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# THE PRESENCE OF GAMES IN MATHEMATICS TEACHING FROM THE PERSPECTIVE OF PRIMARY SCHOOL STUDENTS

***Abstract:*** *This paper explores the presence of games in mathematics teaching in primary school, starting from theoretical and historical approaches to play and its pedagogical and didactic roles. Play is recognized as a universal activity that contributes to the cognitive, social, and emotional development of students, as well as a powerful methodological tool for learning mathematics. The research was conducted on a sample of 239 students from the second to the eighth grade of primary school, to examine the frequency and methods of using games in mathematics teaching. The results show that games are applied significantly more often in lower grades than in upper grades, and their position within the lesson varies depending on the students' age. In lower grades, games are most often used at the beginning and end of the lesson, while in upper grades, they are more frequently applied during the main part of the lesson. Differences were also observed in the mode of implementation: younger students more often participate in individual and group games, whereas in higher grades, individual and group activities, as well as pair work, are more evenly combined. The type of games also varies – in lower grades, manual games dominate, while in upper grades digital games prevail. A particular contrast is evident in their role in assessment: in lower grades, games are*

*seldom connected with grading, whereas in upper grades, they become part of the process of evaluating knowledge. The research results indicate the importance of a balanced and purposeful use of games in mathematics teaching and the need for their more systematic inclusion, especially in upper grades, where their presence significantly decreases despite their recognized pedagogical benefits.*

***Keywords:*** *lower grades, upper grades, didactic games, mathematics, knowledge assessment*

## INTRODUCTION

## THEORETICAL AND HISTORICAL APPROACHES TO PLAY

Play is a universal human activity that appears in all societies and historical periods, playing an important role in human development, socialization, and culture. In philosophy and pedagogy, play has throughout history been a subject of interest to many thinkers. Huizinga (1992), in his work Homo Ludens, emphasizes that play is a fundamental function of human existence, as important as work or thought. He refers to man as homo ludens, since he believes that culture has been shaped and developed through play and as play (Tanghe, 2016). Thus, play becomes more than mere amusement – it is a form of activity that enables both children and adults to explore the world, express emotions and thoughts, and develop abilities. Piaget (1951) viewed play through the stages of cognitive development. Functional play characterizes early childhood and is based on the repetition of actions. Symbolic play appears when a child begins to use imagination and make-believe, while games with rules indicate social maturity as they involve the acceptance of commonly agreed norms. Vygotsky (1978) considered play the most important context for the development of higher psychological functions, as it creates a zone of proximal development. In play, the child achieves more than in other activities, and what he or she can do today with adult assistance will be done independently tomorrow. Bodrova and Leong (2015) emphasize that in play, the child functions above his or her chronological age, developing planning, behavioural regulation, and abstract thinking. Erikson (1963) connects play with developmental crises and identity, while Csikszentmihalyi (2006) examines it through the concept of optimal experience or flow. In play, goals are clear, feedback is immediate, and learners are fully immersed in the activity. Throughout the history of pedagogy, many thinkers have recognized the importance of play: Plato emphasized the value of mathematical games in education, Quintilian believed that learning should be linked with enjoyment, Comenius and Locke stressed play as a method of bringing knowledge closer

to children, and Froebel developed a system of didactic toys that introduced children to the world of creative activity (Bognar, 1986). Play thus gained the status of a bridge between children's needs and educational goals and has been included in the educational process since its beginnings. Later pedagogues such as Dewey (1938) and Montessori (1967) also emphasized the importance of play and learning through experience. Dewey argued that learning should be connected with students' interests and real-life situations, while Montessori developed an educational system in which play and manipulation of materials occupy a central place. In this way, play becomes a fundamental mode of learning and exploring the world.

