Educational Researcher Journal
ISSN: 3064-500x (e)
Year, Vol. 3, No. 2, page 11-17
https://edurj.com/index.php/edurj

OPEN ACCESS

IFP-Based Interactive Tug-of-War Game to Improve Addition and Subtraction Learning Outcomes in Grade I ple Composition Writing Skills Through Interactive Picture Media in Elementary School Students

Ersa Aulia Natasya[1*] 0009-0001-6257-4865
Taufiq Khimas[2] 0000-0001-9781-8076
Khirulnizam Abd Rahman[3] 0009-0008-9958-8743

[1]*Faculty of Teacher Training and Education, Open University, Indonesia*
[2]*Pakauman State Elementary School, West Java, Indonesia*
[3]*Universiti Islam Selangor, Malaysia*

ABSTRACT

This classroom action research (CAR) aimed to improve mathematics learning outcomes in addition and subtraction among Grade I students at SDN Cibilik through an Interactive Flat Panel (IFP)-based tug-of-war game. The initial assessment revealed that 15 of 27 students (55.6%) had not attained the Minimum Mastery Criterion (KKM = 70), with a class average of 67.6. The study applied the Kemmis and McTaggart CAR model across two cycles. Cycle I employed the game for C1–C2 level problems with numbers up to 10, while Cycle II incorporated three systemic improvements: a structured name-card turn-taking mechanism, C3-level problems with numbers up to 20, and mandatory five-minute collaborative review sessions after each game round. Data were collected through end-of-cycle written tests (20 items each) and structured observation sheets. Results showed consistent improvement: the class average increased from 67.6 (pre-cycle) to 74.6 (Cycle I) and 78.9 (Cycle II), while the mastery rate rose from 44.4% to 77.8% and 81.5%—surpassing the 80% success indicator. The IFP-based game effectively engaged students through instant animated feedback, team competition, and concrete visual representations aligned with the concrete operational thinking stage. This research provides evidence that the integration of game-based learning and IFP technology meaningfully advances mathematical achievement in early elementary education.

ARTICLE INFO

Keywords:
addition and subtraction;
classroom action research;
game-based learning;
Interactive Flat Panel;
mathematics learning outcomes

Article History:
Received: 8 June 2026
Revised: 12 June 2026
Accepted: 20 July 2026
Published: 31 July 2026

How to Cite in APA Style:
Ersa Aulia Natasya, Khimas, T., & Abd Rahman, K. (2026). IFP-Based Interactive Tug-of-War Game to Improve Addition and Subtraction Learning Outcomes in Grade I. *Educational Researcher Journal*, *3*(2), 11–17. https://doi.org/10.71288/educationalresearcherjournal.v3i2.152

* Corresponding author: Ersa Aulia Natasya ersaaulianatasya@gmail.com
https://doi.org/10.71288/educationalresearcherjournal.v3i2.152

Introduction

Mathematics plays a fundamental role in the cognitive development of children from an early age. In elementary school, mastery of addition and subtraction forms the essential foundation upon which all subsequent mathematical learning is built (Susanto, 2013). Without a solid grasp of these basic operations, students face accumulating difficulties as they progress to higher grade levels where multiplication, division, and problem-solving all depend on fluency in arithmetic fundamentals.

According to Kurikulum Merdeka (Kemendikbudristek, 2022), students in Phase A are expected to perform addition and subtraction of whole numbers up to 20 and apply these operations in everyday contexts by the end of Grade I. Heruman (2017) argues that learning addition and subtraction should begin with concrete object-grouping concepts, progress to semi-concrete pictorial representations, and only then advance to symbolic notation. Rushing students to the symbolic level without adequate concrete experience frequently results in surface-level procedural knowledge devoid of conceptual depth.

