

(Research/Review) Article

## Gamified Android Learning to Foster Higher-Order Thinking in Students with ADHD

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**Abstract:** This study addresses the problem of how the implementation of HOTS-based Android gamification influences the higher-order thinking skills of students with ADHD, a group that often faces challenges in traditional learning environments. A quantitative experimental research design was applied, involving 26 students with ADHD from four special needs schools (SLBs) in West Kalimantan. The intervention included HOTS-oriented Android gamified learning, and students' performance was measured using pre-tests and post-tests based on HOTS-level questions. The average pre-test score was 23.72, while the post-test score increased to 53.21. A paired sample t-test showed a significant improvement ( $t = 8.688 > t_{table} = 1.708$ , at a 5% significance level). However, only 57.69% of students met the minimum mastery criteria (KKM = 67), indicating that 15 out of 26 students achieved the expected learning standard. The implementation of HOTS-based Android gamification significantly improved the higher-order thinking skills of students with ADHD. Nonetheless, the overall results, based on average scores and classical completeness, indicate that many students still did not reach the expected level of mastery. Further enhancements in instructional design may be necessary to optimize outcomes for this group of learners.

**Keywords:** ADHD; Android Gamification; Higher-Order Thinking; HOTS; Implementation.

### 1. Introduction

Non-routine problems serve as instruments for assessing Higher Order Thinking Skills (HOTS). HOTS go beyond rote memorization of facts or concepts; they require students to apply, analyze, evaluate, and create based on the knowledge they acquire (Koh, Chapman, Gierus, & Others, 2025; Richland & Simms, 2015; Wun & Harun, 2015). To effectively engage in HOTS, students must operate at higher cognitive levels, including analysis, evaluation, and creation, thus demanding strong reasoning and critical thinking abilities (Davoudi & Sadeghi, 2015). Equipping students with HOTS is essential for enabling them to think critically and creatively in solving problems and making informed decisions.

Despite its importance, the implementation of HOTS-based instruction remains uneven across educational levels, both in mainstream and special needs schools. This contradicts the Indonesian government's initiative that all students, regardless of background, should develop HOTS to be better prepared for future challenges. The program aims to foster students who actively participate, analyze, solve problems, and think critically (Samala et al., 2024). The lack of HOTS application in special needs education, particularly among students with Attention Deficit Hyperactivity Disorder (ADHD), presents a significant issue (Asherson, Buitelaar, Faraone, & Rohde, 2016; Banaschewski et al., 2017).

Fabiano & Pyle (2019) and Varrasi et al (2021) mention without tailored educational support, students with ADHD struggle to learn optimally and realize their potential. In fact, these students possess similar intellectual abilities to their typically developing peers and can achieve higher-order thinking skills through appropriate instructional strategies. Gamification in learning has shown potential to enhance student engagement and enthusiasm, including among students with ADHD (Alabdulkareem & Jamjoom, 2020; Lin & Chang, 2025;

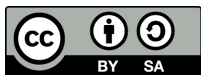
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Mahmoudi et al., 2024). ADHD is a neurological condition characterized by difficulties in impulse control, attention regulation, and behavioral inhibition (Bell, 2010). Children with ADHD may appear restless, struggle with concentration, and act impulsively (Furman, 2005). These students require educational strategies that are equivalent in ambition to those used with typical learners but adapted to their learning needs. Therefore, the integration of HOTS with Android-based gamification presents a promising way to achieve learning equity.