## PLAY AS A PEDAGOGICAL AND DIDACTIC TOOL

In contemporary pedagogy, the importance of active and creative teaching methods is emphasized, in which students are active participants rather than passive recipients of knowledge (Bognar & Matijević, 2005). Didactic games are highlighted as a methodological tool that connects the emotional and cognitive dimensions of learning. They enable students to acquire knowledge through experience, discovery, and exploration, rather than through passive listening. According to Self-Determination Theory (Ryan & Deci, 2020), intrinsic motivation and a sense of well-being are grounded in the fulfilment of basic psychological needs: autonomy, competence, and relatedness. Play naturally satisfies all three needs because it offers freedom of choice, challenge, and success, and fosters social relationships. Nikčević-Milković et al. (2011) emphasize that play increases attention and concentration, engages more passive students, develops problem-solving and creativity, and contributes to long-term memory. Hromek and Roffey (2009) demonstrated that games develop empathy, prosocial skills, and the ability to resolve conflicts constructively. Whitebread et al. (2017) state that games contribute to a child's cognitive, linguistic, socio-emotional, and motor development. The OECD (2019) also recognizes play as a tool for developing key 21st-century competencies such as creativity, critical thinking, and collaboration. Didactic games are not an end in themselves; their value becomes evident when they are aligned with the curriculum, connected to learning outcomes, and adapted to students' interests. The teacher's role is crucial in this process. The teacher plans and prepares games, provides materials and space, guides the course of activities, and links the game to the learning outcomes. Their role shifts from a transmitter of knowledge to a moderator and mentor in the learning process (Matijević & Radovanović, 2011). Didactic games can be applied in all stages of the lesson – at the introductory stage as motivation, in the main part for acquiring and practicing new content, and in the final stage for revision and knowledge checking. In this way, games become an integral part of teaching.

In addition to increasing motivation and involving students in the learning process, games also enable differentiated instruction, as they can be adapted to different levels of knowledge. For instance, the same game can be used to practice basic arithmetic operations in lower grades or more complex algebraic expressions in higher grades. This demonstrates the flexibility and universality of games as a teaching tool.

## DIDACTIC GAMES IN MATHEMATICS INSTRUCTION

Mathematics is a fundamental school subject, yet at the same time one of the most demanding for students. It is often perceived as abstract and difficult, provoking fear and resistance. Didactic games in mathematics therefore have exceptional value because they allow students to grasp complex concepts in an accessible and engaging way. They make mathematics more relatable, foster intrinsic motivation, and develop a positive attitude towards learning. The Curriculum for the Subject Mathematics (MZO, 2019) emphasizes the importance of active learning, problem-solving, an inquiry-based approach, communication, and collaboration. It highlights mathematical processes such as reasoning, modelling, mathematical communication, and making connections, and didactic games are a natural way to implement these processes. The use of games in mathematics can be viewed across different learning areas. In arithmetic, card games, bingo, or dominoes are often used for practicing basic operations, while also developing calculation speed and confidence in handling numbers (Afari et al., 2013). In geometry, tangrams, puzzles, and construction games develop spatial imagination, visualization, and the ability to recognize relationships between shapes (Bognar, 1986). In algebra, games may involve assembling expressions, solving equations through competitive formats, or using digital simulations that enable visualization of relationships among variables and functions (Divjak & Tomić, 2011). In statistics and probability, students explore probability, distribution, and combinatorics through dice games, card activities, or computer simulations, which facilitate the understanding of abstract concepts (Trajkovik et al., 2018). Such examples show that games are not merely a motivational tool but also a means of deeply understanding mathematical concepts and applying knowledge in different contexts (OECD, 2019).

Furthermore, a distinction can be made between manual and digital games. Manual games involve tangible materials such as cards, boards, dice, tangrams, or mathematical puzzles. Their value lies in developing combinatorial thinking, spatial imagination, and logical reasoning (Baranović & Lehman, 2018). Research shows that students remember and retain knowledge more easily when activities relate to experience and play (Nikčević-Milković et al., 2011). Trajkovik et al. (2018) demonstrated that traditional games increase students'

knowledge, motivation, and cooperative skills. Digital games and platforms such as Kahoot, Quizizz, or GeoGebra further enrich teaching by combining competition, collaboration, and reflection (Kebritchi et al., 2010). Students receive immediate feedback, making learning a dynamic and motivating process (Maraza-Quispe, 2024). Divjak and Tomić (2011) found that computer games contribute to more effective acquisition of mathematical concepts, while Ke and Grabowski (2007) concluded that games combined with cooperative learning improve students' attitudes towards mathematics. Despite the benefits of digital games in mathematics teaching, analyses show that teachers still express some uncertainty in implementation due to a lack of resources and professional support (Jukić Matić et al., 2023).

Hui and Mahmud (2023) emphasize that games significantly reduce mathematical anxiety, enabling students to participate more comfortably in the educational process and focus more on understanding the content. Even game-like worksheets have a positive developmental impact on student achievement and attitudes toward mathematics, as they encourage cooperation, motivation, and confidence in their own procedures (van Putten et al., 2022). Afari et al. (2013) further note that games strengthen students' positive self-perception and increase their confidence in working with mathematics. Research shows that games can create an encouraging environment in which students feel more motivated to learn because knowledge is not perceived as an imposed obligation but as an activity associated with enjoyment and personal engagement (Kebritchi, Hirumi & Bai, 2010). Moreover, games help reduce feelings of failure, as they give students repeated, low-stress opportunities to practice and reinforce mathematical concepts (Ke & Grabowski, 2007). Since mathematical anxiety is often linked to negative educational experiences, games can serve as a tool for reshaping students' attitudes toward mathematics (Ashcraft & Krause, 2007). When used in a collaborative context, games further support the development of social skills and a sense of belonging, which reduces individual pressure and stress (Plass et al., 2013).

