

Defeating V.I.L.E. with Carmen Sandiego: GBL and Gamification for Teenagers with Intellectual Disabilities

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Abstract: Gamification is an educational methodology using game aesthetics, dynamics, and mechanics to enhance motivation and learning. In special education, this strategy has been shown to improve motivation, engagement, and knowledge retention, as it allows content to be adapted into a more interactive and playful format while promoting experiential learning. Additionally, gamification fosters autonomy and collaboration among students, which can be key in acquiring and reinforcing social skills and inclusion. This study is based on a gamified didactic proposal inspired by the Netflix series Carmen Sandiego, combined with a game-based learning methodology. A research-based design was implemented alongside a pilot experience in a Spanish public high school involving three adolescents with intellectual disabilities. The intervention consisted of five one-hour sessions using game mechanics, interactive storytelling, problem-solving challenges, and achievement-based rewards. Two data collection methods were employed: participant observation and a semi-structured interview with their teacher to assess the methodology's effectiveness after its implementation. The results indicated a high acceptance of gamification among the students. A firm initial and sustained motivation throughout the sessions was observed, along with a progressive increase in participation in the proposed activities. These positive results suggest that this approach can enhance student engagement and provide positive reinforcement for learning in students with intellectual disabilities. Moreover, the flexibility of the gamified approach was highlighted, allowing for the customization of content and its adaptation to the students' abilities, facilitating greater accessibility and comprehension of the topics covered. In conclusion, gamification based on the Carmen Sandiego narrative proved to be a practical methodology for motivating and improving the learning process of adolescents with intellectual disabilities. The promising results of this pilot study underscore the need for further research in this area. More extensive studies are recommended to confirm these findings and evaluate the long-term impact of gamification in special education, highlighting the importance of ongoing research in this field.

Keywords: Gamification, Game-Based learning, Intellectual disability, High school

1. Introduction

Intellectual disability (ID) is a neurodevelopmental disorder characterized by significant limitations in intellectual functioning and adaptive behavior, affecting conceptual, social, and practical skills necessary for daily living (DSM-5, 2013). These difficulties are intensified during adolescence due to the cognitive, social, and emotional changes typical of this developmental stage. Adolescents with mild ID tend to have poor cognitive flexibility, reduced capacity for abstract reasoning, and difficulties developing social skills, impacting their academic performance and social inclusion (Estrada Rollón, 2022).

Concerning schooling, it is common for these students to be in specific classrooms within ordinary schools. These classrooms offer individualised attention but can lead to isolation from the rest of the pupils if their active participation in school is not encouraged. In this context, maintaining motivation and engagement with learning tasks is crucial to promote their integral development and avoid disengagement phenomena, characterized by apathy, lack of initiative, and low academic self-esteem (Wang & Eccles, 2012).

At a broader level, digital accessibility in education faces several persistent challenges. Significant barriers include insufficient integration of accessibility standards in online platforms, a lack of adapted learning materials, limited personalization, and limited awareness among educators regarding inclusive digital practices (Screpnik, 2024; Sousa et al., 2023). Research has also highlighted that bridging the digital divide requires training programs targeting users with disabilities and their educators, focusing on digital skills and inclusive technologies (Murphy et al., 2024). These limitations impact adoption rates and learning outcomes, making designing digital experiences tailored to this population's needs essential.

With these challenges, active methodologies such as project-based learning (PBL), cooperative learning, and educational gamification emerge as educational strategies that allow content to be adapted and improve the learning experience. Educational gamification is understood as using elements of the game (mechanics,

dynamics, aesthetics) in non-playful contexts, such as the classroom, to increase motivation, involvement, and enjoyment of learning (Deterding et al., 2011).

Research shows the benefits of gamification for students with ID. For example, Abu et al. (2023) implemented play elements in a learning environment with students with mild and moderate ID, observing a significant increase in motivation and active participation. In a similar intervention, Ghasemi Arganeh et al. (2022) employed game-based instruction with students with ID, finding significant improvements in intrinsic and extrinsic motivation after 20 gamified sessions. The study revealed a statistically significant positive effect ($p < 0.01$), with effect sizes of 0.49 and 0.51 for each type of motivation. Koivisto and Hamari (2019) highlighted how personalized gamified environments can enhance student participation and a sense of belonging.

However, few studies integrate immersive, playful narratives and cooperative missions specifically adapted to the context of adolescents with mild ID in specific secondary school classrooms. This study presents a gamified proposal based on Carmen Sandiego's narrative. The main objective is to analyze how this gamified experience influences the motivation, active participation, and socio-emotional development of three adolescents with mild intellectual disabilities who were schooled in a specific classroom of a public secondary school.

