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Research Article

Effectiveness of Kahoot-Based Gamified Assessment on Lower-Order Thinking Skills in Mathematics Achievement at the Primary School Level: An Experimental Study

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ABSTRACT

Gamification based assessment practices improve student engagement, making learning more interactive and enjoyable. This study investigates the role of Kahoot-based gamified formative assessment on lower-order thinking skills among primary school students in the context of mathematics learning. Randomized pretest-posttest control group design was utilized in a true experimental design. The population of this study contained 10 schools, with 248 students in the 5th class in District Astore, which had internet access and an IT lab. A simple random sampling technique was applied to select the sample. A pretest and posttest were conducted to gather data on mathematics achievement of thinking skills. The experts validated pretest achievement thinking skills and also ensured K-20 reliability. The core findings of the results described that gamification-based formative assessment plays a significant role in improving LOTs of students toward mathematics. Besides, there was a significant difference between the experimental and control groups' academic achievement regarding knowledge, comprehension and application. Results from a Tukey HSD post hoc test revealed a significant enhancement in thinking abilities from knowledge to comprehension (mean difference = 6.25926, $p < .05$) and application to knowledge (mean difference = 6.66667, $p < .05$) levels. However, no significant difference was found between comprehension and application levels (mean difference = .40741, $p = .085$), indicating comparable effectiveness of the formative assessment at these levels. Gamification-based formative assessment played a significant role in improving academic achievement in terms of lower-order thinking skills and may be beneficial in ensuring a quality teaching environment. Future studies may be conducted on whether gamification-based formative assessment practices effectively improve higher-order cognitive skills of students.

Keywords: Lower order thinking skills, Gamifide assessment, Learning and Mathematics

Introduction

The incorporation of gaming elements into non-gaming environment is becoming more widely acknowledged in considerations related to education as an effective method for enhancing student motivation, engagement, and academic performance (Ratinho & Martins, 2023; Aparicio et al., 2019). Gamification is a method that, when used in association with game-based learning paradigms, uses technological innovations to reward certain behaviors and enhance educational experiences (Zainuddin et al., 2020).The Kahoot game facilitated the obtaining of knowledge and enhancement of critical thinking abilities regarding the treatment of patients. Kahoot-based gamification is an innovative educational learning method. According to Cadet (2023), students and instructors agree that the Kahoot game is enjoyable and fosters engagement, interaction, and motivation. The use of web-based education and the Kahoot game in the assessment had a beneficial impact on the intramuscular injection skills and expertise of nursing students. The Kahoot game has shown to be a

viable, practical, and valuable instrument for formative assessment by encouraging and supporting learning activities. Based on the study's results, researchers suggest including the Kahoot game in the nursing curriculum for web-based education as a formative assessment tool (Oz & Ordu, 2021). The use of the Kahoot game has been shown to have a positive impact on student motivation, classroom dynamics, and learning success. Previous studies have shown that students were satisfied with their involvement in the Kahoot game and thought it was a fun experience (Al Ghawail & Yahia, 2022). Moreover, teachers may collect real-time feedback on how accurately students responded, making quick assessment and feedback processes possible. In addition, this feedback is essential for understanding the context more accurately. Different thinking skills are categorized in the literature which is essential for human being to perceived actual learning.

Bloom's Taxonomy is a well-known theoretical framework in the field of education that categorizes human cognitive processes into six hierarchical levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. The first three levels of these tiers are widely known as Lower Order Thinking Skills (LOTS), while the subsequent three levels are referred to as Higher Order Thinking Skills (HOTS). Lower Order Thinking Skills (LOTS) are crucial for acquiring basic or factual knowledge, whereas Higher Order Thinking Skills (HOTS) need pupils to interpret, analyze, or manipulate information (Saido, et al., 2018; Apino & Retnawati, 2017). Higher-order thinking skills (HOTS) have become essential elements in educational curriculum in many countries (Yusoff & Seman, 2018; Chen, 2016), and are actively encouraged and incorporated into classroom settings, including mathematics instruction. The development of higher-order thinking skills (HOTS) is considered vital for nurturing the ability to think logically and critically, which is necessary for effectively addressing daily issues. Developing high-level thinking skills leads to improved problem-solving abilities, more self-assurance in mathematics learning, and better academic success in complex tasks that need advanced cognitive abilities. Essentially, HOTS provides students with the adaptability and ingenuity required to address a wide range of difficulties. Nevertheless, the focus on higher-order thinking skills (HOTS) has led to the disregard of lower-order thinking skills (LOTS) (Tikhonova & Kudinova, 2015). This has prompted some experts to argue that HOTS is better in terms of its application and applicability (Jones & Idol, 2013; Kamarulzaman, Sailin, Mahmor, & Shaari, 2017).

On the other hand, some studies have emphasized the importance of lower-order thinking skills (LOTS) in establishing a basic framework for the implementation of higher-order thinking skills (HOTS) (Assaly & Smadi, 2015; El-Khalili & El-Ghalayini, 2014; Chiu & Mok, 2017; Razak, Sutrisno, Immawan, & Muchsin, 2018; Agarwal, 2019). Bloom and other researchers have proposed the taxonomy to be a sequential progression: proficiency in cognitive processes at lower levels is a necessary condition for achieving performance at higher levels. Therefore, it is argued that evaluative thinking cannot occur without the prior acquisition of factual information, understanding the facts, being skilled at applying the facts, and having the capacity to analyze and reassemble them (Bloom et al., 1956; Chen, 2016). Moreover, LOTS (lower-order thinking skills) are considered fundamental and essential as they support the growth of students' cognitive pathways, the learning of information in many fields, and the successful application of gained knowledge (Agarwal, 2019).

The current literature extensively examines the advantages of gamification in enhancing interactive and engaging learning methods, with a primary emphasis on its influence on higher-order cognitive skills (HOTS) (Rodríguez et al., 2020). Lower-order thinking skills (LOTS) should not be underestimated, particularly in fundamental topics such as mathematics. Basic cognitive skills include essential qualities such as acquiring knowledge, understanding, and applying information, which are crucial for a student's cognitive development (Barut & Wijaya, 2021). Development of lower-order thinking skills (LOTS) is essential for developing higher-order skills (Kamarulzaman et al., 2017). Despite its significance, there is a study gap about the impact of gamification on LOTS, namely in mathematics education for primary school students.
In primary school mathematics education, the development of competence in mathematics is emphasized because of its strong connection to meeting grade-level learning goals and requirements. The abilities mentioned serve as the foundation for understanding mathematical concepts, processes, and procedures, supporting the development of more complex topics (Barut & Wijaya, 2021). Therefore, assessing the influence of gamification on LOTS has significant consequences for instructional strategies focused on achieving educational objectives. In order to learn the basics of mathematics and get a handle on the many operations and processes involved, it is necessary to develop lower-order cognitive abilities. Students may find it challenging to go on to more complex mathematical subjects if they need to understand these basic concepts fully. The development of lower-order cognitive abilities is often given more weight in the primary school mathematics curriculum. It is because these skills are closely related to the learning goals and requirements for the grade. In order to get significant insights into how well instructional techniques satisfy curricular objectives, it is essential to investigate the effects of gamification on lower-order abilities. Primary school students in District Astore Gilgit Baltistan had their low-order thinking skills tested in this study to see if Kahoor -based formative assessment affected their lower-order thinking skills.

Rationale of the Study

The extensive weightage has been given in the mathematics curriculum from primary to secondary which shows its importance in this era. The students' performance is poor both internal and external test, despite the importance has been given to mathematics subject but its results are disheartened (Maruta et al., 2022). This problem is caused by a number of things, such as students' lack of interest and discipline, big class numbers, stress from traditional assessment practices, and inadequate basic knowledge (Mogege & Egara, 2022; Nzeadibe et al., 2019; Okeke et al., 2023). Moreover, students frequently encounter difficulties in retaining mathematical concepts and maintaining engagement, exacerbating the overarching challenge (Nzeadibe et al., 2020; Osakwe et al., 2023). Traditional formative assessment methods sometimes fail to successfully achieve student outcomes, resulting in a decline in thinking skills and restricting their ability for innovative thinking. In addition, traditional formative assessment practices in mathematics have been associated with student discomfort, anxiety, and a lack of engagement (Wood et al., 2013). This discomfort often inhibits the development of students' lower-order thinking skills, hindering their ability to grasp fundamental mathematical concepts (Kristiana & Suyanto, 2013). Many students dislike the mathematics subject taught in the classroom (Boaler, 2014). Previous research studies conducted in developing countries (Al-Hosni et al., 2023; AlJuraywi, 2019; Alfulaih, 2018; Alabbasi, 2018) have investigated the use of gamification in educational settings, particularly its effectiveness in enhancing learning and teaching methods, as well as its impact on the acquisition of scientific concepts, academic achievement, and student motivation. While some studies have explored the benefits of gamification in improving students' understanding and motivation in mathematics (Chang et al., 2015; Khalid et al., 2019), there remains a gap in understanding how Kahoot based gamified assessment practices influences lower-order thinking skills (Knowledge , Comprehension and Application) in primary school students. Therefore, this study aims to investigate the effect of gamification-based formative assessment on primary school students' lower-order thinking skills in mathematics learning, aiming to contribute to the advancement of educational practices in this domain.