All the above confirms that games in mathematics are not merely a method for "simplifying" instruction but a systematic and scientifically grounded approach that enables the achievement of curriculum goals, the development of mathematical processes, and the fostering of a positive student attitude toward the subject (MZO, 2019).

Didactic games can be used in all phases of a lesson. In the introductory phase, they motivate students and create a positive atmosphere; in the main phase, they support the acquisition of new knowledge and skill practice; and in the final phase, they are used for revision and knowledge checking (Nikčević-Milković et al., 2011). The teacher plays a crucial role in this process, connecting the game with learning outcomes and adapting it to students' abilities (Matijević & Radovanović, 2011). In addition to their

advantages, the use of games also presents challenges. It requires additional teacher preparation, material design, and adaptation to different competency levels (Baranović & Lehman, 2018). Nevertheless, research confirms that games significantly contribute to success in mathematics and develop students' positive attitudes toward learning (Divjak & Tomić, 2011; Ke & Grabowski, 2007; Kebritchi et al., 2010; Hui & Mahmud, 2023). All of this shows that games in mathematics instruction are not merely an add-on but a powerful pedagogical tool that connects the curriculum, goals, and learning outcomes with students' interests, needs, and motivation (MZO, 2019). When games are used systematically, they become a means of achieving curriculum goals, developing competencies, and creating a positive learning culture (OECD, 2019).

## METHODOLOGY

### Aim and Hypothesis

Drawing on theoretical insights into the importance of play in child development and its application in education, as well as the principles of the contemporary Mathematics Curriculum (MZO, 2019), this research focuses on examining the use of games in mathematics instruction. Although play is a natural form of children's activity and a powerful methodological tool, in practice the question often arises as to how frequently it is incorporated into mathematics lessons, especially in the upper grades of primary school where the level of abstraction in mathematical content increases and frontal teaching becomes more common.

Previous research has shown that the frequency and manner of using didactic games vary depending on the grade level. Nikčević-Milković et al. (2011) note that games are more frequently used in the lower primary grades because they align with pupils' developmental needs, whereas their use declines in the upper grades due to increased curriculum demands and the focus on formal learning outcomes. Similar findings are reported by Baranović and Lehman (2018), who state that lower-grade teachers are more inclined to integrate games into everyday instruction, whereas upper grades tend to prefer more traditional approaches.

Matijević and Radovanović (2011) emphasize that games in lower grades are more often used in the introductory and motivational parts of the lesson, whereas in higher grades they are used less frequently or in abbreviated form, primarily for revision. Differences have also been observed in the mode of implementation: younger pupils more often participate in manual and group games, while in higher grades, digital games and online platforms are increasingly used (Kebritchi et al., 2010; Divjak & Tomić, 2011). Research has further shown that teachers at different grade levels choose different types

of games – competitive, problem-solving, inquiry-based, or constructional (Trajkovik et al., 2018) – and that games are rarely used as an assessment tool, particularly in the upper grades of primary school (Jukić Matić et al., 2023).

This research aimed to gain insight into how frequently and in what ways games are used in mathematics instruction in primary schools in the Republic of Croatia, as well as to examine students' perceptions of the effectiveness of games. Special attention was given to differences between grades, perceptions of game attractiveness, the relationship between playing games in class and playing in free time, and the connection between the use of games and achievement in mathematics. The research also aimed to identify which types of games, manual or digital, are most commonly used during the instructional process. Based on theoretical and empirical findings, the following research hypotheses were formulated:

- *There is a statistically significant difference in the frequency of using games in mathematics instruction with respect to grade level.*
- *There is a statistically significant difference in the part of the lesson in which games are used with respect to grade level.*
- *There is a statistically significant difference in the mode of implementing games in mathematics instruction with respect to grade level.*
- *There is a statistically significant difference in the type of games used in mathematics instruction with respect to grade level.*
- *There is a statistically significant difference in the use of games for assessment with respect to grade level.*

## Sample and Research Procedure

As part of the master's thesis by student Darija Čupić, this research was conducted with a total of 239 primary school pupils in Croatia, from second to eighth grade. All pupils confirmed that various games are used in mathematics lessons, which ensured the completeness of the sample and made it unnecessary to exclude any participants. Concerning gender, the research included 100 female pupils (41.8%) and 139 male pupils (58.2%).

