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Impact of Digitalization on Elementary Students Cognition: The Brain Rot Phenomenon

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Abstract
This study aims to identify the impact of gadget use on the cognitive ability of elementary school students, focusing on the phenomenon of brain rot caused by excessive exposure to technology. The method used is a quantitative approach with survey and test design. A total of 10 students from SD N 7 Catur Tunggal became participants in this study. Data was collected through questionnaires regarding the duration of device use per day and cognitive tests that measured students' concentration, memory, and critical thinking. The results showed that students who spent more than 6 hours per day using gadgets had lower cognitive scores, indicating a decline in ability in all three cognitive aspects. In contrast, students who used their devices for less than 3 hours per day tended to show better cognitive test results, with a total score of 20-26. These findings showed a significant negative relationship between the duration of gadget use and students' cognitive ability ($r = -0.55$, $p < 0.05$), leading to the phenomenon of brain rot.

Keywords
Brain Rot; Digitalization; Elementary school; Gadgets; Student Cognition

INTRODUCTION

The development of digital technology has brought major changes in various aspects of life, including education (Sardiana & Moekti, 2022). In the digital era, technology has become integral to daily activities, especially among children (Amarulloh et al., 2020). Gadgets, computers, and tablets are widely used as learning tools in elementary schools, providing easy access to information and enriching learning experiences (Wardana et al., 2022). Digitalization offers the potential to accelerate learning, enhance 21st-century skills, and provide wider access to educational resources. However, the excessive use of

technology presents challenges, particularly regarding its impact on children's cognitive development.

An alarming phenomenon associated with the overuse of digital technology is "brain decay", which refers to the decline in cognitive abilities due to prolonged exposure to digital devices (Urwatulwutsqo et al., 2025). In elementary school children there is a decrease in concentration, memory, and critical thinking skills, which inhibits the learning process (Eogenie Lakilaki et al., 2025). Too much screen time, without a balance of physical activity and social interaction, can disrupt sleep quality, increase stress, and negatively impact the developing brain (Aribowo & Bagaskara, 2025). Children struggle to absorb information effectively and face difficulties in tasks that require concentration and deep thinking.

Research has shown a link between excessive gadget use and cognitive decline in children, including impairments in working memory and attention (O'Connor et al., 2021). Azqa et al. (2025) also found that early exposure to digital media adversely affects brain development, with a more significant impact on younger children. However, while numerous studies address the mental and physical health impacts of digitalization, few specifically examine the phenomenon of brain rot in elementary school students, particularly focusing on cognitive aspects. There is a lack of quantitative studies measuring the direct decline in three key cognitive aspects concentration, memory, and critical thinking due to digitalization.

Although many studies discuss the psychological impacts of technology use, such as anxiety or depression, there remains a research gap regarding the phenomenon of brain rot among elementary school students (Fraga-González et al., 2021; Hidayat, 2020). Most existing research focuses on psychological issues, but few explore how digitalization affects direct cognitive functions like concentration, memory, and critical thinking in children (Arsyad & Bashori, 2025; Fahdika Ahmad, 2024; Putra & Nasution, 2024). This study aims to address this gap by investigating the impact of digitalization on cognitive abilities and exploring the brain rot phenomenon in elementary school students.

It is important to clarify that "brain rot" is not a medical diagnosis but rather a behavioral and cognitive phenomenon. Excessive use of technology, especially passive consumption such as entertainment and social media, has been linked to attention deficits and poor memory retention due to an imbalance in daily life (Gerstorf et al., 2018). This

decline in cognitive abilities occurs due to the overuse of digital devices, which disrupt attention, memory, and executive functions (Akkurt Yalçıntürk, 2025). This phenomenon highlights the need for behavioral interventions and lifestyle changes to mitigate its impact on children's cognitive development.