The situation at SDN Cibilik presented a case requiring immediate instructional intervention. Classroom observations in April 2026 showed the teacher relying predominantly on conventional direct instruction—whiteboard explanations, note-taking, and textbook exercises—providing limited opportunities for active student engagement. A diagnostic test administered to all 27 Grade I students revealed a class average of 67.6, with only 12 students (44.4%) achieving the Minimum Mastery Criterion (KKM = 70). The remaining 15 students (55.6%) remained below the mastery threshold.

Grade I students, aged approximately 6–7 years, are at the concrete operational stage of cognitive development (Piaget, as cited in Heruman, 2017). At this stage effective learning depends heavily on direct experiences with concrete and visual representations before children can meaningfully process abstract mathematical symbols. Abstract instruction through direct teaching alone is insufficient to build deep conceptual understanding; strong visual and participatory experiences are required as bridges to formal mathematical thinking (Suwangsih & Tiurlina, 2010).

SDN Cibilik already possessed Interactive Flat Panel (IFP) devices that remained largely underutilised for instructional purposes. IFP is a large-screen touch-display that integrates the functions of a projector, digital whiteboard, and computer in a single unit, making it particularly well-suited for presenting dynamic and interactive content responsive to direct screen touch (Purnama & Wahyudi, 2021). Anggraini (2022) confirmed that IFP use in elementary mathematics classrooms significantly enhanced student engagement and learning outcomes compared to conventional media.

Game-based learning (GBL) has emerged as a highly effective pedagogical approach for early elementary students. Rahmatina (2015) noted that for children aged 6–7 years, play is the primary mode of cognitive development; learning designed as a game not only increases motivation but also activates deeper cognitive processes through emotional involvement, competitive stimulation, and immediate feedback. Prasetyo and Suhartini (2021) demonstrated that educational games in Grade I mathematics significantly improved basic arithmetic performance compared to conventional teaching.

Despite the individual potential of IFP and GBL, no study had investigated their combined application in the form of an interactive tug-of-war game specifically designed for addition and subtraction instruction at SDN Cibilik. This research addresses that gap by designing and implementing an IFP-based tug-of-war game and examining its effectiveness. The research question guiding this study was: Can the application of IFP-based interactive tug-of-war game media improve mathematics learning outcomes in addition and subtraction among Grade I students at SDN Cibilik in the second semester of 2025/2026.

Method

Research Design

This study employed classroom action research (CAR) following the model developed by Kemmis and McTaggart (1988), which structures research into iterative cycles each consisting of four phases: planning, acting, observing, and reflecting. This model was selected for its suitability in addressing instructional problems requiring gradual, reflective improvement. The research was declared successful when at least 80% of students (≥ 22 of 27) achieved a score of ≥ 70 on the end-of-cycle test.

Participants

Participants comprised all 27 Grade I students at SDN Cibilik in the second semester of the 2025/2026 academic year, including 11 male and 16 female students. The class was selected based on diagnostic assessment data indicating persistently low mathematics achievement on the addition and subtraction topic. Research was conducted from April to May 2026.

Data Collection

Two instruments were employed. First, written tests of 20 items covering addition and subtraction of whole numbers up to 20 were administered at the end of each cycle to assess learning outcomes against the KKM of 70. Items were designed to correspond to revised Bloom's taxonomy levels C1–C3 aligned with each cycle's learning objectives. Second, structured observation sheets were used to evaluate six dimensions of student activity during game-based learning: active participation, enthusiasm and motivation, accuracy of responses, team cooperation, willingness to approach the IFP, and conceptual understanding. Each dimension was rated on a four-point scale (1 = Poor; 4 = Excellent).

Research Procedure

Pre-Cycle. Classroom observation and a diagnostic test were conducted in the fourth week of April 2026 to establish baseline data. Results confirmed the need for instructional intervention.

Cycle I. Implemented in the first week of May 2026 across two sessions (each 2 × 35 minutes). The IFP-based tug-of-war game was applied with C1–C2 level problems for addition and subtraction with numbers 1–10. The class was divided into two evenly balanced teams. Students took turns approaching the IFP to input answers via the on-screen numeric keypad; correct answers triggered an animation of the character pulling the rope toward their team. Reflection on Cycle I identified unequal turn distribution and insufficient problem variety as areas requiring improvement.

