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Adapted Mathematical Games: A Comparative Study of Spain and the United States

Juegos matemáticos adaptados: Un estudio comparativo de España y Estados Unidos

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ABSTRACT

This comparative analysis explores the use of adapted mathematical games in Spanish and US inclusive classrooms for students with learning disabilities, neurodiversity, and other special needs. The analysis, based on information from 24 schools (12 per country), uses surveys, interviews, classroom observations, and policy analysis. Findings reveal that American teachers routinely adapt games according to Universal Design for Learning (UDL) principles, individual education plans (IEPs), and differentiated instruction. The adaptations are more formalized, supported by training, and embedded in curriculum objectives. Spanish teachers, although affirmative about game playing, use games less frequently and undertake more improvisation since they have less access to formal training and more formalized curricula. Students in both environments enjoy games, but only American students show sustained gains in school performance from modified gameplay. Spanish classrooms prefer to employ games as an incentive rather than as a pedagogy, with fewer accommodations for differences in needs. Cultural attitudes toward differentiation and disability also shape implementation: American schools prefer individualism and autonomy, whereas Spanish schools lean toward group cohesion and standardization. The study discovers that modified games hold immense promise for inclusion if they are designed to their specifications and adequately supported. It recommends additional professional development, curriculum flexibility, and culturally responsive practice in modification. Highlighting strengths and limitations at the national level, provides insight into future classroom practice, training, and policy for inclusive mathematics education.

Keywords: Adaptation strategies, Game-based learning, inclusive education, mathematical games, neurodiversity

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RESUMEN

Este análisis comparativo explora el uso de juegos matemáticos adaptados en aulas inclusivas españolas y estadounidenses para estudiantes con discapacidades de aprendizaje, neurodiversidad y otras necesidades especiales. El análisis, basado en información de 24 escuelas (12 por país), utiliza encuestas, entrevistas, observaciones de aula y análisis de políticas. Los hallazgos revelan que el profesorado estadounidense adapta juegos rutinariamente según los principios del Diseño Universal para el Aprendizaje (DUA), los planes de educación individualizados (PEI) y la instrucción diferenciada. Las adaptaciones están más formalizadas, respaldadas por formación e integradas en los objetivos curriculares. El profesorado español, aunque se muestra positivo respecto a los juegos, los utiliza con menos frecuencia y recurre a la improvisación, ya que tiene menos acceso a formación formal y currículos más formalizados. Los estudiantes de ambos entornos disfrutan de los juegos, pero solo los estadounidenses muestran mejoras sostenidas en el rendimiento escolar gracias a los juegos modificados. Las aulas españolas prefieren emplear los juegos como incentivo en lugar de como pedagogía, con menos adaptaciones a las diferencias de necesidades. Las actitudes culturales hacia la diferenciación y la discapacidad también influyen en la implementación: las escuelas estadounidenses prefieren el individualismo y la autonomía, mientras que las españolas se inclinan por la cohesión grupal y la estandarización. El estudio revela que los juegos modificados tienen un gran potencial para la inclusión si se diseñan según sus especificaciones y cuentan con el apoyo adecuado. Recomienda mayor desarrollo profesional, flexibilidad curricular y prácticas de modificación culturalmente receptivas. Al destacar las fortalezas y limitaciones a nivel nacional, proporciona perspectivas para futuras prácticas en el aula, capacitación y políticas para la educación matemática inclusiva.

Palabras Clave: Estrategias de adaptación, aprendizaje basado en juegos, educación inclusiva, juegos matemáticos, neurodiversidad

I. INTRODUCCIÓN

In the mathematics teaching world of the 21st century, mathematics education is not merely being required to be standards-based and rigorous but also inclusive, challenging, and accessible to students with different needs. Against a background of heightened international concern with differentiated and student-centered approaches, one classroom pedagogy that has risen to prominence is the use of mathematical games in the teaching arsenal. Well-designed and implemented mathematical games afford active opportunities for the strengthening of conceptual understanding, cooperation, strategic thinking, and intrinsic motivation. While their potential has been acknowledged in theory and in teacher training courses for a very long time, a rigorous examination of adapted mathematical games—those modified or specially designed to meet students with learning differences or neurodiversity—is weak, especially in cross-national contexts (Brinkhuis *et al*., 2020; Samavati *et al*., 2024).