The main objective of this study is to identify how digital technology use affects the cognitive abilities of elementary school students, specifically focusing on the brain rot phenomenon due to excessive gadget use. This study aims to measure the relationship between gadget use frequency and duration and cognitive decline in areas such as concentration, memory, and critical thinking. Additionally, the study will offer recommendations for educators, parents, and policymakers on managing technology use in schools to minimize its negative effects on children's cognitive health, contributing to the optimal use of technology in education.

THEORETICAL SUPPORT

Cognitive Development and Digitalization

Cognitive development in children, according to Piaget, occurs in interconnected stages that form the foundation for more complex thinking abilities. In the concrete-operational stage (around ages 7-11), children begin to develop the ability to think logically about concrete objects and real-life situations, although they still struggle with abstract concepts (Piaget, 1972). Piaget emphasized that cognitive abilities develop through the child’s interaction with their surrounding environment and the active process of knowledge internalization. In the context of digitalization, excessive use of technology can disrupt this learning process by diverting children’s attention from direct experiences that help build foundational concepts (Clemente-Suárez et al., 2024). Therefore, uncontrolled technology use can hinder children’s cognitive development, as evidenced by declines in concentration and memory, which result from overstimulation without balance with social interaction and physical activity.

Baddeley’s theory of working memory explains that working memory is a cognitive system with limited capacity responsible for storing and manipulating short-term information used in decision-making, problem-solving, and learning (Lourenço & Machado, 1996). Working memory consists of several components, including the central executive, phonological loop, visuospatial sketchpad, and episodic buffer. In the context

of technology use, excessive exposure to digital information can overload the capacity of working memory, reducing children's ability to process information effectively, particularly in tasks that require concentration and critical thinking. Additionally, Sweller's Cognitive Load Theory states that effective learning depends on managing cognitive load to avoid exceeding the capacity of working memory. Excessive cognitive load, which often occurs in children exposed to intensive technology use, can disrupt the learning process by increasing mental stress, reducing attention, and impairing memory (Khan et al., 2023). Therefore, the use of technology in education must consider the limitations of children's working memory capacity to avoid cognitive overload that can worsen conditions like "brain rot." (Serenko, 2025; Yousef et al., 2025).

Digitalization in Education and the Use of Technology in Children

Digitalization in education refers to the integration of digital technology in various aspects of learning, such as the use of computers, gadgets, and the internet to support the educational process (Putra & Nasution, 2024; Yousef et al., 2025) In recent decades, digital technology has been widely accepted at various levels of education, including in elementary schools. Research by (Arsyad & Bashori, 2025) shows that digital technology can improve the quality of learning by providing richer resources and speeding up the communication process between students and teachers. The use of digital devices gives students access to faster and wider information, as well as allows them to develop skills relevant to the demands of the 2nd century.

The excessive use of digital devices has also raised concerns, especially in the context of children (Aribowo & Bagaskara, 2025) Research by Dardanou et al (2020) reveals that the increased time children spend in front of screens may risk reducing the time children should spend on physical activities and social interactions that are important for cognitive development. In this context, it is important to understand how technology is used in education in primary school and its potential impact on children's development.

The Phenomenon of Brain Rot in Elementary School Children

The phenomenon of brain rot refers to a decline in cognitive abilities caused by excessive exposure to digital technology, especially gadgets (Badžak et al., 2024). This condition is characterized by a decrease in concentration, memory, and critical thinking skills. Research by Sinaga (2025) explains that excessive exposure to digital media can interfere with basic cognitive processes, such as attention and working memory, which are

crucial for children's learning abilities. The phenomenon of brain rot is often accompanied by reduced interest in academic activities, decreased ability to focus, and difficulty solving problems independently.

In elementary school children, cognitive development is in a very sensitive stage, where external factors such as digital media can significantly affect the learning process. According to research by Azqa et al (2025), children who are exposed to too much digital technology show symptoms such as being easily distracted, lack of motivation to learn, and reduced ability to think logically. This decline in memory and concentration can result in decreased academic achievement and social skills.

