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THE EFFECTIVENESS OF LEARNING THROUGH PLAY IN GRADE 2 MATHEMATICS IN VIETNAM: EVIDENCE FROM A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

This study examined the effectiveness of learning through play in Grade 2 mathematics within the context of Vietnam's 2018 General Education Curriculum. Although learning through play is considered developmentally appropriate for young learners, empirical evidence regarding its effectiveness in Vietnamese primary mathematics classrooms remains limited. The study employed a quasi-experimental pre-test–post-test control-group design involving 132 Grade 2 students from two public primary schools in Bac Ninh Province, Vietnam. The experimental group consisted of 65 students who participated in structured learning-through-play activities, whereas the control group comprised 67 students who received the usual mathematics instruction. Data were collected through pre-tests, post-tests, classroom observations, and students' learning products. The pre-test results showed that the two groups had comparable initial mathematics achievement. Following the intervention, the experimental group achieved a post-test mean score of 8.08, compared with 6.93 for the control group. The experimental group also demonstrated a substantially greater mean gain from pre-test to post-test. Classroom observations indicated that students participating in the learning-through-play activities displayed active engagement, collaboration, and persistence when completing mathematical tasks. These findings provide preliminary empirical support for the use of structured learning-through-play activities in Grade 2 mathematics and offer practical implications for competency-oriented primary mathematics teaching in Vietnam.

KEYWORDS: learning through play; Grade 2 mathematics; primary education; mathematics learning outcomes; quasi-experimental study.

1. INTRODUCTION

Competency-based education has become a major direction in contemporary curriculum reform, shifting attention from the transmission of subject knowledge to learners' ability to mobilize knowledge, skills, attitudes, and personal resources in meaningful situations. In mathematics education, this orientation requires students not only to perform procedures accurately but also to

reason, communicate, solve problems, and apply mathematical knowledge in practical contexts (National Council of Teachers of Mathematics [NCTM], 2014; Organisation for Economic Co-operation and Development [OECD], 2019). Accordingly, mathematics classrooms need to provide learning experiences that encourage active participation, exploration, interaction, and reflection rather than relying primarily on teacher explanation and repetitive practice.

Vietnam's 2018 General Education Curriculum reflects this international orientation by identifying the development of students' qualities and competencies as a central educational goal. In primary mathematics, the curriculum emphasizes five components of mathematical competence: mathematical thinking and reasoning, mathematical modelling, mathematical problem solving, mathematical communication, and the use of mathematical tools and means (Ministry of Education and Training [MOET], 2018). These expectations require teachers to design learning activities in which students actively construct mathematical understanding, test ideas, explain solutions, and connect mathematical knowledge with everyday experiences.

Grade 2 is an important stage in primary mathematics education. At this level, students consolidate foundational knowledge of numbers and operations while developing initial understandings of geometry, measurement, statistics, and probability. However, their learning continues to depend strongly on concrete experiences, visual representations, manipulation of objects, emotional engagement, and interaction with peers and teachers. Instructional approaches that are developmentally appropriate and combine mathematical content with meaningful activity are therefore particularly important for sustaining students' attention, motivation, and understanding.

Learning through play has increasingly been recognized as a promising pedagogical approach for young learners. It is not limited to the use of games for entertainment or lesson reinforcement; rather, it refers to learning experiences that combine clear educational purposes with playful characteristics such as enjoyment, meaningfulness, active engagement, iteration, and social interaction (Parker et al., 2022; Zosh et al., 2017). Through well-designed play-based activities, students can explore materials, test strategies, make decisions, exchange ideas, and revise their actions in a supportive learning environment. These processes are consistent with the developmental characteristics of primary students and with the principles of competency-oriented teaching.

In mathematics education, learning through play can transform abstract, repetitive, or procedurally demanding tasks into interactive learning experiences. Activities involving number cards, manipulatives, visual models, role-play, movement, and group challenges can support students in practising calculation, comparing quantities, recognizing geometric forms, measuring objects, and interpreting simple data. When such activities are closely aligned with lesson objectives, they can strengthen conceptual understanding and procedural fluency while also promoting mathematical communication, cooperation, and problem solving (Fisher et al., 2013; Pyle et al., 2017).

Despite these potential benefits, the implementation of learning through play in primary mathematics classrooms remains uneven. Play-based activities are often used mainly to create initial interest or reinforce knowledge at the end of a lesson rather than as a structured pedagogical approach for knowledge construction and competency development. Teachers may also face difficulties in selecting appropriate mathematical content, designing tasks that preserve both playfulness and academic purpose, managing classroom interaction, and assessing students' learning processes. In the Vietnamese context, empirical evidence concerning the effectiveness of learning through play in Grade 2 mathematics remains limited, particularly classroom-based studies comparing learning outcomes between experimental and control groups.

