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IMPACT OF "DONKEY", "SNAP" DAN "KING" (DSK) NON-DIGITAL GAMIFICATION CARDS ON FOURTH-GRADE STUDENTS' MATH PERFORMANCE IN FRACTIONS

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ABSTRACT

This research investigates the impact of Non-digital Gamification (NDG) techniques on students' math achievement, focusing on Fractions. Utilizing a quasi-experimental design, the study involved 100 primary school students in Perak. Two groups were formed: the control group, which followed traditional teaching methods, and the experimental group, which experienced NDG learning approaches. The findings indicate that students using NDG perform better in math (fractions) assessments compared to those using conventional methods. This study provides empirical evidence supporting the efficacy of NDG in teaching Fractions. The results underscore the potential for educators to innovate and enhance gamification tools, particularly in mathematics, contributing to educational advancements aligned with the goals of the Malaysian Ministry of Education.

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1. INTRODUCTION

It is intriguing to observe the intricacies of the challenges students encounter when grappling with fractions, a topic underscored by the comprehensive study conducted by Setambah et al. (2021). This study delves into the specific difficulties' students face, shedding light on the nuanced aspects of their struggles with understanding and working

with fractions. The findings not only contribute valuable insights to the field of education but also prompt a deeper reflection on the pedagogical approaches employed in addressing these challenges. The urgency of studying the fraction problems identified by Setambah et al. (2021) lies in their foundational importance to mathematical understanding, the widespread prevalence of these challenges among students, the unique insights provided by the study, the potential long-term impact on students' academic trajectories, and the opportunity it presents to refine pedagogical strategies for more effective education. The identified misconceptions and problems shed light on common difficulties in understanding and working with fractions. Let's discuss each of the mentioned issues: (i) Lack of Understanding of Addition and Subtraction of Fractions: This misconception suggests that students struggle with the fundamental operations involving fractions. It could be related to not grasping the concept of a common denominator, which is crucial for adding and subtracting fractions; (ii) Difficulty Changing the Denominator of the Same Fraction: Changing the denominator while keeping the fraction's value unchanged is a fundamental skill. Students might find it challenging to manipulate fractions to have a common denominator, which is necessary for addition and subtraction; (iii) Miscalculation in Fractional Operations: Making errors in basic calculations involving fractions can be a result of not understanding the rules of fraction operations. This could include mistakes in multiplication, division, addition, or subtraction; (iv) Lack of Knowledge in Converting Mixed Fractions to Improper Fractions and Vice Versa: Understanding the relationship between mixed fractions and improper fractions is crucial. Students may struggle with converting between these forms, affecting their ability to perform operations involving mixed numbers; and (v) Incorrect Implementation of Fractional Processes: This general category could encompass a range of errors, including application mistakes in various steps of working with fractions. It might involve misinterpreting the question, using the wrong operation, or not following the correct steps in the given problem.

The identified misconceptions, such as adding fractions in parallel (numerator and numerator) and errors in adding denominators and numerators separately, indicate a need for targeted instruction and clarification. For instance, when asked to add 1/4 and 2/3, a student may mistakenly add the numerators (1 + 2 = 3) and the denominators (4 + 3 = 7) separately, resulting in the incorrect answer 3/7. The emphasis on instruction as the main problem to be addressed in addressing misconceptions in mathematics, particularly with fractions, is grounded in its pivotal role in shaping foundational learning, clarifying misconceptions, developing procedural knowledge, employing effective pedagogical strategies, identifying common misconceptions, cultivating mathematical reasoning, promoting conceptual understanding, and providing equitable learning opportunities for all students (Tanujaya et al., 2017).

Here are some strategies that educators can employ to address these specific misconceptions. (1) Clear Conceptual Understanding: Emphasize the fundamental differences between whole numbers and fractions. Make sure students understand that fractions represent parts of a whole, and the rules for arithmetic operations are different from those for whole numbers (Setambah et al., 2021). (2)Visual Models: Use visual representations, such as fraction bars, circles, or rectangles, to help students visualize the addition and subtraction of fractions (Doğan & Tertemiz, 2020). This can aid in developing a more intuitive understanding of how fractions combine or separate. (3) Hands-on Activities: Provide hands-on activities that involve manipulating physical objects to represent fractions (Rahaju & Hartono, 2017). This can help students concretely experience the combination or separation of fractional parts. (3) Real-world Contexts: Connect fraction operations to real-world scenarios to make the concepts more meaningful. Relate adding and subtracting fractions to situations involving sharing, dividing, or combining quantities

(Copur-Gencturk, 2021). (4) Comparing Fractions: Reinforce the importance of finding a common denominator when adding or subtracting fractions. Help students understand why a common base is necessary for these operations (Setambah et al., 2021). (5) Error Analysis: Encourage students to review and analyse their mistakes. Discuss common misconceptions as a class, allowing students to learn from each other's errors. (6) Gradual Progression: Scaffold the learning process by starting with simpler examples and gradually increasing the complexity of fraction problems. This approach helps students build a solid foundation before tackling more challenging concepts.