The Effect of Gadget Use on Children's Cognitive Development

Several studies have shown a link between excessive use of gadgets and decreased cognitive function in children. (O'Connor et al., 2021) in their study found that children who spent more than two hours a day in front of screens tended to have worse results on cognitive ability tests, especially in terms of working memory and attention. A similar thing was also found by Dardanou et al (2020) who revealed that interaction with digital devices can lead to a decrease in children's ability to focus on tasks that require deep thinking, such as solving math problems or reading complex texts.

The use of gadgets, especially devices that distract children, such as video games or social media, has been shown to impair healthy cognitive development. Research by (Aribowo & Bagaskara, 2025) shows that uncontrolled use of digital devices can cause disturbances in children's ability to filter information and make rational decisions. Therefore, it is important to understand how the type and duration of use of gadgets can affect children's cognitive development.

METHOD

Research Design

This study employs a quantitative research design with a survey and test approach to investigate the relationship between gadget use duration and its impact on students' cognitive abilities. The survey will gather data on the frequency and duration of gadget use, while the cognitive test will assess the students' concentration, memory, and critical thinking skills. This design aims to provide objective data regarding how excessive digital device use affects elementary school students' cognitive development.

Population and Sample

The population in this study consists of elementary school students at SD N 7 Catur Tunggal, Sleman, Yogyakarta. A purposive sampling method was used to select a sample of 10 students, ensuring that participants regularly use gadgets and computers for learning activities. The sample comprises 5th and 6th-grade students, as they are considered to have developed cognitive abilities mature enough to participate in this study. The sampling criteria include consistent use of digital devices for educational purposes.

Research Instruments

Two main instruments will be used for data collection, namely the questionnaire on the use of gadgets and the cognitive test used in this study. The categorization of the instrument can be divided based on the range of total score values of 3 sub-aspects (concentration, memory, and critical thinking) using the Likert scale. Here is a formula or table that can be used to classify cognitive categories based on total scores.

Table 1. Cognitive Categories

Golongan	Total Score Range	Explanation
Tall	25 – 30	Students demonstrate excellent cognitive abilities in all aspects of the test (concentration, memory, and critical thinking).
Intermediate	20 – 24	Students have good cognitive abilities, but there are still areas that need improvement.
Low	15 – 19	Students show decreased cognitive abilities, with difficulties in concentration, memory, or critical thinking.

Source: (Gass et al., 2021)

Data Analysis Techniques

Data from questionnaires and cognitive tests will be analyzed using descriptive statistics to summarize gadget usage patterns and cognitive test results. The relationship between the duration of gadget use and cognitive ability will be examined using Pearson correlation analysis. This analysis will help determine if there is a significant relationship between excessive technology exposure and cognitive decline in elementary school.

RESULT

Duration of Use of Gadgets by Students

Based on the questionnaire given to 10 students, data on the duration of use of gadgets showed significant variations. Table 1 shows the duration of daily use of gadgets by students and activities carried out while using digital devices.

Table 2. Duration of Gadget Use per Day by Students

No.	Duration of Gadget Use per Day	Frequency of Use (Hours)	Main Activities	Number of Students (%)
1	1-2 Jam	1-2	Study, Read	3 (30%)
2	3-4 Jam	3-4	Playing Games, Watching Videos	3 (30%)
3	5-6 Jam	5-6	Watch Videos, Social Media	2 (20%)
4	>6 Jam	>6	Gaming, Social Media	2 (20%)

Based on the data obtained, most students (30%) use gadgets between 1 and 2 hours per day, with the dominant activity being for studying or reading. Another 30% of students spend between 3 and 4 hours per day, which is more spent playing games and watching videos. As many as 20% of students report using devices between 5 and 6 hours per day, with most of the time spent watching videos and using social media. Finally, the other 20% of students spend more than 6 hours per day with gadgets, the majority of which are used to play games and interact on social media. This data shows significant variations in the duration of gadget use among students, which can affect behavior and cognitive development, especially related to the phenomenon of brain rot.