The participants were selected using a convenience sampling method, based on the availability of schools and the willingness of teachers and pupils to participate. The research was carried out in the 2024/2025 school year during regular mathematics classes, in agreement with the teachers. Participation was voluntary and anonymous, with written consent obtained from parents or guardians. No personal data were collected, only information necessary for the analysis, such as grade level, gender, mathematics grade, and attitudes toward the use of games in lessons. All participants were informed in advance about the purpose of the study, and the procedure was conducted in accordance with

ethical principles of pedagogical research, with full respect for pupils' privacy and integrity.

The survey was administered in paper form during one school lesson. Pupils completed the questionnaire independently, with an average completion time of ten to fifteen minutes. The authors conducted the survey to oversee the process and to ensure that instructions were understood, with the presence of the subject teachers. After collection, the responses were coded and entered into a database for further statistical analysis.

## Research Instrument

The main research instrument used in the study was a questionnaire titled *The Use of Games in Mathematics Teaching*. The questionnaire was developed specifically for this research, with an emphasis on simplicity, clarity, and age appropriateness for students from second to eighth grade. It was designed so that students could complete it independently, without assistance from their teachers.

The questionnaire consisted of twenty questions covering three thematic areas. The first section focused on students' sociodemographic data, such as grade level, gender, and final grade in mathematics, to enable comparisons based on age and academic achievement. The second section examined the frequency and types of games used in mathematics lessons, including questions about the part of the lesson in which games are applied, whether the games are manual or digital, and how often they are used. The third section addressed students' attitudes towards the use of games in mathematics teaching. In this section, students evaluated the extent to which games contribute to their motivation, understanding of mathematical content, and overall interest in mathematics. These questions were formulated as statements on a five-point Likert scale, where 1 indicated complete disagreement, and 5 indicated complete agreement.

In designing the questionnaire, attention was given to students' level of abstract thinking and their previous experience with survey research. Simple language and clear instructions were used to ensure that all respondents could understand the questions and provide honest responses.

## Data Survey Methods

The collected data were coded and entered into the statistical software SPSS 29.0 for further analysis. Nonparametric tests were used because the variables under study were categorical (e.g., frequency of game use, part of the lesson, mode of implementation, type of games, use of games for assessment), and thus did not meet the assumptions of normal data distribution. Since the aim was to determine whether there was an association between categorical

variables and grade level, the chi-square test of independence ($\chi^2$) was applied. This test was appropriate because it allows for the comparison of observed and expected frequencies in contingency tables and for examining whether statistically significant differences exist between groups.

Statistical significance in all analyses was assessed at the $\alpha = 0.05$ level.

## RESULTS AND DISCUSSION

*Analysis of Differences in the Frequency of Using Games in Mathematics Classes with Respect to Grade Level*

To verify the hypothesis *There is a statistically significant difference in the frequency of using games in mathematics instruction with respect to grade level*, a $\chi^2$ test of independence was used. At the 5% significance level, it can be concluded that there is a statistically significant difference in the frequency of using games between lower and upper primary grades. The test results showed that there is a statistically significant difference between the observed categories, $\chi^2(3) = 16.50$, $p < .001$.

In lower primary grades (one teacher primary education), students most frequently indicated that games are used once a week or once a month, whereas in upper primary grades (subject-based education), they reported much more often that games are used less than once a month (28.3% compared to 8.0% in lower primary grades). Only one student in the lower grades and two students in the upper grades stated that games are used in every lesson, as shown in Table 1.

**Table 1**
*Frequency of using games by grade-level groups*

| | Every lesson | 1× week | 1× month | < 1× month |
|---|---|---|---|---|
| **Lower primary education** | 0.9% | 46.4% | 44.6% | 8.0% |
| **Upper primary education** | **1.6%** | **35.4%** | **34.6%** | **28.3%** |

The results confirm that there is a statistically significant difference in the frequency of using games with regard to grade level, with games being used considerably more often and for a wider range of pedagogical purposes in the lower primary grades. In the upper primary grades, their use is less frequent and oriented more toward logical and problem-solving challenges, as noted by Kurnik (2009), which reflects the transition from concrete-operational to formal-operational thinking and the increasing level of abstraction in mathematics instruction. Accordingly, Markovac (2001) emphasizes that manipulation with objects, visualization, and play are essential in early mathematics education because children are only beginning to move from