Combining mathematics instruction with gamified Android applications aligns well with the goals of HOTS-based learning. Previous studies show that students with ADHD are more capable of solving comprehension-level problems based on Bloom's Revised Taxonomy when supported by HOTS-based materials and gamified tools (Alabdulkareem & Jamjoom, 2020; Jiang et al., 2022). Moreover, they benefit from test instruments that include HOTS indicators to help them adapt to more complex problems. (Oktaviana & Susiaty, 2020) found that HOTS-oriented test instruments have a positive level of effectiveness. HOTS-based mathematics modules for middle school students have proven effective (Susiaty & Oktaviana, 2021), and apps like Morndumath have been shown to improve HOTS among students (Susiaty, Fitria, & Saputro, 2022). Games designed to match students' needs have also resulted in high classical completeness (Susiaty & Prihatin, 2021). Further, Android-based applications have been successfully used as teaching tools. Suciati (2022) confirmed that implementing HOTS in instruction correlates positively with learning outcomes and improves students' critical thinking. Similarly, Fanani (2018) showed that HOTS assessments enhance academic achievement by training students to think critically and creatively, thus preparing them to compete nationally and internationally. Dwijayanti (2021) emphasized that critical thinking can be embedded in HOTS-based learning, as students are required to solve problems through high-level cognitive processes. Consistent with these findings, Wardana & Sagoro (2019) demonstrated that gamification increases student activity, motivation, and achievement. Mee, Rita Wong Mee, Pek Lim Seong (2021) also concluded that gamification is effective in promoting active learning. Rahmani (2020) found that gamified learning improves students' competitiveness.

The implementation of HOTS-based Android gamification offers a valuable opportunity to nurture higher-order thinking in students with special needs, especially those with ADHD. Traditionally, HOTS have been largely neglected in mathematics instruction for these students, and non-routine or HOTS questions are rarely introduced. With the use of gamified, Android-based HOTS tools, teachers can now support the development of critical thinking in ADHD students through engaging and game-like learning environments. Beyond enhancing learning outcomes, this approach also helps educators understand the specific characteristics of HOTS development in ADHD students, allowing for more tailored instructional strategies that align with the objectives of mathematics education.

Therefore, integrating higher-order thinking skills (HOTS) into gamified, Android-based instruction may provide an effective and engaging approach for students with ADHD, who often struggle with traditional methods. Although prior studies have shown the potential of gamification and HOTS-based instruction in general populations, there remains a lack of empirical research focusing specifically on students with ADHD in special needs education. To address this gap, this study aims to investigate the impact of HOTS-based Android gamification in enhancing cognitive outcomes among students with ADHD.

The research question guiding this study is: "To what extent does the implementation of HOTS-based Android gamification improve higher-order thinking skills among students with ADHD?"

## **2. Preliminaries or Related Work or Literature Review**

### **2.1. Gamification**

Gamification is a pedagogical approach that integrates game elements such as points, challenges, levels, badges, leaderboards, and reward systems into the learning process to increase student engagement and motivation. Gamification is a game process that can increase performance motivation by increasing user engagement with enthusiasm in completing existing challenges (Sagirani, Wahyuningtyas, Wulandari, & Efendi, 2020). Gamification is the use of game elements in a non-game context to motivate and engage students in learning (Hidayati & Rafikayati, 2024). In an educational context, gamification does not aim to turn learning into a full game, but rather utilizes game mechanisms to create a more interesting, healthy competitive and meaningful learning experience.

### **2.2. Higher-Order Thinking**

This non-routine question is a Higher Order Thinking (HOT) instrument. HOT is a thinking skill that goes beyond simply memorizing facts or concepts but also requires students to do something about those facts (Hasyim & Andreina, 2019). Students are required to

master knowledge at the level of analyzing, evaluating, and creating so that students' reasoning and critical thinking skills are really needed in HOTS (Rapih & Sutaryadi, 2018). Students also need to be equipped with HOTS skills with the aim of having high-level thinking skills such as critical thinking and creative thinking to solve problems and make decisions (Kurniasih, Nugroho, & Harmianto, 2020).

HOTS instruments have not been implemented evenly across all levels of education, both in public and special needs schools. This contradicts the government's program, which mandates that all students acquire HOTS skills to face future challenges and develop students who actively participate, analyze and solve problems, and think critically (Dilah, 2023).

