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TEACHING AND LEARNING FRACTIONS IN PRIMARY SCHOOL THROUGH EDUCATIONAL VIDEO GAMES

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Abstract/Izvleček
This study analysed the impact of incorporating Educational Video Games (EVGs) in teaching and learning fractions in primary school. A total of 218 fifth-grade students from two schools participated in a quasi-experimental study. Students in both groups followed the same curriculum framework for learning fractions, but the experimental group additionally incorporated EVGs as part of a blended learning approach that combined traditional instruction with EVGs in teaching and learning fractions. Results show higher achievement for students in the experimental group compared to their peers in the control group on all items of the knowledge test, highlighting the advantage of using EVGs in boosting students' interest in learning fractions.

Poučevanje in učenje ulomkov v osnovni šoli z uporabo izobraževalnih videoiger
V študiji analiziramo vpliv vključevanja izobraževalnih videoiger (IVI) v proces poučevanja in učenja ulomkov v osnovni šoli. V kvazieksperimentalni študiji je sodelovalo skupno 218 učencev petega razreda z dveh šol. Učenci v obeh skupinah so pri učenju ulomkov sledili istemu učnemu načrtu, pri čemer je ekperimentalna skupina v proces poučevanja in učenja ulomkov dodatno vključevala izobraževalne videoigre. Rezultati kažejo višje dosežke učencev v eksperimentalni skupini v primerjavi z njihovimi vrstniki v kontrolni skupini pri vseh postavkah preizkusa znanja, kar poudarja prednost uporabe izobraževalnih videoiger pri spodbujanju zanimanja učencev za učenje ulomkov.

Ključne besede:
poučevanje in učenje, ulomki, osnovna šola, izobraževalne videoigre.

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Introduction

Conceptual understanding of fractions and procedures for conducting arithmetic operations with them are among the most challenging concepts for many primary school students when learning mathematics. Difficulties emerge from the early years of primary school, when fractions are initially introduced to students (Kumta and Phusee-orn, 2024) and persist among students in upper levels of education (Kärki et al., 2022). Researchers admit that "fraction and decimal arithmetic pose large diffi-culties for children and adults, despite the prolonged and extensive instruction de-voted to these topics" (Lortie-Forgues et al., 2015, p. 217).

Learning fractions is crucial to building mathematical knowledge, as the proportional reasoning that underpins them is essential for comprehending other concepts, such as ratio, proportion, percentages, sequences, etc. The lack of understanding of frac-tions in primary school substantially affects students' capacity to handle more advanced topics in subsequent grades in mathematics and natural sciences. These circumstances prevent many students from pursuing higher education and careers in STEM disciplines and those related to ICT areas, which often lead to higher income and well-paid jobs that would contribute to a greater well-being (Yea and Kaci, 2023).

Studies show that students' learning and achievements are directly affected by the quality of instruction they experience (Mula and Hodnik, 2020). Therefore, many researchers have examined students' progress in learning fractions and provided te-achers with instruction on how to stimulate students' effective learning. In addition to using traditional instruction involving face-to-face activities, manipulatives, and various hands-on materials to learn fractions (Kumta and Phusee-orn, 2024), a growing number of researchers are advising teachers to be more creative and embrace educational video games (EVGs) as tools for supporting students in com-prehending fractions more successfully (Kärki et al., 2022). By engaging students in fun activities that combine play and learning simultaneously, teachers can spark students' curiosity and strengthen their commitment to learning fractions.

Recent studies highlight that there is a high level of consumption of digital games worldwide among young people (Dan et al., 2024) and estimate that "children 8 to 17 years of age spend an average of 1.5 to 2 hours daily playing video games" (Alanko, 2023, p. 23). The strong interest of students in digital games, primarily for enjoyment, has motivated many researchers to explore ways to harness their potential for educational benefits. In this regard, integration of EVGs into the teaching and learning process, accompanied by qualitative "targeted digital training and systemic support" (Miočić et al., 2025, p. 271) of teachers, is considered a promising approach.