The connection between mastery of fractions and future success in algebra and mathematics, as mentioned by Siegler and Lortie-Forgues (2015), underscores the importance of addressing these misconceptions early in a student's education. Fractions, deemed a critical component of mathematical understanding and a gateway to various occupations, have been shown to uniquely predict subsequent gains in mathematics knowledge, transcending traditional class settings to play a vital role in physical, biological, and social sciences, as well as in middle-income occupations; consequently, they are a major focus in elementary and middle school curricula, according to the Siegler and Lortie-Forgues (2015), with students expected to develop an understanding of fraction magnitudes in Grade 3, gain competence in fraction arithmetic and word problems from Grade 4 to Grade 6, and apply fraction arithmetic to problems involving ratios, rates, and proportions in Grade 6 and Grade 7. By providing targeted support and using varied instructional strategies, educators can help students develop a strong understanding of fraction operations, laying the groundwork for success in more advanced mathematical concepts.

The emphasis on effective teaching and the use of teaching aids, as highlighted by Noh et al. (2016), is crucial in addressing misconceptions related to fractions. Educators employ diverse strategies such as real-life examples, manipulatives, interactive activities, technology integration, differentiated instruction, ongoing assessment and feedback, scaffolded learning, and collaborative approaches to create a comprehensive and engaging learning experience. But in this research, Researcher are limit to teaching aid. Teaching aids play a pivotal role in enhancing students' understanding of subjects, minimizing confusion, and fostering success in learning Mathematics by providing clarity and facilitating a direct connection between the teacher's intelligence and student influence; serving as wonderful teaching tools, TAs contribute to a friendly learning atmosphere in the classroom through activities such as body language, eye contact, facial expressions, allowing student participation, and personal engagement, ultimately bridging the gap between teachers and students; teachers, acting as models, narrators, singers, presenters, dancers, and friends, encourage active student participation, keeping them alert and promoting efficient learning in the process (Rezli & Phoong, 2022).The integration of innovative teaching materials can significantly enhance the learning experience and promote better understanding among students. By investing in the development and implementation of innovative teaching aids, educators can create an enriched learning environment that addresses the specific challenges students face with fractions. The combination of visual, hands-on, and interactive materials can contribute to more effective teaching, clearer explanations, and improved conceptual understanding of fractions (Doğan & Tertemiz, 2020; Rezli & Phoong, 2022; Setambah et al., 2021).

Teachers are expected to undergo transformation and reform in practicing teaching and learning methods that foster skills and enhance the added value of human capital. This can begin with the development of appropriate teaching and learning materials, where innovative materials can have a more significant impact. An alternative approach recently considered by teachers and educators in schools is the non-digital gamification (NDG) approach. This approach involves elements of fun, exploration, and active experiences to

advance learning through features such as challenges, interest, self-expression, exposure, immediate feedback, clear objectives, player control, coordinated efforts, competition, rewards, and low risk (Ke et al., 2016). For example, the " Donkey", "Snap" dan "King" (DSK) Non-Digital Gamification Cards " represents a dynamic and engaging educational approach that integrates multiple elements to enrich students' comprehension of fractions. In this gamified learning experience, students embark on a captivating quest, encountering challenges that involve real-life scenarios with immediate feedback for misconceptions. The game promotes self-expression, allowing students to creatively demonstrate their understanding, while clear objectives align with curriculum goals. With player control enabling individual exploration, collaborative efforts, and friendly competition through features like leader board rankings, the game fosters a motivating environment. Rewards for achievements and a low-risk setting encourage students to experiment with fraction concepts, making learning an enjoyable and impactful game.

In the NDG approach, existing physical game models such as cards, dice, board games, or innovations from the teachers themselves are used. Solving problems or tasks during the game gives students the freedom to plan strategies, explore, and find solutions without intervention from the teacher (Park & Lee, 2017). NDG provides teachers with opportunities for formative assessment as they observe students' actions, decisions, and interactions during gameplay. This insight into individual and group dynamics informs the teaching process. The NDG approach provides a clear presentation of specific processes and activities involving tasks where players engage manually, giving them exposure to how things are done in the real world (Radzi et al., 2017). This approach encourages critical thinking and provides opportunities for teachers and students to discuss how to improve the game in terms of rules and gameplay to add elements of fun, challenge, and competition (Hromek & Roffey, 2009).

In contrast, conventional learning uses the 'chalk and talk' approach, where teachers deliver content, and students are then asked to analyze information in textbooks while engaging in drill activities for reinforcement (Nair et al., 2014). Comparing digital gamification (DG) and NDG, a study by Fang et al. (2016) found significant differences between digital and traditional board games, with traditional games providing better social interaction. According to Fang et al. (2016), students feel more familiar, empathetic, and satisfied when playing traditional Monopoly board games. Rahutami et al. (2019) further indicate that direct interactions (visual, verbal, physical) in NDG have a greater impact on players than just verbal/audio interactions in DG. Therefore, considering social factors such as critical thinking, collaboration, communication, and respecting opponents, NDGBL is considered superior to DG (Rahutami et al., 2019). In general, findings from past studies suggest that NDG enhances performance by providing a more enjoyable and active learning environment. Apart from creating an engaging learning environment, a well-designed NDG approach can improve skills such as interaction, teamwork, investigative skills, information assessment, and decision-making (Chung et al., 2017).