### **2.3. Students with Special Needs (ADHD)**

Children with special needs are defined as children with characteristics that differ from those of most children, namely those with abnormalities/deviations in physical, mental, intellectual, social, and emotional development. There are several types of children with special needs, including autism, hyperactivity, intellectual disability, hearing impairment, visual impairment, speech impairment, Down syndrome, and others (Suzuki Syofian, 2017). Children with special needs are children who require special treatment due to developmental disorders or abnormalities that affect their physical, psychological or social development (Alfirah & Gustiana, 2024). Children with special needs are children who naturally have characteristics that differ from those of children in general. They experience obstacles in their growth and development. They have disabilities compared to other normal children (Azizah, Nisak, Wildan, & Widyastuti, 2024). One of the children with special needs is a child with Attention Deficit Hyperactivity Disorder or ADHD for short (Megaputri & Rusmawan, 2023). Attention Deficit Hyperactivity Disorder (ADHD) is a neurobiological developmental disorder characterized by three main symptoms, namely difficulty maintaining attention, impulsive behavior, and hyperactivity that appears inappropriate for the child's developmental age. ADHD, or Attention Deficit Hyperactivity Disorder, is an attention deficit disorder. The term refers to an internationally recognized medical condition that affects brain function (Vidyananta, Noviyanthi, & ..., 2025). Students with ADHD tend to be easily distracted by small stimuli in their environment, have difficulty completing tasks, and take longer to refocus after experiencing distractions. Furthermore, their impulsive nature often leads them to act without considering the consequences, such as answering questions before they're finished, moving without permission, or suddenly changing activities. One disorder that affects children's growth and development is Attention-Deficit Hyperactivity Disorder (ADHD). Children with ADHD exhibit inadequate social behavior, accompanied by social impairments and problems with reciprocal relationships with their environment (Ni Luh Putu Ika Sintya Devi & Ni Ketut Suarni, 2024). The behavioral impacts of ADHD include being demanding, interfering with others, easily frustrated, lacking self-control, and easily changing attitudes. The social impacts on children with ADHD include selfishness and anxiety (Ulfadhilah & Nurkhafifah, 2024).

ADHD children who cannot control their behavior often disturb their friends during the teaching and learning process (Zahroh, Wardani, Salimah, Putri, & Delta, 2025). Hyperactivity, which manifests as excessive movement, fidgeting, or an inability to sit still, also presents challenges in classroom learning. Therefore, learning strategies for students with ADHD must be designed with an engaging, concise, and structured approach to maintain attention and reduce distractions. Engaging learning can be achieved through the use of visual media, audio, responsive activities, educational games, and interactive technology that can stimulate focus without burdening concentration.

## **3. Materials and Method**

This study employed an experimental research design using a One-Group Pretest-Posttest Design. In this design, two assessments were conducted: one before the treatment (pretest) and one after the treatment (posttest), with a single intervention in between. The intervention consisted of a learning activity using HOTS-based Android gamification, aimed at improving the higher-order thinking skills of students with ADHD. The study was conducted in four special needs schools (SLBs) in West Kalimantan during the odd semester of the 2024–2025 academic year. The participating schools were SLB Dharma Asih Pontianak, SLB Kinasih Pontianak, SLB Negeri Rasau Jaya, and SLB Negeri Singkawang. The population in this study included all Phase D students diagnosed with ADHD at the four participating schools. A total of 26 students with ADHD were selected as the sample using purposive sampling. Prior to sampling, coordination was carried out with school principals, curriculum vice principals, and classroom teachers to ensure appropriate participant selection. The data collection technique used in this study was measurement, with the main instrument being a test designed to assess the higher-order thinking skills of students with ADHD. The

data analysis was performed using inferential descriptive statistics to examine both the improvement and the characteristics of higher-order thinking skills following the implementation of HOTS-based Android gamification. Hypothesis testing was conducted using the paired sample t-test. The average pretest and posttest scores were categorized based on the criteria outlined in Table 1.