To address this gap, the present study employed a quasi-experimental pre-test–post-test control-group design to examine the effectiveness of learning through play in Grade 2 mathematics in Vietnam. It compared students' mathematics learning outcomes before and after the intervention and examined differences between an experimental group receiving structured learning-through-play activities and a control group receiving the usual mathematics instruction. The study aimed to provide empirical evidence concerning whether structured learning-through-play activities could improve Grade 2 students' mathematics learning outcomes and whether this approach was feasible for implementation in Vietnamese primary classrooms.

Accordingly, the study addressed the following research questions:

1. Does learning through play improve Grade 2 students' mathematics learning outcomes?
2. Are the post-test mathematics learning outcomes of the experimental group higher than those of the control group?
3. How do Grade 2 students engage in structured learning-through-play activities during mathematics lessons?

2. LITERATURE REVIEW

2.1. Concept of Learning Through Play

Learning through play is an educational approach in which playful experiences are intentionally connected with clearly defined learning objectives. It does not treat play as an activity separate from formal learning; instead, play serves as a meaningful context through which learners explore ideas, interact with others, solve problems, and construct knowledge (Parker et al., 2022; Zosh et al., 2017). From this perspective, learning is not merely an incidental consequence of play but an outcome supported by the purposeful design of tasks, materials, interactions, and teacher guidance.

The concept encompasses a continuum of play-based experiences, ranging from child-directed free play to guided play and more structured playful activities. Free play is largely initiated and controlled by children, whereas guided play combines children's agency with explicit educational purposes and flexible adult support. In guided play, teachers establish the learning environment, select appropriate

materials, pose questions, and provide prompts while allowing students to make choices, test strategies, and develop solutions. This balance between learner autonomy and pedagogical guidance distinguishes learning through play from both unrestricted recreation and highly teacher-directed instruction (Pyle et al., 2017; Weisberg et al., 2016).

Learning through play should also be distinguished from the occasional use of classroom games. A classroom game may be introduced mainly to create interest, provide relaxation, or reinforce previously taught content. By contrast, learning through play represents a broader pedagogical orientation in which playful experiences are deliberately designed to support knowledge construction and competency development. Its educational value therefore depends not simply on whether an activity is enjoyable, but on whether students are required to engage meaningfully with the intended learning content.

In this study, learning through play is understood as an intentional pedagogical approach in which Grade 2 mathematics activities combine clearly specified learning outcomes with playful tasks that encourage students to explore, manipulate materials, communicate, cooperate, test strategies, and reflect on their solutions. The teacher acts as a designer and facilitator who maintains the mathematical focus of the activity while preserving students' active participation and opportunities for choice.

2.2. Characteristics of Learning Through Play

Learning through play is characterized by a set of interrelated features that distinguish it from both conventional teacher-centred instruction and recreational play without explicit educational purposes. Rather than focusing solely on enjoyment, this approach integrates playful experiences with intentional learning outcomes and enables students to construct knowledge through exploration, interaction, experimentation, and reflection (Zosh et al., 2017). Five characteristics are particularly important: joyful engagement, meaningfulness, active engagement, iteration, and social interaction.

The first characteristic is joyful engagement. Enjoyment creates a positive emotional environment that can stimulate curiosity, sustain attention, and increase students' willingness to participate in challenging tasks. When learners experience interest and enjoyment, they are more likely to persist, explore alternative strategies, and remain engaged in the learning process. However, enjoyment alone does not constitute learning through play; playful activities must remain connected to clearly defined educational purposes.

The second characteristic is meaningfulness. Learning is meaningful when students can connect new ideas with their prior knowledge, personal experiences, and familiar situations. Meaningful contexts help learners understand the relevance of mathematical concepts and support deeper conceptual development. For Grade 2 students, this means that playful tasks should be grounded in age-appropriate situations and should enable students to recognize relationships between mathematical content and everyday experience.

The third characteristic is active engagement. Students are expected to manipulate materials, make decisions, test ideas, communicate their reasoning, and construct understanding rather than passively receive information. In mathematics lessons, active engagement may involve calculating, comparing, arranging shapes, explaining solutions, checking answers, and revising strategies. Through such participation, students experience mathematical ideas directly and develop greater ownership of their learning.

The fourth characteristic is iteration. Learning through play provides opportunities for students to try different approaches, make mistakes, receive feedback, and adjust their actions. This repeated cycle of trial, reflection, and revision supports the refinement of mathematical thinking and encourages persistence when initial solutions are unsuccessful. Iteration therefore contributes to both conceptual development and self-regulated learning.

The fifth characteristic is social interaction. Playful activities naturally create opportunities for students to communicate, cooperate, negotiate, and make shared decisions. Through interaction with peers and teachers, students explain mathematical ideas, compare strategies, justify their reasoning, and learn from different perspectives. These processes support not only mathematical understanding but also communication and collaboration competencies.

