

Modification of Impulsive Behavior in Children with ADHD Through a Visual Board-Based Token Economy in Elementary School

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Abstract: Impulsive behavior is one of the characteristics often shown by children with Attention Deficit Hyperactivity Disorder (ADHD) and can hinder the learning process and social interaction. This study aims to analyze changes in impulsive behavior and examine the effectiveness of a visual board-based token economy among elementary school children with ADHD. The research uses the Single-Subject Research (SSR) method with an A–B–A design consisting of a baseline phase (A1), an intervention (B), and a second baseline (A2). The study subject was an ADHD child who exhibited impulsive behavior during learning activities. Data were collected by observing four indicators of impulsive behavior: interrupting conversations, answering before the question is finished, difficulty waiting for their turn, and acting without instructions. Data analysis used visual analysis within and between conditions, including directional tendencies, data stability, level changes, and overlap percentages. Results showed a consistent decrease in impulsive behavior from baseline phase A1 to intervention phase B, with no change in baseline phase A2. The mean level of impulsive behavior decreased from 17.80 in baseline phase A1 to 10.12 in the intervention phase, then to 4.20 in baseline phase A2. These findings suggest that a visual board-based token economy can be an effective intervention strategy to help reduce impulsive behavior in ADHD children in elementary school.

Keywords: ADHD, impulsive behavior, token economy, visual board, single-subject research.

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■ INTRODUCTION

Basic education is an important phase in developing students' self-regulation, adaptive behavior, and social interaction skills. At this stage, students begin to learn rules, control emotions, and build study habits that support academic and social success. The success of the learning process in elementary school is greatly influenced by students' ability to control their behavior and obey class rules (Fadillah & Pranungsari, 2023). Therefore, schools serve not only as places for knowledge transfer but also as environments that support the development of children's behavior and social skills. In the context of inclusive education in Indonesia, elementary schools must

accommodate the needs of students with diverse characteristics, including those with Attention-Deficit/Hyperactivity Disorder (ADHD), as stipulated in the Regulation of the Minister of National Education Number 70 of 2009 concerning Inclusive Education. Implementing appropriate behavior management strategies helps ADHD students adapt to the learning environment and follow learning rules effectively (Asegaf & Widyasari, 2023).

ADHD is a neurodevelopmental disorder characterized by symptoms of inattention, hyperactivity, and impulsivity that have an impact on children's academic and social functions (American Psychiatric Association, 2022; Novita

Sari, 2024). Children with ADHD generally have difficulty concentrating, maintaining focus, and controlling their behavior in the moment. This condition often makes it difficult for children to follow classroom learning. Globally, the prevalence of ADHD in school-age children ranges from 5–7% (Erdyanto, 2024). In addition, ADHD also has the potential to continue into adulthood if it does not get the right intervention early (Sibley et al., 2021). This shows that the handling of ADHD requires serious attention, especially at the basic education level, as the initial stage of children's academic and social development.

In learning activities in elementary school, one of the most common problems that arises in ADHD children is impulsive behavior. Impulsive behavior manifests as actions carried out spontaneously, without considering consequences, such as interrupting conversations, answering before questions are finished, having difficulty waiting for one's turn, and acting without the teacher's instructions (Evans et al., 2018; Widihapsari & Yoenanto, 2022). These behaviors not only affect individuals but also disrupt overall classroom learning dynamics. Students find it difficult to follow class rules, while teachers struggle to create a conducive learning environment. If impulsive behavior is not appropriately managed, it can affect children's long-term academic, social, and emotional development. Various studies show that behavior-based interventions are one of the effective approaches in dealing with the problems of students with ADHD. One widely used strategy is the token economy, a reinforcement system that provides tokens as secondary reinforcers that can be exchanged for primary reinforcers (Cooper et al., 2021; Anggraini, 2025). During implementation, tokens are given each time a child successfully demonstrates behavior that meets a predetermined target. This system is considered effective because it increases

children's motivation to maintain positive behavior consistently.

Several previous studies have shown that the token economy is effective in increasing attention, compliance, and reducing hyperactive and impulsive behavior in ADHD children. Research by Irianjani and Rohmah (2020) shows that applying a token economy can increase attention in children with ADHD through a single-subject approach. Other research also finds that these strategies can reduce hyperactive behavior and improve student adherence to class rules (Faizah, 2022). In addition, recent research shows that a token economy effectively shapes academic discipline and increases adherence to class rules among children with ADHD (Manullang et al., 2025; Anggraini, 2025). Research by Nofriyaldi and Kusumastuti (2025) also revealed that the application of a token economy can reduce the frequency of aggressive behavior among ADHD students in inclusive classes. The findings show that the token economy has great potential as a behavioral intervention in inclusive learning.