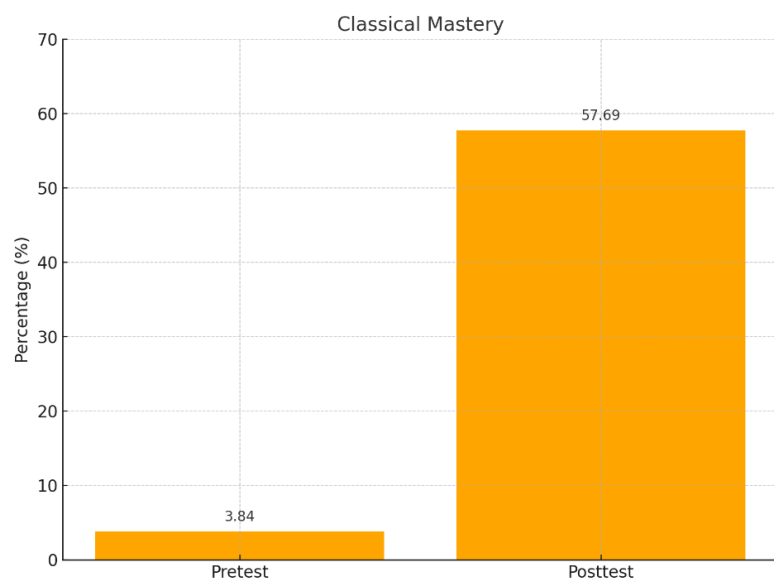
**Table 1.** Categories of Higher-Order Thinking Skills in Students with ADHD.

Average Score	Category
90 – 100	Very Good
81 – 89	Good
75 – 80	Fair
51 – 74	Poor
0 – 50	Very Poor

Source: Sugiyono (2018)

#### 4. Results and Discussion

This section presents and discusses the findings obtained during the research. The data related to the mastery levels in the pretest and posttest of higher-order thinking skills (HOTS) among students with ADHD are shown in Figure 1.

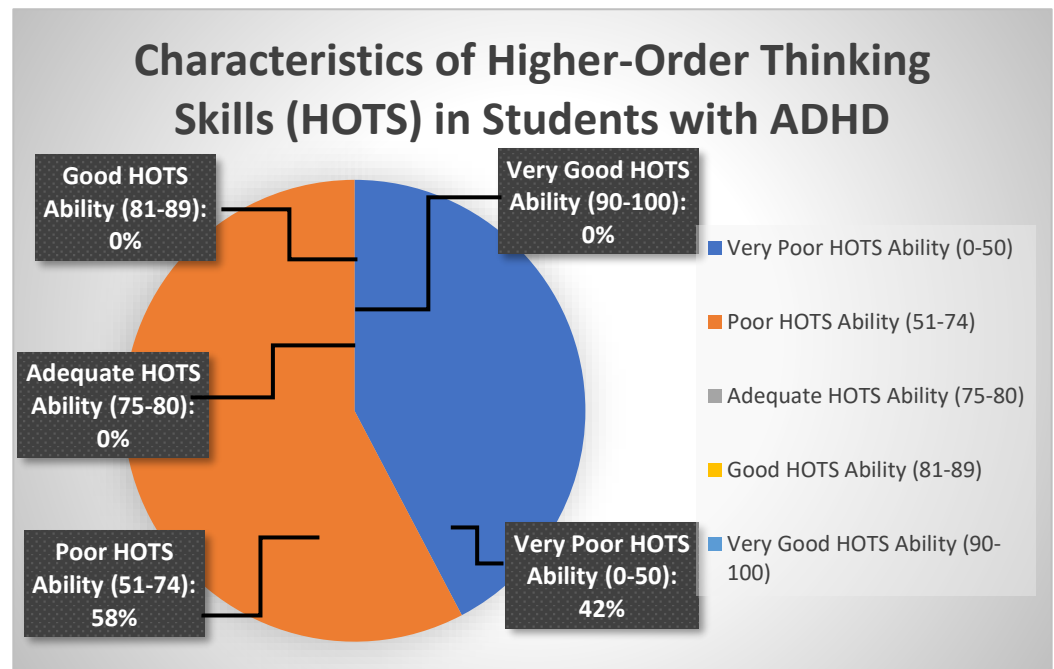


**Figure 1.** Pretest and Posttest Mastery Results.

A significant improvement in the mastery of HOTS among students with ADHD following the implementation of HOTS-based Android gamification learning. Specifically, the proportion of students who achieved mastery increased from 3.84% in the pretest to 57.69% in the posttest.