intuitive understanding to rule-based comprehension. Nevertheless, games could be used more frequently in the upper primary grades as well, since they can serve as an important motivational tool and an extension of abstract content, as Bognar (1986) writes. Similar results are reported by Russo et al. (2021), who confirm that lower primary teachers extensively use mathematical games – with about 81% of them applying games several times per week (regularly or often). Slightly lower frequency was observed among mathematics teachers in the upper grades, but it still represents a high proportion, given that approximately 76% of teachers state that they use games several times per week. As highlighted in the theoretical section of the thesis, games enhance motivation and facilitate understanding, and therefore, it would be desirable for them to be used more frequently in the upper primary grades as well. Since mathematics is a demanding and often stressful subject for many students, games could serve as a tool to further motivate older students and encourage more active class participation. Research shows that the use of serious games in teaching significantly contributes to the development of mathematical fluency, with the positive role of gamification in increasing students' motivation and achievement being particularly emphasized (Fraga-Varela et al., 2021).

*Analysis of Differences in the Part of the Lesson in Which Games Are Used with Respect to Grade Level*

To test the hypothesis *There is a statistically significant difference in the part of the lesson in which games are used with respect to grade level*, a $\chi^2$ test of independence was applied. At the 5% significance level, it can be concluded that there is a statistically significant difference in the part of the lesson in which games are used concerning grade level. The test results showed a statistically significant difference between the observed categories, $\chi^2(3) = 32.64$, $p < .001$.

In the lower primary grades, games are most frequently used at the beginning of the lesson and in a combination of the beginning and end of the lesson, while they are used less often in the middle and at the end of the lesson. In contrast, in the upper primary grades, games are predominantly used at the end and in the middle of the lesson, while the beginning and the combination of beginning and end are less represented, as shown in Table 2.

**Table 2**
*Differences in the Part of the Lesson in Which Games Are Used by Grade-Level Groups*

| | **Beginning** | **Beginning and end** | **Middle** | **End** |
|---|---|---|---|---|
| **Lower primary education** | 35.7% | 27.7% | 9.8% | 26.8% |
| **Upper primary education** | 25.2% | 5.5% | 22.0% | 47.2% |
| **Total** | **30.1%** | **15.9%** | **16.3%** | **37.7%** |

In the lower primary grades, games are most frequently used at the beginning and end of the lesson, primarily as a means of motivation and revision, whereas in the upper primary grades, they are more often applied in the central and final part of the lesson, where they serve for the exploration of more complex content and for knowledge checking. This distribution arises from the developmental characteristics of students: younger pupils maintain attention more easily when the lesson begins with a game, and revision through play at the end further consolidates what has been learned (Markovac, 2001; Nikčević-Milković et al., 2011). Older students, on the other hand, see games as an opportunity for deeper understanding of abstract concepts and for solving problem-based tasks, which is why their use in the central part of the lesson is didactically justified (Kurnik, 2009). Such an adaptation may also be viewed as an advantage, as it enables teachers to align their methods with students' developmental needs and with the specific objectives of the teaching process (OECD, 2019).

Nikčević-Milković et al. (2011) confirm that play in the lower primary grades increases student activity and encourages even passive pupils, thereby significantly enhancing their engagement and motivation. Additionally, play has multiple developmental effects: it supports cognitive development through problem-solving and creative thinking, language development through verbal interaction and rule acquisition, socio-emotional development through self-regulation, empathy, and prosocial behaviour, and psychomotor development through coordination, precision, and graphomotor skills. Whitebread et al. (2017) report similar findings, emphasizing that games contribute to balanced cognitive, socio-emotional, and motor development, while Hromek and Roffey (2009) highlight their role in developing social skills and constructive conflict resolution.

Matijević and Radovanović (2011) write that games encourage students to explore, discuss, and think creatively, and that problem situations often lead to a heuristic "aha moment," that is, the independent discovery of mathematical concepts and relationships. This explains the more frequent use of games in the central part of the lesson in the upper primary grades, where students have the capacity for deeper analysis and understanding. Russo et al. (2021) confirm in their research that most primary school teachers, regardless of grade level, most often use games in mathematics teaching as a warm-up activity at the beginning of the lesson (59%), while they are used less frequently as the main instructional activity (49%). Similar results appear in the research by Ke and Grabowski (2007), who found that the use of games in different phases of the lesson increases motivation and contributes to a better perception of students' own abilities.

All of the above confirms that games in mathematics instruction have multiple roles − motivational, developmental, and didactic − and that their placement within the lesson is not accidental but derives from students' developmental needs and teachers' pedagogical aims.

*Analysis of Differences in the Mode of Implementing Games in Mathematics Instruction with Respect to Grade Level*

To test the hypothesis *There is a statistically significant difference in the mode of implementing games in mathematics instruction with respect to grade level*, a $\chi^2$ test of independence was applied. At the 5% significance level, it can be concluded that there is a statistically significant difference between the variables in question. The test results showed a statistically significant difference between the observed categories, $\chi^2(3) = 53.30$, $p < .001$.