Literature Review

Kahoot Based Gamification

Among the many game-based apps used in educational settings, Kahoot is a well-known example of educational technology. In order to increase student engagement, this platform uses gamification, which turns traditional classroom dynamics into interactive quiz-style experiences (Boden & Hart, 2018). Teachers use Kahoot to foster students' curiosity and passion for learning the English language, which helps them understand sometimes complex and tedious material (Pahamzah et al., 2022). Kahoot is a platform that offers gamification-based learning features for educational purposes, suitable for students from elementary to tertiary levels. Kahoot's accessibility as a free platform provides educators a simple way to conduct quizzes and exams, removing the need for conventional oral delivery techniques in classrooms (Kaur & Naderajan, 2020). Gamification may be used to learn using a specific platform, such as Kahoot. It is an assessment tool that is considered an effective and engaging learning tool for students. Kahoot is an educational approach that integrates gamification features to enhance student performance (Wirani et al., 2022). Studies have shown that including it in vocabulary teaching improves students' understanding of words, leading to better comprehension, retention, and interest in learning new vocabulary (Surayya et al., 2023).

Lower Order Thinking Skills

Benjamin Bloom presented Bloom's taxonomy in 1956, establishing stages of thinking that are now fundamental to education. David Krathwohl revised a fundamental structure known as the "Original Taxonomy" in 2002, creating what is now called the "Revised Taxonomy." This study utilized the Original Taxonomy, which consists of six categories in the Cognitive Domain. The first three categories, knowledge, comprehension, and application, are considered lower-order thinking skills (LOTS). In comparison, the remaining three categories, analysis, synthesis, and evaluation, are classified as higher-order thinking skills (HOTS). Researchers and teachers widely recognize the significance of both levels of thinking for the development of students. However, educational institutions of items (LOTS) play a crucial and essential function in enabling the development of fundamental cognitive processes, the gaining of information in many fields, and its efficient use. Mastery of fundamental cognitive abilities is necessary before advancing to the higher-order thinking skills (HOTS) level, where students conduct comparative analysis and create creative material based on their knowledge. Higher-order thinking skills (HOTS) are essential because they encourage advancements in education and the development of answers to current difficulties by using new ideas within established structures. There is a common view that there is a significant relationship between lower-order thinking skills (LOTS) and higher-order thinking skills (HOTS), indicating that being skilled in fundamental cognitive processes is necessary before being able to use higher-order thinking skills in learning effectively (Kamarulzaman et al., 2017; Barut, & Wijaya, 2021).

Kahoot Based Gamification and Lower Order Thinking Skills

Technological integration in education is popular at all levels of schooling and is especially useful in mathematics instruction. Abidin, Mathrani, and Hunter (2017) suggest that technology is crucial in changing the methods of mathematics instruction. Integrating technology into math education is important because it helps students better understand and study arithmetic, especially because many find the subject challenging. Furthermore, using digital technologies and successful teaching methods can develop a range of abilities, as Viberg, Grönlund, and Andersson (2020) emphasized. Using technology in teaching primary school mathematics somewhat improves pupils' achievement.

Kahoot is an educational application that enables instructors to develop gamified assessments to strengthen educational material and enhance the teaching-learning process (Cortés-Pérez et al., 2023). Educational technology benefits emotional and motivational aspects of cognitive efficiency and may be essential in gamified learning vocabulary (Salimei et al., 2022). Participants participating more often in Kahoot-based gaming activities tend to get higher test results. Kahoot-based gaming positively affects students' academic performance and their perspective on the learning process (Toth et al., 2019). Integrating Kahoot as a game review in the classroom enhances students' understanding of vocabulary and course ideas and provides immediate feedback (Baszuk & Heath, 2020).

There is a growing awareness that incorporating Kahoot-based gamification into mathematics teaching might influence pupils' basic cognitive abilities. There are several benefits to integrating online gaming platforms into mathematics education, one of which is that it makes learning new mathematical ideas easier. Many online Game-Based Learning (GBL) programs are excellent in teaching young students, especially in subjects like geometric understanding of 2D and 3D forms (Hidayat et al., 2024). Students are particularly happy with the Kahoot game, which is helpful and engaging in improving the learning process (Balaskas et al., 2023).

The educational content that is currently available highlights the benefits of gamification in terms of increasing motivation and engagement, but further research is necessary to determine how it affects the development of lower order thinking skills. Further studies have to focus on describing how Kahoot-based gamification impacts the growth of mathematical lower-order thinking abilities, as this can provide important information for improving teaching strategies and achieving better learning results.

Theoretical Background

The major theoretical framework used in this study is Bloom's Revised Taxonomy of Educational Objectives, which organizes knowledge acquisition processes into levels of complexity, recognizing LOTS, including remembering, understanding and applying. These skills can be useful in getting basic knowledge in courses such as mathematics at the primary level (Anderson & Krathwohl, 2001). In turn, the present use of fun applications like Kahoot facilitates such interrelated cognitive processes by offering appealing formats that allow constant repetition, which in turn guarantees better retention and understanding of the content (Plump & LaRosa, 2017). Kahoot's active elements correspond to gamification theory, according to which motivation should be integrated into the process to increase students' interest (Deterding et al., 2011). A the same way gamers get engaged to get more points to be ranked high on the leaderboards, Kahoot promotes an environment that ensures students get engaged to respond with correct answers to help them grasp what has been taught to them, especially in Mathematics (Wang & Tahir, 2020).

Besides, this framework is rooted in Constructivist Theory, which establishes that learning takes place when learners activate prior information to create new information (Piaget, 1971; Vygotsky, 1978). Kahoot offers the student a way to engage their knowledge in order to apply it practically without pressure to improve their knowledge. The literature review also shows that gamification with assessments increases consciousness, hence increasing knowledge retention, specifically lower-order thinking skills (Licorish et al., 2018). According to Wang and Tahir (2020), a study shows that the pedagogy of the use of Kahoot enhances students' achievements and engagement because of its knowledge recall and comprehension, which falls under Bloom's Taxonomy. Extension of this framework using Self-Determination Theory (Deci & Ryan, 1985) helps in understanding Kahoot's ability to fulfill the intrinsic needs for competency, autonomy and relatedness among learners, making it easier for students to focus and master basic skills through practice in an enjoyable manner (Ryan & Deci, 2000). Specifically, this theoretical framework enables the use of Bloom's Revised Taxonomy, gamification principles, and elements of constructivist learning to explore the place of Kahoot in boosting lower-order thinking skills in achievement in primary-level mathematics.

Digital games like Kahoot provide pleasure to users, increase engagement, and reward accomplishment, ultimately improving learning experiences. Kahoot has positively enhanced language skills and attitudes in preservice teachers (Lashari et al., 2023). Kahoot based gamification improves students' mental health and thinking skills by using gamification in assessments, outperforming the effectiveness of traditional exams. Students in traditional educational settings often feel anxious and stressed when they cannot provide the correct answers during lessons, especially due to ethical and moral expectations from their classmates. This emotional weight may negatively impact lower-order thinking skills and impede academic achievement. Kahoot-based gamification solves this problem by offering immediate corrective feedback and tracking student progress in real-time. Kahoot pushes students to actively engage and strive for success by providing scores, badges, leaderboards, and challenges in a competitive and dynamic learning environment. Kahoot's game-based formative assessment allows instructors to easily monitor student progress, identifying strengths

and weaknesses in ability and enabling personalized instruction suited to specific student requirements. Kahoot-based gamification has significant potential to transform instruction by promoting engagement, reducing stress, and offering prompt feedback.