NDG present distinct advantages over digital games in educational settings. One key advantage is their low cost, as NDG typically requires minimal resources and doesn't involve expenses related to devices or software. The ease of implementation is another noteworthy benefit, as NDG doesn't require technological setup or concerns about compatibility, making it accessible for quick integration into lesson plans. Furthermore, NDG promotes inclusive accessibility, ensuring that all students can participate regardless of their access to digital devices, making it particularly suitable for schools with varying levels of technological infrastructure. The tactile learning experience offered by NDG, involving physical manipulation of game components, enhances engagement and understanding, providing a multisensory approach that may be more limited in digital environments. NDG encourages

face-to-face interaction among students, fostering communication, collaboration, and cooperative problem-solving, skills that may be less emphasized in digital games, which often involve individual screen time. Additionally, NDG often mirrors real-world scenarios, providing students with tangible connections to practical applications of theoretical concepts. The minimal reliance on screens addresses concerns related to screen time and contributes to a healthier learning environment. Overall, the adaptability, inclusivity, tactile learning, and social interaction aspects make NDG a practical and effective choice in various educational settings.

Past studies have been conducted to examine the role of the NDG approach in various subjects such as English grammar (Cesur, 2019), biology (Ramly et al., 2017), chemistry (Bankole, 2018), and accounting (Jamaluddin et al., 2016), and the benefits of NDG have been confirmed in these studies. In the context of learning Mathematics, several studies have also been carried out to investigate the effectiveness of NDG in learning various topics/subtopics in Mathematics, such as algebra (Michael & Anugwo, 2016), geometric shapes (Chung et al., 2017), geometric lines (Busadee & Klieosinak, 2017), numbers (Elofsson et al., 2016; Scalise et al., 2020), and angle measurement (Vitoria et al., 2020). These studies collectively highlight the positive impact of the NDG approach on learning outcomes in Mathematics across diverse content areas.

Specifically, the NDG method was found to introduce enjoyable and meaningful learning processes that enhance the interest, engagement, and achievement of high school students in learning geometric lines in the study by Busadee and Klieosinak (2017) (e.g., using cards to learn basic geometry) and in learning geometric shapes in the study by Chung et al. (2017) (using board games). (Vitoria et al., 2020) found that the understanding of primary school students about angle measurement for two-dimensional shapes is better when using the NDG approach compared to conventional teaching methods. In particular, the NDG group (learning using the 'snake and ladder' board game) showed improvement in attention, interaction, and performance throughout three learning sessions. It is argued that the nature of the game that allows students to work in small groups and compete with each other fosters cooperation and communication through group discussions; for example, to ensure that all group members understand how to correctly implement the fraction card game for fraction operations. As for the fraction topic, several past studies have investigated learning the topic using various teaching methods (Doğan & Tertemiz, 2020; Rahaju & Hartono, 2017; Rezli & Phoong, 2022). However, no previous studies have focused on NDG.

The findings from the literature review also indicate that NDG is seldom explored to enhance mathematical achievement, especially in primary school mathematics. This is evident from past studies conducted by Grangeia et al. (2019), Hanus and Fox (2015), Aldemir et al. (2018), Mavletova (2015), Leclercq et al. (2017), Mitchell et al. (2017), Tu et al. (2019), and El-Hilly et al. (2016). Therefore, the need to conduct NDGBL studies in mathematics education, especially in primary school mathematics, is highly crucial, and examining the impact of NDGBL is warranted, particularly in enhancing students' interest in mathematics education. In the context of the study, NDGBL involves using gamification kits developed by researchers.

There are various topics covered in mathematics for students in grades 1 to 6, such as numbers and operations, measurement and geometry, relationships and algebra, statistics, and algebra (Ministry of Education Malaysia, 2014). However, the researcher selected the topic of fractions based on several justifications. Fractions have been viewed as numbers with unique properties compared to whole numbers previously studied by students. The uniqueness of their properties makes them challenging to understand (Braithwaite et al., 2018). This topic often leads to misconceptions, as explained by Salleh et al. (2013), Braithwaite et al. (2018), Saparwadi et al. (2017), and Tian and Siegler (2017). According

to them, there are four common mistakes made by students when answering fraction addition and subtraction questions, namely systematic errors, random errors, carelessness, and not knowing how to answer fraction questions.

Learning the concept of fractions can be one of the most challenging skills for elementary school students (Gaetano, 2014; Ghani & Maat, 2018). The Challenges involving difficulties in understanding fractional parts, comparisons, equivalence, and operations. Effective strategies include using visual aids, relating fractions to real-life examples, and emphasizing denominators' significance. Hands-on activities and systematic approaches to comparing, practicing equivalence, and performing operations are crucial. Word problems should be tackled methodically, with consistent practice through diverse resources to reinforce understanding and application of fractions in various contexts. Fractions are also seen to influence other mathematical knowledge such as algebra. This, in turn, will affect mathematical achievement (Siegler & Lortie-Forgues, 2015). If viewed in the long term, this knowledge will also impact their mathematical abilities in secondary school (Siegler & Pyke, 2013). This needs to and can be overcome through the teaching and learning process. One aspect that can enhance students' understanding is through the use of effective teaching aids (Noh et al., 2016). Therefore, innovation and transformation must be carried out through the development and construction of teaching aids in the form of DSK Fraction Cards.

