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Effectiveness of gamification and game-based learning in Spanish adolescents with dyslexia: A longitudinal quasi-experimental research

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ABSTRACT

Background: Gamification and game-based learning can provide motivating learning opportunities. The scientific literature suggests that these play strategies could be supportive tools for the learning of students with diagnosed dyslexia.

Aims: This study compares the effectiveness of an educational gamification and game-based learning (GBL) methodology versus a transmissive methodology for the improvement of reading processes and academic performance in the subject of Spanish Language and Literature in Spanish high school students with dyslexia.

Methods and Procedures: Longitudinal quasi-experimental research was conducted with control and experimental groups. Ninety students with a mean age of 14.22 years ($SD = 0.95$) participated in the study. The assessment instruments used were the PROLEC-SE reading process assessment battery and academic performance through subject grades. The intervention with the experimental group consisted of gamification and GBL of 15 one-hour sessions in which students' oral and written skills were worked with playful learning strategies.

Outcomes and Results: The results indicate that the experimental group had statistically significant improvement in their reading skills ($\eta_g^2 = 0.616$) and academic performance, albeit less in pseudoword speed, compared to the control group ($\eta_g^2 = 0.197$).

Conclusion and Implications: The study highlights the usefulness of gamification and GBL as practical tools for meaningful learning in students with dyslexia.

What this paper adds?

This research provides evidence on the effect of gamification and game-based learning (GBL) on the academic performance and reading processes of Spanish students diagnosed with dyslexia. The programme is detailed to make it replicable for other teachers and researchers. The intervention carried out with these students has shown statistically significant differences between those who have taken the gamification programme and those who have received a transmissive education in favour of the gamification and GBL group.

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1. Introduction

Dyslexia is a learning difficulty of neurological origin, characterised by difficulties of precision and fluency in recognising written words and problems of decoding and spelling (Roitsch & Watson, 2019).

Students with dyslexia may display related difficulties in academic motivation (Łodygowska et al., 2017) and require extra care compared to neurotypical students (Chua, 2020). Apart from reading and writing, other problems that are particularly common during adolescence include behaviour difficulties, frustration, misreading words, requiring a long time for homework, poor general knowledge, the desire for others to tell them information and taking longer than others in most written tasks (Reid, 2016).

Literacy difficulties may vary by country due to the variation between languages, meaning there are differences in reading and spelling development between languages (Seymour et al., 2003). It is relatively easier to learn about phonemes if a letter is consistently assigned to the same phoneme or if a phoneme is consistently set to the same letter. In contrast, it can be more challenging to learn about phonemes if a letter can be pronounced in various ways (for example, the letter 'A' in English corresponds to a different phoneme in the very familiar words 'cat' and 'made') (Davies et al., 2007; Ziegler & Goswami, 2006).

The prevalence of dyslexia, both in children and adolescents, is variable, ranging between 7% and 10% of the population (Rello, 2018). It is estimated that between 5% and 11% of students in Spain have dyslexia (Carrillo et al., 2011). However, transparent languages like Spanish are more likely to be a hidden or undetected difficulty (Del Mazo, 2020).

For this reason, it is essential to offer new learning methodologies that teach from a more active and participatory approach that values these students' capacities (Stienen-Durand & George, 2014). The aim of inclusive education is that everyone can learn through accessible educational practices that manage to provide for diversity (Reid, 2006). Access to information and learning can be improved through methodologies capable of adapting to the needs and interests of students (Gros, 2016).

To support and complement the learning of high school students with disabilities such as dyslexia, it is suggested that using playful strategies such as gamification and game-based learning (GBL) can facilitate learning and increase motivation (Vasalou et al., 2017). Various investigations (Chapman & Rich, 2018; Iglesias et al., 2019; Arias et al., 2021) show how both methods benefit learning, school motivation and even the self-esteem of students with disabilities.

GBL consists of the application of games in teaching (Marín, 2018). Its objective is for curricular content and competencies to be guided through games, achieving greater motivation and fun (Plass et al., 2016). Gamification is defined as using the elements and mechanics of video games. Its goal is to apply these mechanisms to generate an educational opportunity that stimulates interest in learning (Manzano et al., 2022). Gamification is related to motivation and indirectly influences improving learning (Kalogiannakis et al., 2020). The differences between the two methodologies are shown in Table 1.

GBL promotes educational interventions that facilitate learning while having fun and working cooperatively (Magno de Jesús & Silveira, 2021). It also generates benefits for acquiring and reinforcing reading skills (Ronimus et al., 2019; Turgut & Irgin, 2009). Berns et al. (2016) highlighted the effectiveness of using video games with the Spanish population when they used a mobile game app, VocabTrainerA1, with beginner students of the German language for four weeks. The game had four levels. The first three levels were individual games to practice listening, reading, and writing, while the fourth was an online collaborative murder mystery game. Their results significantly improved vocabulary and grammar, reporting a large effect size ($D > 0.8$).

