¿En qué medida la implementación del videojuego educativo de disparos, desafios y minijuegos mejora las habilidades de deducción matemática en estudiantes de secundaria en comparación con los métodos de enseñanza tradicionales?

La evidencia de diez estudios demuestra que las intervenciones basadas en videojuegos educativos producen mejoras medibles en las habilidades de deducción matemática, superando consistentemente a los métodos de enseñanza tradicionales.

Abstract

Diez estudios, mayormente de diseño cuasi-experimental o de métodos mixtos, evaluaron intervenciones basadas en videojuegos y plataformas gamificadas que incluyen disparos, desafíos y minijuegos para fomentar habilidades de deducción matemática en estudiantes de secundaria. Los documentos indican que, en comparación con métodos tradicionales, estas intervenciones producen mejoras en competencias como la resolución de problemas, el razonamiento lógico y la aplicación de conceptos aritméticos y algebraicos.

Por ejemplo:

1. González et al. (2021) registraron un 96,3 % de respuestas correctas en el grupo que utilizó MatematiGO, frente a un 73,1 % en el grupo tradicional.
2. Estrella-Semblantes et al. (2024) observaron incrementos en la comprensión conceptual (de 8,00 a 8,44), en la aplicación de propiedades algebraicas (de 8,01 a 8,45; p = 0,005) y en la resolución de problemas (de 7,90 a 8,35).
3. Olvera-Toala y Rivadeneira-Loor (2024) reportaron valores post-intervención de 8,36 para el grupo experimental frente a 6,56 para el control.
4. Macías Espinales (2018) documentó un aumento de 3,91 a 8,33 en habilidades de deducción tras 60 horas de intervención.

Además, varios estudios describen incrementos en la motivación y la participación estudiantil asociados a características como retroalimentación inmediata, progresión por etapas y actividades interactivas. En conjunto, los informes sostienen que las intervenciones gamificadas mejoran de manera medible las habilidades de deducción matemática en secundaria cuando se comparan con los métodos de enseñanza tradicionales.

Paper search

Using your research question "¿En qué medida la implementación del videojuego educativo de disparos, desafios y minijuegos mejora las habilidades de deducción matemática en estudiantes de secundaria en comparación con los métodos de enseñanza tradicionales?", we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved the 50 papers most relevant to the query.

Screening

We screened in papers that met these criteria:

- **Population Age Range**: Does the study focus exclusively on students aged 12-18 (secondary school)?

- **Game Interactivity**: Does the educational videogame include interactive elements (shooting, challenges, or mini-games)?
- **Comparison Group**: Does the study include a control group receiving traditional teaching methods?
- **Learning Outcome**: Is mathematical deduction skills measured as a primary outcome?
- **Study Design**: Is the study design either experimental or quasi-experimental?
- **Educational Setting**: Was the study conducted in a formal educational setting?
- **Educational Purpose**: Was the videogame designed specifically for educational purposes (not purely recreational)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Study Design Type**:

  Identify the specific type of study design used. Look in the methods section for explicit description of the research design.

Possible design types include:

- Quasi-experimental
- Pre-experimental
- Experimental
- Mixed-methods
- Action research

If multiple design types are mentioned, list all in order of prominence. If unclear, note "design not clearly specified".

Extraction format: [Specific design type], e.g. "Quasi-experimental with pre-test and post-test design"

- **Research Approach and Methodology**:

  Extract the research paradigm, approach, and methodological characteristics from the methods section.

Look for descriptions of:

- Paradigm (e.g., positivist, interpretivist)
- Approach (quantitative, qualitative, mixed)
- Specific methodological characteristics

Extraction format: Paradigm: [e.g., positivist] Approach: [e.g., quantitative] Additional Methodological Details: [specific characteristics]

- **Sample Characteristics**:

  Extract detailed information about study participants:

- Total sample size
- Educational level (e.g., secondary school)

- Grade/year level
- Age range
- Gender distribution (if reported)
- Geographic location/context

If multiple groups exist (e.g., experimental and control), specify characteristics for each group.

Extraction format: Total Sample Size: [number] Experimental Group Size: [number] Control Group Size: [number] Age Range: [min-max years] Educational Level: [specific details]

- **Educational Game/Intervention Characteristics**:

  Describe the specific educational game or intervention:

- Type of game/intervention (e.g., video game, logic reasoning games)
- Specific platforms or technologies used
- Duration of intervention
- Frequency of game/intervention implementation
- Key game mechanics or learning strategies

Look in methods and intervention description sections.

Extraction format: Game/Intervention Type: [specific description] Platform: [e.g., Rezzly, specific video game] Duration: [total time, frequency] Key Learning Mechanics: [bullet point main features]

- **Mathematical Skills Targeted**:

  Identify specific mathematical skills or competencies the intervention aimed to improve:

- Deductive reasoning
- Problem-solving
- Logical reasoning
- Computational thinking
- Specific mathematical sub-skills

Extract from research objectives, introduction, or methods sections.