To successfully incorporate EVGs into the learning process, teacher training programs must offer a balanced and critical perspective, focusing not only on effective use but also on raising awareness of potential negative consequences for students, such as the risk of overuse, distraction, "physical inactivity, sleep disturbances and mental health problems" (Dolenc and Fošnarič, 2025, p. 107). As agents of change, well-trained teachers who know how to integrate EVGs into educational activities can contribute significantly to channelling students' interest toward using these games for learning purposes. Although some teachers utilize digital technology in the teaching process, there are only a few studies that focus on examining the impact of video game-based learning in mathematics settings in primary schools. Since EVGs provide an attractive me-dium for students to acquire fraction knowledge during classes and homework, studying their impact on student achievements in countries with different socio-eco-nomic and cultural contexts is necessary. This is especially important because students' consumption of various digital technologies is rapidly increasing, and internet access is becoming the norm. This study aims to investigate whether the integration of EVGs affects students' learning of fractions, and to provide new insights about the importance of mainstreaming EVGs in learning fractions in primary school.

Theoretical Framework

There are primary school students who enjoy mathematics and find it easy to learn fractions. However, many others encounter problems in understanding them. Initi-ally, understanding fractions is less intuitive than understanding whole numbers, and their symbolic notation involves two numbers, a/b (both a and b are integers and $b \neq 0$), which presents an obstacle for many students to grasp them as an integrated expression. Additionally, students face difficulty in understanding different interpretations of fractions and in conducting arithmetic operations with them.

The limited use of fractions in everyday life hinders students' capacity to comprehend them easily (Getenet and Callingham, 2017). Furthermore, the symbolic bipartite notation of fractions with numerator and denominator poses a difficulty for many students to recognize them as a specific value (as a ratio of the numerator to the denominator) because they consider "that the numerator and denominator are separate values" (Van de Walle et al., 2021, p. 341).

Another challenging issue for many students is the conceptual understanding of fractions through different interpretations. Although fractions can be interpreted in five ways, such as: i) part-whole, ii) division, iii) ratio, iv) operator, and v) measurement, many researchers group them into two clusters, admitting that "there are two main meaningful interpretations of fractions that pertain to rational quantity, part-whole and measurement" (Zhang et al., 2020, p. 541). Given the proportional relationship that characterizes fractions, their interpretation as division, ratio, and operator is in-tegrated within the part-whole interpretation. This approach is particularly beneficial when teaching fractions in primary schools because it substantially simplifies their learning at this level of education.

The term *fraction* comes from the Latin term "fractus", which signifies a "broken" thing, so most people define a fraction as "a part of a whole" (Mousley, 2021). Since this definition is more related to the intuitive meaning of fractions, teachers often use it to introduce fractions through real-life situations, such as cutting pizzas or dividing candies. This interpretation is used for introducing fractions in many school textbooks because students' familiarity with "the part-whole concept of fraction is considered fundamental for developing an understanding of fraction concepts" (Ge-tenet and Callingham, 2017, p. 278). Certainly, a clear understanding of the propor-tional reasoning underlying the part-whole interpretation enables students to comprehend the meaning of fractions as a ratio and get an idea of equivalent fractions. It also supports students' understanding of fractions as an operator for calculating a particular subset of a total number of discrete objects (e.g., one-third of six apples). All these elements enhance students' capacity to comprehend more complex concepts about fractions later, such as the comparison of fractions, ordering of frac-tions, and their close relation to decimal numbers and percentages.

On the other hand, the interpretation of fractions as a measurement concept is more complex than the first concept and introduces the fraction as a point of measurement (e.g., on a measuring strip, there is a point that equals one-third of it). This interpretation refers to positioning fractions on number lines, where the length of the measuring strip represents the unit in the number line. Essentially, this interpretation supports students in understanding the concept of a fraction as a single value rather than simply viewing it as one number over another and recognizing it as a magnitude that can be aligned to a specific point on the number line.