DSK Card is refer to donkey, snap and king card. It is fraction gamification card. This card will discuss on subtopic 3.3.2. Cards, specifically designed for fraction representation, offer a tangible and visual method for students to grasp abstract concepts. The hands-on nature of cards allows for interactive learning, aiding in a deeper understanding of fractions. However, it's important to acknowledge that while fraction cards are effective, other manipulatives such as fraction circles, bars, or even virtual tools can also be valuable. Each manipulative has its strengths; for instance, fraction circles provide a clear visual representation, while bars can emphasize the linear aspect of fractions. The key lies in choosing manipulatives that align with students' learning styles and the specific fraction concepts being addressed. The variety of manipulatives ensures a diverse and comprehensive approach to tackling misconceptions and promoting a well-rounded understanding of fractions. Thus, a study related to DSK Fraction Cards to improve the skills of addition and subtraction in the fraction topic should be conducted. This study aims to test the effect of NDG using DSK Fraction Cards on students' mathematics achievement for fractions topics only.

The concept of gamification is still considered new, even though it has been receiving attention for a considerable period. The term "gamification" was coined by Nick Pelling in 2002 (Marczewski, 2013). Educators in the country view gamification as a novel technique applicable in the classroom by incorporating technology (Watson-Huggins, 2018). The term was openly used for the first time in 2008 and has since been widely adopted in various fields (Sailer & Homner, 2020).

Gamification is employed to describe the integration of game elements, frameworks, and mechanisms into non-game scenarios (Johnson et al., 2016). Typically applied in gaming contexts, gamification aims to foster collaboration and problem-solving. It is asserted that implementing a gamified system in the classroom can enhance student participation and motivation (Şahin & Namli, 2016). It is essential to distinguish gamification from game-based learning, as gamification transforms the entire learning process into a game (Al-Azawi et al., 2016).

Kapp (2012) defines gamification as a process in which an individual utilizes game-based mechanisms, aesthetics, and game thinking to create interaction among individuals, motivate actions, promote learning, and solve problems. Scientifically, gamification is defined as the process of applying game elements to non-game contexts (Hamari et al., 2014;

Treiblmaier et al., 2018; Zimmerling et al., 2019). Therefore, in the context of this study, gamification can be defined as the application of game elements in the teaching and learning process of mathematics.

Gamification proves to be effective in enhancing the teaching and learning process for students. Implementing gamification methods can boost students' motivation, cultivate interest in learning, and enable the assessment of desired learning outcomes (Pektaş & Kepceoğlu, 2019). Several game elements and mechanisms can be integrated during the teaching and learning process. Game mechanics encompass essential components like leaderboards, reward points, and badges. These game-based elements often include narratives, challenges, feedback, rewards, etc., creating learning opportunities within a gaming environment (Watson-Huggins, 2018).

Barata et al. (2017) identify game elements across various fields of study, such as game levels, reward points, badges, scoreboards, and avatars. The gamification system incorporates additional mechanisms, including battles, unlocking content, gifting, boss fights, quests, social graphics, certificates, and memes (Buckley & Doyle, 2017). These mechanisms, known as 'elements' in gamification, motivate students to strive for greater goal orientation by enhancing their persistence, promoting learning through repetition, encouraging collaboration, and fostering friendly competition with peers (Ding, 2019).

Pektaş and Kepceoğlu (2019) outline the learning process that begins with establishing objectives, goals, and game rules. Gamification elements in this process involve elements like competition, missions, and rules of victory or defeat. To stimulate student participation, elements such as coins, avatars, characters, and point repetition can be utilized. For assessment purposes, virtual coins and access keywords can be implemented. Lastly, to promote collaboration and cooperation among students, elements like guidance, transactional social interaction, and mutual assistance are recommended. Additionally, several other elements can be employed during the evaluation process, including points, levels, progress bars, game rules, and prohibitions (Ristiana & Dahlan, 2021).

There is limited research on the impact of gamification in the classroom, despite the development of various e-learning platforms aimed at motivating students to learn. These platforms are primarily designed to help students prepare for exams in a relaxed manner (Watson-Huggins, 2018). Through e-learning game applications like Quizizz, Kahoot, and Tarsia, students can engage in hundreds of questions, receive feedback related to items, and assess their performance on a score sheet in comparison to their peers. Research literature suggests that gamification can have a positive influence on academic performance, particularly in terms of enhancing knowledge and skills.

Firstly, gamification can enhance acquisition skills, which include procedural knowledge or knowledge of how to perform a given task. Studies indicate that gamification contributes to an increase in procedural knowledge (Tenório et al., 2016; Tsay et al., 2018). Tenório et al. (2016) found that undergraduate and secondary students performed better in an online learning environment with gamification compared to a non-gaming model.

Additional studies suggest that gamification can also improve students' knowledge acquisition skills (Huang & Hew, 2018; Yildirim, 2017). Yildirim (2017) argues that gamification is particularly effective in facilitating knowledge acquisition as it encourages users to engage in repeated training. A meta-analysis of gamification research on cognitive, motivational, and behavioral learning outcomes consistently shows significant improvements, even if the findings are modest in the cognitive domain (Sailer & Homner, 2020).