The five characteristics should not be viewed as separate or independent components. Their educational value emerges from their integration within well-designed learning activities. Effective learning through play therefore requires teachers to balance enjoyment with academic purpose, learner autonomy with guidance, and exploration with reflection. In Grade 2 mathematics, this balance is essential to ensure that playful engagement contributes directly to intended mathematical learning outcomes.

2.3. Learning Through Play in Primary Education

Primary education is a critical stage in children's cognitive, social, emotional, and physical development. During this period, students develop foundational knowledge, learning habits, communication skills, and problem-solving abilities that influence their subsequent educational experiences. Because primary school students often learn effectively through direct experience, interaction, exploration, and meaningful engagement, instructional approaches should be responsive to their developmental characteristics rather than relying predominantly on teacher-centred explanation and repetitive practice.

Learning through play is regarded as a developmentally appropriate pedagogical approach in primary education because it creates opportunities for curiosity, exploration, collaboration, and active participation. Instead of positioning students as passive recipients of knowledge, learning-through-play activities allow them to investigate questions, manipulate learning materials, exchange ideas, test strategies, and construct understanding through meaningful experiences. These processes are consistent with constructivist perspectives, which emphasize that knowledge is actively developed through learners' interaction with the physical and social environment (Piaget, 1972; Vygotsky, 1978).

Previous research has suggested that learning through play can support multiple dimensions of children's development. Cognitively, playful learning experiences may contribute to conceptual understanding, creativity, problem solving, and flexible thinking. Socially, they can create opportunities for communication, cooperation, negotiation, and shared decision-making. Emotionally, learning through play may strengthen students' confidence, intrinsic motivation, persistence, and willingness to participate in challenging tasks. These outcomes indicate that learning through play can support both academic learning and broader developmental goals in primary education (Parker et al., 2022; Zosh et al., 2017).

The educational value of learning through play, however, depends substantially on the quality of instructional design and implementation. Effective learning-through-play activities require clearly specified learning objectives, age-appropriate tasks, suitable materials, productive interaction, and opportunities for reflection and feedback. Teachers therefore assume multiple roles as instructional designers, facilitators, observers, and assessors throughout the learning process. Rather than reducing teacher involvement, learning through play requires teachers to balance students' agency and exploration with purposeful pedagogical guidance (Pyle et al., 2017).

Learning through play is also consistent with contemporary competency-oriented education because it emphasizes not only what students know but also how they use knowledge, communicate ideas, collaborate with others, and respond to unfamiliar situations. In primary classrooms, this approach can create conditions for students to develop subject knowledge together with communication, cooperation, problem-solving, and self-regulation skills. For this reason, learning through play has increasingly been considered a relevant pedagogical orientation for promoting active, learner-centred, and competency-based education.

2.4. Learning Through Play in Grade 2 Mathematics Instruction

2.4.1. Roles and Educational Significance

Grade 2 is an important stage in primary mathematics education because students consolidate fundamental knowledge of numbers and operations while beginning to develop mathematical reasoning, communication, and problem-solving abilities. Vietnam's 2018 General Education Mathematics Curriculum emphasizes not only procedural proficiency but also mathematical thinking and reasoning, mathematical modelling, mathematical problem solving, mathematical communication, and the use of mathematical tools and means (Ministry of Education and Training [MOET], 2018). Achieving these expectations requires instructional approaches that enable students to engage actively with mathematical ideas through meaningful experiences.

Learning through play is particularly suitable for Grade 2 mathematics because it aligns with young learners' reliance on concrete materials, visual representations, movement, and social interaction. Through playful mathematical tasks, students can manipulate objects, explore numerical and geometric relationships, test strategies, compare solutions, and explain their thinking. Such experiences support

the gradual transition from concrete action to visual representation and symbolic understanding, which is essential in early mathematics learning (Bruner, 1966; Clements & Sarama, 2014).

The educational significance of learning through play extends beyond increasing students' enjoyment. Well-designed activities can support conceptual understanding by allowing students to discover mathematical relationships through exploration rather than memorization. They can also strengthen mathematical communication because students are encouraged to describe procedures, justify answers, compare strategies, and respond to peers' ideas. These processes contribute to the development of reasoning, communication, and collaborative problem solving, which are central to contemporary mathematics education (National Council of Teachers of Mathematics [NCTM], 2014).

Learning through play can also contribute to positive attitudes towards mathematics. Playful but purposeful challenges may help sustain attention, reduce anxiety, strengthen confidence, and encourage persistence when students encounter difficulties. These affective conditions are important because students' willingness to participate and continue working on mathematical tasks can influence both their immediate performance and their longer-term engagement with mathematics.