A lack of understanding of what fractions represent can hinder students' ability to make sense of arithmetic procedures involving them. Technically, students who lack the concept of fractions as a single value tend to incorrectly apply the "shortcut" procedure for conducting addition and subtraction of fractions (e.g., 1/3 + 2/3 = 3/6), instead of linking fractions containing the same denominators to the concept of equal partitioning of the whole and continuing with simple addition of numera-tors (the parts) to find the result. The situation becomes increasingly complex when students need to add or subtract fractions with different denominators. They often struggle to understand why they need to find a common denominator and use equi-valent fractions in these cases.
Regarding multiplication, although the procedure is less complicated, requiring the multiplication of numerators and denominators, some students still feel insecure about whether they have done it correctly (e.g., ½ · ½ = 1/4). Being affected by an earlier experience with whole numbers, where the product of two whole numbers is equal to or greater than each factor, some students face difficulty understanding that there are cases when the product of two fractions can be smaller than each of the multiplicands.
Learning through play is assumed to be the most effective "strategy to promote student engagement, inclusion, and holistic skills development" (Parker et al., 2022, p. 1), particularly in primary school. Therefore, the integration of EVGs into the educational process is considered by many researchers as an asset for overcoming students' obstacles to understanding fractions through play and maximizing their potential in learning them (Kärki et al., 2022; Kiili et al., 2018). The EVGs, as supportive environments that enable primary school students to learn through play, contribute to "enhancing both academic achievement and creative capacity" (Nguyen et al., 2025, p. 307) of students.

Educational Video Games for Teaching and Learning Fractions

Creating a stimulating environment that makes learning mathematics, and particularly fractions, more student-friendly is imperative for many primary school teachers. In this context, the integration of EVGs in mathematics classes is perceived as a valuable advantage for inspiring students' learning of fractions, mainly because of their "unique characteristics (such as fantasy, rules/goals, sensory stimuli, challenge, mystery, and control) that can increase learning motivation" (Matić and Bokun, 2024, p. 335). The situational interest generated through sensory stimuli in EVGs enhances students' incentive to play the game and simultaneously encourages them to perform specific learning tasks. Indeed, studies show that integration of play has a positive impact on primary school students' learning, since it provides a relaxed and engaging environment that encourages a smoother and deeper understanding of concepts (Burke and Williams, 2012), longer retention of acquired knowledge (Dean and Kuhn, 2007), and better skills to apply the knowledge to solving novel problems (Purpura et al., 2016). Considering this, the incorporation of specifically designed video games to promote learning can significantly improve the attention of primary school students to learn mathematics in general (Hartono et al., 2016), and fractions in particular (Kiili et al., 2018).

Among many EVGs designed for teaching and learning fractions, the most important ones are those that are neither too easy nor too hard to play. Certainly, if EVGs are easy to play and involve simple tasks related to fraction learning, many students may find them boring and leave them. On the other hand, games that are overly challenging and embed difficult tasks tend to reduce students' interest in completing them. In both situations, students tend to leave the game, which consequently results in missing the opportunity to achieve the fraction-related learning outcomes that were the aim of gameplay. Therefore, the most effective EVGs are those that support student learning while students are within their zone of proximal development (Plass et al., 2015), and guided instruction through an individual tutor/mentor is needed to master a particular content or skill. In this context, EVGs, especially those designed with varying levels of difficulty and providing scaffolding assistance "that goes just slightly beyond the learner's current competence, complementing and building on their existing abilities" (Shabani et al., 2010, p. 239), are the most bene-ficial ones, because they can replace to a certain extent the tutor's support. Sound effects, rewards, special prompts, and suggestions to progress or not to higher game levels provide substantive feedback for students to assess their success or failure in solving a certain task. The given feedback supports the self-regulation of students, especially in cases of failure, as it enables them to reflect on mistakes and improve their self-efficacy by repeating games and achieving the highest levels (Bell and Gre-salfi, 2017). This can be especially helpful for students who hesitate to learn or have lost interest in learning fractions. The opportunity to replay the games, pay attention to personal mistakes, and accurately reflect and learn from them enables students to catch up and improve their cognitive capacity and learning skills.