Evidently, educational inclusion faces persistent challenges in countries, particularly in math. Children diagnosed with learning disabilities, attention deficits, autism spectrum disorder, or socio-linguistic disadvantage, as a common rule, experience barriers of the system in access and meaningful engagement with typical math curricula. System barriers are accompanied by inflexible instructional design and the absence of differentiation, especially in traditional classes of mathematics, abstract thought and symbolic manipulation become the core focus. Against this backdrop, adapted math games seem to be promising tools that are able to ease such problems through visual, touch-based, group, and kinesthetic features that are more in line with Universal Design for Learning (UDL) principles (Andrews & Diego-Mantecón, 2015; Gris *et al*., 2017).

The present study is a response to the critical gap in research and practice: the lack of empirical comparative analysis of the application, adaptation, and pedagogical effectiveness of math games in inclusive learning settings. While there is a significant body of literature on game-based learning and its possibilities for traditionally developing student populations, fewer have considered intentionally modifying such games for marginalized or neurodiverse students. Even less has discussed how cultural, institutional, and pedagogical

factors intersect with design and implementation of adapted games in multicultural national contexts. Spain and America—two countries with contrasting education systems, inclusion policies, teacher training programs, and mathematical and disability cultural attitudes—richly offer such a comparative investigation (Ivan *et al*., 2017).

Current research into game-based learning in math centers on general cognitive benefits: increased participation, concept exposure, colearning, and improved problem-solving capacity. While these findings are valuable, they typically assume access and sharedness that exclude students with different cognitive, social, or behavioral needs. Studies that do look at adaptation are typically based on either treatment settings or computer games, not standard classroom use. Furthermore, there is mostly single-nation case study work that exists currently, which does not allow one to see how more broad systemic, cultural, and pedagogical settings shape practice (Chu *et al*., 2021; Lindstedt *et al*., 2020).

This study assists in this significant deficiency by carrying out a comparative, mixed-methods study of how adapted mathematical games are developed, enacted, and accepted in Spanish primary and lower-secondary school classrooms and those in the United States. Specifically, it examines how teachers in the two contexts extend mathematical games to include students with varying learning profiles; how these extensions articulate inclusive education values and curriculum purposes; and what organizational or cultural forces facilitate or render them difficult to achieve.

Spain and the United States are two enlightening cases to contrast because they possess different but intersecting approaches to mathematics education and inclusive education. The United States, with decentralized but legally mandated institutions like the Individuals with Disabilities Education Act (IDEA), has implemented mechanisms of differentiated instruction through IEPs (Individualized Education Programs) and inclusion mandates (Shute *et al*., 2016). It also possesses a fairly robust ecosystem of educational research and resource development for gamification and learning technologies. Spain, being more centralised in terms of curriculum and teacher training, has become more proactive in promoting inclusive education through national reform like the LOMLOE (Organic Law for the Modification of the LOE), albeit patchy implementation and strong dependence on autonomous community policy (Clarke, 2011; Gocheva *et al*., 2022).

Also, the countries differ significantly in classroom culture, classroom autonomy, parental participation, and the believed function of games in the learning process. For example, American teachers have more freedom over lesson planning and are rewarded with the encouragement to try things in the classroom, while Spanish teachers have more rigid structures, usually controlled by external exams and textbook-driven curricula. These differences will probably impact how mathematical games are interpreted, translated, and implemented into regular class practice, particularly for those who require special accommodations (Radha *et al*., 2016; Sarría *et al*., 2017).

The main goal of this research, therefore, is to provide a detailed, evidence-based description of how adapted mathematical games are used to promote inclusive learning of mathematics in two contrasting education systems, and what can be learned about policy, teacher preparation, and pedagogy from such a comparison. The study uses teacher and student interview data, class observation, questionnaires, and analysis of policy documents collected in 24 schools (12 in each country), offering both depth and breadth of data.