In the lower primary grades, the most frequently reported modes are group work and combined formats, followed by individual work, while pair work is rare. In the upper primary grades, group work (44.9%) and pair work (26.0%) predominate, followed by individual work, whereas combined formats are rare (Table 3).

**Table 3.**
*Differences in the Mode of Implementing Games by Grade-Level Groups*

| | **Independently** | **Pair** | **Group** | **Combination** |
|---|---|---|---|---|
| **Lower primary education** | 31.3% | 0.9% | 33.9% | 33.9% |
| **Upper primary education** | 22.8% | 26.0% | 44.9% | 6.3% |
| **Total** | **26.8%** | **14.2%** | **39.7%** | **19.2%** |

The mode of implementing games varies according to the level of instruction and the age of students. In the lower primary grades, individual and group forms of work are more frequently used, while pair work is less common. In the upper primary grades, group, pair, and individual work are equally present, reflecting the greater independence and more developed social skills of older students. Independent games allow students to explore and discover mathematical concepts at their own pace, while pair games create opportunities for dialogue, argumentation, and joint problem-solving. Group games, although more demanding to organize, are particularly noteworthy because they promote collaborative learning, idea exchange, and the development of teamwork skills (Johnson & Johnson, 2009).

Pedagogical literature emphasizes that well-prepared group games can significantly enhance the quality of instruction. Although they pose a greater challenge for teachers, as they require precise preparation, clear rules, and

monitoring of group dynamics, their value is multifaceted. Group games develop communication skills, a sense of belonging and responsibility, and often lead to a deeper understanding of concepts because knowledge is constructed through interaction with others (Slavin, 2014). This form of work also contributes to the socio-emotional development of students, as it requires rule adherence, active listening, and prosocial behaviour. With careful preparation and structured tasks, group work becomes a valuable learning method because it strengthens social and communication competencies and contributes to the durability and quality of acquired knowledge.

According to Matijević and Radovanović (2011), individual games strengthen independence and intrinsic motivation and activate higher-order cognitive processes such as exploration, discovery, and problem-solving. Pair work, on the other hand, provides space for immediate idea exchange, argumentation, and constructive disagreement, fostering the development of critical thinking. Group games promote collaboration and socialization and can be organized in either a cooperative or competitive atmosphere, depending on the teacher's didactic objectives. All three forms support active learning and the development of key competencies, but each has specific advantages that make it suitable for instructional situations.

Plass et al. (2013) conducted an experimental study in which students played a mathematics game individually, competitively, or collaboratively. The results showed statistically significant differences: the competitive mode elicited greater interest and motivation, while individual play resulted in better mathematical fluency. The collaborative mode was particularly valuable because it combined elements of motivation and social interaction, with results comparable to the competitive mode. These findings confirm that the mode of play significantly affects learning outcomes, and teachers should carefully decide whether a game should be implemented individually, in pairs, or in groups, depending on the instructional goal. Ke and Grabowski (2007) similarly highlight that collaborative play develops a sense of community and increases engagement among all students, while individual games can be useful for acquiring and practicing foundational knowledge.

Furthermore, contemporary research suggests that games can be categorized along multiple dimensions: competitive, collaborative, and individual; digital and analog; problem-solving and practice-based. Each of these dimensions carries specific pedagogical values. Collaborative games encourage the co-construction of knowledge and strengthen teamwork competencies, while competitive games develop persistence and strategic thinking. Individual games, although focused on autonomy, can serve as preparation for more complex tasks that are later tackled in groups. This confirms that diversity in the mode of implementing games is key to successfully engaging different

students and supporting their holistic educational experience (Gillies, 2016; Kirriemuir & McFarlane, 2004).

*Analysis of Differences in the Type of Games in Mathematics Instruction with Respect to Grade Level*

To test the hypothesis *There is a statistically significant difference in the type of games used in mathematics instruction with respect to grade level*, a $\chi^2$ test of independence was applied. At the 5% significance level, it can be concluded that there is a statistically significant difference in the types of games used in mathematics lessons depending on the grade level. The test results showed a statistically significant difference between the observed categories, $\chi^2(3) = 40.60$, $p < .001$.

In the lower primary grades, manual games and a combination of digital and manual games are most frequently reported, while the use of solely digital games is the lowest. In the upper primary grades, a combination of digital and manual games predominates, followed using only digital games, whereas the use of manual games alone is least common (Table 4).