However, learning through play should not be understood simply as the inclusion of games in mathematics lessons. Its effectiveness depends on the alignment between playful activity and intended mathematical learning outcomes. Each activity should require students to use mathematical knowledge, procedures, reasoning, or communication to complete the task. Therefore, the teacher's role involves not only organizing activities but also designing coherent mathematical experiences, guiding interaction, observing students' thinking, providing feedback, and consolidating formal knowledge.

2.4.2. Procedure for Implementing Learning Through Play in Grade 2 Mathematics

The implementation of learning through play in Grade 2 mathematics requires a systematic but flexible instructional process that aligns playful activity with curriculum objectives, students' developmental characteristics, and expected mathematical competencies. In this study, the process is organized into four stages.

The first stage is identifying intended learning outcomes. The teacher determines the mathematical knowledge, skills, and competencies that students are expected to achieve in accordance with curriculum requirements. Clearly specified outcomes provide the basis for selecting or designing appropriate learning-through-play activities and assessment criteria.

The second stage is analysing the mathematical content and designing playful tasks. The teacher examines the target concepts and identifies opportunities for students to engage with them through exploration, manipulation, communication, or problem solving. Materials, rules, classroom organization, and task requirements are then designed to ensure that the activity remains both playful and mathematically purposeful.

The third stage is organizing learning-through-play activities. Students participate individually, in pairs, or in small groups to complete mathematical tasks embedded in playful situations. During this stage, the teacher facilitates learning by explaining the task, posing guiding questions, encouraging discussion, observing students' strategies, and providing support when necessary while preserving students' opportunities for choice and exploration.

The fourth stage is reflection, assessment, and knowledge consolidation. After completing the activity, students explain their strategies, compare solutions, evaluate their results, and reflect on what they have learned. The teacher provides feedback, addresses misconceptions, summarizes key mathematical ideas, and connects students' playful experiences with formal mathematical knowledge.

These four stages should not be treated as rigid or isolated steps. Depending on the lesson, the teacher may move flexibly between them and provide additional guidance when students encounter difficulties. The central requirement is to maintain an appropriate balance between playful engagement and mathematical rigour so that the activity functions as a meaningful means of achieving intended learning outcomes.

2.5. Research Gap

Over the past decade, research has increasingly highlighted the educational value of learning through play across different learning contexts. Previous studies have suggested that play-based learning can support children's motivation, engagement, conceptual understanding, communication, collaboration, and problem-solving abilities (Parker et al., 2022; Pyle et al., 2017; Zosh et al., 2017). In mathematics education, research has also emphasized the importance of guided exploration, concrete manipulation, and meaningful learning experiences in supporting young learners' mathematical development (Clements & Sarama, 2014; Fisher et al., 2013).

Despite these contributions, several gaps remain. First, much of the existing literature has focused on early childhood education or primary education in general, whereas relatively few studies have examined learning through play specifically in Grade 2 mathematics. Consequently, evidence concerning the application of this approach to a particular grade level and subject area remains limited.

Second, many previous studies have concentrated on students' engagement, motivation, or teachers' perceptions of play-based learning. Comparatively fewer studies have used classroom-based quasi-experimental designs to compare mathematics learning outcomes between students participating in structured learning-through-play activities and those receiving the usual teaching approach. Therefore, additional evidence is needed regarding the extent to which learning through play is associated with measurable improvements in Grade 2 mathematics learning outcomes.

Third, although competency-oriented education has become a central direction of curriculum reform in Vietnam, empirical research on learning through play in Vietnamese primary mathematics classrooms remains limited. Existing studies and professional discussions have often emphasized

theoretical perspectives, instructional recommendations, or descriptive classroom practices rather than classroom-based comparative evidence under regular teaching conditions.

These gaps indicate a need for research examining whether systematically designed learning-through-play activities can improve Grade 2 students' mathematics learning outcomes while remaining feasible for implementation in ordinary primary classrooms. It is also important to examine how students participate and interact during such activities, because classroom engagement may help explain how learning-through-play experiences support mathematical learning.

Accordingly, the present study employed a quasi-experimental pre-test–post-test control-group design to examine the effectiveness of learning through play in Grade 2 mathematics in Vietnam. The study compared students' mathematics learning outcomes before and after the intervention, examined post-test differences between the experimental and control groups, and described students' engagement during the learning-through-play activities. In doing so, the study aimed to contribute classroom-based evidence and practical guidance for competency-oriented primary mathematics teaching.

3. METHODS

3.1. Research Design

The study employed a quasi-experimental pre-test–post-test control-group design to examine the effectiveness of learning through play in Grade 2 mathematics. Intact Grade 2 classes were used, and individual students were not randomly assigned to the experimental and control conditions.