2. Methods

This study is part of design research based on educational practice, with a quasi-experimental qualitative approach. It is a pilot experience in a public secondary school in Spain. Given the study's exploratory nature and the small number of participants, a quasi-experimental qualitative methodological strategy focused on describing and interpreting the experience was chosen.

2.1 Educational Proposal

2.1.1 Pedagogical justification

Adolescents with mild ID have cognitive characteristics that require specific methodological adaptations: concrete thinking, difficulties in abstract reasoning, the need for visual supports and scaffolding for comprehension, as well as longer learning times (Sajewicz-Radtke et al. 2022).

To face these challenges, gamification can offer a structured, motivating, and accessible educational environment, where learning is integrated through play, narrative, and emotional experience (Balarezo Lata et al., 2022). Several authors mention that the didactic possibilities of gamification facilitate the design of exploration, discovery, and positive reinforcement dynamics; constant and precise feedback; tasks adjusted according to the level of competence; and cooperative dynamics that facilitate interaction between equals (Kapp, 2012; Manzano-León et al., 2021).

In addition, the proposal is also nourished by Game-Based Learning (PBL), which allows the content to be approached from the logic of the game: clear rules, defined objectives, possibility of trial and error, and immediate feedback (Sánchez Montero, 2021). In the game, mistakes are not penalized, but become an opportunity for improvement and learning. This characteristic can be key for this student profile, as it reduces anxiety about failure and fosters a positive attitude towards learning.

On the other hand, when combined with Project-Based Learning (PBL), the functional and significant nature of the proposal is reinforced. PBL allows for working in an interdisciplinary way based on a challenge. In this model, Carmen Sandiego's narrative becomes the common thread of a great project: "Helping Carmen stop the plans of V.I.L.E. around the world". Thus, each weekly mission is a micro-project with clear objectives, various activities, games, and cooperative tasks.

2.1.2 Educational objectives

General objective

To design and implement a gamified learning experience based on Carmen Sandiego's narrative that promotes the comprehensive cognitive, affective, and functional development of three adolescents with mild ID, adapting the contents and dynamics to their curricular levels (1st and 2nd year of Primary Education) and their respective Individualized Educational Programs (IEPs).

Specific objectives by area of the IEP

- Area 1: Intellectual and cognitive development

- *Stimulate the processes of attention, memory, comprehension, and logical reasoning through playful activities adapted to the curricular level of 1st and 2nd year of Primary.*
- *Reinforce basic content of the curriculum in language and mathematics through brief, concrete, and visual gamified challenges.*
- *To promote planning, anticipation, and simple decision-making to promote the development of basic executive functions through games.*
- *Area 2: Affective and emotional development*
- *Enhance emotional expression through playful activities, facilitating the identification and verbalization of one's and others' emotions.*
- *Reinforce self-esteem through visible achievements and accessible rewards, favoring individual and group recognition.*
- *Promote tolerance to frustration in contexts of challenge and decriminalized error, as part of emotional learning in the classroom.*
- *Promote a favourable emotional climate in the group, based on cooperation, respect, and mutual support.*
- *Area 3: Skill Development*
- *Develop basic social skills (active listening, speaking turns, collaboration) through cooperative activities.*
- *To promote personal autonomy and responsibility in tasks structured through individual missions with progressively reduced support.*
- *Enhance initiative and choice through controlled options (reward selection, task order, in-game decisions).*
- *Improve visual-motor coordination and fine manipulative skills through games.*

2.1.3 Gamification design

The design of this gamified experience is based on the MDE model (Mechanics—Dynamics—Aesthetics) (Marczewski, 2015).

In this proposal, the aesthetics and narrative are inspired by the animated series *Carmen Sandiego* (2019), distributed by Netflix and created by Duane Capizzi, Jos Humphrey, and Kenny Park. The series reimagines Carmen Sandiego, a rebel former student of the international criminal organization V.I.L.E. who decides to switch sides and become a global vigilante. Accompanied by her team, she travels the world thwarting the plans of this organization. Within the framework of the gamified program, students assume the role of spies collaborating with Carmen, participating in special missions to recover stolen objects or prevent cultural, scientific, or technological crimes. Each session represents a mission in a different country, which allows curricular content (language, mathematics, science, social studies) to be worked on in a transversal way, together with learning related to culture, geography, and ethical values. On a didactic level, this narrative translates into a shared journey, in which learning becomes an adventure and each challenge is solved collaboratively.