Conceptual Framework of the Study

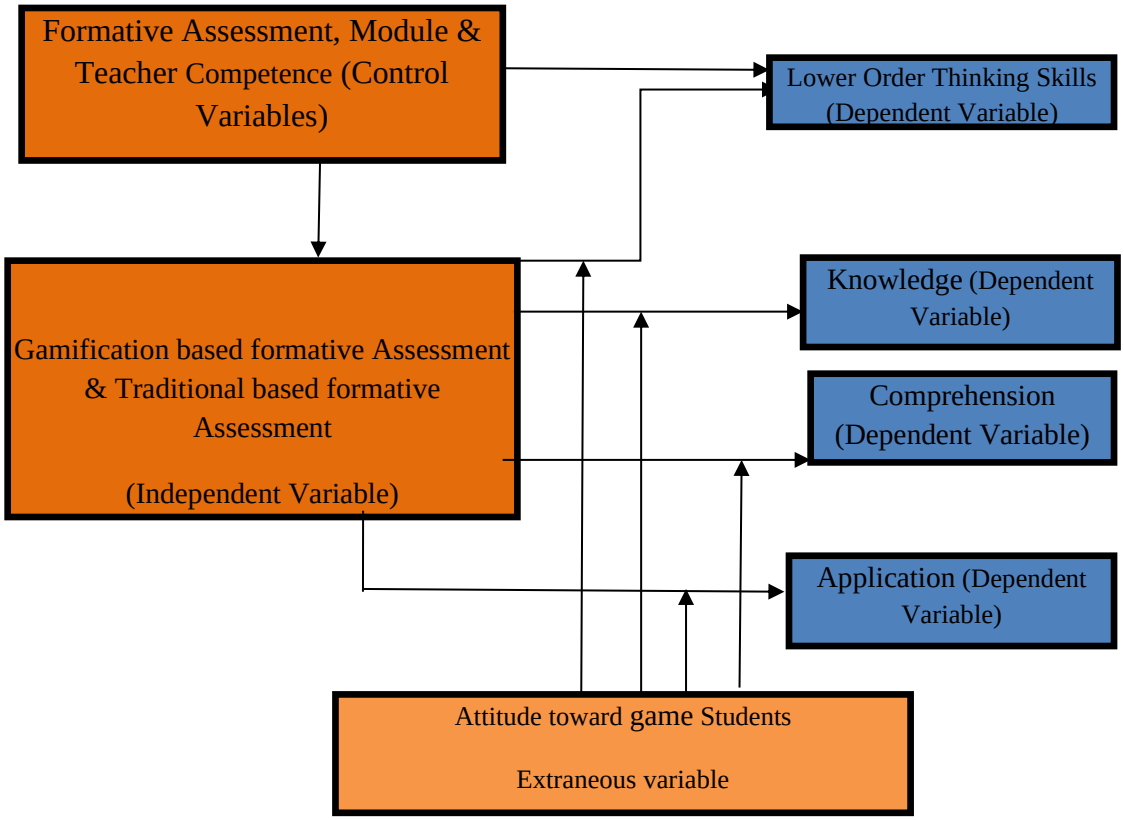

Figure 1 ***Conceptual Framework of the Study***

The major purpose of this study was to investigate the effect of gamification-based formative assessment practices of student lower order thinking skills in terms of mathematics learning. In this study the variables, such as gamification-based and traditional-based formative assessment practices, are independent variables. In contrast, student lower order thinking skills toward mathematics learning (Knowledge, Comprehension and Application) are dependent variables. The conceptual framework of this study is the relationship between the independent variables (Gamification based formative assessment practices through Kahoot and traditional-based formative assessment) and dependent variables, students 'lower order thinking skills. How gamification-based formative assessment practices and traditional-based assessment practices may affect students' lower order thinking skills in mathematics subjects. Students' boredom, fatigue, excitement, and emotional intelligence may be played a role as intervening in this study.

The same formative assessment practices teachers competence and modules are treated as control variables for both groups. The student's attitude toward game may be regarded as extraneous variables. Sound research design may enable the researchers to neutralize their influence (Best & Kahn, 2006). Data collector characteristics might effect on the academic achievement and motivation. This can be control by same data collectors for both groups. Teacher characteristics are likely to affect post treatment scores. Because different teachers teach the methods, they may differ. This was controlled by same teachers teach to both groups.

Objectives

The two objectives of the study are developed which are as under:

- To assess the role of Kahoot-Based Gamified Assessment on students' lower-order thinking skills.
- To compare the influence of Kahoot-Based Gamified Assessment on different levels of thinking skills.

Hypotheses

Null Hypothesis (Ho_1): Students who taught mathematics through Kahoot-Based Gamified Assessment have no significant difference in academic achievement regarding lower-order thinking skills from those who do not participate.

Alternative Hypothesis (H_1): Students who taught mathematics through Kahoot-Based Gamified Assessment have significantly higher academic achievement in terms of lower-order thinking skills than those who do not participate.
Null hypothesis ($H0_2$): There is no significant difference in the role of Kahoot-Based Gamified Assessment on different levels of thinking skills (knowledge, comprehension, and application).
Alternate hypothesis (H_2): There is a significant difference in the role of Kahoot-Based Gamified Assessment on different levels of thinking skills (knowledge, comprehension, and application).

Methodology

Research Design and Procedure

The study utilized a true experimental research design with a pretest-posttest approach to evaluate the impact of Kahoot-Based Gamified Assessment on lower-order thinking skills in primary school mathematics achievement. This design is particularly effective for establishing causal relationships between the independent variable (Kahoot-based assessment) and the dependent variable (students' lower-order thinking skills) while controlling for external factors (Creswell & Creswell, 2017). The pretest measures the students' baseline skills before the intervention, and the posttest assesses any changes in performance attributable to the intervention, thereby enabling a comparison of results and enhancing the validity of the findings (Campbell & Stanley, 2015).

Population and Sample

The population included 248 fifth-grade children from 10 government schools in District Astore, all with internet connection and IT laboratories. Boys High School Gorikote was chosen for the study using a random sampling technique. Fifty-four 5th-grade students from this school were chosen and separated into two groups depending on their pretest results. For experimental and causal-comparative investigations, researchers' recommend a minimum of 30 participants in each group. Under some circumstances, experimental investigations involving only 15 individuals in each group might be acceptable, provided they are conducted with rigorous control. However, it is advisable to carry out studies conducted with only 15 people in each group in order to derive meaningful findings (Fraenkel & Wallen, 1990). The chosen sample size of 27 students for both the Experimental and control in accordance with the suggested norms set by researchers such as Cohen et al. (2000), and Best (2006) for experimental investigations. Students with the same scores were matched to ensure fairness and unpredictability in group creation, and groups were chosen randomly from these pairs.

Intervention

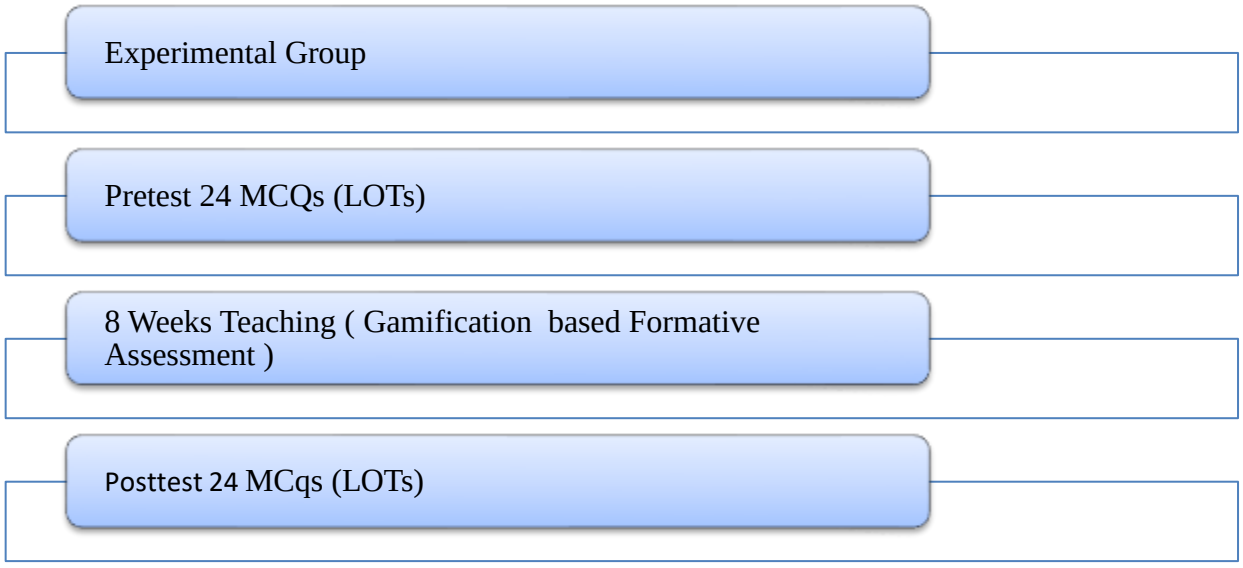

Figure 2: ***Intervention***

The true experiment was conducted from 20th October to 28th December 2023 due to closing sessions in Astore Gilgit-Baltistan schools, and the study period for delivering lessons lasted for eight weeks. Twenty (25) lessons were prepared from the single national curriculum of mathematics grade 5 by a supervisor, experts, and subject specialists to ensure the lesson's quality. The experimental and control group researcher adapted lesson plans comprising 25 lessons from Pakistan's national curriculum for 5th-grade mathematics. Expert and subject teachers validated the lesson plans. The experimental and control groups took a pretest utilizing an achievement test based on the 5th-grade mathematics curriculum. Formative assessment methods were used throughout the instruction session. The experimental group used Kahoot's gamification-based platform,

whereas the control group took traditional-based paper-pencil quizzes. Both students received feedback and monitored their learning, but the experimental group got gamification-based feedback via Kahoot. After completion of the 25 lectures, a posttest was given to both groups.

