Article

Evaluating a UDL-Based Digital Escape Room for Bullying Awareness in Secondary Education

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Abstract: This study evaluates the effectiveness of a digital escape room designed according to the Universal Design for Learning (UDL) principles as an educational tool to raise awareness about school bullying and cyberbullying in lower secondary education. Using a quasi-experimental design with 137 students (66 in the control group and 71 in the experimental group), the gamified activity was compared to a traditional expository intervention. Empathy was measured using the Brief Basic Empathy Scale (BES-B), and bullying-related knowledge and experiences were assessed with the SPB-A scale. The escape room integrated key UDL principles, including multiple means of representation (e.g., video, images, text), action and expression (interactive tasks and puzzles), and engagement (narrative-based missions and collaborative challenges). The results indicate significant improvements in knowledge about behaviors related to school bullying among participants who completed the escape room. Although changes in affective and cognitive empathy were not statistically significant, positive trends were observed in the experimental group. The immersive, collaborative, and accessible nature of the activity positions the escape room as a promising tool within broader strategies for bullying prevention.

Keywords: digital escape room; school bullying; empathy; gamification; Universal Design for Learning (UDL); secondary education

1. Introduction

1.1. Bullying and Cyberbullying in School Contexts

The prevalence of school bullying has become a growing concern in recent years, with significant impacts on the academic and social well-being of students [1,2]. This phenomenon disproportionately affects students from marginalized groups, including racial, ethnic, and sexual minorities, who are often subjected to bullying rooted in systemic inequalities and sociocultural narratives of otherness [3,4]. The construction of "the other" (identities deemed non-normative or deviant by dominant social hierarchies) fosters environments where discrimination is normalized, particularly in schools lacking inclusive frameworks [5]. For instance, students with behavioral disabilities experience heightened bullying due to intersecting prejudices against disability. At the same time, LGBTQ+ youth report bullying rates 2–3 times higher than their heterosexual peers, often linked to gender

expression or sexual orientation [6,7]. Such dynamics amplify in digital spaces, where cyberbullying leverages anonymity and the permanence of online content to perpetuate harassment, further alienating marginalized individuals from the safe participation in virtual communities [8]. This lack of digital safety poses severe risks, as marginalized youth may withdraw from online engagement, affecting their academic, social, and personal development [9].

Empathy emerges as an essential socioemotional competence for understanding and addressing the complexity of bullying and cyberbullying in school settings. Numerous studies indicate that the ability to recognize and share the emotions of others decreases the likelihood of developing aggressive behaviors and strengthens social cohesion [10,11]. Likewise, higher levels of empathy have been identified as a protective factor, mitigating the incidence of victimization and reducing the frequency of perpetration [12,13].

Beyond its direct impact on aggression, empathy also plays a key role in shaping bystander responses to bullying incidents. When students are encouraged to empathize with victims, they become more likely to intervene or seek help, disrupting bullying trajectories and contributing to a safer school climate [14,15]. In digital contexts, this "digital empathy" can manifest as an increased awareness of the emotional weight of online messages and interactions, which helps prevent normalizing harmful behaviors [16,17]. In the context of school interventions, fostering empathy through shared-perspective activities, cooperative learning, and emotional education has proven effective in sensitizing students to diversity and injustice and promoting prosocial behaviors that bolster the educational community's cohesion [18]. Such approaches encourage students to actively consider others' feelings and experiences, laying the groundwork for peer support networks and inclusive school cultures. Moreover, systematically implementing empathy-based training can enhance students' self-regulatory skills, reducing tendencies toward bullying and facilitating long-term behavioral change [19,20].

1.2. The Role of Escape Rooms in Pedagogy: Innovative Pedagogical Tools and Processes

Digital technologies play a paradoxical role in this context. On the one hand, they can exacerbate harm. Around 15–20% of U.S. adolescents experience cyberbullying, with higher rates among girls, LGBTQ+ youth, and students with disabilities [21]. Features like anonymity, rapid dissemination, and the absence of immediate adult oversight create fertile ground for continuous aggression. Perpetrators target victims through hate speech, image-based abuse, doxing, or exclusion from social networks, often causing long-lasting psychological trauma, including anxiety, depression, and suicidal ideation [22].