Although various previous studies have shown that the token economy is effective in improving attention, compliance, academic discipline, and reducing hyperactive and aggressive behavior in ADHD children (Irianjani & Rohmah, 2020; Faizah, 2022; Manullang et al., 2025; Nofriyaldi & Kusumastuti, 2025), studies that specifically place impulsive behavior as the main variable in the context of elementary school learning are still limited. However, most previous research has focused on increased attention and decreased hyperactive behavior. In contrast, impulsive behavior has not been specifically studied as a key variable in the context of elementary school learning. In addition, the implementation of the token economy remains largely general and has not made optimal use of visual support. In fact, children with ADHD often need visual stimuli to understand rules, monitor

their behavior, and improve self-control (Faraone et al., 2021). On the other hand, research integrating the token economy with visual boards to modify the impulsive behavior of ADHD children in elementary school is still limited. Therefore, the effectiveness of the combination of the two strategies needs to be further studied as an alternative behavioral intervention that is in accordance with the characteristics of ADHD children.

Given these conditions, it is necessary to develop interventions that combine reinforcement strategies with concrete, attractive visual media for children. One intervention is a visual board-based token economy. In this approach, visual boards display behavioral rules and where to attach tokens, and visual media monitor students' behavior development. Each positive behavior students successfully demonstrate will earn a token, which will be posted on a visual board so students can see their progress firsthand. Visual supports in behavioral interventions help children with ADHD understand instructions, increase attentional focus, and strengthen self-regulation skills during learning activities (Powell et al., 2023). In addition, behavioral interventions in the school environment need to be systematically designed and aligned with the characteristics of students with ADHD to optimally support children's academic and social development (DuPaul et al., 2020).

Visual media in behavioral interventions also aligns with the learning characteristics of elementary school-age children, who tend to respond more to concrete and visual stimuli. Thus, integrating the token economy with the visual board is expected not only to reduce impulsive behavior but also to increase student involvement in the learning process. Appropriate treatment of ADHD from elementary school age is considered important to help reduce the impact of the disorder on children's behavioral, academic, and social development in the long term (Storebø et al., 2018).

This study uses a Single-Subject Research (SSR) design because it allows researchers to observe individual, in-depth changes in the subject's behavior at each phase of the intervention. Through the SSR design, the effectiveness of the intervention can be analyzed by examining behavioral changes before, during, and after the intervention. This approach is considered appropriate to examine changes in impulsive behavior in ADHD children that require intensive and continuous observation.

Based on the theoretical gaps and practical challenges described above, the research questions addressed in this study are: (1) How does the frequency of impulsive behavior in a student with ADHD change before, during, and after the implementation of a visual board-based token economy strategy? Furthermore, (2) Is the visual board-based token economy strategy effective in modifying impulsive behavior in a student with ADHD, as indicated by the comparison of behavioral data between the baseline and intervention phases?.

Building on these research questions, this study aims to analyze changes and examine the effectiveness of a visual board-based token economy in modifying impulsive behavior in elementary school children with ADHD. This research is expected to contribute theoretically to the development of reinforcement-based behavioral interventions and visual supports, and to provide practical contributions for teachers in managing student behavior in inclusive classrooms in a more systematic and applicable manner.

■ METHOD

Research Design

This study used a quantitative approach with a Single-Subject Research (SSR) A-B-A experimental design to observe changes in the subject's behavior across three phases: baseline A1, intervention B, and baseline A2 (Manikmaya & Prahmana, 2021). The A-B-A design included five observation sessions in baseline A1, eight

sessions in intervention B, and five sessions in baseline A2, for a total of 18 observation sessions.

Research Setting and Subject

The research was conducted from April to May at an elementary school in Purwakarta, Indonesia. The school name is not disclosed to maintain institutional confidentiality. The subject was a male first-grade elementary school student with the initials F, aged 6 years and 6 months. The subject had been diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) and had an IQ score of 93. The subject was purposively selected because he exhibited dominant impulsive behavior during learning activities. The subject's identity was represented by initials to maintain confidentiality.

Before the study was conducted, permission to conduct the research was obtained from the school through a research permission letter issued by the university and submitted to the school principal. In addition, verbal consent was obtained from the subject's parent or legal guardian after the researcher explained the purpose and procedures of the study. The parent or legal guardian agreed to the subject's participation based on this explanation. No written informed consent or formal ethical clearance was obtained for the study. The confidentiality of the subject's identity was maintained throughout the research and reporting process by using initials rather than the subject's real name.