Recent research has also shown that educational gamification positively affects reading skills (Dehghanzadeh et al., 2019; Li & Wah, 2020). Using gamification dynamics and mechanics, students with dyslexia practice spelling exercises with greater engagement and improve their academic performance in this area (Dymora & Niemiec, 2019). This finding coincides with the results of Jiménez-Millán and Domínguez-Pelegrín (2018), who cite a large effect size in language learning ($D > 0.8$), while meta-analyses on general educational gamification report moderate effects ($0.5 < D < 0.8$) (Sailer & Homner, 2020).

In another study, Martí Climent and García Vidal (2021) designed an escape room enriched with ICT to understand Valencian legends and enigmas. In another study, an initial video, QR codes with literary works, dynamics of clues and challenges, social media, and a final challenge to the exit of the room. Their results highlight that gamification encourages students to participate actively and collaboratively and that using ICT with gamification favours literary training. Nevertheless, as their qualitative study mentions, the study of gamification to promote literacy in adolescents is not widespread.

1.1. Study Purpose

This research aims to evaluate the effect of gamification and GBL on reading processes and academic performance in the Spanish

Table 1
Differences between GBL and gamification.

Game Based Learning	Gamification
Use of commercial games or games designed by the teacher for the learning of a content or curricular competence ^a	Adaptation of playful methodology to a non-playful environment ^c
Rules and objectives are designed based on learning ^b	The rules and objectives are designed around the contents to be worked, relating them to the narrative and dynamics of the game ^c
There is a chance to lose the game and still acquire a positive evaluation. Participants learn and have fun with the game ^b	Losing is not an option. It is necessary to perform the challenges to continue the narrative.
Game is the main motivation ^a	Learning is measured based on achievements and experience gained ^d MDA (Mechanics, Dynamics, and Aesthetics) are the main motivation ^e

Note. ^a Cornellà et al. (2020), ^b Giannakos (2013), ^c Kapp et al. (2014), ^d Kim (2015), ^e Marczewski (2015). Own elaboration.

Language and Literature for students with dyslexia. To this end, educational gamification and GBL methodology were designed. The following research questions were posed:

1. Are there differences in the development of reading skills between the gamification and GBL methodology compared to a transmissive method?
2. Do the application of gamification and GBL methodology influence reading processes in the subject of Spanish Language and Literature?
3. Are there differences in Spanish Language and Literature academic grades when applying gamification and GBL methodology compared to a transmissive method? If there are differences, are they stable throughout the academic year?