The integration of escape rooms into pedagogical strategies against bullying and cyberbullying represents a significant step forward toward evidence-based approaches that link experiential learning with the prevention of discriminatory behaviors. Recent studies have highlighted that these gamified environments, by combining structured narratives and collaborative problem-solving, strengthen critical socioemotional skills such as empathy and self-regulation, which are essential for dismantling bullying dynamics [23]. Furthermore, adapting escape rooms to digital contexts enables the replication of online risk scenarios, providing students with opportunities to practice ethical and technical responses to cyberbullying, ranging from managing privacy to reporting abusive content [24].

Although the literature supports the effectiveness of these tools in reducing both victimization and perpetration behaviors [25], challenges remain in their systemic implementation. The lack of teacher training in gamified design and the technological gap in under-resourced educational settings limit the scalability of these approaches [26]. However, collaborative initiatives promoting modular templates and open-source resources

mitigate these barriers, facilitating the adoption of escape rooms as accessible and adaptable educational tools [27,28].

UDL shifts the paradigm from reactive to proactive solutions. Rather than retrofitting classrooms to address bullying, the framework embeds flexibility into curriculum design by anticipating learner variability [29,30]. Its three principles—multiple means of engagement, representation, and expression—enable educators to create environments that value diverse identities [31]. By incorporating digital tools such as interactive narratives or gamified scenarios, teachers can address sensitive topics like discrimination through modalities that resonate with varied learning styles [32]. For instance, a student struggling with text-based content might engage more deeply with a video narrative on inclusion, while another might process ethical dilemmas through a collaborative digital simulation [33].

A recent systematic review demonstrates how escape-room mechanics align with the three core principles of the Universal Design for Learning (UDL), mapping typical features such as branching narratives and adaptive puzzles onto the principle of engagement, while multimodal clues and embedded audiovisual prompts address the principle of representation [34]. Likewise, varied challenge formats, such as code-breaking activities and role-playing, support the principle of action and expression [35]. This structural alignment highlights the intrinsic inclusivity of escape rooms: they offer multiple, flexible pathways for students to engage with content, to access information through diverse sensory modalities, and to demonstrate their understanding using different formats [36]. As such, escape rooms represent a pedagogical strategy that inherently operationalizes UDL guidelines, making them particularly suitable for educational interventions targeting diverse student populations.

Extending UDL's emphasis on variability and flexibility, recent research has explored other innovative digital tools that foster inclusion and socio-emotional learning. For instance, a quasi-experimental study found that a gamified interactive e-book significantly enhanced motivation and anti-bullying knowledge among Chinese primary school students compared to traditional lecture-based approaches [37]. In parallel, intelligent virtual assistants developed for educational contexts have shown promise in detecting bullying patterns through conversational analysis and providing students with confidential support and reporting options, thereby increasing their self-efficacy in help-seeking and bystander intervention [38]. Similarly, immersive virtual reality (VR) simulations have been used to create controlled, scenario-based environments where students interact through avatars in harassment situations, resulting in measurable gains in empathy and decision-making skills in pre-post assessments [39].

While such technologies expand the toolkit of anti-bullying interventions, playful strategies like escape rooms offer a unique combination of experiential, narrative-driven, and collaborative elements within a single, cohesive framework. This integration makes them particularly effective for reinforcing socio-emotional competencies in physical and digital learning environments. Emerging evidence suggests that these gamified formats, combining structured storytelling with collective problem-solving, can foster critical skills such as empathy, emotional regulation, and cooperative decision-making, all essential for disrupting bullying dynamics [40]. Furthermore, adapting escape rooms to digital contexts enables the replication of online risk scenarios, providing students with opportunities to practice ethical and technical responses to cyberbullying, ranging from managing privacy to reporting abusive content [41].

Although the literature supports the effectiveness of these tools in reducing both victimization and perpetration behaviors, challenges remain in their systemic implementation. The lack of teacher training in gamified design and the technological gap in under-resourced educational settings limit the scalability of these approaches [42]. However, collaborative

initiatives promoting modular templates and open-source resources mitigate these barriers, facilitating the adoption of escape rooms as accessible and adaptable educational tools. This study contributes to the growing body of research on gamified educational interventions by providing empirical evidence on the effectiveness of a digital escape room designed to address bullying and cyberbullying in secondary education. For this reason, the present study was guided by the following research questions:

(Q1) Which are the differences in affective and cognitive empathy levels after the intervention between adolescents who participate in a digital escape room and those who receive an expository intervention?