Research Instrument and Data Collection

The independent variable in this study was a visual board-based token economy strategy, while the dependent variable was the frequency of impulsive behavior. Observed impulsive behaviors included four indicators: interrupting conversations, answering before questions were finished, difficulty waiting for a turn, and performing spontaneous actions without instructions.

The research instrument was an impulsive behavior observation sheet validated through expert judgment by Special Education lecturers and inclusive education practitioners. The validation ensured the observation indicators suited the characteristics of impulsive behavior in children with ADHD.

The intervention was implemented using a visual board displaying the target behaviors and a designated area for attaching tokens. During the eight intervention sessions, the visual board-based token economy was implemented using the same sequence of procedures in each session. At the beginning of each session, the researcher explained the target behavior to the subject. The researcher then observed the subject's behavior during the learning activity and recorded the frequency of the four target impulsive behaviors using event recording. When the subject demonstrated the expected behavior, the researcher provided one token and placed it on the designated area of the visual board. The tokens were accumulated throughout the intervention session. When the subject had collected five tokens, the tokens were exchanged for the agreed reward. This sequence was repeated across all eight intervention sessions to maintain consistency in implementing the visual board-based token economy.

Data were collected through direct observation using the event recording technique for 30 minutes in each session. The researcher served as the primary observer and recorded the frequency of each of the four target impulsive behaviors on the observation sheet during every session. The same observation procedure was applied across the baseline A1, intervention B, and baseline A2 phases. Because no independent second observer was involved during data collection, inter-observer agreement (IOA) could not be calculated for 20–30% of the sessions in each phase. To minimize potential recording bias, the researcher used predefined operational definitions for each target behavior and applied the same observation and recording procedures

consistently across all sessions. The observations were conducted across 18 sessions: five sessions in baseline A1, eight sessions in intervention B, and five sessions in baseline A2.

Data Analysis

The data were analyzed using visual analysis within and between conditions, following SSR analysis procedures (Sunanto et al., 2006). Within-condition analysis examined changes in level, directional trend, and data stability within each phase. Between-condition analysis examined changes in level and the percentage of overlap between adjacent phases. The analysis examined changes in level, directional trend, data stability, and percentage of overlap between conditions. The analysis identified changes in the frequency of impulsive behavior across the baseline A1, intervention B, and baseline A2 phases (Takebayashi, 2022). The use of visual analysis was consistent with the characteristics of SSR research in educational settings (Arvianto et al., 2025).

In addition, a nonparametric effect-size analysis using Tau-U was conducted to quantify changes between adjacent phases while accounting for baseline trend. Tau-U was

calculated for the A1–B and B–A2 phase comparisons using the Single Case Research web-based calculator. The corrected-baseline option was selected to control for baseline trend, with the phase order maintained from baseline to the subsequent phase. The analysis generated Tau-U coefficients, Z values, p-values, and confidence intervals to complement the visual analysis of behavioral change.

■ RESULT AND DISCUSSION

Description of Research Results Data

This study used a Single-Subject Research (SSR) A-B-A design with 18 observation sessions, divided into three phases: baseline A1 (sessions 1–5), intervention B (sessions 6–13), and baseline A2 (sessions 14–18). The observed bound variable was the frequency of impulsive behavior in subject F, which included four indicators: interrupting the conversation, answering before the question was finished, having difficulty waiting for a turn, and performing spontaneous actions without instructions. Data were collected using the event recording technique for 30 minutes per session. The recapitulation of the observation data is presented in Table 1.

Table 1. Data recapitulation of the results of observation of the impulsive behavior of subject f

Sessions	Phase	Interrupting the Conversation	Answer Before Questions Are Completed	Difficulty Waiting for Your Turn	Actions Without Instructions	Total
1	Baseline A1	5	4	4	3	16
2	Baseline A1	6	5	4	3	18
3	Baseline A1	5	4	5	4	18
4	Baseline A1	6	5	5	3	19
5	Baseline A1	5	5	4	4	18
6	Intervention B	5	4	4	3	16
7	Intervention B	4	4	3	3	14
8	Intervention B	4	3	3	2	12
9	Intervention B	3	3	3	2	11
10	Intervention B	3	2	2	2	9
11	Intervention B	2	2	2	2	8
12	Intervention B	2	2	1	1	6