Although many commercial companies have recognized the benefits of video games and designed them for various purposes, including generating revenue, others provide free access to their EVGs. This is especially beneficial for teachers and students in lower and middle-income countries, as it enables them to use these materials regardless of their school's budget or family incomes. One of the online platforms that offers free access to EVGs on fraction learning in primary schools is the *Math Playground* platform (https://www.mathplayground.com/). This platform contains a collection of EVGs categorized by grade that support students in understanding dif-ferent curriculum-based notions concerning fractions, such as the part-whole interpretation of fractions (*Pizza Panda, Unit Fractions 1* and *2*), the complement of a pro-per fraction (*Galaxy Pals Fraction*), the equivalence of fractions (*Triplets, Equal Frac-tions 1* and *2*), the comparison of fractions (*Tug Fractions*), fractions of amounts (*Thin-king Block Fractions*), and the measurement interpretation of fractions (*Find the Bus Stop, Number Line Hunt*). It also contains video games related to three arithmetic ope-rations with fractions, such as addition, subtraction, and multiplication of fractions (*Add Fractions, Speedway Fractions, Multiply Fractions, Multiplayer Lobby*), etc. These video games contain simple instructions that lead students to play games and assess their success by collecting stars, trophies, and enjoying pleasant sound effects. They also provide unpleasant sound effects and simple feedback in cases of mistakes. The sensory feedback they receive while playing, along with the overall feedback at the end, may provide the essential support students need.

Primary school students in Kosovo performed poorly on the TIMSS 2019 international mathematics test, ranking Kosovo 49th out of 58 countries (Mullis et al., 2020). A substantial part of this test involved tasks with fractions. For this reason, this study aimed to investigate whether combining traditional instruction with EVGs impacts student understanding of fractions and improves their accuracy in performing arithmetic operations with fractions. The EVGs of the *Math Playground* platform were utilized for conducting this study, owing to free access and the possibility they offered to achieve learning outcomes related to the Grade 5 mathematics cur-riculum about fractions in Kosovo.

Methodology

Research Aim

This study sought to explore the impact of blending traditional instructions and EVGs, as complementary to each other, in supporting Grade 5 school students in learning fractions. Since boys are recognized as more frequent users of video games than girls, this study also investigated whether there was a gender difference in learning fractions in classes where a blended learning approach was implemented. The questions that guided this research study are listed below:

1. To what extent does the blended learning of traditional instruction and the use of EVGs support Grade 5 students' conceptual understanding of fractions and accuracy in performing arithmetic operations with fractions?

2. Are there any gender differences in students' achievement when EVGs are integrated into the teaching and learning of fractions?

Methods

This study employed a three-week quasi-experimental research design to evaluate student progress in learning fractions. To implement this study, two schools in two different cities of Kosovo were selected to participate. Fifth-grade students from a school in Prishtina were chosen to form the experimental group. On the other hand, fifth-grade students from a school in Gjakova were selected to represent the control group. This offered the possibility for limited communication among teachers and two groups of students who participated in the research. The two chosen schools had similar characteristics, including the number of students in the primary level and the socio-economic status of their families. Eight teachers who taught both groups of students had a master's degree in mathematics education and similar average years of professional experience (Table 1). Since the video games on the *Math Playground* platform contained simple instructions in English (not in the students' native lan-guage), the teachers of the experimental group were instructed to demonstrate the video games to the students to overcome potential language barriers they might en-counter while playing.

Table 1
Teachers' characteristics of both groups

	Mean age of teachers	Average years of professional experience
Exp. group	40.50	14.25
Cont. group	42.00	16.50

Sample and Research Instruments

A total of 218 fifth-grade students participated in this study. Four Grade 5 classes from the school in Prishtina were assigned to the experimental group, and the other four Grade 5 classes from the school in Gjakova were included in the control group. Parental permission for participating in the study was obtained for all students. The distribution of students per group and gender is shown in Table 2.