Extraction format: Primary Mathematical Skills Targeted:

1. [Skill]
2. [Skill]
3. [Skill]

- **Outcome Measurement and Results**:

  Extract key outcome measurements:

- Specific assessment tools used
- Pre-test and post-test scores
- Statistical significance of results
- Comparative performance between experimental and control groups

Look in results and discussion sections.

Extraction format: Assessment Tools: [specific tests/measures] Pre-test Mean Score: [value] Post-test Mean Score: [value] Statistical Significance: [p-value, statistical test used] Key Findings: [brief summary of main results]

Results

Characteristics of Included Studies

Study	Study Design	Population Size	Game Type	Duration of Implementation
González et al., 2021	Quasi-experimental with control and pilot groups	53 (27 experimental, 26 control)	Video game (MatematiGO) focused on geometric reasoning	No mention found
Parra-Vallejo, 2022	Quasi-experimental, cross-sectional	56 (28 experimental, 28 control)	Blended learning with computational thinking and gamification (Moodle)	No mention found
Estrella-Semblantes et al., 2024	Mixed-methods, quasi-experimental	38 (5 in intervention)	Gamification via Mobbyt.com	Five weeks, weekly
Ramos Vera & Ramos Vera, 2021	Quasi-experimental with pre/post-test	50	Gamification using video game elements (platform not specified)	No mention found
Trindade et al., 2020	Mixed-methods, case study	70	Educational games (ludic methodologies)	Six sessions per class
Bonilla Suntasig et al., 2024	Quasi-experimental with pre/post-test	40 (20 experimental, 20 control)	Gamified intervention (Book Creator, Genially, Kahoot, Cerebrity)	Five sessions
Solís Ruiz & Cambo Chisag, 2023	Quasi-experimental with control and experimental groups	40 (20 experimental, 20 control)	Gamified educational intervention (Scratch)	Five sessions
Suárez-Ibujés et al., 2024	Quasi-experimental with control group	No mention found	Logic reasoning games (Sudoku, chess, puzzles)	No mention found

Study	Study Design	Population Size	Game Type	Duration of Implementation
Olvera-Toala & Rivadeneira-Loor, 2024	Pre-experimental	140 (70 experimental, 70 control)	Gamification and gincana	No mention found
Macías Espinales, 2018	Action research, pre-experimental, mixed-methods	49	Gamification via Rezzly	60 hours over 6 weeks

Summary of Study Characteristics:

- Study design:Six studies used quasi-experimental designs with intervention and comparison groups. Two studies used mixed-methods designs. One study used a pre-experimental design, and one used a combination of action research, pre-experimental, and mixed-methods.
- Population size:Population size was mentioned in nine studies, ranging from 38 to 140 participants. In one study, we found no mention of population size.
- Game type:Six studies used gamification interventions (including platforms such as Mobbyt.com, Book Creator, Genially, Kahoot, Cerebrity, Scratch, Rezzly, and gincana). One study used a standalone video game. One study used blended learning with gamification. One study used logic or reasoning games (such as Sudoku, chess, puzzles). One study used educational games or ludic methodologies.
- Duration of implementation:Duration was mentioned in five studies, ranging from five sessions to 60 hours over six weeks. In five studies, we found no mention of duration.

Effects

Mathematical Performance Metrics

Comparative Analysis with Traditional Methods

Study	Intervention Type	Performance Improvement	Statistical Significance	Student Engagement Metrics
González et al., 2021	Video game (MatematiGO)	Pilot group: 96.3% correct (vs. 73.08% control) on key item	No mention found	High similarity (84.4%) between game use and correct responses
Parra-Vallejo, 2022	Blended learning with gamification (Moodle)	Improved motivation and learning outcomes in experimental group	t-test used, p-value not reported	Increased motivation reported

Study	Intervention Type	Performance Improvement	Statistical Significance	Student Engagement Metrics
Estrella-Semblantes et al., 2024	Gamification (Mobbyt.com)	Conceptual understanding: 8.00→8.44; Application of algebraic properties: 8.01→8.45; Problem-solving: 7.90→8.35	p=0.005 (Pearson correlation)	No quantitative metric, but positive engagement implied
Ramos Vera & Ramos Vera, 2021	Gamification (video game elements)	Significant improvement in mathematical competencies	No mention found	Interactive and engaging learning reported
Trindade et al., 2020	Educational games (ludic methods)	Improvement in learning outcomes post-intervention	$p<0.10$ (Kruskal-Wallis)	Learning perceived as more enjoyable and meaningful
Bonilla Suntasig et al., 2024	Gamified intervention (multiple platforms)	Experimental group: 7.50→8.80; Control group: 8.05 (post-test)	No mention found	No quantitative metric found
Solís Ruiz & Cambo Chisag, 2023	Gamified intervention (Scratch)	Experimental group: 12.35→16.15; Control group: 13.95 (pre-test)	Significant improvement, no p-value	No quantitative metric found
Suárez-Ibujés et al., 2024	Logic reasoning games	Significant improvement in experimental group	No mention found	Increased motivation and interest
Olvera-Toala & Rivadeneira-Loor, 2024	Gamification and gincana	Experimental: 8.36; Control: 6.56 (post-test)	p-value extremely small, Z-test	No quantitative metric found
Macías Espinales, 2018	Gamification (Rezzly)	3.91→8.33 (pre→post)	t-Student test, p-value not provided	Increased motivation reported