13	Intervention B	1	2	1	1	5
14	Baseline A2	2	2	1	1	6
15	Baseline A2	1	2	1	1	5
16	Baseline A2	1	1	1	1	4
17	Baseline A2	1	1	1	0	3
18	Baseline A2	1	1	0	1	3

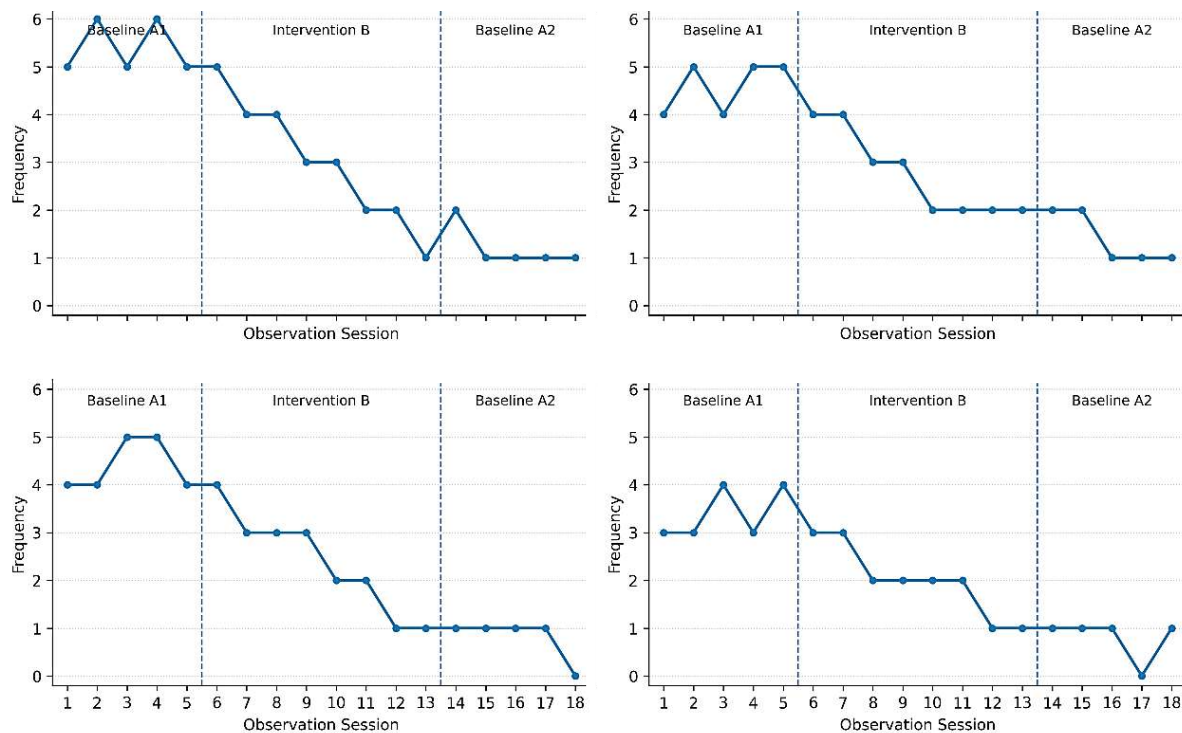


Figure 1. Changes in the frequency of each impulsive behavior indicator of subject F in baseline A1, intervention B, and baseline A2

Figure 1 shows the frequency changes in the four observed impulsive behavior indicators across baseline A1, intervention B, and baseline A2. Overall, all four indicators decreased during intervention B and remained at a lower frequency during baseline A2 than during baseline A1. Although some fluctuations were observed across sessions, the overall pattern indicates reduced interrupting conversations, answering before questions were completed, difficulty waiting for a turn, and actions without instructions.

Figure 2 illustrates the overall frequency of impulsive behavior across the 18 observation sessions. During baseline A1 (sessions 1-5), the total frequency ranged from 16 to 19. During intervention B (sessions 6-13), the frequency decreased from 16 to 5. During baseline A2 (sessions 14-18), frequency remained low, ranging from 3 to 6. The mean frequency decreased from 17.80 in baseline A1 to 10.12 during intervention B and further to 4.20 in baseline A2, indicating an overall reduction