The study has the following primary objectives:

- To explore the types of mathematical games used in inclusive classrooms in Spain and the U.S. and how these are being adapted to meet a variety of student needs.

- To identify general and context-specific pedagogical strategies employed by teachers when utilizing adapted games in mathematics.

- To compare such strategies to national inclusive education and mathematics instruction policy
- To investigate students' attitudes towards participation, accessibility, and learning outcomes with regards to adapted mathematical games
- To analyze the cultural, institutional, and professional development elements that affect teachers' ability to develop and integrate adapted games.

II. LITERATURE REVIEW

Geometry becomes now the object of significant educational discussions with regard to education for inclusivity. Even if geometry retains the extraordinary privilege of being learnable solely by the eye alone, by the hand alone, or with the support of computer technology, this visual/spatial nature retains the significant complicity relations with the students with the precise profiles, namely with the visually impaired ones, the ones with autism and specifically with ASD, with the ones with specific learning difficulties, with the ones with intellectual disabilities. Thus, within this difficult educational environment, the expression “accessible geometry" emerges. This expression indicates the necessity of reinstating the process of learning. “Accessible geometry is about far more than simplifying the math": it is about enabling the same level of participation and attainment for all pupils irrespective of their abilities. Thus, it shares many significant features with other models that base their importance on the responsive teaching for the inclusive classes, namely the del Cerro Velázquez & Morales Méndez model from 2018.

It's also evident that there's a great concern shown by the literature for multisensory methods, which can be considered a means to deal with these types of problems. For example, it's said by Russo *et al*. (2023): “it's essential to initiate visual and kinesthetic methods for mathematics, beginning with those pupils who have learning issues.“ Also, it's observable that there's an important set of key issues being shown by the literature that have to be brought into focus by mathematics education, for example, instruction design, properly designed, correctly, according to Senk *et al*. (2012): “Overall, designing instruction involves several challenges that make this task more complex, and indeed, many educators face challenges related to issues of obstacles in instruction design at the level of the design of the system." Considering instruction design, educators deal with issues regarding “obstacles in an ineffective and inflexible curriculum and generic designs that can’t deal with innovation and modifications that correspond to new needs—itself implies excluding people with different qualities; there are pupils who find themselves “lost in the education system“, according to Moleko (2022). Hence, inclusion becomes even more of a school-wide issue that has to be addressed, as opposed to turning into a personal issue for the teacher. It is further mentioned by Rodriguez-Ascaso *et al*. (2018) in their study that having a collective commitment towards school inclusion implementation is very essential in comprehensively implementing school inclusion. In addition, adaptive methodologies also have to be used while assessing inclusion, and thus, more equal assessments are even more preferred, as mentioned by Quintero *et al*. (2019).

The Research Gap: The Need for Comparative Analysis

Despite the progress made in the law and the adoption of geometrical integration policies like IDEA in the USA and LOMLOE within the Spanish education system, many obstacles must be overcome for SEN students if equal geometrical knowledge is to be achieved by these students within these two countries. Even though a recent increase has been observed within mathematics access studies within inclusive environments within academic publications, a vacuum has been identified concerning unique methodology approaches of geometry within a multicultural environment. Prior studies primarily focused upon conventional studies upon inclusion within mathematics or the use of AT, but little academic attention has been given towards a critical comparison upon geometric accessibility within different educational systems.

The USA and Spain are also relevant and complementary learning contexts to each other, within which a comparative study might be developed. Both have signed political agreements related to inclusion, and both countries have a learning curriculum that focuses on the care of diversity. However, they are different from each other from a structural and cultural point of view since aspects such as the organization of schools, staff training-where differences in the training of teachers were pointed out by Tatto & Senk (2011)-and the implementation of UDL principles have been or are being developed in different ways. Besides that, the impact of the digital divide on these inclusive practices is one more log that researchers such as Li (2025) began to explore in other contexts.