Table 2
The distribution of students per group and gender

	Exp. Group	Cont. Group
Female	54	50
Male	58	56
Total	112	106

Initially, a pretest was designed with 8 items on fractions and their addition and subtraction (similar to the tasks students had learned in the previous academic year). Both groups of students completed the pretest on the same day, before the start of the experimental phase of the study. Furthermore, all Grade 5 students from both groups attended 15 regular mathematics classes over three weeks of the experimental phase as outlined in the mathematics curriculum. Students in the experimental group spent half of their mathematics classes (20 min.) receiving traditional instruction on fractions, and the remaining part of the time (20 min.) practicing fractions through playing video games on the *Math Playground* platform. As for the students in the con-trol group, they attended lessons that followed only the traditional instruction on fractions throughout the 40-minute mathematics classes.
A knowledge test with 10 items clustered into two sections was designed and piloted to assess students' knowledge of fractions (Appendix). The first section included six items, five of which were intended to assess students' understanding of fractions as a part-whole relationship, and the sixth one was designed to evaluate students' suc-cess in understanding the measurement interpretation of fractions by presenting them in a number line. The second part of the test included four items. Each of the first three items required performing one of the three arithmetic operations with fractions: addition, subtraction, or multiplication, whereas the fourth item involved solving a task that included all of these. The piloting of the paper-and-pencil knowledge test related to fractions was done with 29 students from one Grade 5 class. The Cronbach's alpha for all items on the knowledge test was 0.853, indicating a satisfactory level of reliability for this instrument. After three weeks of the experimental phase, a knowledge test was administered to both groups of students to assess their achievement in learning fractions.

Data Analysis
The results of the students on both tests satisfied the assumptions for conducting the parametric tests. Specifically, the variance was homogeneous between the performance of the two groups of students, and the data were measured on an interval scale. Therefore, an independent t-test was applied to conduct the statistical analysis of the students' results.
Levene's test for the difference between students' results in the two groups on the pretest was not significant ($p = .423$), indicating that the variances between the students' results were roughly equal (Table 3). An independent samples t-test implementation showed that the difference between the means of the pretest scores was not statistically

significant (p = .524), indicating that students' knowledge of fractions in both groups was approximately at the same level before the study. Regarding the differences in students' pretest scores based on gender, the independent samples t-test did not reveal any significant difference (p = .467) between boys' and girls' pre-test scores.

After the experimental phase implementation, the knowledge test was delivered to all students on the same day. An independent t-test was implemented to analyse the students' results, and the mean and standard deviation were used as a statistical model to present students' results in the knowledge test.

Table 3
Descriptive statistics (M and SD) of students' results on the pretest and the comparison of the means of the two groups

Descriptive statistics			Levene's test		t-test for the quality of means		
	M	SD	F	Sig.	t	df	p < .05
Exp. group	4.71	.941	.644	.432	.639	216	.524
Cont. group	4.63	1.067					

Results

After attending three weeks of mathematics classes focused on fractions, a knowledge test consisting of 10 items was administered to all students. All items in the test were scored dichotomously: correct/incorrect, except for item 6, which had an additional option of partially correct. The mean and standard deviation of students' results on the knowledge test in both groups are presented in Table 4. This table also contains the independent samples t-test results for comparing the means of the students' results in the two groups.

Table 4
Descriptive statistics (M and SD) of students' results on the knowledge test and the comparison of the means of the two groups

Descriptive statistics			Levene's test		t-test for the quality of means		
	M	SD	F	Sig.	t	df	p < .05
Exp. group	8.08	1.683	.772	.381	6.106	216	.001
Cont. group	6.67	1.728					

The table above reveals that the meaning of the students' results in the experimental group on the knowledge test is M = 8.08 with SD = 1.68, while the corresponding values of their peers' results in the control group are M = 6.67 and SD = 1.73.

As for the equality of variances, Levene's test (Table 4) indicated that the difference in the variance between students' scores in the two groups on the test was not significant

(p = .381). The implementation of an independent samples t-test on the students' scores revealed a statistically significant difference between the means of the test scores of both groups, $t(216) = 6.106$, $p < .05$. This difference represents a medium effect size, $r = .38$, meaning that the interplay of EVGs with the traditional approach has a moderate impact on student performance in learning fractions. Specifically, students from the experimental group who learned fractions through blending EVGs with traditional instruction outperformed their counterparts in the con-trol group, who learned by following the traditional approach.

A comparative analysis of the students' results on the knowledge test reveals that students in the experimental group outperformed their counterparts on all test items (Figure 1). Furthermore, the answers of students from the experimental group on all items of the knowledge test are positive in at least 60% of cases, while in the control group, there are three items where the percentage of positive responses is below 60% and in two of them, it even falls below 40%.

