challenges are not insurmountable. Research consistently shows that ToM skills can be strengthened through targeted interventions and repeated practice. Programs designed around structured social reasoning tasks and video modeling have led to notable improvements in children's ability to understand others' perspectives (Begeer *et al.*, 2010; Dhadwal *et al.*, 2021). These findings underscore the importance of creating opportunities where autistic learners can engage in perspective-taking in safe, supported, and enjoyable contexts.

Tabletop games offer precisely this kind of environment. Their clear rules and turn-based structure align well with the preferences of many autistic children, who often thrive in predictable, low-stress settings (Atherton *et al.*, 2024).

Currently, digital serious games are increasingly used to support social cognition and ToM in autistic children. Digital tools like Tom Tom and Deusto-e-motion 1.0 have shown effectiveness in training emotion recognition and belief inference through structured, screen-based tasks (Monteiro and Pires, 2022; Lázaro *et al.*, 2020). However, these tools often lack role-playing elements and tangible, collaborative interaction, limiting engagement and real-time perspective-taking practice.

This paper introduces *Guess the Animal*, a tabletop game designed to foster ToM in children aged 7 to 12. Drawing on Game-Based Learning (GBL), Universal Design for Learning (UDL), and the Understanding by Design (UbD) framework, the project aims to offer an inclusive, engaging approach to social-cognitive growth through playful interaction.

This prototype aims to address the gaps of transference by enabling players to adopt character roles, receive asymmetric clues, and reason about others' mental states in a live, turn-based setting. This format reflects naturalistic false-belief situations and supports applied ToM practice through social play (Hofmann *et al.*, 2016).

Furthermore, tangible user interfaces (TUIs) have been shown to enhance engagement, embodiment, and collaborative learning, especially among neurodiverse learners (Li *et al.*, 2022). By incorporating TUIs into gameplay, this prototype aims to increase accessibility and real-world skill transfer compared to screen-based games.

2. Design Rationale and Theoretical Frameworks

Designing a game for inclusive social learning requires more than engaging mechanics—it calls for intentional alignment between educational goals, accessibility principles, and the diverse ways learners experience the world. This design is intended for diverse learners, including but not limited to autistic children, and is structured to align instructional goals with inclusive participation. The project integrates insights from three complementary frameworks that shape both its pedagogical structure and inclusive design: game-based learning, Understanding by Design, and Universal Design for Learning.

At the foundation is game-based learning, which emphasizes active participation, collaboration, and systems thinking. Well-designed games can foster cognitive engagement, emotional investment, and authentic social interaction—key conditions for supporting Theory of Mind development (Gee, 2007; Dishon and Kafai, 2020; Plass, Homer and Kinzer, 2015). These features are especially impactful for autistic learners when gameplay offers predictability and scaffolds peer interaction (Kangas, 2010; Mukund *et al.*, 2022; Toh and Kirschner, 2020).

Building on this, Understanding by Design provides a curricular structure that begins with end goals and works backward: identifying what learners should understand, defining how that understanding can be demonstrated, and designing experiences that lead toward those outcomes (Wiggins and McTighe, 2005). In *Guess the Animal*, mechanics such as clue interpretation and cooperative deduction are explicitly designed to elicit behaviors linked to perspective-taking and empathy.

To ensure all learners can access and express these skills, Universal Design for Learning offers an additional layer. The game incorporates visual cues, simplified prompts, and nonverbal participation options that reflect inclusive design principles (CAST, 2018; Bray *et al.*, 2024; Ismailov and Chiu, 2022), treating learner variability not as a challenge to accommodate but as a central design asset.

3. Game Design Process

The game *Guess the Animal* was developed to support two foundational social-cognitive competencies associated with Theory of Mind (ToM): cognitive perspective-taking and affective empathy. These goals were identified early in the design process and guided the development through the Understanding by Design (UbD) backward planning model. This structured approach ensured that every game element—from clue construction to player interaction—was intentionally aligned with the targeted learning outcomes.

At the heart of the gameplay is the mechanism of asymmetric clue interpretation. Each player adopts an animal character and receives a personalized clue card describing the hidden target animal (the “culprit”) in relation to their own character’s features. Because clues are contextual and comparative (e.g., “The culprit is larger than me”), players must interpret them from their character’s point of view. This mechanic cultivates cognitive perspective-taking, requiring learners to reason beyond their own knowledge—a process analogous to false-belief understanding, a core construct in ToM development.