Cognitive Test Results: Concentration, Memory, and Critical Thinking

Cognitive tests conducted to measure students' concentration, memory, and critical thinking abilities showed significant variation in results. Based on the test results, two students who used their devices for more than 6 hours per day showed low scores on cognitive tests, which is in line with the high duration of device use. Here are the results of the cognitive tests that cover all three aspects, as well as the total score obtained from the sum of the three.

Table 3. Student Cognitive Test Results

No.	Student	Concentration (Score 10)	Memory (score 10)	Critical Thinking (Score 10)	Total Score	Category: Cognitive
1	Student 1	8	7	6	21	Intermediate
2	Student 2	9	8	7	24	Intermediate
3	Student 3	7	7	5	19	Intermediate
4	Student 4	5	5	6	16	Low
5	Student 5	9	8	8	25	High
6	Student 6	8	7	7	22	Intermediate
7	Student 7	4	5	5	14	Low
8	Student 8	7	7	6	20	Intermediate
9	Student 9	9	9	8	26	High
10	Students 10	8	8	7	23	Intermediate

Table 3 classifies students based on cognitive categories. Students with a total score between 25-26 fall into the High category, which includes Student 5 and Student 9. The Intermediate Category includes students with a total score of 19-24, consisting of Student

1, Student 2, Student 3, Student 6, Student 8, and Student 10. Meanwhile, Student 4 and Student 7 are included in the Low category, with a total score of 16 and 14 respectively. These two students had a higher duration of use of gadgets, which was more than 6 hours per day, which was consistent with a decline in cognitive ability. These findings show a relationship between excessive use of gadgets and decreased cognitive abilities, especially in terms of concentration, memory, and critical thinking.

Correlation Analysis between Duration of Device Use and Cognitive Test

To analyze the relationship between the duration of use of the device and the students' cognitive test scores, a Pearson correlation analysis was performed. The results of Pearson's correlation analysis between the duration of use of the gadget and the students' cognitive test scores are shown in the following Table 4:

Table 4. Correlation between Duration of Device Use and Total Cognitive Test Score

Variabel	Duration of Use of the Gadget (Hours per Day)	Total Cognitive Test Scores
Duration of Gadget	1.00	-0.55**
Total Cognitive Test Scores	-0.55**	1.00

The Pearson correlation analysis presented in Table 4 shows a significant negative correlation between the duration of device use and students' cognitive test scores, with an r value of -0.55 and $p < 0.05$. This suggests that as the duration of gadget use increases, cognitive test scores tend to decrease, particularly in areas such as concentration, memory, and critical thinking. The negative correlation indicates that excessive gadget use is moderately associated with declines in cognitive abilities. The effect size ($r = -0.55$) reflects a moderate correlation, suggesting that while not every child who uses gadgets excessively will experience cognitive decline, the trend is statistically meaningful. These results emphasize the practical significance of managing screen time to avoid impairments in children's cognitive development, further supporting the phenomenon of "brain rot."

DISCUSSION

This study aims to explore the impact of gadget use on the cognitive abilities of elementary school students, with a special focus on the phenomenon of brain rot that arises due to excessive exposure to technology. The results found in this study show a significant relationship between the duration of gadget use and the decline of students' cognitive

abilities, which include aspects of concentration, memory, and critical thinking. These findings confirm concerns existing in the previous literature that excessive exposure to technology may lead to decreased cognitive performance, especially in children who are in a sensitive stage of brain development (Sage, 2025; Yazgan, 2025).

Students who spend more than 6 hours per day with gadgets, as seen in Student 4 and Student 7, have significantly lower scores on cognitive tests. With a total score of 16 and 14, both are classified as low in concentration, memory, and critical thinking skills. Excessive use of gadgets is often associated with brain decay, a term that describes a decline in mental capacity due to an individual's constant and uncontrolled exposure to digital stimuli (Hu et al., 2018). According to research by Yousef et al. (2025), time spent in front of screens contributes to sleep disorders, decreased memory abilities, and reduced social skills in children. This is in line with the findings in this study that the more time spent in front of the screen, the lower the cognitive score students get.