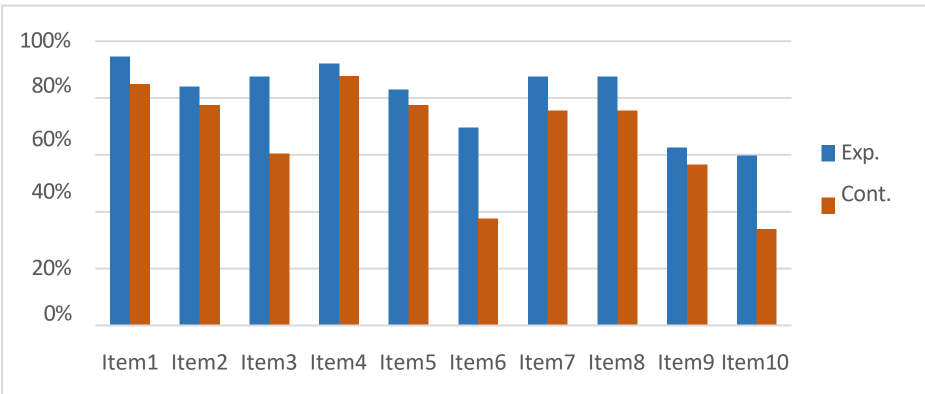

Figure 1
The percentages of students' correct results for both groups on the knowledge test

Among the first five items on the knowledge test that were intended to assess stu-dents' understanding of the part-whole interpretation of fractions, the highest difference among the percentages of students' results in both groups (almost 30 percen-tage points) is found in Item 3, which is linked to equivalent fractions. The additional use of the video games *Triplets* and *Equal Fractions 1* and *2*, which embedded a variety of tasks and different levels of difficulty to associate equivalent fractions during ga-meplay, helped a substantially higher number of students in the experimental group to better understand this concept and attain higher results compared to their coun-terparts, who learned it more formally by following traditional instruction.

As for item 6, participants in the experimental group outperformed their peers in the control group by 32 percentage points in associating fractions with points on the number line. This indicates that the use of the video games *Find the Bus Stop* and *Number Line Hunt* supported a higher percentage of students in the experimental group than in the control group (70% compared to 38%) to construct better knowledge about the most difficult concept related to fractions: the measurement interpretation of fractions.

The same pattern of higher achievement for students in the experimental group is also evident in the second part of the test (items 7-10). While the advantage of the students in the experimental group in solving items 7-10 correctly is obvious, a wider gap exists among students' results in solving item 10, which asked them to perform all three arithmetic operations with fractions. A high difference of 26 percentage points in favour of the students of the experimental group indicates that more students in the experimental group than in the control group (60% compared to 34%) have learned the order of operations with fractions and mastered the skills to solve tasks that embed more than one arithmetic operation with them.

Students' Gender Performance in Understanding Fractions Through EVGs

Since there is a general perception that boys are more addicted to video games than girls, this study investigated whether there was a gender difference in learning fractions when the EVGs were used during the teaching and learning activities. Regar-ding the gender performance of students in the experimental group, the independent samples *t*-test results show that boys performed significantly better than girls on the knowledge test. The mean of boys' results (M = 8.45) is slightly higher than the meaning of girls' results (M = 7.69) (Table 5), and the effect size is relatively small with r = .228. These results reveal that in the experimental group, boys learned fractions more effectively than girls when assisted by EVGs. However, these results also show that girls are not left behind, and they are successfully progressing in this context.

Table 5
Descriptive statistics (M and SD) of students' results in the experimental group based on gender, and the comparison of the means of both groups

Descriptive statistics			Levene's test		*t*-test for the quality of means		
	M	SD	F	Sig.	t	df	p < .05
Male	8.45	1.591	.395	.531	2.452	110	.016
Female	7.69	1.703					