**Table 4**
*Differences in the Type of Games by Grade-Level Groups*

| | **Digital** | **Manual** | **Digital and manual** |
|---|---|---|---|
| **Lower primary education** | 2.7% | 54.5% | 42.9% |
| **Upper primary education** | 30.7% | 24.4% | 44.9% |
| **Total** | 17.6% | 38.5% | 43.9% |

The type of games varies according to the level of instruction: in lower grades, manual games (often combined with digital ones) still dominate, while purely digital games are rarely present. In higher grades, however, combined and exclusively digital forms increasingly predominate, while manual games become the least represented. This confirms a difference in the choice of game types between lower and upper grades, with a noticeable shift toward digital solutions in higher grades. Ersen (2022), in a systematic review of 80 studies published between 2017 and 2021, reports that educational games (card games, puzzles, board games) were used in 8 out of 14 studies focused on elementary school students, while digital computer games were represented in 6 out of 14 studies, indicating a growing trend in digital solutions but also the continued value of manual games.

It is important to emphasize that manual games possess exceptional pedagogical value because they promote the development of graphomotor skills, coordination, and various psychomotor abilities that digital games

cannot fully replace (Matijević & Radovanović, 2011). Moreover, manual games stimulate creative thinking, develop spatial orientation, and provide students with a tactile experience of mathematical concepts, which is particularly important in younger ages when learning is closely linked to concrete experiences. Research confirms that tactile and hands-on activities contribute to a deeper understanding of abstract concepts because they connect experiential learning with formal content (Fisher et al., 2011).

In higher grades, manual games unfortunately lose prevalence as digitalization increasingly takes primacy. Digital games undoubtedly have advantages – they are motivationally engaging, modernly designed, and provide immediate feedback – but excessive reliance on them can lead to the neglect of manual activities. Overexposure to screens in children has already been recognized as a challenge in contemporary education, as prolonged screen time is associated with difficulties in concentration, reduced creativity, and weaker development of fine motor skills (American Academy of Pediatrics, 2016; Twenge & Campbell, 2018). Today's children spend most of their free time in front of screens, making it even more important for schools to provide a counterbalance and ensure experiences that are not exclusively digital.

Mathematics, in this regard, proves particularly suitable for manual activities because the manipulation of concrete objects, geometric shapes, and didactic materials enables students to better understand abstract concepts (Clements & Sarama, 2011). Through manual games, students can practically explore relationships between quantities, form patterns, assemble figures, or solve puzzles, leading to deeper understanding and long-term retention. Excessive reliance on digital games in this context can impoverish the learning experience by excluding physical manipulation and the sense of "learning by doing."

Therefore, it is essential to find a balance between manual and digital games and provide students with diverse experiences. Digital games can enrich instruction but should not completely replace manual forms of activity, which develop fine motor skills, concentration, persistence, and creativity. By combining both types of games, teachers can leverage the advantages of modern technology while preserving the value of traditional, hands-on approaches in mathematics instruction, thereby achieving a comprehensive and balanced development of students.

*Analysis of Differences in the Use of Games for Assessment According to Grade Level*

To test the hypothesis *There is a statistically significant difference in the use of games for assessment with respect to grade level*, a $\chi^2$ test of independence was conducted on a 2×5 table (level of instruction × frequency of using games

for assessment). At a 5% significance level, it can be concluded that there is a statistically significant difference among the mentioned variables. The test results showed a statistically significant difference between the observed categories, $\chi^2(4) = 130.00$, $p < .001$.

In lower grades, games are almost never used for assessment (≈ 98.2% of responses ”never”; only ≈ 1.8% ”always”). In contrast, in upper grades, the distribution is relatively varied: most responses are ”sometimes” (≈ 31.5%), with a notable share of ”often” (≈ 15.7%) and ”always” (≈ 14.2%); about 26.0% of students answered ”never.” These patterns indicate that in lower grades, games are used for formative purposes without assessment, whereas in upper grades, they are occasionally or more frequently evaluated (Table 5).

**Table 5.**
*Differences in the Use of Games for Assessment by Grade Level*

| | **Never** | **Rarely** | **Sometimes** | **Often** | **Always** |
|---|---|---|---|---|---|
| **Lower primary education** | 98.2% | 0.0% | 0.0% | 0.0% | 1.8% |
| **Upper primary education** | 26.0% | 15.7% | 31.5% | 12.6% | 14.2% |
| **Total** | **59.8%** | **8.4%** | **16.7%** | **6.7%** | **8.4%** |

The use of games for assessment clearly differs according to the level of instruction: in lower grades, students experience games in a carefree manner and rarely associate them with evaluation, whereas in upper grades, games increasingly become part of assessment – most often occasionally, but not infrequently often or even always. This confirms the hypothesis regarding differences between primary (lower) and subject-specific (upper) teaching in the way games are evaluated. However, it is important to emphasize that this also raises a serious pedagogical issue: when games primarily serve as an assessment tool, they may lose their original meaning and appeal for students. The game transforms into a ”testing tool” rather than a stimulating and relaxing activity.