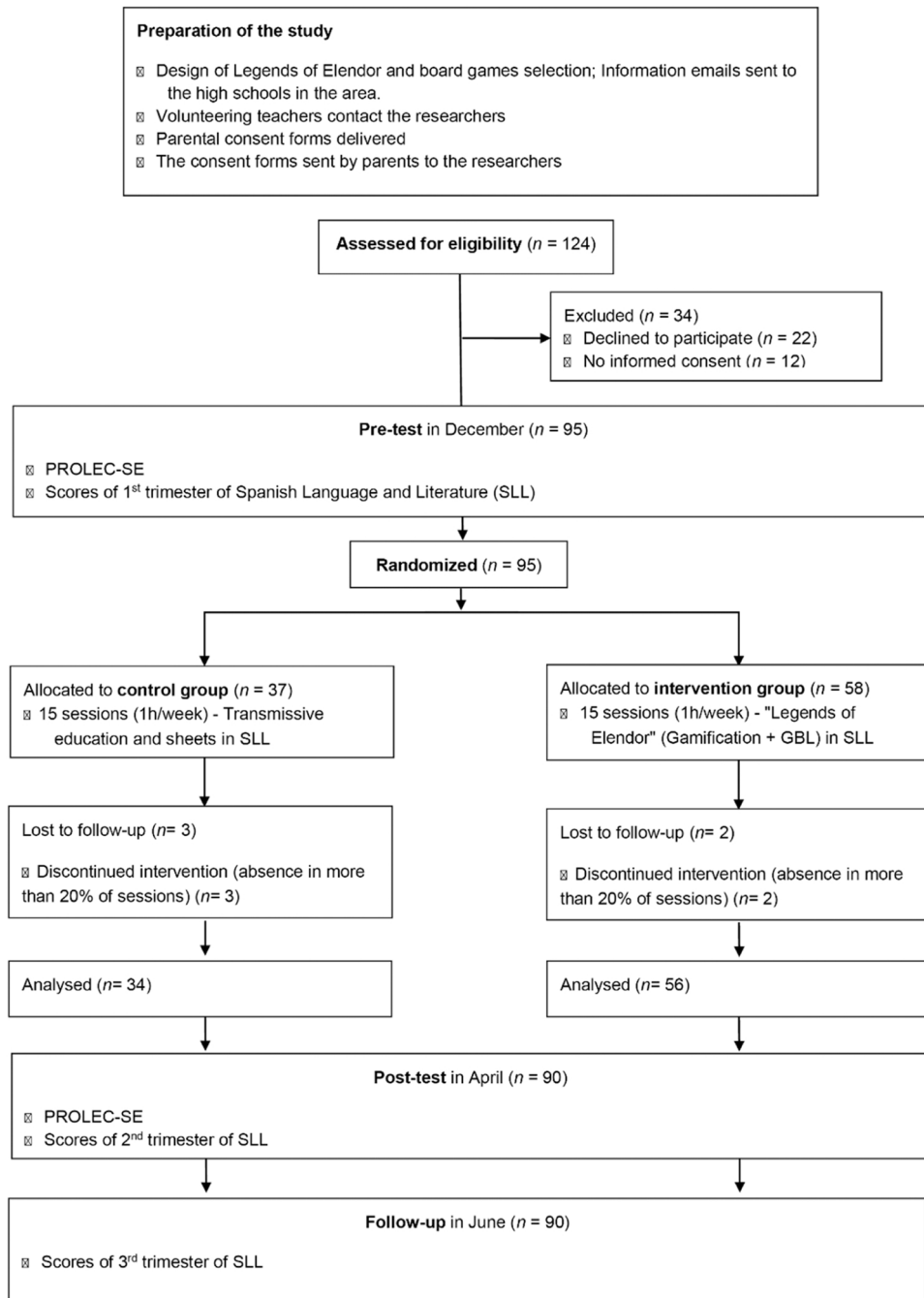


Fig. 1. Flowchart of the study.

The scarcity of research focusing on the implementation of playful strategies with adolescent populations with dyslexia is evident (Dymora & Niemiec, 2019; Peters, Crewther, Murphy, Bavin, 2021), and this paucity becomes even more pronounced when the participants are dyslexic individuals who speak Spanish (Bailón Pilozo & Bolfvar Chávez, 2022). Consequently, this study aims to make a significant and pioneering contribution to educational gamification and game-based learning (GBL) for students with learning disabilities. One of the key aspects that set this study apart is its population focus, targeting Spanish high school students with diagnosed dyslexia. By narrowing the scope to this specific group, the research sheds light on the potential benefits of gamification and GBL strategies tailored to their unique needs and challenges.

Furthermore, this study incorporates a comparative analysis between an educational gamification and GBL approach and a traditional transmissive methodology. This comparative approach offers valuable insights into the effectiveness of gamification and GBL in enhancing the learning experiences and outcomes of students with dyslexia in the context of Spanish Language and Literature. To ensure the reliability of the study's findings, the researchers employed a validated assessment tool, the PROLEC-SE reading process assessment battery. This standardised and well-established instrument allows for a comprehensive evaluation of the participants' reading skills in the Spanish language. In addition, the researchers assessed the impact of the interventions on academic performance by measuring subject grades, providing a holistic view of the student's progress throughout the study.

By combining a focused population approach, a comparative analysis of different methodologies, and reliable assessment instruments, this study aims to bridge the existing research gap and pave the way for future investigations into educational strategies for students with dyslexia.

2. Method

2.1. Participants

For the sample calculation, the scientific literature (Khaleghi, Aghaei, & Behnamghader, 2022; Peters, Crewther, Murphy, & Bavin, 2021) has been consulted to determine the expected effect size in studies with similar characteristics. The effect sizes found vary from medium to large, so a medium effect size has been chosen as the lower limit (Cohen's $d = 0.3$) for this calculation. A β of 1–0.8 and an α of 0.05 have been considered. With these parameters, the required sample size for t-tests is $n = 82$, and for F-tests, it is $n = 90$.

The sample comprises Spanish students with dyslexia in the second year of high school education from five high schools in [name deleted to maintain the integrity of the review process]. The selection of participants was made from a random non-probabilistic sampling (Velázquez, 2017), whose inclusion criterion was the willingness of the management team to participate in the research. From the set of centers that agreed to participate, a random draw was made to select classes that would participate in the control group and those that would participate in the experimental group (See Fig. 1). Regarding the independent variables (age and gender), the data were collected according to the natural availability of each class. The control group participants were taught Spanish Language and Literature with a transmissive approach and reinforcement of exercise sheets. In contrast, the experimental group were taught the subject with gamification and GBL methodology.

The participating students have a diagnosis of dyslexia made by the orientation team of each high school. These teams carry out the psycho-pedagogical evaluation when the student displays literacy difficulties. The conclusions of this psycho-pedagogical evaluation are addressed to determine the educational needs of each student and to make decisions on the modality of schooling, the aids and supports necessary to develop, to the greatest extent possible, the capacities established in the academic curriculum.

The diagnosis of dyslexia considers the data of previous schooling, qualitative information on aspects relevant to the educational intervention, such as personal, family and school development; the learning style, motivation and school climate, and an individual quantitative exploration, evaluating intelligence, reading processes, writing processes, visual-motor perception, and detection of dyslexia.