Gamification is a relatively new but rapidly growing concept in the field of education. It involves using game elements in a non-game context, such as in education, to facilitate learning outcomes. Gamification occurs when game elements like competition,

battles, quests, and others are utilized to encourage collaboration between students in achieving gamification components such as high levels, scores, and avatars. The implementation of gamification is often associated with specific approaches and is more effective in increasing intrinsic motivation and long-term learning outcomes. Research indicates that gamification can positively impact student collaboration and academic performance. However, it is a complex concept that requires careful analysis, considering factors such as the interaction between students, the learning environment, and the game elements involved. A experimental study is crucial to test the impact of gamification in the context of mathematics education. This study can help measure the actual effects of incorporating gaming elements in the teaching and learning process.

2. METHOD

2.1. Research Design

Various research approaches are frequently discussed, including experimental methods, case studies, survey studies, action research, ethnographic studies, and correlation studies (Fraenkel et al., 2012). A quasi-experimental design was adopted for this study. The selection of an experimental method is appropriate if a study aims to examine the relationship between cause and effect (Fraenkel et al., 2012). Quasi-experimental design is used when a study cannot be conducted as a true experiment. The term "quasi" implies that some, but not all, characteristics of a true experiment are present. Therefore, the combination of quasi and experiment implies having some features of a true experiment (Jackson, 2009). The distinction between a true experiment and a quasi-experiment is determined by the sampling method. This is because the study cannot implement a random sampling method for selecting samples when forming treatment and control groups (Chua, 2006; Creswell, 2012; Jackson, 2009). Two groups were established: the experimental group, which utilized the NDG approach, and the control group, which followed the conventional approach. This study was conducted during regular school hours, involving an existing group of students. The research sessions were carried out over a span of 4 week, and a total of 8 sessions were conducted. This approach allowed for an in-depth examination of the impact of NDG to student achievement within the natural context of the school environment and provided valuable insights into the students' responses and engagement over an extended period.

2.2. Participants

A sample of 100 students (Year 3) from national schools in two Perak state schools was selected for the study. The sample was carefully chosen and assessed for homogeneity in terms of mathematics achievement for both schools. This pre-study step aimed to ensure sample equivalence between the two selected schools. The selection of an appropriate sampling technique can reduce internal validity threats (Jackson, 2009). This study employed cluster sampling for the purpose of sample selection. The advantages of implementing this technique include cost-effectiveness, time efficiency, and a reduction in administrative bureaucracy. Cluster sampling involves dividing the population into clusters or groups, randomly selecting some of these clusters, and then including all members from the selected clusters in the sample. This method is particularly advantageous in studies where it is challenging or impractical to individually select participants, contributing to a more streamlined and efficient research process. Additionally, both samples had not yet been exposed to the topic of fractions.

Details of the sample are provided in Table 1. The study included 42 male students and 58 female students, totaling 100 students. The composition comprised 87 Malays, 1

Chinese, and 3 Indians. These students hailed from two schools within the same district. The control group (conventional teaching) consisted of 50 students from School Y, while the experimental group (gamification learning) comprised 50 students from School Z. Employing this method allowed for controlled interaction between the two groups while simultaneously enhancing the study's validity.

Table 1. Distribution of students by gender and ethnicity

School	Male	Female	Total	Malay	Chinese	Indian
Y	20	30	50	47	0	1
Z	22	28	50	40	1	2

2.3. Instrument

In this study, four instruments were utilized, including a) Fraction Topic Mathematical Achievement Test, b) Math textbook (control group), c) Math textbook and Fraction Gamification Kit (experimental group). Specifically, the control group utilized textbooks as the primary teaching guide, while the experimental group incorporated textbooks and Fraction Gamification tools as teaching interventions. Both groups were presented with the same task materials aligned with the learning outcomes of the fraction topic as outlined in the mathematics Curriculum and Assessment Document (DSKP) for Year 3. The study instruments underwent evaluation and verification by three experts, comprising distinguished mathematics teachers, School Improvement Specialist Coaches (SISC+), and a senior lecturer in mathematics. The appointed experts possessed over 10 years of experience in mathematics education, particularly in primary school teaching and learning.

Throughout the study, the mathematics teachers handling both groups received a daily lesson plan (LP) as a guide for implementing the fraction topic. This approach aimed to enhance the validity of the study. The LP was designed according to the format and standards set by the Malaysian Ministry of Education, encompassing learning outcomes and steps for implementing activities during the teaching and learning process. In the assessment phase, all samples from both groups underwent a math achievement test on the topic of fractions after the intervention process.

2.3.1. Control Group

For the control group, the Fraction topic was conventionally taught using mathematics textbooks as the primary reference. The teacher utilized examples and exercises from the textbook as classroom activities. At least three questions were given to the students, demonstrating step-by-step solutions based on the subtopic of fractions. The teacher's explanation included a diverse range of questions from a taxonomic aspect. Subsequently, students were assigned five exercises to complete, with discussions taking place after 20 minutes. The teacher prompted students to write their answers on the whiteboard and explain them to their peers, repeating the process for all five questions.

2.3.2. Experimental Group

The experimental group learned the Fraction topic using the Fraction Gamification Kit. This kit, designed to resemble a children's card game, is cost-effective, easy to produce,

portable, and introduces an element of challenge. The kit comprises Fraction Gamification cards, reward boards, reward badges (badges), and solution boards.