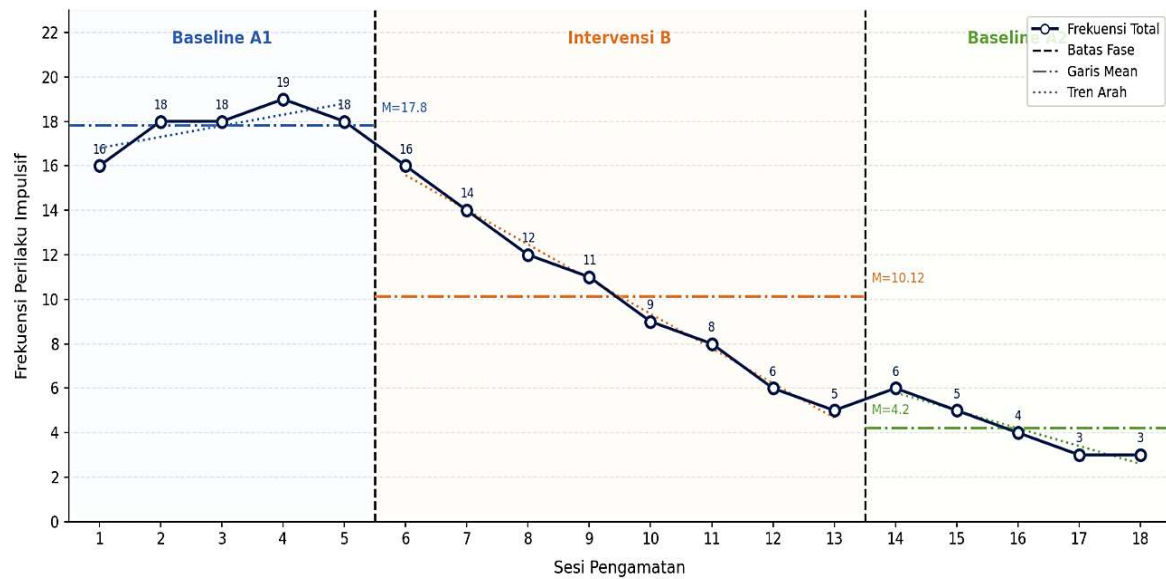


Figure 2. Changes in the frequency of impulsive behavior of subject F in baseline A1, intervention B, baseline A2

in impulsive behavior across the three phases.

Within-Condition Analysis

The analysis under conditions was carried out to observe changes in the data in each phase

separately. The components analyzed included condition length, estimated directional inclination, stability tendency, data trail, stability level and range, and level change. The results of the summary analysis under conditions are presented in Table 2.

Table 2. Summary of analysis results in conditions

Components	Baseline A1 (Sessions 1–5)	Intervention B (Sessions 6–13)	Baseline A2 (Sessions 14–18)
Condition Length	5 sessions	8 sessions	5 sessions
Estimation of Directional Inclination	(+) Rise	(–) Down	(–) Down
Stability Tendencies	Stable (80%)	Variable (25%)	Variable (20%)
Data Footprint	(+) Rise	(–) Down	(–) Down
Stability Level & Range	16.38 – 19.23	8.93 – 11.33	3.75 – 4.65
Mean Level	17.80	10.12	4.20
Level Change	16 → 18 (+2)	16 → 5 (–11)	6 → 3 (–3)

The baseline phase A1 consisted of 5 non-interventional observation sessions that served as the subject's initial condition. Estimated directional and trace tendencies showed an increasing direction, indicating that the frequency of the subject's impulsive behavior tended to increase

during the initial baseline phase. This pattern suggests the target behavior did not improve naturally before the intervention. The mean of 17.80 indicates that the subject's impulsive behavior remained relatively frequent in the initial condition. The data were declared stable in this

phase at 80%, as the value met the stability criterion in the SSR study ($\geq 80\%$) (Sunanto et al., 2006). This stability indicates that the subject's initial condition for impulsive behavior is consistent and can serve as a representative basis before the intervention is administered. The stability range of 16.38–19.23 suggests that most data falls within a relatively narrow range, indicating that variation in impulsive behavior in this phase remains under control. A change in level of +2 (from the first session of 16 to the last session of 18) indicates a tendency toward increased impulsive behavior that continues during the baseline phase, suggesting that without intervention, the behavior does not improve naturally.

Intervention Phase B lasted 8 sessions and implemented a visual board-based token economy. The estimated directional and trace trends showed a decreasing pattern, indicating a shift toward more positive behavior during the intervention. The mean level of 10.12 indicates a decrease in the average frequency of impulsive behavior compared to the baseline phase of A1. This decrease in the mean level indicates that the intervention reduces the occurrence of impulsive behavior among the subjects. The stability range of 8.93–11.33 indicates that the frequency of impulsive behavior has shifted to a lower level than under the initial condition. The stability trend in this phase is classified as variable, with a 25% share, indicating that the data still fluctuates between observation sessions. This condition is natural because the subject is forming new behaviors and adjusting to the applied reinforcement system. This variability reflects the gradual dynamics of learning and behavioral adaptation. A level change of -11 (from 16 in the first session to 5 in the last session) showed a consistent and substantial decrease throughout the intervention phase, indicating that the visual board-based token economy strongly influenced the subjects' impulsive behavior.