The sample consists of a total of 90 teenagers diagnosed with dyslexia with a mean age of 14.22 ($SD = .95$), 42 men (37.8%) and 46 women (62.2%). The sample consisted of a control group and an experimental group; the control group had a total of 34 participants with a mean age of 13.94 ($SD = .95$), comprised of 12 men and 22 women, while the experimental group had a total of 56 participants with a mean age of 14.39 ($SD = .91$), of which 32 were men and 46 women (See Fig. 1). We tested for statistically significant differences between the control and experimental groups concerning gender ($T_{89} = 1.709$, $P = .92$) and age ($T_{89} = 0.370$, $P = .713$), with no difference found.

2.2. Instruments

Assessment of Reading Processes - Secondary and Baccalaureate (PROLEC-SE; Ramos & Cuetos, 2005). This battery is standardised for the Spanish population and is widely used in schools to detect possible reading difficulties. This instrument has nine tests that evaluate lexical processes (read words and pseudowords), syntactic processes (matching and punctuation marks), semantic processes (comprehension and structure) and reading speed (words, pseudowords and text). The psychometric properties present for this battery are Cronbach's reliability coefficient of .79 and high composite reliability ($FC = .93$).

The battery consists of:

- Read words and pseudowords: This test consists of reading a list of words and then another list of pseudo-words. The time spent on each list and the errors made within each list are registered.

- Syntactic processes: On the one hand, there is a test of matching a picture with a sentence. In this test, the number of correct and wrong answers is registered. The other test involves reading a text in which punctuation marks are emphasised. In this last test, the correct answers are recorded without penalising errors.
- Semantic processes: The text comprehension test consists of reading two texts about which questions are asked. Some of the answers that are asked are literal, while to answer others, it is necessary to make inferences about the information in the text. In the structure test, students are asked to read a text and then fill in some spaces arranged according to the order in which they appear in the text.
- Reading speed: In word, pseudoword and text reading tests, the time taken to perform the test is timed. Therefore, a shorter reading time means better test performance.

The PROLEC-SE measures were taken twice, one before the intervention (pre-test) and the other at the end (post-test).

Academic scores were recorded for the Spanish Language and Literature class to assess academic performance. Scores were recorded at the end of each stage (measured in quarters). In this way, three measures were obtained. One before starting the intervention (Evaluation 1), one at the end of the intervention (Evaluation 2), and one three months after finishing the intervention (Evaluation 3).

2.3. Procedure

The *Legends of Elendor* (Manzano et al., 2022) was a gamification and GBL methodology designed for Spanish Language and Literature in the second year of high school education, with a duration of 15 weekly one-hour sessions (See Fig. 2). Gamification followed an MDA (Mechanics-Dynamics-Aesthetics) game design structure (Kusuma et al., 2018):