Fraction Gamification Cards

These cards are themed around animals, information technology equipment, carpentry equipment, types of sports, and plants, with each theme consisting of seven cards. The cards display information related to the theme, fractional values, and basic operations such as addition or subtraction. See Figure 1 for examples of these cards.

Figure 1. Example of DSK fraction card

Reward Board (Papan Ganjaran)

The reward board serves as a platform to showcase the badges earned by students, whether individually or in groups, based on the game's implementation. The configuration of the reward board is illustrated in Figure 2.

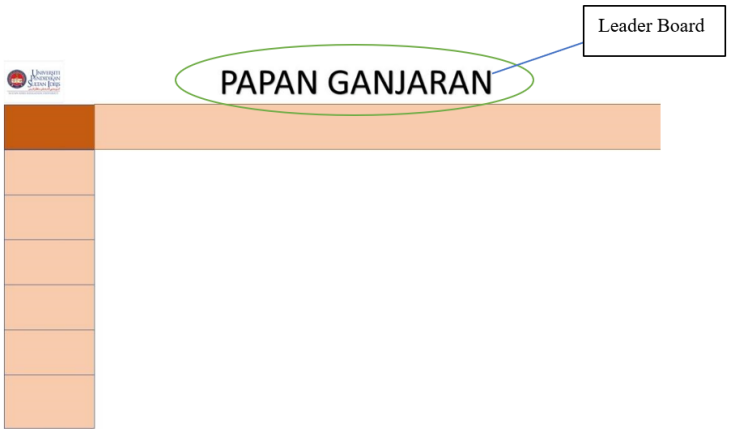

Figure 2. Example of leader board

Reward

Rewarding is a crucial element of gamification, and in the Fraction Gamification Kit, smiley-faced badges are awarded to students. These badges accumulate on the reward board, determining student rankings based on the number of badges earned. Examples of badges are depicted in Figure 3.

Figure 3. Example of badges

Fraction Solution Board (Papan Penyelesaian Masalah)

The fraction solution board is employed for students to engage in fraction comparison operations or execute basic operations involving two fractions. This board follows the "SAKE BEDA" concept, as elucidated by Setambah et al. (2021). In essence, "SAKE BEDA" means maintaining the value when the denominator is the same and multiplying the numbers to equalize when the denominators differ. The configuration of the board is presented in Figure 4.

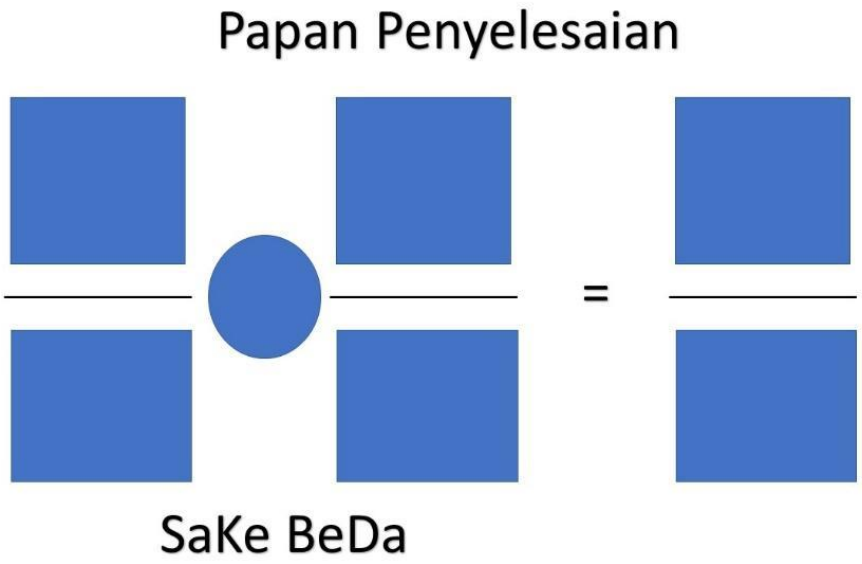

Figure 4. Solution board

These gamification tools adhere to the rules of games like donkey cards, snap cards, and King cards. Students earning badges in each round are displayed on the leader board, with the student accumulating the most badges recognized as the winner. The teaching and learning process mirrors that of the control group but includes gamification kit game activities and the introduction of the "Sake Beda" concept for the addition and subtraction of fractions.

In conclusion, the instruments utilized are as presented in Table 2.

Table 2. Instruments used

Instrument	Description
Fraction Topic Mathematical Achievement Test	Assessing understanding of fraction topics
Math textbook	Used as a teaching guide for control group and experimental group
Fraction Gamification Kit (Experimental Group)	Used as teaching interventions for experimental group
DSK Fraction Cards	Themed cards related to fractions
Reward Board	Displaying earned badges
Reward (Smiley Icons)	Given as badges
Fraction Solution Board	Used for fraction comparison operations

2.4. Procedure

The study commenced with the submission of an application for approval from the Malaysian Ministry of Education. Following approval, a pilot study was conducted, and necessary refinements were made based on the outcomes. The mathematical achievement of both pilot and actual study samples demonstrated equivalence. A comprehensive briefing was conducted for the school head regarding the study's purpose, procedures, and administration. Additionally, the researcher provided tutorial sessions to the teachers involved in both groups, covering topics such as lesson plans, the fractional gamification kit, study instruments, and training. This ensured the consistency of teaching methods and heightened the study's validity.