The choice of this narrative responds to a series of pedagogical and motivational reasons (Manzano-León et al., 2023):

- **Direct connection to youth interests:** The series features an engaging plot, with elements of mystery, technology, and action that capture the attention of young audiences. The context of espionage and adventure offers multiple possibilities for playful adaptation without losing the pedagogical focus.
- **Empowered female reference:** Carmen is a strong, independent, intelligent, and ethical character, which allows for debates and reflections on equality, leadership, and gender stereotypes. This figure acts as a positive and diverse model, especially relevant in educational contexts that seek to make visible other references beyond the traditional ones.
- **High audiovisual and contextual richness:** The series offers explicit and adaptable visual material, which makes it easier for educators to have characters and scenarios already created, only having to adapt them for the different classroom challenges. Each chapter introduces real data on other countries, reinforcing the narrative's didactic value and connection with social science content and knowledge of the environment.
- **Potential to integrate curricular content and social skills:** Narrative facilitates the design of contextualized missions that integrate curricular content, while encouraging cooperation, group decision-making, and peer communication.

Game dynamics refer to the responses that mechanics generate in players, such as cooperation, overcoming challenges, exploration, competition, or decision-making. Concerning the dynamics of this gamification, these were carefully designed to promote meaningful learning, sustained motivation, and the acquisition of social and emotional skills in students with mild intellectual disabilities. Some of the main dynamics used in this program were: Shared visual progress based on a map-mission of the world, which served as an anticipatory element, generating expectations about the next destination; Cooperation, most of the challenges were carried out in groups, trying to get everyone to participate actively, even those who may have more difficulties in initiative; Time-limited challenges such as time trial missions, with a limited duration to solve a challenge or trial. This dynamic encouraged concentration, quick decision-making and emotional regulation in the face of time pressure, always in a safe environment and without penalty for mistakes; Immediate and understandable feedback, since each mission must end by offering an oral and visual review of the achievements obtained, and if they failed or had any doubts, the teacher helped with the doubts; A continuous and chained narrative where the story of Carmen Sandiego developed in an episodic and progressive way. Each session included a narrative fragment connected to the previous mission and left clues or challenges open for the next.

Mechanics are the concrete elements of the game's structure: rules, rewards, conditions, and tools that allow the gamified system to work. In this program, the mechanics were selected and adapted to be accessible, motivating, and understandable for the three participating adolescents with intellectual disabilities. Some of the most outstanding are a coin system, which assigns different coins to each activity passed in the classroom, and an extra-voluntary one outside the classroom for each mission. This system made tracking individual and group progress easier while reinforcing desirable behaviors through tangible recognition; the Spy card was given after each mission, and the first mission was where staff were rewarded for each mission achieved, to see the work done visually. This playful and symbolic element reinforced the sense of belonging to the game, the monitoring of individual progress and the motivation to participate in new missions; Rewards store where you can redeem the coins obtained for privileges previously negotiated with the group (e.g.: choose song, free rest, five extra minutes with favorite material, be helper of the day).

2.2 Participants

The participants of this intervention are enrolled in a specific secondary school classroom in southern Spain, in the autonomous community of Andalusia. According to current regulations, specific classrooms or Special Education classrooms located in ordinary schools are configured as a type of schooling aimed at students with special educational needs, when these needs cannot be adequately met in an ordinary classroom with supports. In these classrooms, students receive intensive and individualised attention, with specific personal and material resources, and with a curriculum adapted to their characteristics and potentialities, although always seeking the maximum possible inclusion in the life of the ordinary school.

Three adolescents, aged between 14 and 15, have participated in this experience: a boy and two girls. All of them have an updated psycho-pedagogical evaluation, carried out by the school's counselor. In this evaluation, the diagnosis of mild intellectual disability is determined following the criteria established by the recognized clinical and psycho-pedagogical reports.

Based on this diagnosis and the individualised assessment process, the teaching team has drawn up an Individualised Educational Programme (IEP) for each student, which includes significant curricular adaptations. The IEP refers to the curricular level equivalent to the First and Second Years of Primary Education in key areas such as Spanish Language, Mathematics, Knowledge of the Environment, and Personal and Social Development.

2.3 Instruments

Participant observation: It is a qualitative technique that allows the researcher to integrate into the participants' natural environment to observe their behavior directly and contextually. This technique is instrumental in educational studies where it is desired to analyze student interaction and responses in real time (Angrosino, 2007). During the five gamified intervention sessions, a research team member directly observed the three participants' interactions while performing the activities based on *Carmen Sandiego's* narrative. The following indicators were documented: Initial and sustained motivation, participation in activities, reactions to challenges and rewards, and collaboration with peers.