Both groups completed a pre-test before the intervention and a post-test after the intervention. The experimental group participated in structured learning-through-play activities, whereas the control group studied the same mathematical content through the usual teaching approach. The intended learning outcomes, mathematical content, instructional duration, and assessment procedures were kept consistent across the two groups. The instructional approach was the principal difference between the experimental and control conditions.

The pre-test results were used to examine the initial comparability of the two groups. The post-test results and changes from pre-test to post-test were then compared to identify observed differences in students' mathematics learning outcomes following the intervention. This design was appropriate for examining the effectiveness of the instructional approach under regular classroom conditions, where random assignment of individual students was not feasible.

3.2. Participants and Research Context

The study involved 132 Grade 2 students from two public primary schools in Bac Ninh Province, Vietnam. The experimental group consisted of 65 students, whereas the control group consisted of 67 students. Intact classes were selected to preserve the normal organization of teaching and learning in the participating schools.

All students followed Vietnam's 2018 General Education Mathematics Curriculum. During the intervention, the two groups studied the same Grade 2 mathematical content and were expected to achieve the same intended learning outcomes. The instructional duration, assessment requirements, and testing conditions were also maintained consistently across the two groups. The principal difference was the instructional approach: the experimental group participated in structured learning-through-play activities, whereas the control group received the usual mathematics instruction.

Before the intervention, both groups completed the same pre-test to assess their initial mathematics learning outcomes. After the intervention, they completed the same post-test under equivalent administration and scoring conditions. The pre-test results were subsequently used to examine the initial comparability of the two groups.

The distribution of participants and the principal instructional conditions are presented in Table 1.

Table 1. Participant Distribution and Instructional Conditions

Characteristic	Experimental group	Control group	Total
Number of students	65	67	132
Grade level	Grade 2	Grade 2	—
School type	Public primary school	Public primary school	—
Mathematics curriculum	2018 General Education Mathematics Curriculum	2018 General Education Mathematics Curriculum	—
Mathematical content	The same Grade 2 content	The same Grade 2 content	—
Instructional duration	Equivalent	Equivalent	—
Assessment	The same pre-test and post-test	The same pre-test and post-test	—
Teaching approach	Learning through play	Usual teaching approach	—

Note. The intended learning outcomes, mathematical content, instructional duration, assessment requirements, and testing conditions were maintained consistently across the two groups. The instructional approach was the principal difference between the experimental and control conditions.

3.3. Experimental Instruction

The instructional intervention was implemented under regular classroom conditions. Both groups studied the same Grade 2 mathematical content and followed the same intended learning outcomes. The experimental group participated in structured learning-through-play activities, whereas the control group received the usual mathematics instruction. The intervention focused on two Grade 2 mathematics lessons representing the Numbers and Operations strand and the Geometry and Measurement strand.

3.3.1. Selection of the Intervention Lessons

Two Grade 2 mathematics lessons were selected for the intervention. The first lesson, *Addition Tables Across Ten*, belonged to the Numbers and Operations strand and focused on consolidating addition facts across ten and developing mental calculation skills. The second lesson, *Practising Folding, Cutting, Combining, and Arranging Shapes and Drawing Line Segments*, belonged to the Geometry and Measurement strand and focused on recognizing plane shapes, manipulating geometric pieces, arranging shapes, and drawing line segments.

The lessons were selected for three reasons. First, they represented two different areas of the Grade 2 mathematics curriculum. Second, they involved different forms of mathematical activity: calculation and strategy use in the first lesson, and visual representation, manipulation, and spatial reasoning in the second. Third, both lessons allowed mathematical learning objectives to be embedded in structured playful tasks using simple and accessible classroom materials.

3.3.2. Design Principles for the Learning-Through-Play Activities

The learning-through-play activities were designed according to five principles. First, each activity was aligned with clearly defined mathematical learning outcomes. Second, students were required to use relevant mathematical knowledge, skills, or reasoning to complete the task. Third, the activities created opportunities for active participation, social interaction, repeated attempts, feedback, and reflection. Fourth, the materials, rules, and task requirements were appropriate for Grade 2 students. Fifth, each activity concluded with discussion, feedback, and consolidation of the targeted mathematical content.

During the activities, the teacher introduced the task, explained the rules, organized individual, pair, or group participation, observed students' learning processes, and provided guidance when necessary. Students were encouraged to calculate, manipulate materials, compare strategies, explain their reasoning, cooperate with peers, check results, and revise their solutions. At the end of each activity, selected students or groups presented their solutions or products, reflected on the strategies used, and received feedback from the teacher.

3.3.3. Activity 1: Kitten Finds the Fish

The activity *Kitten Finds the Fish* was implemented in the lesson *Addition Tables Across Ten*. Its purpose was to consolidate addition facts across ten and develop students' mental calculation skills.