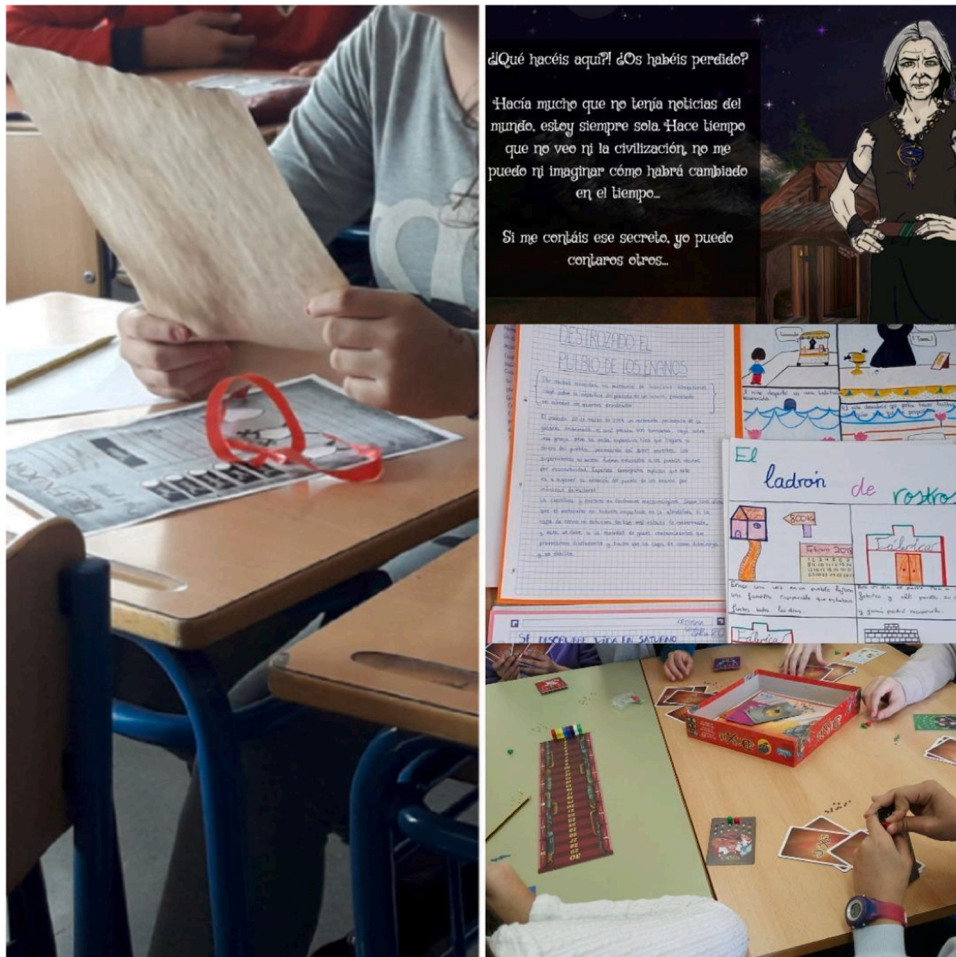


Fig. 2. Photographs of the program. Note: Photograph of a team reading a scroll with the initial mission of gamification; an example of a gamification screen (A powerful witch asks them to write news about the kingdom before providing information about a ritual to defeat the villain); examples of student work; students playing one of the selected board games.

- Aesthetics: a medieval fantasy aesthetic was designed where human, elf and dwarf races coexist. Each student must choose one of these races and a profession (warrior, wizard, and rogue). The gamification narrative is based on finding out who was the killer of the King of Elendor and arresting them.
- Dynamics: Collaboration – students must create clans of 4–6 players to perform the missions; Challenges and tasks – students work in a playful way to carry out different activities related to reading skills. These daily challenges are evaluated using rubrics. Such activities include comic book making, narrative-related readings, and group exposure to a spell and spell design.
- Mechanics: Medals, virtual goods/rewards, experience points and ranking.

The combination of both methodologies aimed to foster a motivating, interactive, and personalised educational experience, as supported by prior research findings (Keim & Jarrard, 2022; Vita-Barrull et al., 2022). Primarily, the gamification design was carefully crafted to captivate students from the outset, igniting their interest and motivating them to actively participate in various activities directly linked to Spanish Language and Literature. This approach strongly emphasised the power of storytelling (Palomino et al., 2019), where students were immersed in captivating narratives, making learning not only educational but also enjoyable and emotionally engaging. Moreover, incorporating a well-structured challenge and reward system gave students a sense of achievement as they progressed through the program (Kapp, 2012). Students were intrinsically motivated to continue learning by conquering challenges and earning rewards. In addition, implementing cooperative dynamics sought to encourage collaborative efforts among students, promoting teamwork and mutual support (Riar et al., 2022).

The program combined gamification with game-based learning (GBL) to elevate student motivation and active participation. Renowned for immersing learners in playful experiences, GBL naturally instilled a sense of curiosity and enjoyment (Yannakakis & Hallam, 2007). The carefully selected games were aligned with the program's objectives, targeting general competencies related to reading processes. Notably, these games provided valuable learning opportunities, allowing students to learn from their mistakes without fear of negative judgement, a relevant aspect to taking care of the school self-esteem of students with dyslexia.

The integration of these playful strategies sought to instil a genuine engagement for learning (Mohamad et al., 2018; Wu et al., 2018). Leveraging the inherent appeal of games, the educational experience was transformed into an exciting and fulfilling adventure, making learning a rewarding journey of discovery.

The average duration of the activities proposed in gamification was 40 min. During the remaining 20 min, the teams played selected board games, reinforcing reading skills (See Table 2).

The whole intervention (Gamification + GBL) was carried out as a reinforcement of the subject contents and was implemented jointly by the class's teacher and two researchers in playful education strategies. The researchers designed *Legends of Elendor*, selected games and trained teachers for 5 h. After receiving the training on gamification, the participating teachers actively participated in the program, serving as facilitators and guides of learning (Luelmo, 2020), solving dilemmas for the students, and correcting the projects derived from the missions.

To ensure the treatment of integrity (Perepletchikova, 2011), the researchers provided the teaching team with a notebook containing the set of materials necessary for implementing each gamification session, proposed activities, rubrics, and a list of games and their pedagogical objectives and rules. At the end of each session, the teacher and the researchers separately filled out a logbook based on the direct observation of the session. At the end of the program, both versions were studied, comparing them with the initially designed notebook, observing that there were no differences in the proposed activities.

Regarding the control group, the curricular content was presented in one-hour sessions in the classroom, during which time. During that time, the teachers imparted theoretical knowledge using a transmissive teaching methodology and exercise sheets to reinforce the content.