Instruments

Mathematics Achievement Thinking Skills Test

The pretest and Posttest mathematics achievement thinking skills used to assess students' thinking skills toward mathematics learning in both the experimental and control groups. The test contained 24 MCQs covering lower-order thinking skills. The test was developed from the Single National Curriculum textbook for 5th-grade mathematics to address cognitive skills such as knowledge 50% weightage, comprehension 25% weightage, and application 25% weightage. The pretest and posttest were carefully designed to assess the student's knowledge, comprehension, and application in cognitive domains. They assessed their mathematics thinking skills thoroughly before and after the intervention.

Validation of Mathematics Lower Order Thinking Skills Test

Table 1: ***Validation of Mathematics Lower Order Thinking Skills Achievement Pretest***

S.NO	Statements	Content Validate Index		
		Aligned	Partially Aligned	Non-Aligned
1	The test items are made appropriately from modules.	05	0	
2	The question items measure the lower-order thinking skills of students in mathematics subjects in 5th grade.	03	2	
3	The achievement test is based on a table of specifications.	05	0	
4	The stems of multiple-choice questions give complete sense and meaning.	05	0	
5	Test items are according to the 5th-grade level.	05	0	
6	The distractors of MCQs are attractive.	04	1	
7	A sufficient time is fixed for the students to attempt the test.	04	01	

The table 1 showed that the content validation index (CVI) of the mathematics achievement test of lower-order thinking skills was ensured. Five experts contained two subject specialists, one Assistant Professor in AIOU Islamabad, Pakistan, in the Education department, and two elementary school teachers who taught mathematics subjects in 5th Grade in public schools, for validation of mathematics achievement test that developed from the four units of mathematics subject of Single National Curriculum of Pakistan. The mathematics achievement test contained 24 items of MCQs. A module of mathematics subjects and a table of specifications were given to experts to validate the mathematics achievement test appropriately and maintain its quality in the test. The scale contained eight questions: three, Point Likert Scale 1 for Aligned, 2 for Partially aligned, and 3 for Non-aligned for the validation of mathematics achievement test. 04 experts were marked in the aligned option, but in items number 2, 6 and 7, some feedback and suggestions by the 03 experts were also marked in the partially aligned option. The achievement test tool was incorporated as per suggestions given by the experts. The researcher calculated the items-wise content validate index (I-CVI) and scale-wise validate index (S-CVI) through MS Excel. All the item numbers were calculated using the (I-CVI) 1. The scale-wise content validation index was calculated: 1. Hence, the calculated values of scale and item-wise content validation index are higher than the proposed value of 0.83.

Validity of Mathematics Lesson Plans

The Mathematics module developed by the KPK government of Pakistan for 5th-grade students was accurately made to enhance the quality of the teaching-learning process. This module underwent a rigorous validation process to ensure its validity and accuracy. Six experts, comprising two subject specialists, two elementary school teachers experienced in teaching 5th-grade mathematics, and two PhD Education Assistant Professors from AIOU Islamabad, Pakistan, were involved in the validation process. The researcher devised a Content Validation Index (CVI) consisting of 12 items to assess the lesson plan quality. This index aimed to gauge whether the lessons included in the module met the requisite quality standards. The feedback provided by the subject specialists was utilized to refine and finalize the module, ensuring its alignment with the established quality criteria. Subsequently, the module was evaluated by the subject specialists, an elementary school teacher specializing in 5th-grade mathematics, and a PhD Assistant Professor in Education. The assessment revealed that all 12 items in the CVI were appropriately addressed, with each item receiving a perfect score of 1.

The overall Validated Content Index (S-CVI) calculated using Microsoft Excel, yielded 1. According to the criteria established by Polit & Beck (2006) and Polit, Beck, and Owen (2007), an acceptable CVI value should be at least 0.83 when validated by a panel of six or more experts. Given that the calculated CVI value for the

mathematics module surpassed this threshold, it can be concluded that the module meets the criteria for good quality as prescribed by the experts.

Data Analysis

Various techniques are available for assessing the normality of continuous data. Some often used methods include the Shapiro-Wilk test, Kolmogorov-Smirnov test, skewness, kurtosis, histogram, box plot, P-P plot, Q-Q plot, and mean with standard deviation. The Kolmogorov-Smirnov test and the Shapiro-Wilk test are often used for assessing normality. Normality testing is crucial for continuous data as it directly impacts judgments related to measures of central tendency, dispersion, and the choice between parametric or nonparametric tests. The technique usually used for assessing normality in small sample sizes is The Shapiro–Wilk test (Mishra et al., 2019).

Table 2: ***Normality Test of Students Lower Order Thinking Skills before Intervention***

		Shapiro-Wilk Test		
Group	N	Statistic	Df	Sig.
Experimental	27	.936	27	.098
Control	27	.940	27	.120

The table 2 presents the results of a normality test conducted using the Shapiro-Wilk test to assess the distribution of students' lower-order thinking skills scores before intervention. The participants were divided into two groups: Experimental and Control. For the Experimental group, comprising 27 participants, the Shapiro-Wilk statistic was calculated as .936 with 27 degrees of freedom, yielding a p-value of .098. Similarly, for the Control group, which also consisted of 27 participants, the Shapiro-Wilk statistic was .940 with 27 degrees of freedom, resulting in a p-value of .120.

Interpreting these results reveals that for both the Experimental and Control groups, the p-values obtained from the Shapiro-Wilk test are greater than the conventional significance level of .05. Consequently, neither group's null hypothesis of normality is rejected. Hence, it indicates that the distribution of lower-order thinking skills scores before intervention in both groups does not significantly depart from a normal distribution. Therefore, assumptions related to normality for subsequent statistical analyses can be sufficiently met, providing a foundation for further investigation into the effects of the intervention on students' cognitive skills. The normality of data before intervention is displayed in the histogram.

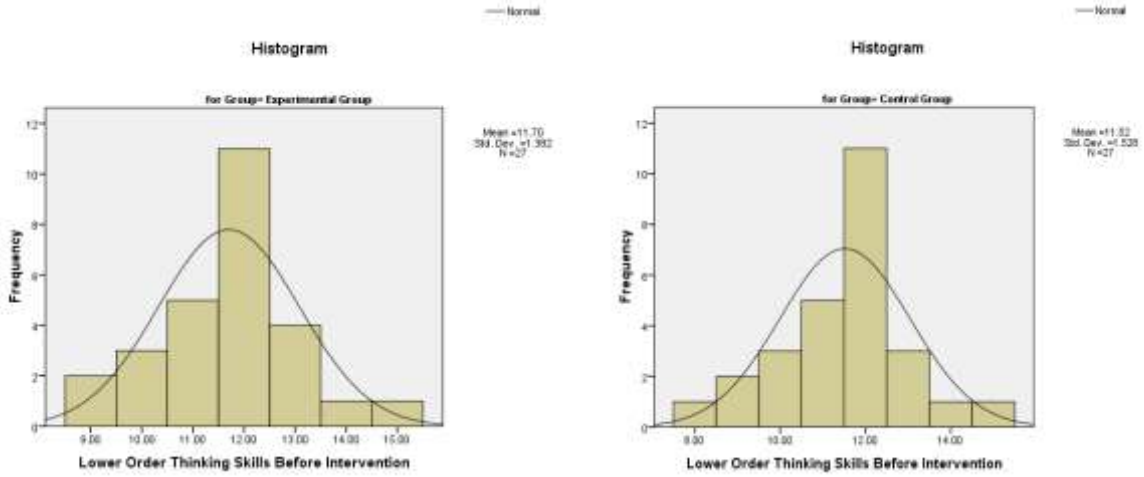

Figure 3 Histogram

Table 3: ***Normality Test of Students Lower Order Thinking Skills After Intervention***

		Shapiro-Wilk Test		
Group	N	Statistic	Df	Sig.
Experimental	27	.953	27	.249
Control	27	.938	27	.108

Table 3 displays the results of a Shapiro-Wilk test to evaluate the normality of students' lower-order thinking skills following an intervention. The participants were divided into two groups: Experimental and Control. For the Experimental group, consisting of 27 individuals, the Shapiro-Wilk statistic was .953 with 27 degrees of freedom, resulting in a p-value of .249. Similarly, in the Control group, which also included 27 participants, the Shapiro-Wilk statistic was .938 with 27 degrees of freedom, yielding a p-value of .108. Upon analysis, it is evident that for both the Experimental and Control groups, the p-values obtained from the Shapiro-Wilk test exceed the conventional significance level of .05. Consequently, the null hypothesis of normality cannot be

rejected for either group. Hence, it implies that the distribution of lower-order thinking skills scores after the intervention does not significantly deviate from a normal distribution in both groups. Thus, these findings suggest that normality-related assumptions for subsequent statistical analyses are met. This information lays the groundwork for further exploration into the efficacy of the intervention on students' cognitive abilities. The normality of data after intervention is displayed in the histogram.