The detrimental effects of screen time on concentration can be understood through the lens of Cognitive Load Theory (Sweller, 1988) and neuroscience research. Excessive screen time demands constant cognitive switching, especially when students multitask between entertainment, social media, and study assignments (Neophytou et al., 2021). This results in cognitive overload, in which the brain's working memory becomes saturated, interfering with the ability to focus and process information effectively. From a neuroscience perspective, prolonged exposure to screens increases dopamine production, which can lead to habituation disorders and reduce the brain's ability to maintain sustained attention (Luo et al., 2020). This explains why students who spend excessive time on screens often show reduced ability to concentrate during tasks that require deep thinking or learning .

The type of digital content accessed also plays an important role in cognitive development. Research by Baddeley (2000) on working memory shows that when students are exposed to content that requires active engagement such as educational videos or online learning platforms, there is a higher chance of improving their working memory (Fenesi et al., 2015). However, content such as entertainment videos or games can have the opposite effect. This type of digital content provides little cognitive challenge and can even interfere with phonological loops and visuospatial sketchpad components of working memory (Pedrotti et al., 2024). In addition, neuroscience studies show that passive consumption of

digital content causes brain regions associated with memory, such as the hippocampus, to become less active, which can interfere with memory retention over time. Consumption of non-educational digital content can interfere with memory processes and reduce cognitive abilities, such as memory and learning efficiency.

This study highlights the difference between the use of harmful and beneficial gadgets. The main difference lies in the intentionality and type of content. The use of gadgets for entertainment purposes, such as playing games or scrolling through social media, typically results in passive learning, which has minimal cognitive benefits and is often associated with cognitive decline, as seen in students with low cognitive scores (Badžak et al., 2024). On the other hand, the use of gadgets in an educational way, such as reading digital books or engaging in online learning platforms, promotes active engagement and supports cognitive development (Nagata et al., 2025). According to Piaget's theory of cognitive development, active learning through interaction with the environment fosters deeper cognitive processes, such as problem-solving and critical thinking. When used for educational purposes, gadgets can provide opportunities for cognitive improvement by offering a variety of information and resources that challenge students' thinking. However, as noted in previous studies (Budiono et al., 2025), the use of gadgets should be closely monitored to ensure they do not replace physical activity or face-to-face social interaction, which is essential for balanced cognitive growth.

This phenomenon underscores the importance of managing the use of technology at home and at school. Technology in education must be used to support active learning, not to replace social interaction or physical activity (Hidayat, 2020; Putri, 2025). Technology can be a very useful tool in increasing learning motivation and access to information, but if not managed wisely, it can actually lead to a decrease in children's cognitive and emotional abilities (Budiono et al., 2025). Therefore, parents and educators need to work together to ensure that technology is used productively and supports children's educational goals, not as a detrimental distraction.

The findings of this study show a negative relationship between the duration of use of gadgets and cognitive ability, but there are still several variables that need to be considered further in future research. For example, the types of gadgets used, the quality of the content accessed, and the role of social interaction in the use of technology need to be explored more deeply to get a more complete picture of the impact of digitalization on

children. More in-depth research on these aspects can help identify more effective strategies for leveraging technology to support children's cognitive development while reducing the negative impacts of excessive technology use.

CONCLUSION

This study shows that excessive use of gadgets has a negative impact on the cognitive abilities of elementary school students, especially in concentration, memory, and critical thinking. Students who use gadgets for more than 6 hours per day consistently obtain low cognitive scores, exhibiting symptoms that are in line with the phenomenon of brain rot. The implications of this study emphasize that teachers should guide students towards productive digital activities and ensure a balance between screen-based and offline learning; Parents should keep an eye on screen time and promote educational content rather than passive entertainment. Despite its valuable insights, the study has limitations, including a small sample size and the absence of broader contextual variables such as family environment, social-emotional conditions, and detailed content analysis of digital exposures.

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