Furthermore, in the application of these policies, the theory appears not to meet practice. Whereas the legislation of IEPs in the U.S. seems to enforce the guarantee of accessibility, this seems susceptible to charges of over-bureaucratization, as was suggested by Lombardi *et al*. (2015). Whereas the LOMLOE framework in Spain seems effective at outlining broader policy guidelines, these seem not to enforce active measures within the classroom activities, a deficiency also identified by Gee *et al*. (2020). This, as Graham argues, attains a two-way dependency between policy and practice, as described by Graham (2020). Thus, this study seeks to fill this existing knowledge gap by evaluating and exploring different approaches directed at teaching in the geometry category that is made available in the US and Spain.

III. METHODS AND MATERIALS

The research consisted of a total of 24 schools—12 in Spain and 12 in the United States. Schools were obtained through various stratified purposeful sampling with the intention of obtaining diversity in school size and geographic location.

The research was conducted over one year. It was a three-phased protocol in the context that it involved preliminary survey distribution and document collation, classroom observation and semi-structured interviewing, and concluding comparative document analysis and validation interviewing with stakeholders. In phase one, teacher and student participants from the two nations conducted standardized questionnaires meant to provide perceptions and self-reported practices with regards to the application of mathematical games. The 40-item Teacher Adapted Games Survey (TAGS), encompassing Likert-scale, multiple-choice, and open-ended items was specially developed for this study and tested via expert review and pilot testing in non-participating schools in the two countries. Items, were written to assess frequency of game utilization, game types utilized, adaptation level, alignment with learning objectives, perceived student outcomes, and implementation barriers. Student Game Experience Survey (SGES) contained 25 items assessing student engagement, enjoyment, perceived difficulty, and ease of access of math games. Surveys were translated into Spanish by bilingual education researchers and back-translated for linguistic equivalence. All participants were advised of their rights and gave informed consent, and all student participants who were under age 18 had parental consent obtained.

During the second phase, a total of 144 mathematics lessons were observed—six per school—according to a structured observation protocol. Observation was scheduled to represent a variety of instructional formats and mathematics content areas, such as number operations, geometry, data analysis, and problem-solving. An Adapted Game Observation Tool (AGOT) was developed for this study and consisted of a checklist and a narrative field notes section. The observers recorded the type of games used, extent of adaptation, student participation patterns, facilitation strategies used by the teachers, accessibility features, and meeting curriculum standards. The observers were trained researchers with knowledge of inclusive pedagogy and bilingual English and Spanish proficiency. Two observers at each school were used to minimize bias and ensure inter-rater reliability. Nearly 20% of the observations were coded independently by both observers, with an inter-rater agreement of 91%, which was in accordance with the pre-determined requirement for acceptable consistency.

In addition to observation, semi-structured interviews were also conducted with teachers, students, and support staff. All teachers completed a 45–60-minute interview with a protocol addressing their

pedagogical philosophy, game adapting strategies, facilitators and challenges, and opinions towards pupil response. 48 teacher interviews and 24 support educator interviews were completed. Student interviews, 20–30 minutes in length, addressed learning style, enjoyment of playing games, self-reported mathematics ability, and perception of inclusion. Student participants were chosen to represent a range of cognitive and socio-emotional profiles. All interviews were recorded electronically and transcribed verbatim. Spanish interviews were translated by native-speaking research personnel and checked for accuracy.

The third phase was analysis of national and institutional documents related to mathematics instruction and inclusive education. Researchers gathered and examined school-level inclusion policies, curriculum guidelines, lesson plans, teacher training materials, and national policy papers such as the U.S. Individuals with Disabilities Education Act (IDEA) and Spain's LOMLOE and LOMCE reforms. A document analysis form was also created to search for themes on game-based learning, inclusion principles, and budgeting. These data were triangulated to consolidate findings from other sources and place observed practice in more general systemic frameworks.

Quantitative survey data were analyzed using SPSS Version 27. Descriptive statistics were calculated for summarizing frequency and types of adapted game use, perceived effectiveness, and self-reported student outcomes. Inferential statistics included independent samples t-tests to determine whether responses varied between national contexts and multiple regression analyses to identify predictors of inclusive game usage, e.g., teacher training, support from the school, and class size. Missing data were minimal (<2%) and addressed with listwise deletion. All statistical tests were conducted at a significance level of $p < .05$.