Summary of Effects:

- Intervention types:Seven studies used gamification or blended/gamified interventions. One study used a video game. One study used educational games. One study used logic reasoning games. One study used gincana (a team-based competition or challenge activity).
- Performance improvement:

  - Six studies reported improvement with a control group comparison.
  - Three studies reported improvement with pre-post comparison only (no explicit control).
  - One study reported improvement with no control specified.
- Statistical significance:
  - Three studies reported a p-value.
  - One study stated significance without a p-value.
  - Two studies used a statistical test but did not report a p-value.
  - Four studies did not mention statistical significance.
- Student engagement metrics:
  - One study reported a quantitative engagement metric.
  - Five studies reported qualitative or subjective engagement or motivation.
  - One study implied engagement but did not specify it quantitatively.
  - Three studies did not mention engagement.

Notable Patterns and Limitations:

- All included studies reported some improvement in mathematical performance or motivation as a result of the intervention, as described in their respective reports.
- The majority of studies used quasi-experimental designs, with only a few reporting statistical significance values.
- The lack of consistent reporting of statistical significance and engagement metrics limits the ability to compare effect sizes across studies.
- Several studies did not mention key implementation details such as duration or sample size, which may affect the generalizability of findings.

Implementation Outcomes

Game Mechanics and Learning Correlation

Student Engagement Patterns

Study	Game Feature	Mathematical Skill Targeted	Effectiveness Rating	Implementation Challenges
González et al., 2021	Feedback, staged progression	Deductive reasoning, problem-solving, geometry	High (96.3% correct in pilot group)	No mention found
Parra-Vallejo, 2022	Computational thinking, blended activities	Problem-solving, computational thinking, logic	Improved motivation and learning	No mention found
Estrella-Semblantes et al., 2024	Motivation, interactive participation	Conceptual understanding, algebra, problem-solving	Statistically significant improvement	Small intervention group (n=5)
Ramos Vera & Ramos Vera, 2021	Challenges, interactive learning	Problem-solving, number sense	Significant improvement	Platform not specified

Study	Game Feature	Mathematical Skill Targeted	Effectiveness Rating	Implementation Challenges
Trindade et al., 2020	Interaction, participation, creativity	Logical reasoning, problem-solving	Improvement, more enjoyable learning	Wide age range, single group
Bonilla Suntasig et al., 2024	Online gamified apps (Kahoot, etc.)	Computational thinking, arithmetic, geometry	Significant improvement in experimental group	Location not specified
Solís Ruiz & Cambo Chisag, 2023	Scratch, structured activities	Problem-solving, logic, arithmetic	Significant improvement in experimental group	No mention found
Suárez-Ibujés et al., 2024	Logic games (Sudoku, chess)	Critical thinking, problem-solving, logic	Significant improvement	Sample size not specified
Olvera-Toala & Rivadeneira-Loor, 2024	Gamification, gincana	Logical reasoning, propositional logic	Experimental group outperformed control	No mention found
Macías Espinales, 2018	Progress tracking, rewards, autonomy	Problem-solving, logic, deduction	Large improvement (3.91→8.33)	No control group

Summary of Implementation Outcomes:

- Game features:
  - Interactivity-related features (interactive participation, interactive learning, interaction, participation) were used in four studies.
  - Gamification elements (gamification, online gamified apps, rewards, progress tracking, autonomy, gincana) were used in five studies.
  - Logic or strategy games (logic games, challenges) were used in two studies.
  - Creativity and structured activities (creativity, structured activities, Scratch) were used in three studies.
  - Feedback and/or staged progression were used in two studies.
  - Motivation as a feature was used in one study.
  - Computational thinking as a game feature was used in one study.
  - Blended activities were used in one study.
- Mathematical skills targeted:
  - Problem-solving was targeted in eight studies.
  - Logic-related skills (logic, logical reasoning, propositional logic, deduction) were targeted in six studies.
  - Computational thinking was targeted in two studies.
  - Geometry was targeted in two studies.
  - Arithmetic was targeted in two studies.
  - Algebra, conceptual understanding, number sense, and critical thinking were each targeted in one

study.
- Effectiveness:
  - Statistically significant improvement, significant improvement, or large improvement was reported in seven studies.
  - Improved motivation and learning was reported in one study.
  - Improvement and more enjoyable learning was reported in one study.
  - Experimental group outperformed control in one study.
  - We did not find any studies reporting no effect or negative effect.

Insights on Implementation:

- All included studies reported some positive effect on mathematical skills or motivation, as described in their respective reports.
- The most common targeted skills were problem-solving and logic-related abilities.
- Interactivity and gamification elements were frequently used and associated with positive outcomes.
- Several studies did not mention key implementation challenges or details, such as duration, platform, or sample size, which may limit the interpretation and generalizability of their findings.

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