Cycle II. Implemented in the fourth week of May 2026 with three key modifications: (1) a structured turn-taking system using name cards drawn randomly to ensure all 27 students received at least two turns per session; (2) problems expanded to C3 level with numbers up to 20 in varied formats; and (3) mandatory five-minute collaborative review sessions added after each game round.

Data Analysis

Data were analysed using descriptive statistics. Learning outcome data were analysed by computing the class mean score and the mastery rate (percentage of students meeting KKM) for each phase. Observation data were analysed by computing average scores per dimension. Progress across pre-cycle, Cycle I, and Cycle II was tracked to determine the trajectory of improvement.

Results

Pre-Cycle Baseline

The initial diagnostic test yielded a class average of 67.6, with only 12 students (44.4%) achieving the KKM of 70. Scores ranged from 55 to 80. Classroom observations confirmed that conventional instruction failed to actively engage students; many displayed inattentiveness and were unable to independently complete addition and subtraction tasks.

Cycle I Results

Following two sessions of IFP-based tug-of-war game learning, the class average improved significantly to 74.6. A total of 21 students (77.8%) achieved the KKM, compared to 12 students (44.4%) in the pre-cycle phase. Six students remained below the KKM threshold. Table 1 summarises the comparison.

Table 1. Learning Outcomes Comparison: Pre-Cycle and Cycle I

Aspect	Pre-Cycle	Cycle I
Class Average	67.6	74.6
Highest Score	80	85
Lowest Score	55	65
Students Passing (≥70)	12 (44.4%)	21 (77.8%)
Students Not Passing	15 (55.6%)	6 (22.2%)
Success Indicator (≥80%)	Not Achieved	Not Achieved

Note: Minimum passed score= 70.

Observation data showed an average activity score of 2.5 (Good). Students demonstrated high enthusiasm and active participation; however, dominant students tended to monopolise turns, limiting practice opportunities for shyer peers. Problem difficulty variation was also identified as insufficient for higher-performing students.

Cycle II Results

The three systematic improvements introduced in Cycle II produced further measurable gains. The class average rose to 78.9, and 22 students (81.5%) achieved the

KKM—surpassing the 80% success indicator. Observation scores averaged 3.7 (Excellent), reflecting full participation of all 27 students. Table 2 presents the comparison between Cycle I and Cycle II.

Table 2. Learning Outcomes Comparison: Cycle I and Cycle II

Aspect	Cycle I	Cycle II
Class Average	74.6	78.9
Highest Score	85	90
Lowest Score	65	65
Students Passing (≥70)	21 (77.8%)	22 (81.5%)
Students Not Passing	6 (22.2%)	5 (18.5%)
Success Indicator (≥80%)	Not Achieved	Achieved ✓

Note: Minimum passed score= 70.

Five students—Fadlan Arkhan Faturahman, Khanaya Selia Putri, Muhamad Raffa Ziyan Ramdani, Nazwa Ayunda, and Saira Hanum Rafifa—each scored 65 and remained below the KKM at the conclusion of Cycle II. All five had the lowest pre-cycle scores (55–60), indicating that their initial competency gap required extended intervention beyond two CAR cycles. Table 3 presents the overall trajectory of improvement.

Table 3. Recapitulation of Results Across All Phases

Aspect	Pre-Cycle	Cycle I	Cycle II
Class Average	67.6	74.6	78.9
Mastery Rate	44.4%	77.8%	81.5%
Success Indicator (≥80%)	Not Achieved	Not Achieved	Achieved ✓

Discussion

The consistent improvement in learning outcomes across the three measurement phases confirms the effectiveness of the IFP-based tug-of-war game in Grade I addition and subtraction instruction. Several interconnected mechanisms account for these results.