Visual analysis showed that the visual board-based token economy was associated with a decrease in the frequency of impulsive behavior across the intervention phase. This change can be understood through the operant conditioning mechanism underlying the token economy system. Whenever the subject demonstrated the expected behavior and restrained impulsive responses, he immediately received a token as a secondary reinforcer that could be exchanged for a primary reinforcer. This principle of immediate reinforcement is relevant for children with ADHD because it provides a more immediate, concrete consequence, which may help address difficulties with time regulation and delayed consequences associated with ADHD (Barkley, 2021). The support of behavior modification theory proposed by Cooper et al. (2021) further explains that reinforcement systems applied systematically and consistently can strengthen expected behavior and reduce inappropriate behavior. This study's findings also align with Ackerman et al. (2020), who explained that a token economy's success depends on clear, consistent consequences for target behavior. In addition, Andzik et al. (2022) found that a token economy can increase compliance with expected behavior and reduce problematic behavior through a structured reinforcement system. Kim et al.'s (2022) meta-analysis also showed that token economy interventions positively affect behavior management and improve adaptive behavior in educational settings.

In this study, the visual board provided concrete visual support that made the reinforcement process more visible and predictable for the subject. The subject could directly observe the accumulation of tokens and progress toward the predetermined reward, allowing the behavioral target and its consequences to be represented in a simple, concrete form. This visual support may have

helped the subject recognize and respond to the expected behavior by making the behavioral target and reinforcement process more concrete during classroom activities. Therefore, the decrease in impulsive behavior observed during the eight intervention sessions is more appropriately interpreted as an indication that the visual board-based token economy provided concrete external support for behavioral regulation during the intervention period. However, the findings do not provide sufficient evidence to conclude that autonomous self-regulation or internalization was fully established, particularly because the intervention duration was relatively short and the study did not directly measure behavior after removing external reinforcement. Thus, the visual board-based token economy can be considered a structured and applicable behavior management strategy that supports behavioral regulation in children with ADHD within an inclusive classroom context. Further research involving longer intervention periods, follow-up observations, and gradual fading of external reinforcement is needed to determine whether the behavioral changes can be maintained and develop into more independent self-regulation.

The gradual and consistent decline in impulsive behavior during the intervention phase cannot be separated from the visual board's contribution as an integral component of the implemented token economy system. This can be understood from the perspective of information processing theory, where children with ADHD have difficulty processing and retaining verbal instructions in working memory due to deficits in executive function, which is one of the main characteristics of ADHD (Willcutt et al., 2005). Concrete visual representations through visual boards help reduce such cognitive burdens by externalizing rules and behavioral progress into a format that can be observed directly. Students do not need to rely on working

memory to remember behavioral expectations, as the information is visually available. These findings align with Faraone et al. (2021), who state that children with ADHD need visual support to help with self-regulation. Powell et al. (2023) also emphasized that visual support helps strengthen the focus and self-control of children with ADHD in the context of learning. In addition, Hume et al. (2021) explain that visual support is an evidence-based practice that helps individuals with special needs understand behavioral expectations and increase independence. Tan et al. (2022) also stated that combining positive reinforcement with visual media can increase student engagement and support behavior change more effectively. These findings suggest that integrating visual media into behavioral interventions should be considered an important part of learning strategies for ADHD students in inclusive classrooms.

The baseline phase of A2 again lasted 5 sessions without intervention to monitor the sustainability of the intervention's effects. Estimated directional and trace trends still show a decreasing pattern. The mean of 4.20 indicates that the average frequency of impulsive behavior is much lower than in the previous phase. This indicates that the behavioral changes developed during the intervention persisted even after treatment was discontinued. A stability range between 3.75 and 4.65 suggests that impulsive behavior is at a low level during the post-intervention observation phase. The stability trend in this phase is classified as variable, with a 20% share, indicating that the data is still fluctuating and not completely stable. However, the fluctuations remained within the lower range of behavioral frequency compared to baseline phase A1 and intervention B. A level change of "3 (from 6 in the first session to 3 in the last session) indicated that impulsive behavior continued to decrease in the post-intervention phase. These findings indicate that the intervention effects

persist and that subjects begin to demonstrate the ability to maintain the behaviors learned during the intervention phase.