Regarding data collection, the concept of the program was explained to the participating students in their classrooms, and they were given written authorisation for their legal guardians. This document described the research objectives and the program's duration and methodology. It also stipulated that data collection would be carried out completely anonymously and confidentially and that data collection, processing, use and conservation were regulated according to international and national provisions, ensuring respect for dignity and protection of human rights and fundamental freedoms. Legal guardians had the right not to sign the consent

Table 2
Selection of games for the program with students with dyslexia.

Name	Publisher	Type of game. Components	Description	Ability related to reading processes
Story cubes	Asmodee	Cooperative. Dices	Tell and / or write stories with the dice icons	Semantic process and syntactic process
Sí Señor Oscuro	Asmodee	Competitive. Cards	Make excuses with the cards to incriminate another player	Semantic process
Maki Stack	Mercurio	Semi-competitive. Cards, figures, and bandage.	Order the figures, listening to the instructions of the partner	Word recognition
Dixit	Asmodee	Competitive. Cards and board.	Tell or write a story as a narrator with your letters or select a card that resembles the narrator's story	Semantic process and syntactic process
Sherlock Q	Guerra de Mitos	Competitive. Cards	Solve a mystery through direct or inferential card reading	Semantic process
Bananagrams	Ludilo	Cooperative or Competitive (depending on the type of game). Lettered tiles.	Build words from letter tiles	Letter identification and word recognition

form, allowing their children not to participate in this study or to leave it at any time without giving reasons to decide. The data obtained would not be used for purposes other than those of this investigation, maintaining the privacy of the individuals and the confidentiality of the data. The participating teachers were informed about the intervention and evaluation of the project. The battery was completed anonymously, assigning each student a numerical code to the group and comparing its results to the second battery application.

This study was conducted following the recommendations of the American Psychological Association and the Declaration of Helsinki. Ethics approval was obtained from the Research Ethics Committee of the University of Almería (Ref. UALBIO 1/2021).

2.4. Data Analysis

To obtain the results of this study, the direct scores were calculated as indicated in the Correction Manual of the PROLEC-SE. Hypothesis contract testing was guided by the research questions posed. To answer these questions, ANOVA tests were conducted to detect possible statistical differences in the PROLEC-SE tests. An ANOVA test with repeated measures was carried out to analyse academic performance, as were subsequent post hoc tests. For all tests, the Bonferroni correction was used as an adjustment. Rstudio version 3.05, which features the tidyverse and rstatix packages, was utilised to perform the statistical analysis (Cohen, 1988).

3. Results

All the means and standard deviations of the direct scores of the PROLEC-SE tests are reported in Table 3. Concerning interpreting the scores, a clarification must be made to ensure the results are understood correctly. In the speed tests, a lower score indicates better test performance. The rest of the tests are the opposite – a higher score means better performance.

To answer the first research question, a comparison was made between the study groups (control-experimental) using the direct scores of the PROLEC-SE. It can be observed that there are no statistically significant differences in the pre-test scores. This indicates that the control and experimental groups start from equivalent scores. However, when looking at the post-test scores, statistically significant differences are observed in all variables (see Table 4). These statistical differences are observed in all cases favouring the experimental group with better scores.

To answer the second research question, the comparison between the groups was analysed concerning the measurements before the program (pre-test scores) and after the program (post-test scores). It can be observed that there were changes in the control group in the speed pseudowords, text speed and whole battery tests (Table 4). Furthermore, the effect size of the total battery in the control group could be considered significant (control group, $\eta_g^2 = 0.126$, experimental group, $\eta_g^2 = 0.616$). On the other hand, the experimental group shows statistically significant changes in all the PROLEC-SE variables. Observing these changes concerning the effect size, differences ranging from medium to large are found, highlighting the effect size of the total battery. Concerning the score of the whole battery, due to the configuration of the test itself, it is reasonable that the changes in it are more significant since the score is obtained in a summative way from the rest of the tests.

To answer the third research question, a repeated measures ANOVA was conducted for the evaluation of academic performance interaction by groups $F(1-88) = 15.60, P < .001, \eta_g^2 = 0.064$ and interaction by time groups $F(1.39-122.58) = 24.39, P < .001, \eta_g^2 = 0.145$. Regarding the time factor, statistical differences are found in the second evaluation $F(1-88) = 21.6, P < .001, \eta_g^2 = 0.197$, and in the third evaluation $F(1-88) = 20.8, P < .001, \eta_g^2 = 0.191$. By observing the means in Table 5, both cases favour the experimental group.

Concerning the interaction of time within the groups, the repeated measures ANOVAs results show no differences within control group $F(1.26-41.6) = 1.16, P = .602, \eta_g^2 = 0.026$. However, the experimental group has differences $F(1.55-85.5) = 58, P < .001, \eta_g^2 = 0.340$. Having performed the post hoc tests to compare various evaluations of the experimental group, differences are found between the first and the second evaluation, $t_{55} = -9.12, P < .001$ and between the first and the third, $t_{55} = -7.51, P < .001$.