Facilitators for both groups, possessing over 10 years of teaching experience, underwent training and guidance. Control group teachers received guidance on conventional lesson plans, while experimental group teachers were trained in the implementation procedures of group interventions using gamification tools. The intervention period spanned four weeks. This concise duration aimed to mitigate external factors like additional classes, peer discussions, or reference to alternative information sources that could impact internal study validity. Subsequently, a Post-Test was administered to all students (lasting 1 hour).

3. RESULT AND DISCUSSION

The research findings and discussions section discusses the methodology and statistical analyses used in a quasi-experimental study. The researchers conducted tests and analyses to determine the suitability of parametric tests, focusing on conditions such as normality, linearity, equality of variance, and outliers. The Kolmogorov-Smirnov test was employed for normality, and Levene's test was used to assess the equality of variance. Outliers were identified through box plots, and the Pearson correlation test was employed for assessing linear correlation.

The study confirmed that the parametric tests of differences were suitable based on non-significant results in the normality test, equality of variance test, and the retained outliers. The researchers then proceeded with ANOVA test analysis to examine significant differences between the treatment group and the control group in the Mathematics (fraction) achievement variable. The results indicated no significant difference in the pre-test mean of mathematics (fraction) achievement between the two groups. This finding suggests that the levels of mathematical achievement in both groups were similar at the beginning of the experiment.

The section also hints at the possibility of further analyses, such as ANCOVA, if needed based on subsequent results (see Table 3). Overall, the findings provide insights into the robustness and appropriateness of the statistical procedures employed in the study.

Table 3. ANOVA test analysis differences in mathematics pre-achievement test between the treatment group and the control group

	Sum of Square	**Df**	**Mean Squared**	**F**	**Sig.**	***Partial Eta Squared***
difference	128.133	1	128.133	3.877	.059	.122
Error	925.333	98	33.048			

* Significant at the confidence level p<0.05

Data were analysed using independent-samples ANOVA. Findings show the effect of teaching methods on the mathematical achievement of sample fraction topics. Findings are significant which is F(1,98)=4.42, p=0.04. The achievement of the experimental group (M=14.83, SD=3.16) is better when compared to the achievement of the control group (M=11.95, SD=5.39) as shown in Table 4.

Table 4. Mean and standard deviation of fraction topic mathematics achievement

Group	**Mean**	**Standard Deviation**
Control (conventional)	11.95	5.39
Experimental (NDG)	14.83	3.16

Findings show that the gamification method is able to provide good benefits and an effective effect on the mathematical achievement of the fractional topic of the study sample compared to the conventional method with a mean difference of 2.88. This finding may be due to the characteristics of the gamification method itself, which is to create a fun environment, with elements of competition and challenge. Therefore, it facilitates the learning of the fraction of the study sample. Through this method too, the sample is more motivated to try something new. This is supported by the statement of Setambah et al. (2019) where the fun factor and playing experience can increase student engagement.

Gamification also builds a meaningful learning through elements of challenge, discovery, goal-setting, reward and collaboration (Ke et al., 2016). Creativity and critical thinking skills can be seen through the seriousness of the players. This is seen when the player tries hard to complete the game's tasks and goals. They will feel satisfied if they can solve problems, especially challenging problems. They will also continue the game until they can complete the goal of the game (Palmer, 2016). Participants are more focused to complete the task of the game because the characteristics of the game require participants to think. If seen from the difference between gamification and conventional methods, gamification kit groups give students the opportunity to interact, collaborate, exchange solution ideas and discuss. This gamification method also allows students to help each other to solve problems together. This is because the instructions of the game require those elements to be implemented (Wang & Zheng, 2021).

As for the conventional group, these students are easily distracted, unwilling to participate, and do not go beyond what is expected of them. This is proven when observation is carried out while they are going through learning without involving gamified materials. They are not active in the learning. Negative behavior can be seen through observations such as 1) playing with a pencil, 2) looking at the time on the wall clock or watch, 3) daydreaming,

4) playing and walking, and 5) going to the toilet. Furthermore, it is noteworthy that all these negative behaviors were conspicuously absent in the experimental group. This stark contrast in behavior between traditional learning observation and the gamified approach underscores the effectiveness of gamification tools in creating a more focused, participatory, and engaging learning environment, aligning with the findings of Vitoria et al. (2020). The use of gamification tools in education is crucial due to their ability to enhance engagement, tap into intrinsic motivation, and provide clear learning objectives. Gamified approaches create a more focused and enjoyable learning environment by offering immediate feedback, accommodating varied learning styles, and incorporating social interaction elements. The novelty effect of introducing gamified materials captures students' interest, contributing to a positive and dynamic educational experience. Overall, gamification proves important for creating engaging, motivating, and effective learning opportunities (Vitoria et al., 2020). Although teachers have their own way of teaching fractions such as the technique of memorizing rules, but conceptualizing is also important to the concept of fractions learned. Therefore, the need for manipulative materials is very important during the teaching and learning of fractions.