Numerous studies indicate that excessive emphasis on grades creates pressure for students, reduces intrinsic motivation, and encourages surface learning focused on short-term memorization rather than lasting understanding (Harlen & Deakin Crick, 2002; Kohn, 2011). Under such circumstances, students learn for the grade rather than for knowledge. As a result, content is quickly forgotten after assessment because it is not perceived as meaningful or personally relevant. This is also reflected in practice in upper grades, where children often report stress and anxiety related to assessment, while the spontaneity and playfulness that make games a strong motivational tool in lower grades almost disappear.

In lower grades, the emphasis on the carefree and spontaneous nature of games creates a positive atmosphere in which students learn through experience and interaction, and mistakes are seen as a natural part of the learning process. In upper grades, games can be a valuable tool for knowledge assessment, but only if used thoughtfully in a way that does not compromise their motivational power. If games become solely a means of evaluation, there is a risk that students will begin to associate them with anxiety and fear of failure, undermining the fundamental purpose of games in education – to foster curiosity, creativity, and active learning.

Ideally, a balance should be established between the motivational and evaluative functions of games. Games should maintain their playfulness and provide space for free exploration, while in certain situations, they can serve as a tool to check acquired knowledge. This allows students to perceive assessment not as a threat but as a natural and integrated part of the learning process. Gómez et al. (2022), in a systematic review of 65 empirical studies, confirm that game-based assessment is applied at various educational levels – from elementary school to university. The most frequent application was observed in secondary schools (23.1% of studies), followed by elementary schools (15.4%), and then universities (10.8%). However, the authors also caution that careful implementation is needed, as students may perceive games as ”just another test,” which diminishes their effectiveness and purpose.

In this context, the problem of excessive focus on grades in the educational system becomes even more pronounced. If children are constantly given the message that the final grade is the sole measure of success, learning loses its meaning, and games, instead of motivating, become symbols of control and evaluation. In the long term, this can lead to a loss of interest in mathematics, decreased creativity, and a lack of intrinsic motivation, which contradicts the fundamental goals of contemporary education that should aim to develop competencies rather than merely quantify results.

## CONCLUSION

The conducted research contributes to a deeper understanding of the role of games in mathematics instruction and represents a significant empirical contribution to pedagogical and didactic science. The results confirm all the proposed hypotheses and indicate the presence of statistically significant differences in the frequency, mode of implementation, lesson segment, type, and purpose of using games with respect to grade level. This confirms that the level of education has an important influence on the selection and implementation of games in mathematics teaching.

The study shows that manual games and group work are most prevalent in primary (lower) grades, where games retain their motivational, social, and

cognitive functions. In subject-based (upper) grades, however, a combination of manual and digital games predominates, and these games are increasingly used for both formative and summative assessment. These findings suggest a gradual transformation of approaches to learning mathematics, whereby games become a tool not only for motivation but also for assessment and monitoring of students' progress.

The scientific contribution of the paper lies in empirically confirming the effectiveness of didactic games in mathematics education, as well as in providing a detailed overview of their patterns of use across grade levels. In doing so, the study fills a gap in existing research within the Croatian context, where systematic investigations of game use in mathematics are scarce. The results may serve as a foundation for designing curriculum and methodological guidelines that encourage a balanced use of manual and digital games, aligned with learning outcomes and the development of students' key competencies.

The implications of the research point to the need for systematic integration of games into subject-based instruction, accompanied by enhanced professional support and methodological training for teachers, in order to increase the confidence and quality of their implementation. In this regard, games are confirmed as a research-based and pedagogically justified approach that contributes to higher student motivation, better understanding of mathematical concepts, and the development of a positive attitude toward learning mathematics.

For future research, longitudinal and experimental studies are recommended to examine the effects of systematic game-based instruction on student achievement and mathematics anxiety, as well as analyses of the impact of teachers' pedagogical competencies on implementation effectiveness. Such studies would further expand scientific knowledge about games as a didactic tool and strengthen the foundations for their more systematic and effective integration into mathematics education.

In conclusion, the results of this study confirm that games in mathematics instruction are not merely a methodological innovation but a scientifically grounded and empirically validated approach to learning that supports the achievement of curriculum goals, the development of mathematical competencies, and the creation of a stimulating and contemporary learning culture.

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