Qualitative interview and observation field note data were coded using NVivo software with a grounded theory approach. Axial coding subsequent to initial open coding established relationships between themes. Inductive code development was obtained through weekly peer debriefing of research staff. End-stage thematic categories consisted of game adaptation strategies, inclusion outcomes, implementation barriers, student empowerment, and contextual influences. Member checks were conducted for a sub-sample of participants within each nation to agree interpretations. Observational information was utilized as independent findings, and also to corroborate self-reported practice from interviews and surveys. Data integration using qualitative and quantitative data took place through convergent design, with findings synthesized at interpretation stage and not sequence.

IV. RESULTS AND DISCUSSION

The first of these major findings relates to the nature and scope of mathematics games used. In the USA, a high variation of adapted games was observed across the grades, especially for student groups with disabilities. These varied from board games with rule adaptations, computer math games with adjustable skill levels, kinesthetic games with physical movement and calculations incorporated, to role-play scenarios with embedded mathematical thinking. Approximately 72% of U.S. classrooms observed played mathematics games at least two times a week. For comparison, only 38% of Spanish classrooms played games during their math lessons once a week, and these were unmodified and more frequently used more often as incentives or enrichment activities rather than as primary instructional tools.

American educators would typically create or select games that incorporated Universal Design for Learning principles to offer multiple means of representation, expression, and engagement. Teachers, for instance, would allow the use of manipulatives or visual supports within a game to address diverse cognitive needs. In one of the fifth-grade American classrooms observed, a mathematics card game was adapted to include color-coded symbols for English Language Learners and a tactile feedback device for a visually impaired student. Spanish instructors, while sometimes adapting games to suit classroom constraints or learning goals, were less likely to include explicit adaptations for students with special educational needs. Adaptations were more likely to be limited to simplified instructions or additional time for gameplay, without underlying changes to core mechanics or game goals.

The second general theme—nature and purpose of adaptations—manifested in clear philosophical and practical distinctions. United States adaptations were more student-centered, with the aim of maximizing access, engagement, and proficiency for students with learning disabilities, autism spectrum disorder (ASD), ADHD, and language impairments. Instructors were seen actively adapting game mechanics like time limits, groupings, ruleset complexity, and evaluation criteria. For instance, it was standard practice to provide students with attention issues with the choice of playing abbreviated rounds or being paired with a peer mentor who would be able to assist with rule compliance and concentration.

Changes were generally reactive, enacted to address specific issues that emerged during teaching rather than planned changes. Teachers referred to more frequently those changes as "informal adjustments" rather than research-based practices. Interestingly, in several cases, Spanish changes had more behavioral or classroom management rather than instructional differentiation functions. One Spanish teacher described modifying a multiplication game by adding a reward system merely to more effectively motivate students and reduce classroom disruptions.

In terms of learning gains and engagement, American students at all times registered higher levels of interaction, verbal engagement, and emotional engagement in game-based learning activities. Quantitative survey data showed that 87% of American students with formally documented learning needs reported enjoying math more when games were used, and 62% reported that games helped them to better grasp key concepts. In Spain also, although 75% of the participants also reported pleasure with game-based activities, just 41% of them associated them with improved understanding. The same pattern appeared in classroom observations: games in U.S. classrooms were woven into formative assessment practices and generally concluded in guided reflection or mini-conferences to consolidate learning. On the other hand, in Spanish classes, less regular game time followed metacognitive or academic processing and therefore lowered its instructional potential.

There were also salient disparities in the dimension of autonomy on the part of the students and peer collaboration. The United States students were more likely to have the freedom to decide on one of many game formats or take on a main role, i.e., game facilitator or scorekeeper. Autonomy was also associated with increased motivation and social learning. In Spain, although students enjoyed playing games, they were more teacher-directed with little room for student-initiated adaptations or options. Peer interaction in Spanish classrooms was more likely to be friendly competition than problem-solving cooperation, and that is one possible explanation for the lower levels of academic discussion observed during game playing.