(Q2) Which are the differences in the perception of behaviors related to bullying (identification, witnessing, and experiencing) between students who participate in a digital escape room and those who receive a traditional intervention?

2. Materials and Methods

2.1. Participants

The study involved 137 students enrolled in the first cycle of Compulsory Secondary Education (CSE) in Spain, with an average age of 13.32 years (*SD* = 0.88). Participants were recruited from six classrooms across two public secondary schools in Andalusia and selected based on accessibility and willingness to participate. High schools were contacted through existing collaborative networks with the research team, and participation was voluntary for both institutions and students.

Eligibility criteria for inclusion in the study were: (1) being enrolled in a participating school and present during the scheduled intervention session; (2) being in the 12–14 age range, which corresponds to early adolescence and the first two years of CSE in the Spanish education system; and (3) having obtained signed informed consent from a parent or legal guardian. No exclusion criteria related to sex, academic performance, or prior experiences with bullying were applied to ensure representativeness and ecological validity.

To assign participants to conditions, entire classes were randomly assigned to either the experimental group (digital escape room; n = 71) or the control group (traditional anti-bullying session; n = 66), maintaining the natural classroom structure to respect school dynamics. Table 1 outlines the sample distribution by group, gender, and age.

Table 1. Study participants.

	Sex		Age		N
	Female	**Male**	*M*	*DT*	
Control	32	34	13.41	0.86	66
Experimental	39	32	13.24	0.89	71
Total	71	66	13.32	0.88	137

Before data collection, students were informed about the study's aims and procedures and assured that their participation would remain anonymous. Informed consent was also obtained from their legal guardians. The digital escape room activity (experimental group) and the traditional anti-bullying session (control group) were integrated into the students' regular tutoring schedules to ensure ecological validity.

This study followed the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the University of Almería Ethics Committee (UALBIO2023/019).

2.2. Instruments

2.2.1. Empathy

Empathy was measured using the Brief Basic Empathy Scale (BES-B), a psychometric instrument composed of 9 items designed to assess empathy in children and adolescents by distinguishing between two main dimensions: affective empathy and cognitive empathy. In the study by Merino-Soto, López-Fernández, and Grimaldo-Muchotrigo [43], the scale demonstrated an adequate bifactorial structure and acceptable levels of reliability (α and $\omega > 0.70$), as well as metric and scalar invariance across sex and educational level. These findings support the conclusion that the scale measures empathy equivalently among Spanish-speaking children and adolescents, regardless of gender.

2.2.2. Bullying-Related Knowledge and Experience

The Self-Perception and Perception of Bullying in Adolescents Scale (SPB-A) [44] was employed to evaluate students' understanding of bullying and their related experiences. This instrument comprehensively assesses the experience of school bullying among students in Compulsory Secondary Education. It consists of 27 items distributed across four factors: knowledge of behaviors that constitute bullying, witnessing bullying behaviors, experiencing bullying behaviors, and the impact of bullying behaviors. The scale was validated through exploratory and confirmatory factor analyses, demonstrating a robust factorial structure and high internal consistency ($\alpha = 0.86$). In addition, multigroup factorial invariance analyses confirmed that the instrument is invariant across sex, grade level, and school type, supporting its reliability and validity for use in diverse educational settings.

2.3. Escape Room Design

The digital escape room was developed through a multi-phase design process grounded in pedagogical and technical criteria aligned with Universal Design for Learning (UDL) principles. The objective was to create an engaging, accessible, and educational experience that increases students' awareness of school bullying and promotes socio-emotional competencies.

2.3.1. Platform Selection and Design Phases

The activity was created using Genially, a web-based platform selected for its interactive capabilities, ease of use, and compatibility with multimedia resources. Genially allowed the integration of dynamic visual elements, audio, videos, and interactive components without requiring advanced programming skills, thus ensuring replicability in diverse educational settings. Its responsive design enabled implementation across devices (computers, tablets, or interactive whiteboards).