A finding that deserves particular attention is the continued decrease in the frequency of impulsive behavior during the A2 baseline phase after the intervention had been discontinued. This pattern indicates that the frequency of the target behavior did not return to the level observed during the initial A1 baseline. This continued reduction may suggest that the behavioral improvement established during the intervention was maintained after withdrawal. The maintenance of behavioral improvement may be related to the consistent exposure to behavioral expectations, visual cues, and reinforcement procedures during the eight intervention sessions. In particular, the visual board provided a concrete representation of expected behavior and the consequences associated with behavioral responses, which may have supported continued expected behavior after the intervention was discontinued. Heiniger et al. (2022) similarly reported that consistently implemented token economy procedures may contribute to maintaining positive behavior and increasing learner independence. Pandey et al. (2018) also emphasized that developing self-regulation may contribute to more stable behavioral changes, while DuPaul et al. (2020) noted that behavioral interventions adapted to individual characteristics can support behavioral improvements across different contexts.

However, the continued decrease in A2 should be interpreted cautiously within the context of the A-B-A reversal design. In single-subject research, the return of the target behavior toward its initial baseline level following withdrawal of an intervention can provide stronger evidence of experimental control because it demonstrates that behavioral changes correspond with the introduction and removal of the intervention. In

the present study, the frequency of impulsive behavior remained relatively low during A2 rather than returning toward the A1 baseline level. Therefore, although the A2 pattern may indicate maintenance of behavioral improvement, it also limits demonstration of experimental control through the reversal procedure. The observed pattern cannot be taken as definitive evidence that the behavioral change resulted exclusively from the intervention or that autonomous self-regulation was fully internalized. This interpretation aligns with principles of single-subject research, where experimental control strengthens when changes in the target behavior are systematically replicated across intervention and withdrawal conditions (Horner et al., 2005; Ledford & Gast, 2018). Thus, the A2 findings in this study are better interpreted as evidence of continued behavioral improvement after intervention withdrawal, which may reflect a maintenance effect while also highlighting the A-B-A design's limitation in demonstrating a clear reversal of target behavior.

The practical implication is that the visual board-based token economy may support not only reducing impulsive behavior during intervention but also maintaining behavioral improvement after the intervention is discontinued. Nevertheless, future research should use longer follow-up periods and, where ethically and practically appropriate, alternative single-subject designs such as multiple-baseline designs to provide stronger evidence of experimental control and to distinguish maintenance effects from other factors that may contribute to continued behavioral improvement.

Between-Condition Analysis

Analysis between conditions was conducted to compare changes between two adjacent phases. A summary of the results of the analysis between conditions is presented in Table 3.

Table 3. Summary of results of inter-condition analysis

Components	B/A1 (A1 → B)	A2/B (B → A2)
Number of Variables Changed	1	1
Change of Directional Inclination	(+) Up → (-) Down	(-) Down → (-) Down
Change in Stability Tendencies	Stable → Variable	Variable → Variable
Level Change	18 → 16 = -2	5 → 6 = +1
Percentage Overlap	12.5%	25%

The comparison between conditions A1 and B indicates a clear change in the behavioral pattern after implementing the visual board-based token economy. During the initial baseline, the subject's impulsive behavior tended to increase, suggesting the target behavior remained difficult to regulate during baseline. After the intervention, the behavioral pattern shifted toward a decreasing trend. This change suggests that the subject gradually adapted to the structured behavioral expectations and reinforcement contingencies provided through the visual board-based token economy. The visual board may have supported this adaptation by making the behavioral targets, token accumulation, and expected consequences more concrete and predictable for the subject. Although the behavior remained variable during the intervention, the overall downward trend indicates that the subject responded more to the intervention and showed a more favorable behavioral pattern over time. The level change between the last data point of A1 (18) and the first data point of B (16) was -2, indicating an immediate decrease in impulsive behavior at the start of the intervention. The percentage of overlap was 12.5%, indicating that one of the eight data points in the intervention phase B fell within the range of the A1 baseline data. This relatively low overlap further indicates that most intervention data points fell outside the baseline range, supporting the observed change in behavioral pattern after the intervention was introduced. Thus, the change between A1 and B reflects not merely a difference in frequency, but a shift in the behavioral pattern from an increasing

tendency toward a decreasing tendency following the introduction of the intervention.