The success of this NDG depends on several things. (1) Sample size and scope: The study was conducted in two non-Dual Language Program (DLP) schools, which may limit the generalizability of the findings. It is recommended that future studies use samples from DLP schools and compare samples from urban and rural areas to provide a more comprehensive understanding; (2) Subject and level specificity: The study focused specifically on the topic of fractions in primary school mathematics. Further research is needed to explore the effects of non-digital gamification methods on students at different levels and in other subjects; (3) Language of instruction: The teaching and learning of mathematics was conducted in the Malay language. This may limit the applicability of the findings to educational contexts with different language of instruction; and (4) External factors: The relatively short implementation period of 4 weeks was chosen to avoid external factors that may affect the internal validity of the study. However, this short duration may not capture the long-term effects of non-digital gamification methods on mathematics achievement.

Knowledge can be retained longer if visual activities and educational games involve physical activity. The element is an advantage in NDG (Muhamad et al., 2018) than memorizing facts and completing drills through conventional learning methods. Therefore, the educational game increases the potential and skills of students (Setiyawan, 2018). For example, there is a competition between students in answering questions through a gamification kit allowing them to have a fun experience. This simultaneously builds a memory that can be remembered until they grow up. The effect of the NDG method is consistent with previous studies, which is to improve students' understanding of the concept of a topic such as polynomial operations (Barros et al., 2020), algebraic concepts (Andini & Yunianta, 2018), mathematical creativity (Park & Lee, 2017) and geometric concepts (Pratama & Setyaningrum, 2018).

It's important to note that while gamification can be an effective tool for engaging students and enhancing the learning experience, there are potential challenges and limitations to consider. Some of these may include: (1) Implementation challenges: Designing and implementing effective non-digital gamification methods can require significant time and effort from educators. It may also require resources to create and maintain gamification materials; (2) Individual differences: Students may have different learning style preferences, and while gamification can be engaging for many, it may not resonate with every student; (3) Overemphasis on rewards: There is a risk that students will focus more on the rewards and competition aspect of gamification than on the actual learning

content. Researchers also suggest that rewards are also given to the control group in order to see a more effective effect. Therefore, the study reduces the internal validity that occurs in this experimental study. This can help researchers distinguish between the effects of gamification and the effects of rewards on student achievement; (4) Assessment and Evaluation: It can be difficult to assess and evaluate the effectiveness of non-digital gamification methods in terms of learning outcomes and academic achievement; and (5) Equity and access: Not all students may have equal access to the resources or technology required for certain gamification methods, potentially creating inequities in learning experiences.

4. CONCLUSION

In the context of teaching methods, the findings of this study highlight the role of NDG in improving the learning of sample fraction topics. NDG in this study involves games that have materials such as cards, badges, solution boards, and reward boards. All of these materials are concrete materials that are able to improve the learning atmosphere that is interesting, interactive, conducive environment and meaningful teaching. This happened in the experimental group. The performance of the experimental group was seen to be better than the conventional group. This study also has implications for teachers, especially the aspects of teaching and learning. Therefore, the use of NDG is suggested to mathematics teachers in order to be able to practice it in their teaching and learning, especially the topic of fractions. NDG is able to change the learning scenario of students even though fractional topics are said to be difficult as noted in previous studies.

This study becomes empirical evidence and fills the gap of previous studies on the topic of fractions (mathematics) and the gamification approach in education. In addition, this study also proves that students' behaviour can be changed through learning methods that are interesting and suitable for them. This at the same time changes the students' perception of mathematics where according to them mathematics is difficult, complicated and boring. The characteristics of NDG activities such as student involvement, inquiry, exploration is motivating and successful in changing their behaviour for the better.

The results of the overall research found that NDG are one of the learning media that contribute to creating an effective learning environment. Today's schools on average have implemented learning activities while playing with students feel happy and interested in learning mathematics which has been difficult and boring through NDG. This is evidenced by the many enthusiastic students in responding to the use of learning media by stating that learning becomes enjoyable and easy to understand. Students really want if the game is developed in a non-digital form in accordance with current technological developments. The teacher also wants a game that refers to the mathematics subject material that is conceptual and mathematical, so that students can understand the material through the game. Therefore, this research can be used as a reference for teachers and researchers to try this NDG method.

Teachers need to diversify teaching techniques in the classroom in any subject taught to suit the current changes in the education system in line with globalization and the rapid pace of information technology, knowledge -based economy, fierce competition and efforts towards world -class education system. Elements of creativity and innovation in education also need to be given attention so that this gamification practice can be fully implemented. The gamification method is very suitable for use by teachers, especially teachers who teach mathematics and subsequently are able to apply the characteristics of high order thinking skills (HOTS) in teaching and learning Mathematics in accordance with the development of 21st century education and the revised Primary School Standard Curriculum 2017. Overall, teachers supported the development of gamification tools for mathematics, particularly the

topic of fractions. Thus, researchers suggest that educators can develop these gamification tools to help mathematics teachers implement a fun approach. Math learning will be more engaging, motivated, more efficient, and holistically impactful if teachers or educators can develop a variety of gamification tools. This can also help students achieve the aspirations of the country. This variable will be the next future research about gamification.

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