The development process followed three main stages:

- Narrative conceptualization: A fictional storyline was constructed around a school experiencing a bullying crisis, where superhero characters enlist students to help identify and resolve harmful behaviors. This narrative structure was chosen to foster emotional engagement and intrinsic motivation through role-play and mission-based tasks.
- Content and challenge design: Educational content was structured into three thematic environments: the classroom, the library, and the cafeteria. Each contains multiple interactive tasks. These tasks included decoding puzzles, completing video-based reflections, solving word searches, and participating in a comic-based scenario. Activities aligned with bullying-related learning objectives.
- Visual and multimedia development: All visual content was created through the AI-based generative tools DALL·E and ChatGPT 4o with an image generator GPT or sourced from the royalty-free image platform Pixabay. The resulting materials

were curated to ensure cultural sensitivity, visual clarity, and thematic coherence with the narrative.

The research team pilot-tested the escape room internally to ensure its functionality, clarity of instructions, and age-appropriateness.

2.3.2. Escape Room Structure

The escape room was structured around a narrative [45] set in a fictional school environment. In the storyline, the school principal expresses concern about a rise in bullying cases and activates the "red alert," summoning several superheroes—fictional characters familiar to young audiences [46] to help address the problem. These superheroes request the students' collaboration to identify inappropriate behaviors and propose ways to improve coexistence within the school.

Once the mission is accepted, students—working in small groups of 3 to 4 players— must overcome a series of challenges distributed across three virtual school settings: the classroom, the library, and the cafeteria.

In the first phase, located in the classroom, the challenges include:

- A spiral with a hidden message: Participants must interact with various objects in the virtual environment to find a clue that helps decode a message related to bullying.
- A video activity: Students watch a YouTube video about a bullied child. After viewing the video, they must answer a comprehension question related to it and solve an interactive puzzle.

In the second phase, taking place in the library, students face two activities:

- A word search: Students must identify six concepts related to bullying. Based on the terms they find, a reflective question is then posed.
- An interactive comic: A bullying scenario is illustrated ("Extraña como yo" by Gavin Aun Thang) to foster empathy and recognize inappropriate behaviors.

The third phase occurs in the cafeteria, where students encounter reflective messages and practical advice on preventing bullying. They must also find a hidden password to complete the activity there.

Upon entering the password correctly, students are directed to a final screen. This screen displays the date of the International Day Against Bullying and congratulates the students as a symbolic recognition of their engagement with the proposed mission (See Figure 1).

2.3.3. Application of Universal Design for Learning (UDL) Principles in the Escape Room Design

The escape room was designed in accordance with the principles of the Universal Design for Learning (UDL) [47] to provide an educational experience that is accessible, inclusive, and meaningful for all students. Specifically, the following aspects were considered:

- Providing multiple means of representation: Content is presented through diverse formats (text, video, images, audio, comics, interactive activities), allowing students to access information according to their preferences and learning styles.
- The escape room provides multiple means of action and expression: It includes a range of challenges, from puzzle-solving to reflective tasks, allowing students to demonstrate their understanding through various cognitive and creative approaches.
- Providing multiple means of engagement: The gamified narrative, use of fictional characters, and progression through phases foster intrinsic motivation and active participation. Furthermore, the reflective messages and connection to a socially relevant issue (bullying) encourage emotional engagement with the activity.

Figure 1. Sample screenshots from the escape room. Note: English translation: Congratulations!! Now you have superpowers against bullying!

In addition, the design prioritizes intuitive and autonomous navigation, enabling implementation in various contexts (individual, group, classroom, or remote) and accommodating different learning paces. This approach fosters an inclusive learning experience tailored to the diverse needs and abilities of all students.

2.4. Procedure

This study followed a quasi-experimental pre- and post-test design with a control and an experimental group. The study was conducted during regular school hours in public secondary education centers in [removed for revision], Spain. After obtaining the necessary approvals from the schools, participants were assigned to either the experimental or control group based on their existing class groups, as random assignment was not feasible in the natural school setting.

Before the intervention, all participants completed the battery of instruments. These pre-test assessments were administered collectively in the classroom under the supervision of one of the researchers and the classroom teacher.

Following the pre-test, the interventions were implemented:

- Experimental group: Students participated in a digital escape room developed with the Genially platform, chosen for its interactive and engaging features, designed according to the Universal Design for Learning (UDL) principles to ensure accessibility and engagement. The activity lasted approximately one hour and was completed in small groups of 3 to 4 students. The escape room included multimedia challenges,

such as videos, comics, interactive puzzles, and reflection questions, distributed across three virtual environments: the classroom, library, and cafeteria. All were related to the theme of bullying and school coexistence.