In addition to perspective-taking, the game embeds affective empathy through naturalistic social interactions. Players are rewarded with tokens when they demonstrate prosocial behaviors such as offering help, yielding a turn, or affirming another player's contribution. These actions are not explicitly scripted but emerge organically, fostering spontaneous emotional responsiveness. Turn-taking and shared deduction further reinforce recursive reasoning (i.e., second-order ToM) by prompting players to monitor others’ thought processes and adjust their own strategies accordingly. The table 1 below illustrates how specific game mechanics correspond to subcomponents of Theory of Mind.

Table 1: Mapping of Game Mechanics to Theory of Mind Subskills

Game Mechanic	Targeted ToM Subskill	Description
Clue interpretation from character's perspective	Cognitive perspective-taking	Requires players to assess clues relative to their animal’s traits, simulating false-belief reasoning.
Turn-taking and shared deduction	Understanding of others’ mental states	Players infer peers’ knowledge and intentions during collaborative decision-making.

Game Mechanic	Targeted ToM Subskill	Description
Token rewards for prosocial behaviors	Affective perspective-taking/ empathy	Reinforces emotionally responsive behavior through social reinforcement mechanisms.
Collaborative guessing with partial information	Recursive reasoning (second-order ToM)	Encourages meta-cognition (e.g., "I think they think…") in joint problem-solving.

By translating abstract ToM constructs into concrete, interactive experiences, these mechanics offer repeated, low-pressure opportunities for autistic learners to practice essential social reasoning skills. Importantly, these skills are not taught through direct instruction but are enacted and reinforced through play.

To ensure equitable access for diverse learners, the game is also grounded in Universal Design for Learning (UDL)principles. Visual supports, simplified instructions, and multimodal options for participation (e.g., speech, gestures, pointing, visual aids) ensure that players with different communication styles and sensory preferences can engage meaningfully. These inclusive design features position neurodiversity not as a constraint, but as a foundational value of the learning environment.

In sum, *Guess the Animal* transforms complex Theory of Mind objectives into engaging, developmentally appropriate gameplay, offering a flexible and inclusive platform for practicing social cognition in autistic learners.

4. Gameplay

The following section provides a detailed breakdown of player roles, components, setup, and gameplay flow.

4.1 Players and Moderators

The game accommodates two to nine players and is facilitated by an adult moderator. The moderator, typically an educator or therapist familiar with autistic learners, does not participate as a player but oversees the session. Their responsibilities include selecting the target animal ("culprit"), distributing clue cards, and guiding turn-taking and interpretation throughout the game.

The players are children diagnosed with Autistic Spectrum Disorder that has understanding of verbal and visual instructions.

4.2 Game Components

4.2.1 Animal cards

A set of ten distinct animals, each defined by three visual traits: body size (small, medium, large), clothing color (e.g., red, blue, green), and tail length (short, medium, long).

4.2.2 Clue cards

Personalized clues distributed to each player based on their character. Each clue compares the culprit's features to the player's animal. For instance, if the culprit is a mouse, a clue might say, "This animal is bigger than me," depending on the player's character.

4.2.3 "Guess Who" boards

Each player receives a board displaying all ten animals. Players flip down animals that do not match the clues they interpret each round.

4.2.4 Reward tokens

Sensory items are awarded to players who correctly identify the culprit at the end of the game.

4.3 Setup and Play

At the start of each session, the moderator secretly selects one animal as the culprit. Each player then selects or draws a character card and places it face up, making all character traits visible to others.

The game unfolds over three rounds. In each round, the moderator distributes a clue card related to one trait category (e.g., body size). Players read their personalized clues aloud and interpret them from their character's perspective, then eliminate animals on their boards that do not match their reasoning. To support diverse communication needs, and in alignment with UDL principles, players may express their thinking verbally or nonverbally using gestures, pointing, or visual aids provided. After all three rounds, players make a final guess as to the culprit's identity. The moderator reveals the correct animal, and reward tokens are given to players who made accurate deductions—reinforcing both reasoning skills and collaborative engagement.