Discussion

Learning fractions is a key concept in the primary school mathematics curriculum that stimulates and predicts students' later mathematics achievement. The poor results of many primary school students in learning fractions pose a concern for many stakeholders in the educational community (Mullis et al., 2020). It mobilizes them to take action in addressing this issue and recommending ways to improve it. The findings from this study indicate that integration of EVGs as learning tools leads to higher achievement among Grade 5 students in learning fractions. Students in the experimental group scored significantly higher on the knowledge test (M = 8.08, SD = 1.68) compared to students in the control group (M = 6.67, SD = 1.73). The medium-sized effect (r = .38) observed between the experimental and control gro-ups, while not large, is sufficiently meaningful to show that integrating EVGs in learning fractions positively affects student outcomes. This finding suggests that integration of EVGs contributes to improved performance of students in learning fractions, though additional factors may also influence it, such as differences in tea-cher characteristics (such as age, experience, or approaches towards students), school context, socio-economic status of students, etc. The advantage of students in the experimental group compared to their peers in the control group in Kosovo is consistent with findings from other countries (Kärki et al., 2022; Kiili et al., 2018), indicating that integrating EVGs in the educational process can act as a "catalyst" for learning fractions. Furthermore, it shows that "creative engagement boosted student confidence and motivation, which in turn contributed to improved learning" (Nguyen et al., 2025, p. 317).

The substantial achievement by students in the experimental group is the result of a successful combination of three crucial factors: the careful selection of EGVs, the correct implementation of the model plans by teachers who taught students of the experimental group, and the educational context that required students to grasp frac-tion-related concepts in the first part of the lessons and consolidate their learning through playing games in the second one.

The selection of EVGs for learning purposes is the most important factor in facilitating students' learning of fractions. Not all video game implementations yield hig-her achievement in learning fractions (Zhang et al., 2020). Therefore, the beneficial video games are those that are high-quality and well-designed, grounded in pedago-gical principles, capable of engaging students, sustaining their motivation to play and learn, and, more importantly, providing feedback to support their success or guide improvement through incentives that are part of a learning system. Since the EVGs from the *Math*

Playground platform fulfilled these criteria, were free of charge, and supported Grade 5 students at primary school in Kosovo in achieving learning out-comes related to fractions, these video games are used in this study. The use of EVGs from the *Math Playground* platform has been effective, as students in the expe-rimental group performed better than their peers on all items from the knowledge test, with the largest percentage differences in students' results found in three items, which are related to the most difficult concepts of fractions and operations with them, such as equivalence of fractions (item 3), association of fractions with points in number line (item 6), and conducting more than one arithmetic operation with fractions (item 10).

A close analysis of students' work in solving item 3, which required them to find the equivalent fractions when the denominator is not a factor of the other one, as in the case 4/10 = /25, shows that besides solving it through extending fraction by a decimal number (a kind of repeated addition in this case), which was the typical way that students of the control group used (Figure 2), there were students in the expe-rimental group who solved the task in a novel way (Purpura et al., 2016) by perfor-ming two operations, by easily simplifying and expanding fractions with natural numbers (Figure 3). As a result of implementing both approaches, a substantially higher percentage of students in the experimental group (88%) than in the control group (60%) solved it correctly.

As for the measurement interpretation of fractions (item 6), similar to students' re-sults in other countries (Kiili et al., 2018; Zhang et al., 2020), the incorporation of creative online games that engage students in designing number lines and associating various fractions with their numerical representations has proven to be more effec-tive in enhancing students' understanding of the magnitude of fractions and their relationship to points on the number line. Similarly, learning and playing through EVGs helped students in the experimental group to excel at solving tasks that required performing one or more arithmetic operations with fractions.