- The control group received a one-hour standard session with their classroom tutor, which was carefully designed to align with the duration and topic of the escape room. This ensured that both groups were exposed to comparable levels of the subject matter, enhancing the study's balance and impartiality.

To enhance comparability, the control session covered the same core themes: recognizing bullying behaviors, understanding the consequences of bullying, and strategies for intervention. It was delivered in a lecture-based format using a slideshow presentation accompanied by group discussion facilitated by the classroom tutor. No interactive or gamified elements were included. While both conditions addressed the same learning objectives, the instructional strategies differed notably in terms of engagement and modality: the experimental group participated in a collaborative, multimodal, narrative-based activity, whereas the control group engaged in a conventional didactic session with limited student interaction.

One week after the intervention, both groups completed the same set of instruments used in the pre-test and post-test under the same conditions. Data collection was anonymous and coded to allow for pre–post comparisons. This study complied with the recommendations of the Declaration of Helsinki. Ethical approval was obtained from the University of Almería Ethics Committee (UALBIO2023/019).

2.5. Data Analysis

The data for this research study were processed using SPSS Version 26. To ensure coherence with the two research questions, the analysis was structured accordingly:

For RQ1 (Which are the differences in affective and cognitive empathy levels after the intervention between adolescents who participate in a digital escape room and those who receive an expository intervention?), the following steps were followed:

- Initial equivalence between groups was assessed using independent samples *t*-tests on pre-test scores for affective and cognitive empathy.
- Subsequently, individual pre–post differences (Δ) were calculated for each participant by subtracting post-test scores from pre-test scores.
- These difference scores were compared between groups using independent samples *t*-tests to evaluate.
- Effect sizes were computed using Cohen's d to estimate the magnitude of the differences beyond statistical significance.

For RQ 2 (Which are the differences in the perception of behaviors related to bullying—identification, witnessing, and experiencing—between students who participate in a digital escape room and those who receive a traditional intervention?), a similar analytic strategy was used:

- Pre-test equivalence between groups was verified using independent samples *t*-tests for each bullying-related indicator.
- Post–pre difference scores (Δ) were calculated for each participant on the three indicators: knowledge about bullying behaviors, witnessing bullying, and experiencing bullying.
- Group differences in these change scores were assessed using *t*-tests, and Cohen's d was again used to interpret effect sizes (small ≈ 0.20, moderate ≈ 0.50, large ≥ 0.80).

Results were reported with means, standard deviations, t-values, *p*-values, and effect sizes for all comparisons.

3. Results

Regarding the first research question (Which are the differences in affective and cognitive empathy levels after the intervention between adolescents who participate in a digital escape room and those who receive an expository intervention?), an analysis was conducted to compare changes in affective and cognitive empathy between the experimental group (digital escape room) and the control group (traditional expository session).

First, the groups' initial equivalence was assessed using an independent samples t-test applied to the pre-test scores. No statistically significant differences were found in empathy dimensions, indicating that both groups started from similar levels before the intervention (See Table 2).

Table 2. Means (M) and standard deviations (SD) of affective and cognitive empathy by group and moment.

Variable	Moment	Experimental Group (M ± DT)	Control Group (M ± DT)	p (Pre-Test)
Affective empathy	Pre	12.35 ± 3.86	11.35 ± 4.32	$p = 0.153$
	Post	16.43 ± 2.15	12.89 ± 3.37	$p < 0.001$
Cognitive empathy	Pre	18.52 ± 3.84	17.76 ± 4.66	$p = 0.295$
	Post	21.27 ± 2.40	19.18 ± 3.58	$p < 0.001$

Subsequently, the pre–post differences (Δ) were calculated, and t-tests were applied to compare independent samples. Although the differences did not reach statistical significance, the experimental group showed more significant improvements than the control group in both dimensions of empathy. The effect size was small, especially in the cognitive dimension (See Table 3).

Table 3. Comparison of pre–post differences in affective and cognitive empathy (Δ).

Variable	Δ Experimental Group (M ± DT)	Δ Control Group (M ± DT)	t	p	d Cohen
Affective empathy	4.08 ± 3.03	1.54 ± 4.97	3.63	$p < 0.001$	0.62
Cognitive empathy	2.75 ± 2.92	1.44 ± 5.91	1.65	0.100	0.28

For the second research question (Which are the differences in the perception of behaviors related to bullying (identification, witnessing, and experiencing) between students who participate in a digital escape room and those who receive a traditional intervention?), three dimensions were analyzed: knowledge about behaviors that involve bullying, bullying behaviors witnessed, and bullying behaviors suffered.