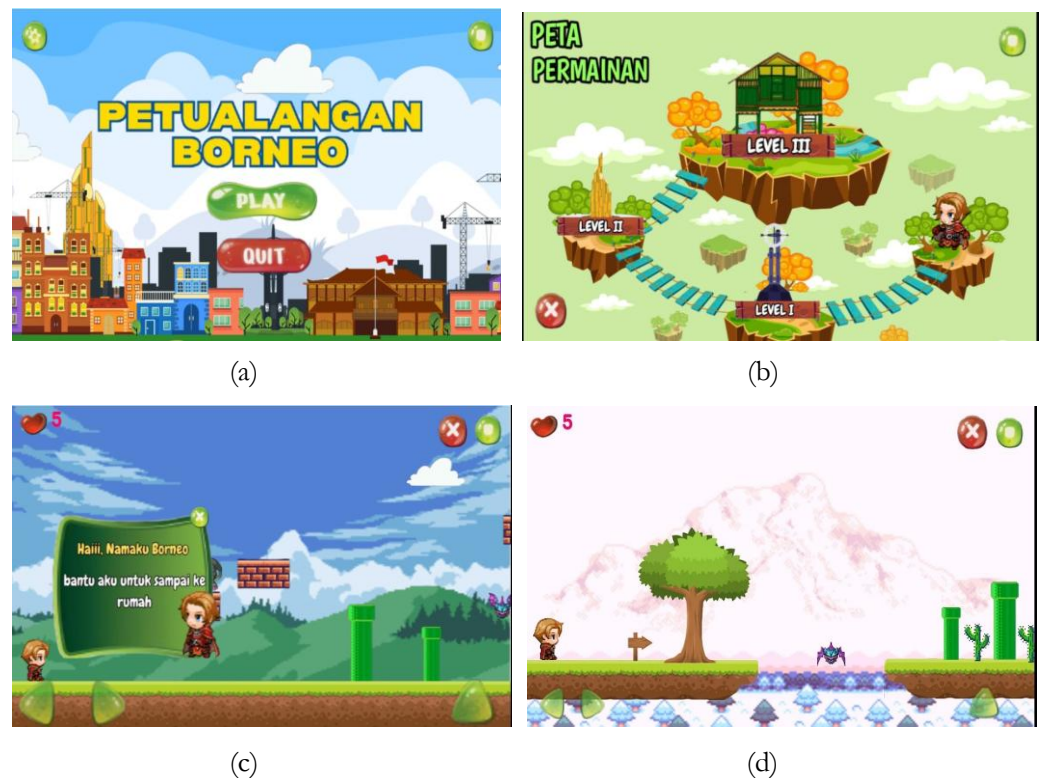
The test, which consisted of HOTS-based questions, was administered to 26 students with ADHD from four special needs schools (SLBs) in West Kalimantan. The average pretest score was 23.72, while the average posttest score rose to 53.21. Based on the paired sample t-test, the statistical analysis yielded  $t = 8.688$ , which is greater than the critical  $t$ -value = 1.708 at the 5% significance level, indicating a significant improvement in HOTS following the intervention.

Despite this statistically significant improvement, the overall results in terms of both average scores and classical mastery have not yet reached an optimal level. The classical mastery rate in the posttest was 57.69%, meaning that only 15 out of 26 students met the Minimum Mastery Criteria (KKM) of 67 in mathematics learning. The average scores also reflected this trend: the pretest average score of 23.72 falls under the "very poor" category, and the posttest average of 53.21 is categorized as "poor", according to the classification in Table 1. These findings suggest that although students with ADHD showed notable progress in their higher-order thinking skills after the HOTS-based gamified learning experience, their performance still did not reach the minimum expected level, which is the "fair" category. Further analysis of how students with ADHD performed on HOTS-based questions after the gamification-based intervention is presented in Figure 2.