The other critical factor was teacher training and beliefs. US educators felt more competent and able with adapted math games, as 81% had trained specifically on game-based learning and universal instruction. Some referred to professional development workshops, special education coursework, and online communities of practice that provided tools and structures for adaptation success. An elementary school teacher in Texas explained, "Games aren't necessarily fun—they're data-rich environments if you know how to look. I learned how to differentiate game mechanics when I got my special ed certification, and it revolutionized the way I teach."

Confidence for Spanish teachers was less consistent. Only 39% of the teachers reported having learned through formal training game-based learning methods, and 68% reported that they would be more comfortable using games if they had formal manuals or peer mentoring. A Spanish instructor encapsulated the challenge: "We like games, but we don't always know how to make them work for everyone." More often than not, they were given the status of a cameo appearance, as opposed to being a centerpiece of the lesson." Spanish teacher interviews showed broad recognition of games' motivational value, but less agreement about games' instructional role, especially for students with disabilities.

Systemic and cultural forces also played a strong role in mathematics game integration. American school and district policies often actively encouraged instructional innovation, including teaching with games. Most American schools also had innovation teams or inclusion coordinators who encouraged adaptive

game adoption through demonstration lessons or curatorial treatment of curriculum. Lastly, the American emphasis on Individualized Education Programs (IEPs) demanded ongoing consideration of instructional access and often included the selection or creation of adapted math games.

Spanish schools, however, were subject to more centralized curriculum and assessment demands, some teachers described as limiting experimentation with innovative pedagogical methods. Although current Spanish education reforms encourage inclusive orientations, uneven policy-practice implementation persists. Interviews revealed that although school principals were inclined to support inclusive ambitions, significant professional development investment in this regard still remained absent. Furthermore, cultural norms regarding competition and conformity in teaching sometimes clashed with the open and student-centeredness of game-based activities.

These trends were also corroborated by the quantitative component of this study. On a Likert-scale questionnaire of self-reported effectiveness of mathematics games on conceptual understanding development (1 = strongly disagree, 5 = strongly agree), U.S. teachers had a mean of 4.3 (SD = 0.5) in contrast to Spanish teachers with a mean of 3.1 (SD = 0.8). Professional development ($\beta = 0.42$, $p < .01$) and administrative support ($\beta = 0.35$, $p < .05$) were predicted by regression analysis to be predictors of high fidelity implementation of the game.

Pre- and post-unit quiz measures of student performance and rubrics assessing problem-solving within game activities revealed small but statistically significant gains in U.S. students' conceptual understanding and procedural skill exposed to adapted games. Spanish students reported positive affect with no significant performance differences between game and non-game instruction, suggesting instructional framing and adaptation quality to be crucial to generating academic gain.

The critical need for the study is supported by the identified research gap itself, which is the need to subject adapted mathematical games to serious scrutiny, especially in cross-national contexts. Given this important deficiency noted by authors in the field, who pointed out the lack of such comparative analysis-with specific reference to Brinkhuis *et al*., 2020, and Samavati *et al*., 2024-the robust, comparative, mixed-method approach adopted here directly answers that call.

This core quantitative finding-that only American students demonstrate sustained gains in school performance from modified gameplay-is important for the refinement of pedagogical theory. The implication of such an outcome is that while games-very enjoyable in both countries (87% in the US, 75% in Spain)-are not enough in and of themselves, what actually translates engagement into academic gain is the quality of instructional framing and adaptation. This corroborates the literature that warns game-based learning may leave behind certain students with different cognitive, social, or behavioral needs, unless games are purposively modified.

The research on adaptive mechanisms for improvement supports the greater effectiveness observed in US classrooms, where adaptations were formalized and guided by UDL principles. A study confirming that the implementation of adaptive game-based instruction may result in statistically significant changes in mathematical performance, especially in students diagnosed with mathematics learning disorder (Samavati *et al*., 2024), corroborates the finding that modified games can be extremely promising if they are designed to specifications and sufficiently supported. In addition, the usage of in-game formative assessment in the US through formal planning mechanisms like IEPs supports the call for embedding assessment and adaptation in games (Shute *et al*., 2016). The inclusion of visual, touch-based, group, and kinesthetic features in adapted games in the US supports external recommendations that these types of features are better aligned with UDL principles (Andrews & Diego-Mantecón, 2015; Gris *et al*., 2017).