Finally, to know if the program has produced differences by gender, a MANOVA (Multivariate Analysis of Variance) has been conducted, and the results based on Wilks' Lambda are as follows: $F = 1.184$ and $p = .315$.

Table 3

Means and standard deviations of the direct scores obtained in the Prolec-SE of the control and experimental groups.

	Control				Experimental			
	Pre M	SD	Post M	SD	Pre M	SD	Post M	SD
Words	37.8	2.02	37.1	3.10	38.1	1.45	39.3	0.89
Speed Words	41.0	25.9	32.2	8.07	39.1	17.0	27	3.64
Pseudowords	35.3	5.31	35.6	5.58	35.9	3.49	38.8	1.43
Speed Pseudowords	61.4	31.4	45.3	11.0	51.9	17.4	41.3	8.92
Matching	16.5	6.30	16.6	5.04	15.6	4.12	20.2	3.00
Punctuation Marks	19.3	3.96	18.1	4.19	18.0	5.30	23.3	1.06
Comprehension	8.79	5.89	8.15	5.26	7.59	3.43	13.6	3.96
Structure	6.65	2.59	6.76	3.97	6.95	2.06	8.93	3.84
Text speed	146.21	48.1	131.91	37.7	149.32	34.8	155.62	30.9
Total Battery	120.26	18.03	131.02	9.53	120.67	11.46	146.96	9.38

Table 4
Results of ANOVAs, between-group and within-group.

	Between Groups				Within Groups			
		<i>F</i>	<i>P.adj</i>	η^2_G		<i>F</i>	<i>P.adj</i>	η^2_G
Words	Pre	0.60	.882	0.007	Control	1.44	.478	0.021
	Post	26.3	***	0.23	Experimental	23.20	***	0.206
Speed Words	Pre	0.18	1	0.002	Control	3.86	.116	0.052
	Post	17.4	***	0.165	Experimental	26.60	***	0.196
Pseudowords	Pre	0.40	1	0.005	Control	0.13	1	0.000
	Post	16.5	***	0.158	Experimental	33.30	***	0.233
Speed Pseudowords	Pre	3.41	0.136	0.037	Control	9.60	***	0.109
	Post	3.44	0.134	0.038	Experimental	15.50	***	0.130
Matching	Pre	0.71	0.810	0.008	Control	0.01	1	0.000
	Post	17.5	***	0.166	Experimental	47.90	***	0.292
Punctuation Marks	Pre	1.60	.401	0.018	Control	1.23	.552	0.021
	Post	77.6	***	0.469	Experimental	54.80	***	0.331
Comprehension	Pre	1.51	.446	0.017	Control	0.26	1	0.003
	Post	31.7	***	0.265	Experimental	66.40	***	0.405
Structure	Pre	0.36	1	0.004	Control	0.03	1	0.000
	Post	6.54	*	0.069	Experimental	19.82	***	0.095
Text speed	Pre	0.12	1	0.001	Control	5.86	*	0.028
	Post	10.5	***	0.107	Experimental	1.67	.402	0.009
Total Battery	Pre	0.01	1	0.000	Control	7.58	*	0.126
	Post	60.1	***	0.406	Experimental	157.12	***	0.616

Notes. * = $p < .05$, ** = $p < .01$, *** = $p < .001$, Dfn = 1, DFd = 88, n control = 34, n experimental = 56

Table 5
Academic performance measured by the scores obtained in the subject of Spanish Language and Literature.

	Evaluation 1		Evaluation 2		Evaluation 3	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Control	5.12	1.61	5.59	1.13	5.53	1.11
Experimental	4.95	1.30	6.68	1.05	6.5	0.89

4. Discussion

This study addresses gamification and the GBL methodology's effectiveness in improving reading processes in high school students with dyslexia. The results of this study show that it is possible to improve reading processes using playful methodologies. These changes were shown to be consistent throughout the evaluation of reading processes. Nevertheless, the speed pseudowords did not differ between gamification and transmissive methodologies, since improvements are observed in both groups. The text speed test improves only in the transmissive methodology group. Upon analysing the results of the detainees, one fact draws considerable attention – a paradox emerges. The experimental group shows notable improvements in all aspects except for the text speed test. In contrast, the control group exhibits minimal progress in any area except for this test and the pseudoword speed test. The authors attribute these findings to the likelihood that the individuals who participated in the program gained a heightened awareness of their dyslexia. Consequently, they intentionally reduced their reading speed to prevent errors and achieve better comprehension of the text. To verify this potential hypothesis, conducting interviews with the participants or employing an instrument to measure their objectives would have been valuable.

Other studies with comparable programs have found similar results in students with dyslexia (Bigueras, 2020; Dymora & Niemiec, 2019). In the case of the present study, a statistically significant difference was obtained in academic performance in favour of the experimental group. Similar findings have been found (Li & Wah, 2020) in which playful methodologies positively affect academic performance.