In this case, the equivalence between groups was rigorously checked in the pretest, and no significant differences were found, providing reassurance about the study's methodology (See Table 4).

Table 4. Means (M) and standard deviations (SD) of the perception of behaviors related to bullying by group and moment.

Variable	Moment	Experimental (M ± DT)	Control (M ± DT)	p (Pre-Test)
Knowledge about bullying behaviors	Pre	44.84 ± 13.50	43.45 ± 14.53	$p = 0.574$
	Post	50.19 ± 15.59	39.92 ± 16.46	$p < 0.001$
Bullying behaviors witnessed	Pre	36.03 ± 18.28	35.15 ± 15.39	$p = 0.767$
	Post	37.14 ± 15.50	32.55 ± 16.25	$p = 0.102$
Bullying behaviors suffered	Pre	19.31 ± 11.95	19.97 ± 14.82	$p = 0.782$
	Post	18.16 ± 10.86	19.28 ± 13.59	$p = 0.613$

Subsequently, pre–post differences (Δ) were calculated, and independent samples *t*-tests were conducted. Although the differences did not reach statistical significance, the experimental group demonstrated more substantial improvements than the control group in both dimensions of empathy. The effect size for cognitive empathy was small, indicating no significant changes occurred following the program's implementation. However, for affective empathy, the observed effect size was medium [48], which also suggests the presence of statistically meaningful changes. According to Cohen, a medium effect size may already indicate a noticeable change in this field (See Table 5).

Table 5. Comparison of pre–post differences in perception of behaviors related to bullying (Δ).

Variable	Experimental Δ (M ± DT)	Control Δ (M ± DT)	t	p	d Cohen
Knowledge about bullying behaviors	5.34 ± 20.41	−3.53 ± 21.14	−2.43	0.016	−0.427
Bullying behaviors witnessed	1.10± 25.06	−2.60 ± 22.47	−0.891	0.375	−0.156
Bullying behaviors suffered	−1.15 ± 16.93	−0.74 ± 16.93	0.135	0.893	0.024

4. Discussion

This study demonstrates that a digital escape room based on Universal Design for Learning (UDL) principles can be an effective introductory strategy for enhancing knowledge and critical awareness about bullying among secondary school students.

The results highlight two key findings: first, the intervention's capacity to enhance students' knowledge about bullying behaviors, and second, its potential as a motivational entry point within broader socio-educational programs aimed at promoting empathy. Although increases were observed in both affective and cognitive empathy, only the affective component showed a statistically significant change, and even then, effect sizes were in the small to medium range. These modest results suggest that while the intervention may trigger initial emotional engagement, it is unlikely to generate more profound or lasting changes in empathic abilities without further reinforcement. This finding is consistent with prior research, which shows that short, stand-alone interventions can yield transient empathy gains. However, sustained exposure is generally required to consolidate these effects [49,50]. Recent thematic reviews also highlight that effective empathy development often requires multi-week interventions that include structured perspective-taking and opportunities for reflection, to foster sustained behavioral change [51]. Therefore, brief activities like digital escape rooms may be best conceptualized as complementary tools that spark interest and raise awareness, rather than as definitive solutions for empathy training. This limitation is significant when addressing bullying linked to systemic exclusion, such as that experienced by LGBTQ+ students or learners with disabilities, where long-term, inclusive pedagogical frameworks are necessary to challenge entrenched social biases [52].

The most significant result was an improvement in knowledge about bullying behaviors, supported by the power of gamified narratives to enhance the acquisition of socio-emotional competencies [53]. Escape rooms, through their immersive and collaborative structure, enable students to identify and articulate behaviors such as exclusion, cyberbullying, and verbal microaggressions [54]. For marginalized populations, this explicit training in recognizing patterns of discrimination represents a critical first step toward breaking cycles of victimization [55].