By comparison, the Spanish case, relying more on games for incentive than pedagogy and with ad hoc reactive modifications, had less scaffolding and less measurable academic gain. This is in line with findings that single nation case studies, normally dominating the field and confined to specific settings of treatment

or specific computer games, do not reveal how a systematic lack of support and formal adaptation-as in the case of Spain-restricts the flow of motivation into improved learning outcomes in mathematics (Chu *et al*., 2021; Lindstedt *et al*., 2020).

Indeed, professional development ($\beta = 0.42$, $p < .01$) and administrative support ($\beta = 0.35$, $p < .05$) were strong predictors of high-fidelity implementation, reinforcing the broader literature on systemic influences. The difference in greater confidence and specific training reported by US teachers stands in contrast to the more generic, less systematized training in Spain and underlines how cultural and institutional factors, such as teacher training and curriculum flexibility, importantly influence how math education is implemented across cultures (Radha *et al*., 2016).

This difference in implementation is further framed by cultural attitudes toward differentiation, with American schools preferring individualism and Spanish schools leaning toward group cohesion and standardization. The differences permeate how the mathematical games are "interpreted, translated, and implemented" Radha *et al*. (2016). That finding agrees with the observation that systemic structures shape teacher autonomy and practice, such as the legal mandates in the US through the IDEA, versus the more centralized and textbook-driven curriculum in Spain, an important area for comparative study Ivan *et al*. (2017).

V. CONCLUSIONS

- In the study, the implementation of math game design as adapted inclusive education practices within the educational environments of two national educational systems, the United States and Spain, across the educational levels of elementary schools and middle schools, is compared. On behalf of analyzing teacher practices, structural issues within institutions, cultural views, and educational outcomes within math game design, implementation, and effectiveness to adapt them to pupils having disabilities and/or learning disabilities in math, a comparative analysis of the study follows based on the qualitative and quantitative design of research.

- Essentially, the research reiterated the potential for mathematical games designed with consideration for the specific needs of varied learners. Engaging interest, enjoyment, and interaction were prevalent for the students at the two sites while learning mathematical problem-solving through playing games. How well the games were implemented to realize measurable learning outcomes and equitable learning experiences differed drastically between the two sites and hinged on factors like teacher preparedness and systemic factors. There are several critical implications emanating from the research findings.

- To start with, it has been confirmed that playing mathematics games, per se, lacks potency and inclusiveness; instead, it resides within their design, supplementation, and integration with larger designs of curriculum. The educators in the United States showed preference to modify the rules, content, and formats based on learners with learning disabilities, Autism Spectrum Disorder (ASD), or Attention-Deficit/Hyperactivity Disorder (ADHD). There has been preference to modify based on their Individual Education Plans (IEPS), Universal Design for Learning (UDL), and consultation with special educators, which contributed to specialized learning objectives, better alignment with curriculum benchmarks, and achievement outcomes with respect to targeted mathematics concepts.

- Games were also employed within Spanish lessons, although again, more as motivational tools and fewer as structured learning strategies. The educators did not have the expertise of using games with those of different learning needs, and this is observed through fewer games, fewer scaffolds, and fewer learning accomplishments that were visible. Despite games promoting social inclusion and support among peers within Spanish lessons, results were less predictable with games and learning concepts, and thus, there is the general conclusion that social learning requires effective intentions and expert learning.

- Next, the success factor of teacher training in implementing the software was important here too. Although it was not directly featured in the US context, the training of the teaching staff in the US regarding the use of the software not only enabled them to deliver accommodation in the class but also to implement the use of the software to achieve cognitive learning goals. Notably, the training of the teaching staff in Spanish courses is not as systemic as it is in the US, especially with regard to in-service training in mathematics teaching methods.

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