Semi-structured interview: It is a data collection technique that combines previously designed questions with the flexibility to adapt new questions according to the interviewee's answers. This technique helps gain subjective and detailed insights, especially from experts such as teachers. According to Adams (2015), semi-structured interviews allow for a deep understanding of the participant's experience, balancing structure and

spontaneity. At the end of the experience, the teacher in charge of the group was interviewed. The interview focused on the teacher's perception of the methodology's effectiveness, changes observed in the motivation, understanding, and participation of the students, and assessing the flexibility and accessibility of the gamified approach.

2.4 Data Analysis

The analysis was conducted using a qualitative approach, using an inductive thematic analysis, due to the study's exploratory nature (Mieles Barrera, Tonon, and Alvarado Salgado 2012). Two primary sources were analyzed: observations of the sessions and a semi-structured interview with the teacher. The data were manually coded on a first reading, then grouped into thematic categories such as sustained motivation, active participation, and improvement in social skills. The triangulation between the observations and the interview allowed the findings to be validated from different perspectives.

3. Results

The participant observation and the semi-structured interview results reflect an upbeat assessment of the gamified experience by the three participating students and their teacher.

From the first session, a high initial motivation was evidenced, manifested in the enthusiastic attitude of the students at the beginning of the activity, their willingness to assume roles within the game, and their interest in the materials. The field notes recorded that the students were curious about the content of the missions and actively asked about the characters and the day's objective. This motivation was maintained and consolidated throughout the five sessions, thanks to the progressive narrative structure, the system of visual rewards such as the spy card, and the emotional connection with the different characters of Carmen Sandiego. According to the teacher, "From the moment they walked through the door, they were already asking what country we were going to today, they loved the idea of being spies with a mission to fulfil."

In terms of participation, a clear evolution was observed. In the first session, most of the interventions by the students were brief and required constant guidance. One of the students, in particular, avoided verbal participation. However, from the third session, a change was evident: "during the mission in Australia, [student 1] raised her hand on her initiative to propose a solution to the enigma of one of the activities and she was very excited when she got it right, I think it was the most beautiful thing of the day". In the last session, the three students actively participated in the group's decisions, shared ideas confidently, and engaged engagingly throughout the session. The teacher also highlighted this progress: "One of the girls has a hard time starting an activity without support, but here she saw the challenge on the screen and immediately wanted to participate; that is not usual with other academic tasks [...]. While [the student] has a hard time concentrating more than ten minutes on the same task, and especially on the last day with the final escape room, he worked all hours without complaining, I would like to continue doing this type of activity to promote his concentration."

The social and emotional dimension also showed a remarkable development throughout the process. While in the first session, more individualistic behaviors or conflicts to interact were detected, in the fifth session, fluid cooperation was observed. "The students offered each other help, respected the turns, and celebrated the team's successes together," said the teacher. In addition, an improvement in error tolerance was noted. In one of the final sessions, after making a mistake in a mission against the clock, the three students reacted with humor and expressions such as "it is okay, let us go again!", which reflected a change in emotional regulation in the face of frustration.

A small evolution in autonomy was also observed. At the beginning of the program, students expected constant prompts on what to do next. For the last session, although they required support from the teacher, they first tried to do one or two resolution tests before asking for help. This coincided with the teacher's perception, who stressed that "everyone felt part of Carmen's team and wanted to do their part, increasingly on their initiative."

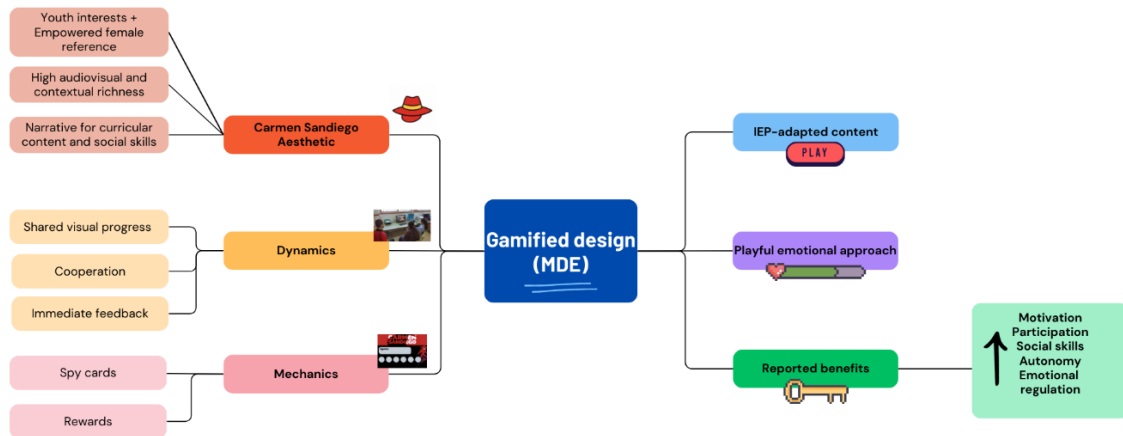


Figure 1: Diagram of the results of implementing the Carmen Sandiego-based gamified learning experience