Students received kitten cards containing addition expressions and fish cards displaying the corresponding results. Their task was to calculate each expression and match each kitten card with the fish card showing the correct answer. Students initially completed the task individually and subsequently checked and discussed their answers in pairs or small groups.

During the activity, students were encouraged to explain how they calculated each sum, compare alternative mental calculation strategies, identify incorrect matches, and revise their answers. The teacher observed students' performance and used guiding questions such as "How did you calculate this sum?", "Can you find another strategy?", and "Why do these two cards match?". At the end of the activity, selected students presented their strategies, and the teacher summarized and consolidated the relevant addition facts.

3.3.4. Activity 2: Young Architects

The activity *Young Architects* was implemented in the lesson *Practising Folding, Cutting, Combining, and Arranging Shapes and Drawing Line Segments*. Its purpose was to strengthen students' recognition of familiar plane shapes, develop spatial manipulation skills, and support mathematical communication and cooperation.

Students worked in small groups and used prepared geometric pieces to fold, cut, combine, and arrange pictures according to assigned themes. They were required to identify the shapes used, describe how the pieces were positioned or combined, and present their completed products to the class.

The teacher observed the group work and posed questions about the names, characteristics, positions, and combinations of the shapes. Students were encouraged to adjust their arrangements when the pieces did not fit the intended product and to explain the changes they made. At the end of the activity, each group presented its product, and the teacher reviewed and consolidated the relevant geometric knowledge.

3.3.5. Instruction in the Control Group

The control group studied the same lessons and targeted mathematical content without participating in the structured learning-through-play activities. Instruction followed the usual classroom approach, including teacher explanation and guidance, textbook-based tasks, individual practice, question-and-answer exchanges, and lesson review.

The intended learning outcomes, mathematical content, instructional duration, and assessment requirements were maintained consistently across the experimental and control groups. The principal difference between the two groups was the use of structured learning-through-play activities in the experimental condition.

Table 2. Overview of the Instructional Intervention

Lesson	Curriculum strand	Experimental group	Control group	Main learning focus
<i>Addition Tables Across Ten</i>	Numbers and Operations	<i>Kitten Finds the Fish</i>	Usual teaching approach	Addition facts across ten and mental calculation
<i>Practising Folding, Cutting, Combining, and Arranging Shapes and Drawing Line Segments</i>	Geometry and Measurement	<i>Young Architects</i>	Usual teaching approach	Shape recognition, spatial manipulation, and mathematical communication

Note. The two groups studied the same targeted mathematical content and followed the same intended learning outcomes. The structured learning-through-play activities constituted the principal difference between the instructional conditions.

3.4. Research Instruments

The study employed a mathematics achievement test and a classroom observation checklist to collect quantitative and qualitative data.

The mathematics achievement test was administered as both the pre-test and the post-test. It was developed in accordance with the intended learning outcomes specified in Vietnam's 2018 General Education Mathematics Curriculum for Grade 2 and covered the mathematical content addressed in the intervention lessons. The test included tasks assessing students' conceptual understanding, computational skills, shape recognition, spatial manipulation, and application of mathematical knowledge. The same test structure, scoring rubric, administration procedures, and scoring scale were used for the pre-test and the post-test to support comparability.

The test consisted of eight items, was completed in 35 minutes, and was scored on a 10-point scale. The scoring rubric specified the number of points assigned to each item and was applied consistently to both groups.

The classroom observation checklist was used during the learning-through-play activities to document students' participation and learning behaviours. The observation indicators focused on engagement in mathematical tasks, interaction with peers, communication of mathematical ideas, cooperation, strategy use, persistence, and task completion. The observational data were used as supplementary qualitative evidence to support the interpretation of the test results.

Before implementation, the instruments were reviewed by 15 primary school teachers with experience in teaching Grade 2 mathematics. They evaluated the instruments in terms of content relevance, clarity,

age appropriateness, alignment with the intended learning outcomes, and feasibility of administration. Their feedback was used to refine the wording of test tasks, the scoring criteria, the observation indicators, and the administration procedures. These teachers served as instrument reviewers and were not participants in the main intervention.

Table 3. Research Instruments

Instrument	Purpose	Participants	Data collected
Mathematics achievement test	Measure students' mathematics learning outcomes before and after the intervention	Experimental group and control group	Quantitative test-score data
Classroom observation checklist	Document students' participation and learning behaviours during the learning-through-play activities	Experimental group	Qualitative observational data

Note. The same mathematics achievement test, scoring scale, administration procedures, and scoring criteria were used for the experimental and control groups.

3.5. Data Collection and Analysis

Data were collected before, during, and after the instructional intervention. Before the intervention, students in the experimental and control groups completed the same mathematics achievement pre-test under equivalent administration and scoring conditions. During the intervention, the experimental group participated in structured learning-through-play activities, whereas the control group received the usual mathematics instruction covering the same targeted content. Classroom observations were conducted during the learning-through-play activities to document students' participation, interaction, strategy use, cooperation, persistence, and task completion. After the intervention, both groups completed the same mathematics achievement post-test under equivalent assessment conditions.