In the comparison of B/A2 conditions, both phases showed a downward trend (""), indicating that the behavioral changes during the intervention continued into the post-intervention phase. The change in level between the last data point of phase B (5) and the first data point of phase A2 (6) is +1. This relatively small difference suggests no substantial increase in impulsive behavior after the intervention stopped. The tendency for stability in both variable categories suggests the data are still fluctuating, although at a lower level of impulsive behavior than in the early phase of the study. The overlap percentage was 25%, indicating that 2 of the 8 data points in intervention phase B fell within the range of the A2 baseline data. This finding indicates that some data points during the intervention overlapped with the range observed in the post-intervention phase. However, most intervention data remained outside the A2 range, and the overall frequency of impulsive behavior was lower than in the initial baseline phase. Thus, the reduction in impulsive behavior tended to be maintained in the post-intervention phase, although some overlap between the intervention and post-intervention data remained.

Tau-U Effect Size Analysis

To complement the visual analysis, a Tau-U effect-size analysis was conducted to quantify changes between adjacent phases while controlling for baseline trend. The results are presented in Table 4.

Table 4. Tau-U effect size analysis across adjacent phases

Phase Comparison	Tau-U (TAUb)	Z	p-value	CI 90%
A1 → B	-1.1139	-3.2205	0.0013	-1.000 to -0.538
B → A2	-0.2051	-0.5855	0.5582	-0.762 to 0.362

Note. Tau-U values were obtained using the corrected-baseline option in the Single Case Research web-based calculator. Negative values indicate a decrease in the frequency of impulsive behavior; lower scores indicate improvement.

The Tau-U analysis showed a statistically significant change between baseline A1 and intervention B, with a Tau-U coefficient of -1.1139 ($Z = -3.2205$, $p = 0.0013$, 90% CI [-1.000, -0.538]). This result indicates a significant change in the frequency of impulsive behavior after introducing the visual board-based token economy, after accounting for the baseline trend. In contrast, the comparison between intervention B and baseline A2 yielded a Tau-U coefficient of -0.2051 ($Z = -0.5855$, $p = 0.5582$, 90% CI [-0.762, 0.362]), indicating that the change between the intervention and post-intervention phases was not statistically significant after baseline-trend correction. However, the descriptive data showed that the frequency of impulsive behavior remained substantially lower during A2 than during the initial baseline A1. Thus, the Tau-U results provide quantitative support for the change from A1 to B, while the visual analysis suggests that impulsive behavior remained reduced during A2.

However, this study has several limitations that should be considered when interpreting the results. First, the study involved only one subject, so the findings cannot be generalized to all children with ADHD with diverse characteristics. Second, the relatively short intervention duration limited assessment of the sustainability of behavior change over the long term. Third, the research was conducted in one elementary school context, so the effectiveness of interventions in different learning environments could not be thoroughly evaluated. Fourth, the study did not involve an independent second observer during data

collection. Consequently, the study could not establish inter-observer agreement (IOA), and observer-related recording bias cannot be completely ruled out. Future studies should involve an independent observer and calculate IOA for approximately 20–30% of sessions in each phase to strengthen the reliability of event-recording data. Therefore, further research should involve more subjects, extend the duration of observation, and test the application of visual board-based token economy across different ADHD characteristics and inclusive school contexts to provide a more comprehensive picture of intervention effectiveness.

■ CONCLUSION

Based on the results, the study concludes that a visual board-based token economy effectively modifies impulsive behavior in ADHD children in elementary school. These changes are shown by reduced interrupting, answering before the question is finished, difficulty waiting for their turn, and acting without instructions during the learning process. These behavioral changes are not only visible during the intervention phase but also persist in the post-intervention phase, indicating that the expected behavior begins to form and is maintained by the subject. These findings indicate that a combination of a structured reinforcement system through a token economy and concrete visual support through a visual board can be an effective and applicable strategy for managing impulsive behavior in children with ADHD in an inclusive elementary school classroom.

Further research should involve more subjects, extend intervention duration, and test the application of visual board-based token economy across different ADHD characteristics and severity to provide a broader picture of effectiveness. In addition, further research may explore applying these interventions to other behavioral contexts related to self-regulation and social skills in children with ADHD.

■ DECLARATION OF GENERATIVE AI USAGE IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used generative artificial intelligence (AI), specifically Claude (claude.ai), to a limited extent. AI assistance was used for language refinement and proofreading, improving sentence structure and clarity, ensuring citation consistency with the reference list, and helping format responses to reviewer comments. Following the use of this tool, each AI-assisted passage was critically reviewed and appropriately adjusted by the authors before being incorporated into the manuscript. The authors remain fully responsible for the accuracy, validity, authenticity, and overall integrity of the content presented in this article.

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