4. Discussion and Conclusions

The results obtained in this pilot study confirm that gamification, when intentionally designed and adapted to students' needs, can positively impact the motivation, participation, and socio-emotional development of adolescents with mild intellectual disabilities. The gamified experience based on Carmen Sandiego's narrative facilitated the active involvement of the students from the first session. It sustained their interest throughout the five sessions, which was reflected both in the enthusiasm observed and in the comments of the teacher, who highlighted the spontaneous commitment of the students to history, missions, and materials. These findings are consistent with recent studies that have shown the potential of gamification as an inclusive educational strategy. For example, Abu et al. (2023) highlight how incorporating playful elements in educational settings can increase the desire to participate and improve learning attitudes among students with intellectual disabilities, especially when significant roles, rewards, and challenges are integrated. Likewise, Rahmatullah (2024) showed that multisensory methodologies based on play increase cognitive engagement and contribute to progress in basic areas of learning, such as vocabulary, memory, and sustained attention.

The positive evolution of students in this experience, both in their autonomy and in their tolerance to frustration, is supported by Cruz and Palaoag (2019), who argue that gamified environments with immediate feedback, clear narrative structure, and visible rewards stimulate persistence in the task and self-efficacy among students with specific needs. Similarly, the role of intrinsic motivation and the feeling of competence has played a fundamental role in sustaining students' effort and attention, especially in tasks such as the final escape room, which demanded more time and concentration (Alramammnh et al. 2024).

In addition to the motivational value of game dynamics and mechanics, students' motivation can be influenced by narrative and its Pygmalion effect, understood as the positive influence of high expectations on students' performance and attitude. When teachers project positive beliefs about their students' abilities, even those with more significant difficulties tend to respond with greater commitment, self-confidence, and perseverance (Isamail et al., 2022). This phenomenon is especially relevant in special education contexts, where low expectations can limit the development of key cognitive and emotional skills. In this sense, the narrative used in the gamified proposal – focused on the figure of the student as a spy who must save the world together with Carmen Sadiago – not only provided the framework for the development of the didactic proposal, but also conveyed an implicit message of confidence in the students' abilities: "We need you to save the world. Without you, V.I.L.E. will win." Such a design may have generated an emotionally safe and stimulating environment that favored a positive self-image and reinforced intrinsic motivation, in line with what Weinstein (2018) proposes, who points out that educational interventions with high expectations can become authentic "positive prophecies of self-confidence" when applied to historically marginalized students or students with special needs.

However, these results should be interpreted cautiously, as the study has several limitations inherent in its design. The sample comprised only three students, which prevents any statistical generalization. In addition, it was a short-term experience without a control group or longitudinal follow-up, which limits the possibility of establishing causal relationships between the intervention and the changes observed. Despite these limitations, the study provides relevant evidence consistent with recent research, which reinforces the relevance of continuing to explore gamification and GBL as an educational tool in special education contexts. Future studies

could incorporate a mixed design, with larger samples and quantitative assessment tools, and explore the long-term effects of this type of methodology on the academic, social, and emotional development of students with intellectual disabilities.

In conclusion, this study has shown promising indications about the potential of play strategies to improve motivation, active participation, and socio-emotional development in students with intellectual disabilities. Despite the limitations inherent in the study's exploratory nature, the results allow us to glimpse relevant pedagogical benefits, especially in special education contexts where commitment to the task and methodological accessibility are key factors. Experience suggests that didactic proposals based on play and narrative can foster more inclusive, meaningful, and emotionally positive environments, in which students feel like protagonists of their learning process. The need to continue research in this line is highlighted, incorporating broader and more systematic designs that allow for a more in-depth evaluation of the impact of gamification and GBL on inclusive education.

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AI declaration: While preparing this work, the authors utilized GPT-4 and Grammarly to enhance the work's English language. After using this tool, the authors reviewed and edited the content as necessary and took full responsibility for the publication's content.

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