The design of *Elendor's Legends* seeks to achieve student engagement to carry out activities related to reading skills through a strong narrative and different dynamics and game mechanics. Using narrative and various games encourages participants to remain active as it appeals to different types of players and their interests (Marczak et al., 2018). Educational gamification can also be related to tasks that promote applying different, more active methodological approaches (Bai et al., 2020).

It is essential to consider that our program was implemented with Spanish students, and dyslexia may pose additional challenges in opaque languages. The significance of our intervention lies in its focus on enhancing reading performance through motivation, lexical, and semantic processes rather than exclusively targeting dyslexia-related difficulties. In contrast, existing studies employing Serious Games have primarily emphasised training specific skills, such as phonological abilities, which hold particular importance in opaque languages (Khaleghi et al., 2022; Vanden Bempt et al., 2021; Bertoni et al., 2021) or improving eye movement control (Peters, Crewther, Murphy, Bavin, 2021). Notably, the outcomes of this program indicate notable improvements in the performance of individuals with dyslexia, particularly among students immersed in transparent languages. This suggests that fostering awareness and comprehension has led participants to intentionally reduce their reading speed, effectively avoiding errors and achieving enhanced

reading abilities.

One possible explanation for the results found in this research may be the students' motivation. According to other research (Risqi, 2015), using playful strategies facilitates the enjoyment, motivation, and participation of students with dyslexia. In addition, such strategies can benefit reading skills, as they strengthen linguistic competence, working memory and executive functions, favouring the learning process significantly (Macas-Macas & Guevara-Vízcaíno, 2020). C.C. Chen, Li et al. (2018); X. Chen, Li et al. (2018) show that students who used a gamified system improved their academic performance, reading speed, vocabulary, learning skills, and problem-solving. These findings are reinforced by the results of the present study – by applying cooperative challenges and games that demand interest, concentration, creativity, and especially skills related to reading and writing, the experimental group significantly improved their reading skills. This highlights the importance of designing gamification in a multimodal interactive manner, offering the possibility of adaptation and immediate feedback (Khaldi et al., 2023).

Carrying out this experience between researchers and educators has facilitated reflection on the gamification + GBL program, where some limitations in implementing playful strategies can be highlighted. Firstly, teacher training is necessary for it to work appropriately, as many teachers do not feel comfortable working with gamification due to a lack of training or prejudices about games in the classroom (Quecano & Viñambres, 2020). Therefore, a preliminary step for these programs to function in schools is training conducted by specialists. Secondly, the design of playful strategies must effectively integrate curriculum objectives and create a system for assessing learning progress (Plass et al., 2020). Meta-analysis studies and systematic reviews provide data on the effectiveness of these methodologies in students' learning and academic performance (Noroozi et al., 2020). However, for this condition to occur, the playful design must connect appropriately with the pedagogical design and for curriculum content or competencies to be present throughout the procedure. The activities must be relevant to support this content, and students should feel that their progress is assessed coherently with active feedback. Thirdly, playful strategies entail additional time for planning and organisation for teachers (Sánchez-Mena & Martí-Parreño, 2017), as it requires the development of extra materials compared to traditional teaching. Nevertheless, starting with simple approaches and gradually increasing the quantity and complexity of playful elements over time can be effective. Finally, if gamification and game activities are not well-designed or attractive enough, students may lose interest or not be motivated to participate fully. To achieve that engagement, it would be beneficial to involve students as much as possible in the design (Marczewski, 2015). For example, in the Legends of Elendor, items and the value of store rewards were jointly discussed with students and teachers to make them feel like valuable rewards. Additionally, students were allowed to select GBL games if they varied from one session to another.

Although the results revealed promising advances in investigating playful strategies to improve the reading processes of high school students with dyslexia, several limitations must be acknowledged. Firstly, the present study is limited by the relatively small sample size. Larger samples are needed to allow the generalisation of the results. Furthermore, this sample was chosen for convenience, without social validity assessment. Future research could focus on longitudinal studies on gamification programs and GBL, investigating other variables, such as school motivation, classroom climate or engagement.

5. Conclusions

In conclusion, the results of this study suggest that the implementation of educational gamification and GBL with students with dyslexia can be an effective tool for teaching reading skills, ultimately helping students obtain better academic grades in courses directly related to reading and writing. This research enriches the scientific literature by providing the design, implementation, and evaluation of cooperative gamification and GBL methodology, demonstrating that a balanced structure of aesthetics, dynamics, mechanics, and games allows students with dyslexia to improve their reading skills and academic performance.

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CRedit authorship contribution statement

José M. Rodríguez-Ferrer: Conceptualization, Methodology, Software, Data curation, Writing- Original draft preparation. Ana Manzano-León: Investigation, Validation, Writing- Reviewing and Editing. José Manuel Aguilar-Parra and Adolfo Cangas: Visualization, Supervision.

Data Availability

Data will be made available on request.

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