Quantitative data from the pre-test and post-test were analysed using means and standard deviations. An independent-samples t-test was used to examine whether the experimental and control groups differed significantly in their initial mathematics achievement. Statistical significance was evaluated at the .05 level. Mean gains from pre-test to post-test were calculated for each group to describe changes in mathematics learning outcomes during the intervention period.

The post-test mean scores and mean gains of the two groups were compared descriptively. Because no inferential test was conducted on individual gain scores, differences in mean gain were interpreted as observed differences rather than definitive statistical effects.

Classroom observation data were organized according to the predetermined indicators in the observation checklist. The observations were summarized qualitatively to describe students' engagement, mathematical communication, cooperation, strategy use, persistence, and completion of

learning tasks during the learning-through-play activities. The quantitative and observational findings were interpreted together to provide a more comprehensive account of students' learning outcomes and classroom participation.

4. RESULTS

4.1 Pre-test results

Before the instructional intervention, both the experimental group and the control group completed the same mathematics achievement test to examine their initial learning outcomes. Table 4 presents the descriptive statistics and the independent-samples t-test results for the pre-test.

Table 4. Pre-test Results of the Experimental Group and the Control Group

Group	N	Mean score	SD	t-value	p-value
Experimental group	65	6.82	1.03	0.17	0.87
Control group	67	6.79	1.01		

The experimental group achieved a pre-test mean score of 6.82 (SD = 1.03), whereas the control group achieved a mean score of 6.79 (SD = 1.01). The difference between the two groups was very small. The independent-samples t-test indicated that this difference was not statistically significant, $t = 0.17$, $p = 0.87$. These findings suggest that the two groups had comparable initial mathematics achievement before the intervention.

4.2 Post-test results

Following the instructional intervention, both the experimental group and the control group completed the same mathematics achievement post-test. Table 5 presents the descriptive statistics for the two groups.

Table 5. Post-test Results of the Experimental Group and the Control Group

Group	N	Mean score	SD
Experimental group	65	8.08	0.86
Control group	67	6.93	0.94

The experimental group achieved a post-test mean score of 8.08 (SD = 0.86), whereas the control group achieved a mean score of 6.93 (SD = 0.94). The observed difference between the two groups was 1.15 points in favour of the experimental group.

The experimental group also showed a slightly smaller standard deviation than the control group. However, because the difference in score dispersion was modest and no formal test of variance was conducted, this result should not be interpreted as evidence of substantially greater score consistency.

Overall, the descriptive results indicate that students who participated in the structured learning-through-play activities achieved higher observed post-test scores than those who received the usual mathematics instruction.

4.3. Comparison of Pre-test and Post-test Results

To examine changes in mathematics learning outcomes more clearly, the pre-test and post-test mean scores of the experimental and control groups were compared. The results are presented in Table 6.

Table 6. Comparison of Pre-test and Post-test Results

Group	N	Pre-test mean	Post-test mean	Mean gain
Experimental group	65	6.82	8.08	1.26
Control group	67	6.79	6.93	0.14

The experimental group showed a marked increase in mathematics learning outcomes, with the mean score rising from 6.82 before the intervention to 8.08 after the intervention. This represented a mean gain of 1.26 points. By contrast, the control group showed only a modest increase, from 6.79 to 6.93, corresponding to a mean gain of 0.14 points.

Although both groups showed some improvement, the increase observed in the experimental group was substantially greater than that observed in the control group. The difference in mean gain between the two groups was 1.12 points.

These findings suggest that participation in structured learning-through-play activities may have contributed positively to students' mathematics learning outcomes. However, because the comparison of mean gains was descriptive and no inferential test was conducted on individual gain scores, the results should be interpreted as observed differences rather than definitive statistical effects.

4.4. Classroom Observation Findings

Classroom observations indicated that students in the experimental group displayed active engagement during the structured learning-through-play activities. In the activity *Kitten Finds the Fish*, students participated enthusiastically in calculating addition expressions, matching the cards, checking their answers, and discussing alternative strategies with peers. Many students were willing to explain how they obtained their answers and to revise incorrect matches after receiving feedback.

During the activity *Young Architects*, students worked collaboratively in small groups to select, combine, and arrange geometric pieces. They communicated with one another about the names,

positions, and combinations of the shapes, negotiated how to complete the assigned products, and adjusted their arrangements when the pieces did not fit as intended. The activity also created opportunities for students to present their products and explain the geometric ideas involved.

Across the observed lessons, students generally demonstrated engagement in mathematical tasks, interaction with peers, communication of mathematical ideas, cooperation, persistence, and task completion. These behaviours were consistent with the intended characteristics of learning through play, particularly active engagement, iteration, and social interaction.