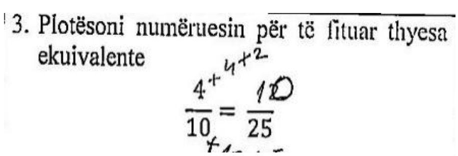

Figure 2
Solution done by a student of the control group

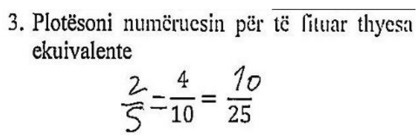

Figure 3
Solution done by a student of the experimental group

The successful implementation of the blended learning instructional model in mathematics requires well-trained teachers. In a technology-rich environment filled with various educational video games, the teacher's role is crucial in identifying and implementing suitable games that enable students to both play and learn fractions. As Drijvers (2015) stated, "the integration of technology in mathematics education is not a panacea that reduces the importance of the teacher. Rather, the teacher has to orchestrate learning" (p. 148) through a blend of conventional paper-and-pencil instruction and engaging video games that capture students' interest to learn in a fun and playful way. The success of students in the experimental group is a result of their teachers' readiness to adopt new roles, such as being more active in explaining content and facilitating students' work during the first part of the lessons and transfor-ming to a coaching role in supporting students' utilization of EVGs in the second part, as instructed by the authors of this article. For independent work with students, teachers should receive professional assistance in identifying and implementing various EVGs into the teaching and learning of fractions and other mathematical concepts. Since digital technology is rapidly evolving, the continuous professional development of teachers in ICT should be a priority in educational settings. Also, teachers should receive structured pedagogical guidance on how to "encourage active play, limit excessive screen use, and promote healthy habits" (Dolenc and Fošnarič, 2025, p. 109) among students using EVGs for learning.

Regarding the educational context, similar to a study conducted by Zhang et al. (2020), learning different concepts about fractions during the first part of the lesson and practicing them through intertwining learning with play in the second part, in equal portions, resulted in an effective strategy. This approach has motivated students in the experimental group to stay highly focused during the first part of the lessons and grasp various fraction-related concepts before applying them in specific games during the second part. Since learning was complemented by fun and pleasure, this experience enabled students in the experimental group to construct a deeper understanding of fractions and achieve better results in the knowledge test about fractions.

Recent trends indicate that the use of digital technology is increasing in all areas of life, including mathematics classes. For successful implementation, teachers need to be supported in their efforts by "offering hands-on experience with commonly used tools and fostering mentorship from digitally proficient peers" (Miočić et al., 2025, p. 283), as the integration of digital technology into the educational process is no longer just an innovative method, but a necessity for moving forward in a digitalized society that is transforming the ways we learn, disseminate knowledge, live, work, communicate, and, most importantly, interact.

Conclusions and Recommendations

Normally, it is not easy to maintain the attention of primary school students for 40 minutes in a lesson. To address this concern, teachers are trying to implement effective learning approaches that offer the possibility to attract students' interest throughout the lesson. This study demonstrates that learning fractions in primary school can be both engaging and effective if the lesson structure is well-designed, especially by combining the learning of fractions in the first part of the lesson with playing related games during the second part, which can bring some relief to students and even increase their attention and commitment towards learning. Indeed, learning through games creates a friendly environment that brings satisfaction and positive emotions to primary school students towards mathematics. It increases students' zeal to play and learn independently based on their personal needs, by reflecting and using feedback provided through various visual, musical, and other game features.

However, it is crucial to note the fundamental role of the teacher in this process, as their responsibility is to identify EVGs that are grounded in pedagogical instruction to support students in understanding fractions and mastering operations with them. A total of 218 students from two schools located in different cities participated in this quasi-experimental study. To gain a deeper understanding of how the integration of EVGs affects mathematics learning in primary schools, especially in the area of fractions and from the gender perspective it is important to conduct studies with a larger number of participants from more schools. This would support the generalization of the results to a broader population.

Disclosure Statement

Both authors of this article declare that there is no conflict of interest.

Data Availability Statement

The article is based on data fully presented and discussed within the article itself; therefore, no additional data archiving is required.

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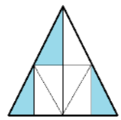
Appendix

Knowledge test on fractions and arithmetic operations with fractions

1. Write the fraction that represents the coloured part of the given figure. 	**2. Write the fraction that represents the uncoloured part of the triangle.** 
3. Complete the numerator to get equivalent fractions **4** **=** **10 25**	**4. In the given set of stars** **2 of 15 stars = stars.** **5** 
5. A package has 10 candies. 2 3 packages **5** **have __candies.**	**6. Present 4 and 1 3 on the number line.** **5 7** 
7. Calculate **2 3 5** **7 + 4 + 14 =**	**8. Calculate** **5 1 1** **6 − 2 − 5 =**
9. Calculate **2 □ 1 =** **5 4**	**10. Calculate** **1 3 2 5** **+ □** **3 4 3 12**

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