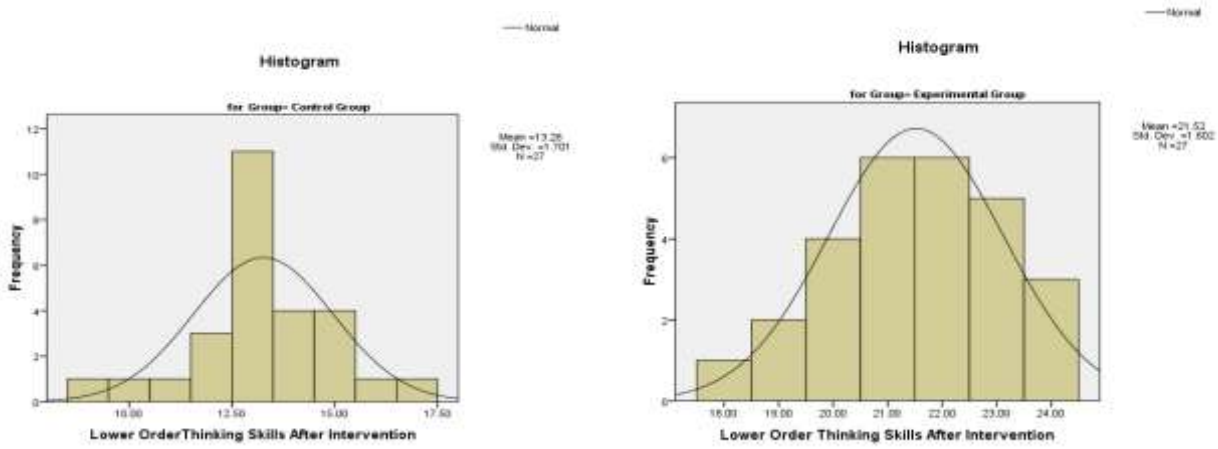

Figure 4 Histogram

Table 4: ***Lower Order Thinking Skills of Students Before Intervention***

Group	N	Mean	Std. Deviation	T	P	Cohen's d
Experimental	27	11.7037	1.38160	.467	.642	0.12
Control	27	11.5185	1.52846			

Table 4 presents students' lower-order thinking skills before the intervention, categorized into Experimental and Control groups.

In the Experimental group of 27 participants, the mean lower-order thinking score was 11.7037, with a standard deviation of 1.38160. The T-value associated with this group is .467, while the corresponding p-value is .642. Cohen's d, a measure of effect size, was also calculated to be 0.12 for this group. For the control group, which comprised 27 participants, the mean lower-order thinking skills score was slightly lower at 11.5185, with a slightly higher standard deviation of 1.52846. However, the table does not provide the specific T-value and p-value for this group.

Interpreting these data indicates that before the intervention, the Experimental and Control groups had comparable mean scores regarding lower-order thinking abilities, with slight variations in standard deviation. The T-value and associated p-value suggest no significant difference between the two groups regarding lower-order thinking abilities before the intervention. Cohen's d value of 0.12 indicates a small effect size for the difference between the Experimental and Control groups in terms of lower-order thinking abilities before the intervention.

Table 5: ***Lower Order Thinking abilities of students After Intervention***

Group	N	Mean	Std. Deviation	T	P	Cohen's d
Experimental	27	21.5185	1.60217	18.369	.000	4.9
Control	27	13.2593	1.70051			

Table 5 outlines students' lower-order thinking skills after the intervention, which are categorized into experimental and control groups.

The mean lower-order thinking score in the Experimental group, comprising 27 participants, significantly increased to 21.5185, with a standard deviation of 1.60217. The T-value associated with this group is notably high at 18.369, and the corresponding p-value is .000, indicating a highly significant difference. Furthermore, the effect size, measured by Cohen's d, is substantial at 4.9 for this group.

For the control group, which also consisted of 27 participants, the mean lower-order thinking score rose to 13.2593, with a standard deviation of 1.70051. Interpreting these findings demonstrates a significant improvement in lower-order thinking abilities for the Experimental group after the intervention. The considerably high T-value and associated p-value of .000 indicate a substantial difference compared to pre-intervention scores. Moreover, the large effect size, represented by Cohen's d of 4.9, underscores the magnitude of this improvement. Conversely, the Control group also showed an increase in mean lower-order thinking scores post-intervention, albeit to a lesser extent than the Experimental group. However, with

specific T-value and p-value details for the Control group, the significance of this change can be determined from the provided data.

Table 6

ANOVA

Comparison the Influence of Gamification-based Formative Assessment of Different Levels of Thinking Skills

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	754.099	2	377.049	784.650	.000
Within Groups	37.481	78	.481		
Total	791.580	80			

The analysis of variance (ANOVA) was conducted to compare the influence of Gamification-based Formative Assessment on different levels of thinking skills. The results of the table 6 revealed a significant difference between the groups ($F(2, 78) = 784.650$, $p < .001$). The between-groups analysis demonstrated a substantial variability (SS = 754.099, MS = 377.049), indicating diverse impacts across varying levels of thinking skills. This suggests that implementing Gamification-based Formative Assessment has a discernible effect on different cognitive processes.

Table 7: Post Hoc

Multiple Comparisons

Tukey HSD Post Hoc Test On Comparison The Influence Of Gamification-Based Formative Assessment On Different Levels Of Thinking Skills

(I) Levels Thinking	(J) Levels Thinking	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Knowledge	Comprehension	6.25926*	.18867	.000	5.8085	6.7100
	Application	6.66667*	.18867	.000	6.2159	7.1174
Comprehension	Application	.40741	.18867	.085	-.0434	.8582

*. The mean difference is significant at the 0.05 level.

The provided data presents the results of a Tukey Honestly Significant Difference (HSD) post hoc test conducted to compare the influence of gamification-based formative assessment on different levels of thinking abilities: knowledge, comprehension, and application.

The mean difference between knowledge and comprehension levels is 6.25926, with a standard error of .18867. This difference is statistically significant ($p < .05$), indicating that the gamification-based formative assessment significantly enhances thinking abilities from knowledge to comprehension levels. The 95% confidence interval for this difference ranges from 5.8085 to 6.7100, further confirming the significance of this finding.

Similarly, the mean difference between knowledge and application levels is 6.66667, with a standard error of .18867. This difference is also statistically significant ($p < .05$), demonstrating that the formative assessment significantly improves thinking abilities from knowledge to application levels. The 95% confidence interval for this difference ranges from 6.2159 to 7.1174, further supporting the statistical significance of this result.

However, the mean difference between comprehension and application levels is .40741, with a standard error of .18867. This difference is insignificant at the .05 level ($p = .085$). Although there is a numerical difference between comprehension and application levels, it is not statistically significant, suggesting that the effectiveness of the formative assessment may not differ significantly between these two levels of thinking abilities. The results indicate that the gamification-based formative assessment significantly enhances thinking abilities from knowledge to comprehension and application levels. However, no significant difference was observed between comprehension and application levels in terms of the effectiveness of the formative assessment.

Discussion

This study highlights a significant improvement in lower-order thinking skills following the intervention, particularly within the experimental group. Initially, both experimental and control groups displayed comparable mean scores, indicating similar baseline levels of lower-order thinking abilities. However, post-intervention, the experimental group demonstrated a significant increase in mean scores, accompanied by a

notable effect size (Cohen's d = 4.9). The intervention enhancing students' lower-order thinking skills. Kahyaoğlu Erdoğmuş and Kurt (2023) described that students reported enhancements in the learning process due to game-based learning initiatives. In gamification applications, competitive gaming emerges as the most impactful mechanism for enhancing students' cognitive skills and motivation (Zhan et al., 2022). Conversely, when games are utilized as teaching aids or student projects, their effects predominantly manifest in academic achievement. Elbyaly and Elfeky (2023) conducted a study that revealed that participants in the experimental group, engaged in instructional gaming applications, demonstrated superior performance compared to their counterparts in the control group, who underwent conventional learning methods in various facets of creative thinking, including total score, fluency, flexibility, and originality.