Moreover, the reduction in self-reported bullying experiences and observation by bystanders suggests that increased awareness may precede behavioral changes [56,57]. These findings are supported by previous studies, which have shown that gamified interventions increase awareness of bullying, laying the groundwork for gradual transformations [58,59]. Based on the Universal Design for Learning (UDL) principles, the design amplified these effects by ensuring equitable accessibility. Multiple formats (videos, comics, puzzles) and

collaborative tasks removed barriers for diverse learning styles [60], demonstrating how pedagogical inclusion enhances the impact of interventions [61].

These results position digital escape rooms as versatile tools within comprehensive anti-bullying strategies. Their ability to generate initial engagement and critical awareness makes them ideal allies for long-term initiatives, such as peer mentoring programs or restorative justice curricula [62,63]. For instance, integrating these activities with modules on intersectional diversity or digital literacy workshops could amplify their relevance in contexts marked by structural inequalities [64].

While the study's results provide promising evidence regarding the potential of digital escape rooms designed following UDL principles to promote empathy and awareness of bullying among adolescents, several limitations must be acknowledged to contextualize the findings appropriately.

First, the sample was selected using a non-probabilistic convenience method from only two public schools. This restricts the external validity of the results and limits the ability to generalize findings to broader populations. Future research should aim to include more diverse and representative samples, spanning different regions, school types, and socioeconomic backgrounds, to enhance generalizability and evaluate the impact of contextual variables.

Second, the intervention consisted of a single session lasting approximately one hour. While short-term positive outcomes were observed, particularly in recognizing bullying behaviors, it is essential to acknowledge the challenges of achieving and sustaining meaningful empathy gains through such brief interventions. Therefore, future studies should adopt longitudinal designs or include follow-up assessments to examine whether initial improvements in empathy translate into durable behavioral changes over time.

Third, the study relied exclusively on self-report instruments. Although these tools demonstrated sound psychometric properties, self-report data may be subject to limitations such as social desirability bias or limited self-awareness. Incorporating behavioral observations, peer nominations, or teacher assessments in future research would provide more robust and triangulated measures of empathy-related change.

Finally, considerations related to digital equity and facilitation expertise also emerged. Variability in device quality, internet access, and familiarity with digital tools may have impacted students' ability to fully engage with the escape room, particularly in under-resourced settings. These challenges intersect with language proficiency, which can influence how students interpret and respond to text- and audio-based content. Grounded in the UDL framework, future iterations of the escape room should include customizable and inclusive features that actively support linguistic and cognitive diversity. These may involve multilingual interfaces, audio narration to assist students with reading difficulties, and simplified or adjustable text formats [65]. Moreover, incorporating accessibility tools such as haptic feedback or voice-guided navigation, which have been successfully tested in accessible VR escape rooms, could ensure broader usability for students with visual impairments [66].

5. Conclusions

Digital escape rooms based on UDL principles offer a promising tool for enhancing secondary students' knowledge and critical awareness of bullying behaviors. The intervention's immersive, gamified structure proved particularly effective in helping students identify and articulate subtle forms of bullying, such as exclusion, cyberbullying, and microaggressions—behaviors often normalized in school settings.

While empathy gains were modest, this aligns with its socially constructed nature. Sustained engagement is typically needed to deepen empathetic skills. This suggests that

brief interventions, such as escape rooms, are better positioned as catalysts for long-term programs rather than standalone solutions [67]. Their ability to generate initial engagement and foundational awareness makes them ideal for integration into comprehensive strategies, such as peer mentoring or restorative justice curricula, which can foster more profound empathy and promote lasting behavioral change over time. The UDL framework was crucial in ensuring accessibility and inclusivity, critical to the intervention's success. By incorporating multiple modalities (e.g., videos, puzzles, collaborative tasks), the escape room accommodated diverse learning needs, reinforcing the importance of pedagogical flexibility in addressing systemic inequities, especially for marginalized groups like LGBTQ+ students or those with disabilities who face disproportionate bullying risks.

Moreover, these findings have clear practical implications for educators and policymakers. Incorporating digital escape rooms into existing anti-bullying programs can engage students early and foster critical awareness. Schools should provide facilitator training in UDL principles and basic technical troubleshooting to ensure consistent, immersive experiences. Future research should explore the longitudinal implementation of escape rooms, integrating them into multi-session modules, and assessing their impact on behavioral outcomes over time. It would also be valuable to compare different gamified formats (e.g., VR simulations, mobile apps) and to investigate scalability across diverse cultural and resource contexts.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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