**Figure 2.** Analysis of the Characteristics of Higher-Order Thinking Skills (HOTS) in Students with ADHD.

Figure 2 illustrates that, although the level of achievement did not meet the intended learning objectives following the implementation of HOTS-based Android gamification, there was a notable improvement in the higher-order thinking skills (HOTS) of students with ADHD. Despite their cognitive abilities still falling within the "very poor" and "poor" categories, the intervention led to a significant enhancement in their thinking skills. Figure 3 presents the interface of the HOTS-based Android gamification used in the study.



**Figure 3.** (a) Initial Game Display; (b) Game Level Map View; (c) Game Level 1 View; (d) Game Level 3 View.

The results of learning by implementing HOTS-based Android gamification showed that the post-test scores were better than the pre-test scores. This indicates a significant

improvement in the higher-order thinking skills (HOTS) of students with ADHD, as confirmed by the paired sample t-test. One of the students with special needs in this context is a student with ADHD. ADHD is a condition that involves brain dysfunction, where an individual experiences difficulty in controlling impulses, inhibiting behavior, and maintaining attention, or has a short attention span that is easily diverted (De La Fuente, Xia, Branch, & Li, 2013). Children with ADHD may appear restless, have trouble concentrating, and act out of control. According to Hayati & Apsari (2019), what children with ADHD need is a learning approach that supports their development like typical children, although they face obstacles in fulfilling their learning needs. Based on these needs, the equal distribution of HOTS learning can be facilitated through HOTS-based Android gamification.

However, the results of the hypothesis test showing a significant improvement contradict the average and classical mastery results of students' higher-order thinking skills with ADHD, which have not yet reached optimal outcomes. The classical post-test mastery results indicate that only half of the ADHD student sample achieved the minimum mastery criteria set for mathematics learning. The average HOTS scores of students with ADHD also reflect a similar pattern, with the pre-test average falling in the "very poor" category and the post-test average in the "poor" category. These results show that the HOTS of students with ADHD have not yet reached the minimum standard, which is the "adequate" category in mathematics learning.

Furthermore, although the success level did not meet the desired learning objectives after implementing HOTS-based Android gamification due to students' HOTS remaining in the very poor and poor categories there was still a significant improvement in their higher-order thinking skills. These findings are not in line with the study by Saraswati & Agustika (2020), which found that out of 85 students analyzed using the PAP method, 16 students (19%) had high HOTS, 22 students (26%) had moderate HOTS, 45 students (53%) had adequate HOTS, and only 2 students (2%) had low HOTS. This difference arises due to the differing cognitive characteristics between fifth-grade elementary students and special needs students with ADHD in Phase D. However, the current study aligns with research by Mukarromah & Agustina (2021) and Rahmani (2020), which indicated that gamification using digital game-based media is beneficial in learning. It can develop children's skills, such as cognitive and language abilities, and improve motivation, participation, and collaboration. Additionally, gamification integrated into the learning system indirectly helps teachers sharpen their skills.

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## 5. Conclusion

Based on the research findings and discussion, it can be concluded that the higher-order thinking skills (HOTS) of students with ADHD significantly improved after using the developed HOTS-based Android gamification media. However, this result contrasts with the average scores and classical mastery levels, as the higher-order thinking abilities of students with ADHD had not yet reached optimal outcomes. The post-test classical mastery results showed that only half of the students with ADHD met the Minimum Mastery Criteria set for mathematics learning. The average HOTS scores also reflected a similar trend, where the pre-test average was categorized as "very poor" and the post-test average as "poor." These findings indicate that the HOTS of students with ADHD have not yet reached the minimum required level for mathematics learning, which is the "adequate" category.

From this research, it is hoped that special education teachers (SLB teachers) can implement and further develop learning media that not only motivate students but also make them feel comfortable and engaged in learning through technology-based applications using gamification. However, teachers must also be willing to explore and apply various types of educational media applications, as no single learning application can perfectly enhance higher-order thinking skills—especially for students with ADHD. There are still many models and types of learning media that can be used strategically to improve the HOTS of students with ADHD.

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