The observational findings provide supplementary qualitative evidence regarding students' participation in the learning-through-play activities. However, because classroom observations were conducted only in the experimental group, they should be interpreted as descriptions of students' behaviours during the intervention rather than as direct behavioural comparisons with the control group.

5. DISCUSSION

The present study examined the effectiveness of learning through play in Grade 2 mathematics in Vietnam using a quasi-experimental pre-test–post-test control-group design. The findings indicated that the experimental group achieved higher post-test mathematics scores and a substantially greater mean gain than the control group. Specifically, the experimental group's mean score increased by 1.26 points, whereas the control group's mean score increased by only 0.14 points. These findings suggest that structured learning-through-play activities may contribute positively to students' mathematics learning outcomes when implemented in regular primary classrooms.

The findings are consistent with previous studies emphasizing the educational value of learning through play for young learners (Parker et al., 2022; Pyle et al., 2017; Zosh et al., 2017). Previous research has suggested that playful learning environments can enhance students' engagement, conceptual understanding, communication, and motivation. The present study extends this body of evidence by demonstrating that structured learning-through-play activities can also be associated with improved mathematics learning outcomes in the context of Grade 2 primary education in Vietnam.

One possible explanation for these findings is that the intervention created opportunities for students to engage actively with mathematical ideas rather than receiving information passively. During the learning-through-play activities, students manipulated materials, explored alternative strategies, explained their reasoning, collaborated with peers, and reflected on their solutions. These learning processes are consistent with constructivist perspectives, which emphasize that mathematical understanding develops through active participation, meaningful interaction, and guided exploration (Bruner, 1966; Piaget, 1972; Vygotsky, 1978).

The classroom observations further supported the quantitative findings. Students participating in the learning-through-play activities displayed active engagement, mathematical communication, cooperation, persistence, and willingness to revise their strategies when necessary. These observed

behaviours correspond closely with the core characteristics of learning through play described by Parker et al. (2022) and Zosh et al. (2017), particularly active engagement, iteration, and social interaction. Although the observational findings do not establish causal relationships, they provide useful qualitative evidence regarding how students participated during the intervention.

The findings also have practical implications for primary mathematics teaching. Rather than treating games as occasional classroom activities, teachers may consider designing structured learning-through-play experiences that align closely with intended mathematical learning outcomes. Such activities should require students to use mathematical reasoning, communication, and problem-solving skills while maintaining opportunities for exploration, collaboration, and reflection. When carefully designed, learning through play can support both mathematics learning and the development of broader competencies emphasized in Vietnam's 2018 General Education Curriculum.

Several limitations should be acknowledged. First, the study involved only 132 Grade 2 students from two public primary schools in Bac Ninh Province, which may limit the generalizability of the findings. Second, the intervention was conducted within a relatively short instructional period and focused on two mathematics lessons. Third, intact classes rather than randomly assigned groups were used; therefore, the findings should be interpreted within the constraints of a quasi-experimental design. Fourth, classroom observations were conducted only in the experimental group and therefore describe students' behaviours during the intervention rather than providing direct behavioural comparisons between the two instructional conditions.

Future studies could involve larger and more diverse samples, extend the duration of the intervention, include additional mathematical topics and grade levels, and incorporate longitudinal or mixed-methods designs to examine both immediate and longer-term effects of learning through play on students' mathematical development.

6. CONCLUSION

This study examined the effectiveness of learning through play in Grade 2 mathematics in Vietnam using a quasi-experimental pre-test–post-test control-group design. The findings showed that the experimental group achieved higher post-test mathematics scores and a greater observed mean gain than the control group after participating in structured learning-through-play activities. Classroom observations also indicated that students in the experimental group displayed active engagement, mathematical communication, cooperation, persistence, and willingness to revise their strategies during the intervention.

The study provides preliminary empirical support for the use of structured learning-through-play activities in competency-oriented Grade 2 mathematics teaching. When playful tasks are closely aligned with intended mathematical learning outcomes, they can create opportunities for students to practise mathematical knowledge, explain ideas, collaborate with peers, test strategies, and reflect on their learning. These features are consistent with the emphasis of Vietnam's 2018 General Education Mathematics Curriculum on active participation and mathematical competency development.

For classroom practice, learning-through-play activities should be purposeful, age-appropriate, mathematically focused, and accompanied by teacher guidance, feedback, and knowledge consolidation. Nevertheless, the findings should be interpreted in light of the study's limited sample, short intervention period, use of intact classes, and observational data collected only from the experimental group. Further research with larger samples, longer interventions, additional mathematics topics, and more rigorous comparative analyses is needed to provide stronger evidence regarding the effectiveness and sustainability of learning through play in primary mathematics education.

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