First, the IFP game provided concrete visual representations of arithmetic problems that aligned with the cognitive developmental level of Grade I students. According to Piaget's theory of concrete operational thinking (as cited in Heruman, 2017), children aged 6–7 learn most effectively through direct interaction with concrete and visual materials. The large-screen IFP display presented problems such as "8 + 5 = ?" with clear visual clarity, supported by animated characters and immediate visual feedback, bridging the gap between concrete understanding and symbolic mathematical representation more effectively than whiteboard-based instruction.

Second, the team competition mechanism inherent in the tug-of-war game design proved highly effective in motivating sustained engagement. The animated feedback—correctly answered questions caused the game character to pull the rope toward the winning team—provided immediate reinforcement linking correct arithmetic responses to tangible and visually rewarding outcomes. This finding aligns with Rahmatina's (2015) research demonstrating that educational games with competitive elements consistently

improve intrinsic learning motivation among lower primary school students, and with Mayer's (2019) observation that GBL creates optimal learning conditions through intrinsic motivation generated by game mechanics.

Third, the structured name-card turn-taking system introduced in Cycle II was directly responsible for a significant portion of the improvement between cycles. In Cycle I, dominant students tended to monopolise response opportunities, resulting in uneven practice distribution. The structured system guaranteed that all 27 students participated at minimum twice per session, ensuring sufficient individual practice volume across the entire class. This supports Prasetyo and Suhartini's (2021) finding that equitable participation structures in game-based contexts are essential for broad achievement gains rather than improvement concentrated among already high-performing students.

Fourth, the mandatory collaborative review sessions added in Cycle II functioned as effective collective error-correction mechanisms. By revisiting frequently missed problems immediately after each game round in a non-threatening game context, misconceptions were identified and addressed promptly. The relaxed atmosphere of game-based correction increased student receptivity to feedback and contributed to consolidating conceptual understanding (Sudjana & Rivai, 2013).

The five students who remained below the KKM at the end of Cycle II warrant particular attention. Their pre-cycle scores (55–60) represented the lowest initial competency in the class, suggesting that while they made measurable progress, the achievement gap was too large to close within two CAR cycles of game-based instruction alone. Observation notes further indicated these students showed difficulty processing simultaneous verbal and visual stimuli, possibly indicating specific learning needs requiring individualised intervention. A targeted remedial programme using physical manipulatives before reintroducing IFP-based digital representations is recommended for these students.

The findings of this study align with and extend earlier research. Anggraini (2022) confirmed IFP's effectiveness in improving engagement and outcomes in elementary mathematics. Widyastuti and Pujiastuti (2014) demonstrated that game-based learning significantly improved mathematics interest and achievement in Grade I. Prasetyo and Suhartini (2021) showed that educational games improved basic arithmetic performance in lower primary school. The current study adds to this literature by demonstrating that the synergistic combination of IFP technology and a purpose-designed tug-of-war game format produces learning gains that are both statistically meaningful and practically significant.

Conclusion

This classroom action research demonstrated that the application of an IFP-based interactive tug-of-war game effectively improved mathematics learning outcomes in addition and subtraction among Grade I students at SDN Cibilik. The class average increased from 67.6 (pre-cycle) to 74.6 (Cycle I) and 78.9 (Cycle II), while the mastery rate rose from 44.4% to 77.8% and 81.5%—surpassing the predetermined 80% success indicator. These improvements were driven by the visual concreteness of IFP-displayed problems, the motivating effect of team competition and instant animated feedback, structured equitable participation, and systematic collaborative review.

Practically, this study recommends that Grade I teachers implement structured game-based learning using IFP with a guaranteed turn-taking mechanism to ensure all students benefit equally. School principals are encouraged to provide technical and pedagogical training for IFP utilisation to maximise the technology already available in classrooms. Future research may

extend this intervention to other mathematical topics such as multiplication, measurement, and geometry; investigate its effects on affective outcomes including mathematics anxiety and self-efficacy; or examine its scalability across different Grade I settings.