The ANOVA results indicate a significant difference in the influence of gamification-based formative assessment on different levels of thinking abilities (knowledge, comprehension, and application). Implementing this pedagogical approach has a discernible effect on enhancing cognitive processes. The substantial variability observed between groups further reinforces the notion that gamification-based formative assessment impacts different levels of thinking skills differently. The subsequent Tukey HSD post hoc test provides further insight into the specific nature of these differences. The significant mean differences between knowledge and comprehension levels and between knowledge and application levels highlight the effectiveness of gamification-based formative assessment in improving thinking abilities from lower-order to higher-order thinking skills. These findings underscore the potential of gamification as a valuable tool for promoting deeper learning and critical thinking among students.

However, the non-significant mean difference between comprehension and application levels suggests that the effectiveness of the formative assessment may be similar between these two levels of thinking abilities. While there is a numerical difference, it may need to be more substantial to reach statistical significance. This finding prompts further investigation into the specific factors influencing the effectiveness of gamification-based formative assessment across different cognitive processes. It's essential to acknowledge the study's limitations, such as the particular context in which the research was conducted, the characteristics of the participants, and the measures used to assess thinking abilities. Additionally, future research could explore the long-term effects of gamification-based formative assessment on learning outcomes and examine potential moderating variables that may influence its effectiveness. The findings provide valuable insights into the potential of gamification-based formative assessment as an effective educational intervention for promoting cognitive thinking skills. By understanding how this pedagogical approach influences different levels of thinking abilities, educators can better design instructional strategies to enhance student learning and engagement in diverse educational settings. According to Korkmaz and Öztürk (2020), integrating educational games into social studies education yields substantial enhancements in students' cooperative learning skills compared to traditional instructional methods. Additionally, using educational games in social studies education significantly enhances students' academic achievement in the subject matter compared to conventional teaching approaches. Wu, Tien, Hsu, & Wen (2021) proposed a study that offers theoretical and practical insights by integrating gamification into Information Systems (IS) learning. They advocate for gamification as a potent strategy to augment students' knowledge acquisition in a compelling, timely, cost-effective, and iterative manner. Nurtanto et al. (2021) elucidate that gamification influences student conduct and academic achievements across affective, cognitive, behavioral, and performance domains.

Implications and Conclusion

It is concluded that gamification-based formative assessment plays a significant role in improving LOTs of students toward mathematics learning particularly primary level. The results of the ANOVA and Tukey HSD post hoc test indicate that gamification-based formative assessment significantly influences different levels of thinking abilities, including knowledge, comprehension, and application. The ANOVA analysis revealed a significant difference between the groups, suggesting that implementing gamification-based formative assessment leads to diverse impacts across varying levels of thinking skills. Specifically, the post hoc comparisons revealed statistically significant mean differences between knowledge, comprehension, and application levels. These findings suggest that gamification-based formative assessment effectively enhances thinking abilities from lower-order to higher-order cognitive processes. It highlights the potential of gamification as a powerful educational tool for promoting deeper learning and thinking skills among students. However, the comparison between comprehension and application levels did not yield a statistically significant mean difference, indicating that the effectiveness of the formative assessment may not vary significantly between these two levels of thinking abilities. While there may be a numerical difference, it may not be substantial enough to reach statistical significance. The findings suggest that gamification-based formative assessment is a promising approach for improving students' lower order thinking skills across different cognitive levels. By understanding the nuanced impacts of this pedagogical strategy, educators can better tailor instructional practices to foster enhanced learning outcomes and thinking skills among students.

Teachers may get valuable insights into the enhancement of lower-order thinking skills (LOTS) in children in primary schools via the use of gamification-based formative assessment, as concluded and shown by the study's findings. By integrating gamified practices into their instruction, teachers may establish more captivating and interactive learning settings, so enhancing student motivation and their academic

achievement particularly for improving lower order thinking skills. Furthermore, curriculum designers may use this information to create educational tools that employ gamification to improve students' comprehension of mathematics. Future studies may be conducted examining the impact of using gamification-based formative assessment on the development of higher-order thinking skills (HOTS) at various cognitive levels. Studying in both qualitative and quantitative research may provide a thorough comprehension of the influence of gamified methods on student learning. Future study including carrying out longitudinal studies to monitor the lasting impacts and investigating variations in individuals' responses to gamified assessments practices. The results of this research help policymakers understand the possible advantages of incorporating formative assessments based on gamification into the math curriculum for primary school students.

References

1. Abidin, Z., Mathrani, A., & Hunter, R. (2017). Student Engagement with Technology Use in Mathematics Education: An Indonesian Secondary School Context. In PACIS (p. 165). https://aisel.aisnet.org/pacis2017/165/
2. Agarwal, P. K. (2019). Retrieval practice & Bloom's taxonomy: Do students need fact knowledge before higher order learning?. *Journal of educational psychology*, *111*(2), 189. https://doi.org/10.1037/edu0000282
3. Al Ghawail, E. A., & Yahia, S. B. (2022). Using the E-Learning Gamification Tool Kahoot! to Learn Chemistry Principles in the Classroom. Procedia Computer Science, 207, 2667-2676. https://doi.org/10.1016/j.procs.2022.09.325
4. Alabbasi, D. (2018). Exploring Teachers' Perspectives towards Using Gamification Techniques in Online Learning. *Turkish Online Journal of Educational Technology-TOJET*, *17*(2), 34-45.
5. Alfulaih, W. K., & Attiya Elsayed, F. (2018). The impact of using games on developing Saudi female EFL students' speaking skills. *British Journal of Humanities and Social Sciences*, *19*(2), 14-23.
6. Al-Hosni, H. A., & Al-Balushi, S. M. (2023). The impact of using a gamification approach-based mobile application on 4th grade students' acquisition of scientific concepts during COVID-19 pandemic. *University of Sharjah Journal for Humanities & Social Sciences*, *20*(1). https://doi.org/10.36394/jhss/20/1/9
7. Aljraiwi, S. (2019). Effectiveness of gamification of web-based learning in improving academic achievement and creative thinking among primary school students. *International Journal of Education and Practice*, *7*(3), 242-257.https://doi.org/10.18488/journal.61. 2019.73.242.257
8. Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives: complete edition*. Addison Wesley Longman, Inc.. https://eduq.info/xmlui/handle/11515/18824
9. Apino, E., & Retnawati, H. (2017, February). Developing instructional design to improve mathematical higher order thinking skills of students. In *Journal of Physics: Conference Series* (Vol. 812, No. 1, p. 012100). IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/812/1/012100/meta
10. Assaly, I. R., & Smadi, O. M. (2015). Using Bloom's Taxonomy to Evaluate the Cognitive Levels of Master Class Textbook's Questions. *English Language Teaching*, *8*(5), 100-110.
11. Balaskas, S., Zotos, C., Koutroumani, M., & Rigou, M. (2023). Effectiveness of GBL in the Engagement, Motivation, and Satisfaction of 6th Grade Pupils: A Kahoot! Approach. Education Sciences, 13(12), 1214. https://doi.org/10.3390/educsci13121214
12. Barut, M. E., & Wijaya, A. (2021, March). Examining Middle School Student's Lower Order Thinking Skill. In 7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS 2020) (pp. 362-367). Atlantis Press. file:///C:/Users/Shagufta/Downloads/125953679.pdf
13. Baszuk, P. A., & Heath, M. L. (2020). Using Kahoot! to increase exam scores and engagement. Journal of Education for Business, 95(8), 548-552. https://doi.org/10.1080/08832323.2019.1707752
14. Best, W. J., & Kahn, V. J. (2006). Research in education. Tenth Edit. *United States of America: A and B Pearson*.
15. Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain (pp. 201-207). New York: McKay.
16. Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). The classification of educational goals. *Taxonomy of educational objectives*, *207*, 207..
17. Boaler, J. (2016). Mathematical Mindsets Unleashing Students' Potential Through Creative. *math, inspiring messages, and innovative teaching*. John Wiley & Sons.https://elibrary.sekolahsabilillah.sch.id/sdis/index.php?p=show_detail&id=1011
18. Boden, G. M., & Hart, L. (2018). Kahoot-Game based student response system. Compass: Journal of Learning and Teaching, 11(1), 1-4. https://pdfs.semanticscholar.org/4a20/442db3c2cb18946b82a87b28708ee0c66e04.pdf