5. Assessment and Testing

Evaluating whether *Guess the Animal* meets its intended goals involves assessing both learning outcomes and usability. Specifically, the design targets two core dimensions: improvements in ToM, especially perspective-taking, and the game's effectiveness and accessibility for autistic learners.

To assess gains in ToM, several methods can be employed. Standardised false-belief tasks (e.g. the Sally-Anne test) can be administered before and after gameplay to measure changes in children's ability to reason about others' beliefs. In addition, the Theory of Mind Inventory (ToMI), a caregiver-report measure, provides insight into how children apply perspective-taking in real-life situations (Peters and Thompson, 2018). These tools are complemented by behavioural observations during gameplay. Facilitators may document how players interpret clues, engage in turn-taking, or collaborate with peers—behaviours that indicate growing social-cognitive flexibility (Atherton and Cross, 2021). Semi-structured surveys and observation protocols can further capture these interactions systematically.

Evaluating educational effectiveness also involves examining whether skills developed in the game transfer to broader social contexts. Observing how children use game-learned strategies outside the session can reveal real-world impact (Whalen et al., 2010). For example, when players have learned to interpret clues that can be ambiguous, the moderator can assess whether the ambiguity is understood with other commands by intentionally removing subjects in commands and observing if the player understands that such ambiguous commands are the same concept with the ambiguous rules in the game.

Feedback from children and caregivers also plays a critical role. Using simple Likert scales or emotive rating systems tailored to autistic users, facilitators can gather input on enjoyment, challenge level, and perceived relevance (Xavier et al., 2022). These responses, combined with behavioural data, help identify strengths and areas for refinement.

Finally, engagement metrics such as how often children choose to play and how long they remain involved provide additional insight into the game's motivational impact. When paired with ToM assessments and usability observations, these measures form a well-rounded understanding of how the game supports both social learning and inclusive participation.

6. Conclusion

Guess the Animal was designed to support social-cognitive learning in an inclusive, engaging format. By centering perspective-taking and empathy as its guiding goals and aligning them with structured gameplay, the project offers a model for translating complex Theory of Mind objectives into practice. Rather than teaching these skills through isolated instruction, the game situates them within peer interaction and shared reasoning, allowing players to experience and demonstrate social understanding as it unfolds in real time.

Importantly, the game also reflects a commitment to accessibility. Through multimodal input and expression, scaffolded interactions, and opportunities for flexible participation, *Guess the Animal* embraces learner variability as a foundation for design. These UDL-informed choices help ensure that autistic learners and others with diverse communication profiles can meaningfully participate—not in spite of their differences, but in ways that value and draw upon them.

While the current prototype has shown strong potential as a classroom-friendly tool for building social cognition, further research is needed to explore its adaptability, long-term impact, and integration across instructional contexts. In particular, future iterations may expand the range of social reasoning it supports, offer additional sensory accommodations, or reduce facilitator dependence to increase scalability.

Ultimately, *Guess the Animal* is more than a learning game; it is an attempt to rethink how we structure participation, belonging, and shared meaning-making. Its design suggests that with the right alignment of goals,

mechanics, and inclusive intent, playful learning can open space for every student to be seen, heard, and understood—one interaction at a time.

7. Limitations

Guess the Animal is currently a conceptual prototype informed by established Theory of Mind frameworks. While the design aligns with evidence-based principles, no empirical testing has yet been conducted. As such, claims regarding effectiveness remain preliminary.

We acknowledge this limitation and plan a small-scale pilot study with autistic learners to assess usability, engagement, and early indicators of ToM development. These findings will inform further refinement and validation of the game design.

Ethics Declaration: While no human participants were involved in the current stage of development, future testing is planned to evaluate the educational effectiveness and usability of the game. Recruitment will involve autistic children aged 7–12 through partnerships with local clinics and schools, following informed consent procedures from parents or legal guardians. Ethical approval will be obtained from an institutional review board (IRB) prior to implementation. Testing sessions will be designed to prioritize participant comfort, minimize anxiety, and allow for withdrawal at any time without consequence. Observations, surveys, and pre/post assessments will be used to ensure low-risk, developmentally appropriate data collection.

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