References

Abdurrahman, M. (2012). Anak berkesulitan belajar: Teori, diagnosis, dan remediasinya. PT Rineka Cipta.

Anggraini, D. (2022). Efektivitas penggunaan Interactive Flat Panel dalam meningkatkan hasil belajar matematika siswa sekolah dasar. Jurnal Pendidikan Dasar Nusantara, 8(1), 45–58. https://ojs.unpkediri.ac.id/index.php/pgsd

Arikunto, S. (2015). Dasar-dasar evaluasi pendidikan (2nd ed.). PT Bumi Aksara.

Arikunto, S., Suhardjono, & Supardi. (2015). Penelitian tindakan kelas (Rev. ed.). PT Bumi Aksara.

Arsyad, A. (2017). Media pembelajaran (20th ed.). PT Raja Grafindo Persada.

Dimyati, & Mudjiono. (2013). Belajar dan pembelajaran (5th ed.). PT Rineka Cipta.

Hamalik, O. (2014). Kurikulum dan pembelajaran (14th ed.). PT Bumi Aksara.

Heruman. (2017). Model pembelajaran matematika di sekolah dasar (3rd ed.). PT Remaja Rosdakarya.

Kemendikbudristek. (2022). Capaian pembelajaran Fase A mata pelajaran matematika Kurikulum Merdeka. Kemendikbudristek. https://kurikulum.kemendikdasmen.go.id

Kemmis, S., & McTaggart, R. (1988). The action research planner (3rd ed.). Deakin University Press.

Mayer, R. E. (2019). Belajar dengan memori kerja terbatas. In R. E. Mayer & L. Fiorella (Eds.), Pembelajaran yang dapat diatur secara mandiri (pp. 204–221). Cambridge University Press.

Mulyono, A. (2010). Pendidikan bagi anak berkesulitan belajar (2nd ed.). PT Rineka Cipta.

Prasetyo, A., & Suhartini, T. (2021). Penerapan game edukasi matematika untuk meningkatkan hasil belajar operasi hitung siswa kelas I sekolah dasar. Jurnal Riset Pendidikan Dasar, 4(2), 112–124. https://journal.unismuh.ac.id/index.php/jrpd

Purnama, I. L., & Wahyudi, T. (2021). Optimalisasi pemanfaatan Interactive Flat Panel sebagai media pembelajaran inovatif di era digital. Jurnal Teknologi Pendidikan, 23(2), 89–102. http://jtp.ppj.unp.ac.id

Purwanto, M. N. (2016). Prinsip-prinsip dan teknik evaluasi pengajaran (20th ed.). PT Remaja Rosdakarya.

Rahmatina, D. H. (2015). Penggunaan permainan matematika dalam pembelajaran matematika untuk meningkatkan motivasi dan hasil belajar siswa. Jurnal Peluang, 3(2), 54–63. https://jurnal.usk.ac.id/peluang

Rusman. (2017). Belajar dan pembelajaran berorientasi standar proses pendidikan. Kencana.

Sadiman, A. S., Rahardjo, R., Haryono, A., & Rahardjito. (2014). Media pendidikan: Pengertian, pengembangan, dan pemanfaatannya (17th ed.). PT Raja Grafindo Persada.

Sudjana, N. (2016). Penilaian hasil proses belajar mengajar (21st ed.). PT Remaja Rosdakarya.

Sudjana, N., & Rivai, A. (2013). Media pengajaran (11th ed.). Sinar Baru Algensindo.

Susanto, A. (2013). Teori belajar dan pembelajaran di sekolah dasar. Kencana.

Suwangsih, E., & Tiurlina. (2010). Model pembelajaran matematika (Rev. ed.). UPI Press.

Widyastuti, E., & Pujiastuti, P. (2014). Pengaruh pembelajaran berbasis permainan terhadap minat dan prestasi belajar matematika siswa kelas I sekolah dasar. Jurnal Prima Edukasia, 2(2), 185–193. https://journal.uny.ac.id/index.php/jpe