19. Buil, I., Catalán, S., & Martínez, E. (2020). Understanding applicants' reactions to gamified recruitment. Journal of Business Research, 110, 41-50. https://doi.org/10.1016/j.jbusres.2019.12.041
20. Cadet, M. J. (2023). Application of game-based online learning platform: Kahoot a formative evaluation tool to assess learning. Teaching and Learning in Nursing, 18(3), 419-422. https://doi.org/10.1016/j.teln.2023.03.009
21. Campbell, D. T., & Stanley, J. C. (2015). *Experimental and quasi-experimental designs for research*. Ravenio books. https://books.google.com.pk/books?hl=en&lr=&id=KCTrCgAAQBAJ&oi=fnd&pg=PT4&dq=Campbell,+D.+T.,+%26+Stanley,+J.+C.+(1963).+Experimental+and+quasi-experimental+designs+for+research.+Houghton+Mifflin.&ots=Mfo2FPsDWI&sig=FTG7SZ_dW3S0uOs4eL5hITMK6PM&redir_esc=y#v=onepage&q&f=false
22. Chang, M., Evans, M. A., Kim, S., Norton, A., & Samur, Y. (2015). Differential effects of learning games on mathematics proficiency. *Educational Media International*, *52*(1), 47-57. https://doi.org/10.1080/09523987.2015.1005427
23. Chen, M. H. (2016). Theoretical framework for integrating higher-order thinking into L2 speaking. *Theory and Practice in Language Studies*, *6*(2), 217-226. http://dx.doi.org/10.17507/tpls.0602.01
24. Chiu, T. K., & Mok, I. A. (2017). Learner expertise and mathematics different order thinking skills in multimedia learning. *Computers & Education*, *107*, 147-164. https://www.sciencedirect.com/science/article/abs/pii/S0360131517300088
25. Cohen, L., Manion, L., & Morrison, K. (2000). Research methods in Education. London: Routledge.
26. Cortés-Pérez, I., Zagalaz-Anula, N., López-Ruiz, M. D. C., Díaz-Fernández, Á., Obrero-Gaitán, E., & Osuna-Pérez, M. C. (2023, February). Study Based on Gamification of Tests through Kahoot!™ and Reward Game Cards as an Innovative Tool in Physiotherapy Students: A Preliminary Study. In Healthcare (Vol. 11, No. 4, p. 578). MDPI. https://doi.org/10.3390/healthcare11040578
27. Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications. https://cumming.ucalgary.ca/sites/default/files/teams/82/communications/Creswell%202003%20-%20Research%20Design%20-%20Qualitative%2C%20Quantitative%20and%20Mixed%20Methods.pdf
28. De Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional science*, *38*(2), 105-134. https://doi.org/10.1007/s11251-009-9110-0
29. Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. *Plenum Press*. https://doi.org/10.1007/978-1-4899-2271-7
30. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011, September). From game design elements to gamefulness: defining" gamification". In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9-15). https://dl.acm.org/doi/abs/10.1145/2181037.2181040
31. Dugard, P., & Todman, J. (1995). Analysis of pre-test-post-test control group designs in educational research. Educational Psychology, 15(2), 181-198. https://doi.org/10.1080/0144341950150207
32. Elbyaly, M. Y. H., & Elfeky, A. I. M. (2023). The Efficiency of Instructional Gaming Programs In Stimulating Creative Thinking. European Chemical Bulletin, 12, 6613-6621. https://orcid.org/0000-0001-9208-8537
33. El-Khalili, N. H., & El-Ghalayini, H. (2014). Comparison of Effectiveness of Different Learning Technologies. *International Journal of Emerging Technologies in Learning*, *9*. https://doi.org/10.3991/ijet.v9i9.4158
34. Finneran, C. M., & Zhang, P. (2005). Flow in computer-mediated environments: Promises and challenges. *Communications of the association for information systems*, *15*(1), 4. https://doi.org/10.17705/1cais.01504
35. Fraenkel, J. R., & Wallen, N. E. (1990). *How to design and evaluate research in education*. Order Department, McGraw Hill Publishing Co., Princeton Rd., Hightstown, NJ 08520.
36. Hidayat, R., Qi, T. Y., Ariffin, P. N. B. T., Hadzri, M. H. B. M., Chin, L. M., Ning, J. L. X., & Nasir, N. (2024). Online game-based learning in mathematics education among Generation Z: A systematic review. *International Electronic Journal of Mathematics Education*, *19*(1), em0763. https://www.iejme.com/download/online-game-based-learning-in-mathematics-education-among-generation-z-a-systematic-review-14024.pdf
37. Hrynchak, P., & Batty, H. (2012). The educational theory basis of team-based learning. Medical teacher, 34(10), 796-801. https://doi.org/10.3109/0142159x.2012.687120
38. Jones, B. F., & Idol, L. (2013). *Dimensions of thinking and cognitive instruction*. Routledge.
39. Jones, B. F., & Idol, L. (2013). *Dimensions of thinking and cognitive instruction*. Routledge
40. Kahyaoğlu Erdoğmuş, Y., & Kurt, A. A. (2023). Digital game-based learning: Pedagogical agent and feedback types on achievement, flow experience, and cognitive load. Education and Information Technologies, 1-26. https://doi.org/10.1007/s10639-023-12368-2
41. Kalyuga, S. (2011). Cognitive load theory: How many types of load does it really need?. *Educational psychology review*, *23*, 1-19. https://doi.org/10.1007/s10648-010-9150-7

42. Kamarulzaman, M. S., Sailin, S. N., Mahmor, N. A., & Shaari, A. J. (2017). Correlation between lots and hots scores among UUM. Asian Journal of Educational Research, 5(3), 71-76. https://d1wqtxts1xzle7.cloudfront.net/54526978/full-paper-correlation-between-lots-and-hots-scores-among-uum-students-libre.pdf?1506324614
43. Kamarulzaman, M. S., Sailin, S. N., Mahmor, N. A., & Shaari, A. J. (2017). Correlation between lots and hots scores among UUM. *Asian Journal of Educational Research*, *5*(3), 71-76. https://d1wqtxts1xzle7.cloudfront.net/54526978/Full-Paper-CORRELATION-BETWEEN-LOTS-AND-HOTS-SCORES-AMONG-UUM-STUDENTS-libre.pdf?1506324614=&response-content-disposition=inline%3B+filename%3DCORRELATION_BETWEEN_LOTS_AND_HOTS_SCORES.pdf&Expires=1716720719&Signature=d~JoixxTk3Sw4YrQGFWEjz5TnZAp3SXZu2oJdompWXCwM4O41NjHMRL6wJ5ivHaOG-wcMrxu9Pva-yD2CdrgYuteoOiGsKiwXaWbQx5XzjK2apiF4Q8YqbucEuAGtF6iugbpQZDBZLKLtFnkldmU5B8Y-VFP76sBgNc1-fldjnC1R5gE8lxrVKM57cMJ4wUryJRVt0dxMYUi3EeB4GNPPQr-2CbnTEpDacLKDls-R9UnagM29dje52kCj0eeGfunAmUDpLUK~m8Liruc6xZ3OgijO0X1sCNrv5hE0IahkflGJ8NKWiLnj~vNSoPjPGqeftqnEDWhyCvPkYuLogIEkQ__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA
44. Kaur, P., & Naderajan, R. (2019). Kahoot in the English language classroom. South East Asia Journal of Contemporary Business, Economics and Law, 20(6), 49-54. https://seajbel.com/wp-content/uploads/2019/12/KLICELS14_45.pdf
45. Khalid, T., Batool, S. H., Khalid, A., Saeed, H., & Zaidi, S. W. H. (2019). Pakistani students' perceptions about their learning experience through video games: A qualitative case study. *Library Hi Tech*, *38*(3), 493-503. https://doi.org/10.1108/LHT-03-2019-0068
46. Kim, J., & Castelli, D. M. (2021). Effects of gamification on behavioral change in education: A meta-analysis. International Journal of Environmental Research and Public Health, 18(7), 3550. https://doi.org/10.3390/ijerph18073550
47. KORKMAZ, Ö., & ÖZTÜRK, Ç. (2020). The effect of gamification activities on students' academic achievements in social studies course, attitudes towards the course and cooperative learning skills. Participatory Educational Research, 7(1), 1-15. https://doi.org/10.17275/per.20.1.7.1
48. Krathwohl, D. R. (2002). A Revision Bloom's Taxonomy: An Overview. *Theory into Practice*. https://www.tandfonline.com/doi/pdf/10.1207/s15430421tip4104_2
49. Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. Theory into practice, 41(4), 212-218. https://doi.org/10.1207/s15430421tip4104_2
50. Kristiana, D., & Suyanto, W. (2013). Implementasi heuristic problem solving dalam menyelesaikan soal cerita untuk meningkatkan prestasi dan sikap matematika. *Jurnal Prima Edukasia*, *1*(1), 17-29. https://doi.org/10.21831/jpe.v1i1.2313
51. Lashari, T. A., Fiayaz, R., Lashari, S. A., Khan, I., Sultana, S., & Afzal, T. Kahoot. (2023): A game-based web tool to assess motivation, engagement fun, and learning outcomes among engineers. Computer Applications in Engineering Education. https://doi.org/10.1002/cae.22684
52. Licorish, S. A., Owen, H. E., Daniel, B., & George, J. L. (2018). Students' perception of Kahoot!'s influence on teaching and learning. *Research and Practice in Technology Enhanced Learning*, *13*(1), 1-23. https://link.springer.com/article/10.1186/s41039-018-0078-8
53. Maruta, S. I., Bolaji, C., Musa, M., & Ibrahim, M. O. (2022). Effects of Polya and Bransford-stein models on students' performance in trigonometry, among senior secondary school students in Kano State, Nigeria. The Journal of the Mathematical Association of Nigeria, 47(2), 7-14. https://man-nigeria.org.ng/issues/ABA-EDU-2022-13.pdf
54. Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of cardiac anaesthesia*, *22*(1), 67.
55. Mosimege, M. D., & Egara, F. O. (2022). Perception and perspective of teachers towards the usage of ethno-mathematics approach in mathematics teaching and learning. Multicultural Education, 8(3), 288-298.
56. Nacke, L. E., & Deterding, S. (2017). The maturing of gamification research. Computers in Human Behavior, 71, 450-454. https://doi.org/10.1016/j.chb.2016.11.062
57. Nurtanto, M., Kholifah, N., Ahdhianto, E., Samsudin, A., & Isnantyo, F. D. (2021). A review of gamification impact on student behavioral and learning outcomes. iJIM, 15(21), 23. https://doi.org/10.3991/ijim.v15i21.24381
58. Nzeadibe, A. C., Egara, F. O., Inweregbuh, C. O., & Osakwe, I. J. (2020). Effect of problem-solving and collaborative strategy on secondary school students' retention in geometry. African Journal of Science, Technology and Mathematics Education, 5(1), 9-20.
59. Okeke, A. M., Egara, F. O., Orga, A. C., & Nzeadibe, A. C. (2023). Effect of symbolic form model on students' interest in logic content of the mathematics curriculum. Pedagogical Research, 8(2). https://doi.org/10.29333/pr/13077
60. Osakwe, I. J., Egara, F. O., Inweregbuh, O. C., Nzeadibe, A. C., & Emefo, C. N. (2023). Interaction patterns: An approach for enhancing students' retention in geometric construction. International Electronic Journal of Mathematics Education, 18(1), em0720. https://doi.org/10.29333/iejme/12596

61. Öz, G. Ö., & Ordu, Y. (2021). The effects of web based education and Kahoot usage in evaluation of the knowledge and skills regarding intramuscular injection among nursing students. Nurse Education Today, 103, 104910. https://doi.org/10.1016/j.nedt.2021.104910
62. Pahamzah, J., Syafrizal, S., & Nurbaeti, N. (2022). The effects of EFL course enriched with Kahoot on students' vocabulary mastery and reading comprehension skills. Journal of Language and Linguistic Studies, 18(1), 643-652.
63. Panmei, B., & Waluyo, B. (2022). The pedagogical use of gamification in English vocabulary training and learning in higher education. Education Sciences, 13(1), 24. https://doi.org/10.3390/educsci13010024
64. Piaget, J. (1971). The theory of stages in cognitive development. In D. R. Green, M. P. Ford, & G. B. Flamer, *Measurement and Piaget*. McGraw-Hill. https://psycnet.apa.org/record/1973-02118-011
65. Plump, C. M., & LaRosa, J. (2017). Using Kahoot! in the classroom to create engagement and active learning: A game-based technology solution for eLearning novices. *Management Teaching Review*, *2*(2), 151-158. https://journals.sagepub.com/doi/abs/10.1177/2379298116689783
66. Ratinho, E., & Martins, C. (2023). The role of gamified learning strategies in student's motivation in high school and higher education: A systematic review. Heliyon. https://doi.org/10.1016/j.heliyon.2023.e19033
67. Razak, F., Sutrisno, A. B., Immawan, Z., & Muchsin, S. B. (2018, June). Analysis Students' Thinking Level with Cognitive Style "Field Independent" Based on Van Hiele Theory. In *Journal of Physics: Conference Series* (Vol. 1028, No. 1, p. 012161). IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1028/1/012161/meta
68. Rodríguez, I., Puig, A., Tellols, D., & Samsó, K. (2020). Evaluating the effect of gamification on the deployment of digital cultural probes for children. International journal of Human-Computer studies, 137, 102395. https://doi.org/10.1016/j.ijhcs.2020.102395
69. Rutledge, C., Walsh, C. M., Swinger, N., Auerbach, M., Castro, D., Dewan, M., ... & Chang, T. P. (2018). Gamification in action: theoretical and practical considerations for medical educators. Academic Medicine, 93(7), 1014-1020. . https://doi.org/10.1097/acm.0000000000002183
70. Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, *25*(1), 54-67. https://www.sciencedirect.com/science/article/pii/S0361476X99910202
71. Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American psychologist, 55(1), 68. https://doi.org/10.1037/0003-066X.55.1.68
72. Saido, G. M., Siraj, S., Nordin, A. B. B., & Al_Amedy, O. S. (2018). Higher order thinking skills among secondary school students in science learning. *MOJES: Malaysian Online Journal of Educational Sciences*, *3*(3), 13-20. https://ijie.um.edu.my/index.php/MOJES/article/view/12778/8203
73. Salimei, A., & Zangeneh, H. (2022). The effect of gamification on vocabulary learning (learning English as a second language) among the fifth-grade elementary school students. Technology of Education Journal (TEJ), 16(4), 723-734. https://doi.org/10.22061/tej.2022.8550.2686
74. Senko, C., Hulleman, C. S., & Harackiewicz, J. M. (2011). Achievement goal theory at the crossroads: Old controversies, current challenges, and new directions. Educational psychologist, 46(1), 26-47. https://doi.org/10.1080/00461520.2011.538646
75. Surayya, S. A., Jaelani, S. R., & Ilmiani, I. (2023). The Use of Kahoot! Application to Teach English Vocabulary Learning in Rural Area. Pioneer: Journal of Language and Literature, 15(1), 183-194. https://doi.org/10.36841/pioneer.v15i1.2928
76. Teng, C. I., & Huang, H. C. (2012). More than flow: revisiting the theory of four channels of flow. *International Journal of Computer Games Technology*, *2012*, 4-4. https://doi.org/10.1155/2012/724917
77. Tóth, Á., Lógó, P., & Lógó, E. (2019). The Effect of the Kahoot Quiz on the Student's Results in the Exam. Periodica Polytechnica Social and Management Sciences, 27(2), 173-179.
78. Tsay, C. H. H., Kofinas, A. K., Trivedi, S. K., & Yang, Y. (2019). Overcoming the novelty effect in online gamified learning systems: an empirical evaluation of learner engagement and performance. http://hdl.handle.net/10547/623516
79. Van Merriënboer, J. J., & Sweller, J. (2010). Cognitive load theory in health professional education: design principles and strategies. *Medical education*, *44*(1), 85-93. https://doi.org/10.1111/j.1365-2923.2009.03498.x
80. Viberg, O., Grönlund, Å., & Andersson, A. (2023). Integrating digital technology in mathematics education: a Swedish case study. Interactive Learning Environments, 31(1), 232-243. https://doi.org/10.1080/10494820.2020.1770801
81. Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol. 86). Harvard university press. https://home.fau.edu/musgrove/web/vygotsky1978.pdf
82. Wang, A. I., & Tahir, R. (2020). The effect of using Kahoot! for learning–A literature review. *Computers & Education*, *149*, 103818. https://www.sciencedirect.com/science/article/pii/S0360131520300208

83. Wirani, Y., Nabarian, T., & Romadhon, M. S. (2022). Evaluation of continued use on Kahoot! as a gamification-based learning platform from the perspective of Indonesia students. Procedia Computer Science, 197, 545-556. https://doi.org/10.1016/j.procs.2021.12.172
84. Wood, L., Teras, H., Reiners, T., & Gregory, S. (2013). The role of gamification and game-based learning in authentic assessment within virtual environments. *Research and development in higher education: The place of learning and teaching*, 514-523. http://hdl.handle.net/20.500.11937/30116
85. Wu, T., Tien, K. Y., Hsu, W. C., & Wen, F. H. (2021). Assessing the effects of gamification on enhancing information security awareness knowledge. Applied Sciences, 11(19), 9266. https://doi.org/10.3390/app11199266
86. Yusoff, W. M. W., & Seman, S. C. (2018). Teachers' knowledge of higher order thinking and questioning skills: A case study at a primary school in Terengganu, Malaysia. *International Journal of Academic Research in Progressive Education and Development*, *7*(2). https://core.ac.uk/download/pdf/300464513.pdf
87. Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. Educational research review, 30, 100326. https://doi.org/10.1016/j.edurev.2020.100326
88. Zhan, Z., He, L., Tong, Y., Liang, X., Guo, S., & Lan, X. (2022). The effectiveness of gamification in programming education: Evidence from a meta-analysis. Computers and Education: Artificial Intelligence, 3, 100096. https://doi.org/10.1016/j.caeai.2022.100096