



COGNITIVE DYNAMICS OF SCREEN-BASED LEARNING: ATTENTION AND MEMORY AMONG THE ADOLESCENTS

Sukanya Sil

Ph.D. Scholar, Department of Education, Adamas University. Email id: silsukanya158@gmail.com

ORCID: 0009-0005-4045-4976

Abstract

This study explores the cognitive dynamics of screen-based learning, with particular emphasis on attention and memory processes among adolescents. In an era of pervasive digital technology, adolescents increasingly engage with educational content through screens, fundamentally altering traditional learning mechanisms. Grounded in cognitive and educational psychology, the study examines how prolonged exposure to screen-based environments influences attention control, working memory, and long-term memory retention.

Adopting a qualitative approach, the research focuses on the assessments of attention span and memory performance with categorical insights into students' learning experiences. Standardized cognitive tasks, along with questionnaires and semi-structured interviews, are employed to capture the subjective perceptions. The sample consists of adolescents aged 13–18 from secondary and higher secondary institutions, ensuring representation across varied socio-educational contexts.

The findings are expected to contribute to a nuanced understanding of how digital learning environments shape cognitive functioning in adolescence. By identifying both facilitative and inhibitory effects on attention and memory, the research aims to inform pedagogical practices, curriculum design, and policy frameworks. Ultimately, the study seeks to support the development of balanced, cognitively effective approaches to integrating technology in education.

Keywords: *Screen-based learning, Cognitive dynamics, Attention processes, Memory retention, Adolescents, Digital technology.*

1. INTRODUCTION:

In an age marked by rapid digital transformation, technology has become a fundamental pillar of contemporary life, influencing virtually every aspect of human activity and redefining educational practices. From effortless communication through smartphones to data-driven decision-making across industries, technology enhances efficiency, drives innovation, and strengthens global connectivity.

The rapid integration of digital technologies into education has fundamentally transformed the nature of teaching and learning processes. Screen-based learning refers to an educational approach where digital devices—such as computers, tablets, smartphones, and interactive whiteboards—serve as the primary medium for delivering instructional content and facilitating learner engagement. Unlike traditional methods reliant on print

materials or face-to-face lectures, it leverages screens to present multimedia resources like videos, simulations, interactive quizzes, and adaptive software, enabling anytime, anywhere access to knowledge. Screen-based learning—defined as learning mediated through digital devices such as smartphones has become an integral part of contemporary educational environments. Particularly in the post-pandemic era, where online and hybrid modes of instruction have gained prominence, students are increasingly exposed to prolonged screen interaction as a primary mode of acquiring knowledge. Research on smartphones, multitasking, social media networks, and digital devices and technologies appears to be relatively well-connected (Urška Žnidariča, Erik Štrumbelja, Octavian Machidona, 2026). Experimental, meta-analytic, and review evidence links frequent multitasking and interruption-heavy use to reduced sustained attention, poorer inhibitory control, and learning inefficiencies via divided-attention and interference mechanisms, with stronger and more consistent effects under high interruption frequency and in younger users (Kong et al., 2023; Clinton-Lisell, 2021; Eliseev and Marsh, 2021; Chen and Yan, 2016; Ershova, 2019; Liu et al., 2017). With the increasing availability of technology and immediate introduction in classrooms at a very early age, children may be prevented from learning and reinforcing basic skills (Martin Wolak and Mi Song Kim, 2023).

Adolescence represents a crucial developmental stage characterized by significant neurological, cognitive, and socio-emotional changes. During this period, the brain undergoes substantial maturation, particularly in regions associated with executive functions, including attentional control, working memory, and cognitive flexibility. These cognitive faculties are essential for processing, organizing, and retaining information. However, the increasing reliance on screen-based learning introduces new patterns of information engagement that may both enhance and disrupt these processes. Understanding how digital environments interact with the developing adolescent brain is therefore essential for optimizing educational outcomes.

Smartphones have become indispensable, particularly among students and young people, who are the primary users of these devices (Liu et al., 2021). Screen-based learning environments differ markedly from traditional learning contexts in terms of structure, stimuli, and cognitive demands. Digital platforms often present multimodal content—combining text, audio, video, and interactive elements—which can facilitate deeper engagement and support diverse learning styles. From the perspective of cognitive load theory, such multimodal representations can enhance learning by distributing cognitive processing across different channels. Similarly, constructivist approaches emphasize that interactive digital tools enable learners to actively construct knowledge through exploration and manipulation of content. These affordances suggest that screen-based learning has the potential to positively influence attention and memory by making learning more engaging and meaningful. However, the same features that make digital learning environments appealing may also contribute to cognitive challenges. One of the most frequently cited concerns is the impact of screen exposure on attention span. Digital interfaces often encourage rapid shifts in focus through notifications, hyperlinks, and multitasking opportunities. This fragmented mode of engagement can undermine sustained attention, a critical component

for deep learning and comprehension. The idea of schemas, which are cognitive frameworks that assist people in organizing and interpreting information, is essential to comprehending learning in this context (Anderson, 2010).

Adolescents, whose attention control systems are still developing, may be particularly vulnerable to such distractions. Research indicates that frequent task-switching and media multitasking are associated with reduced attention capacity and increased cognitive fatigue, potentially impairing academic performance. According to the schema theory, learning entails integrating new knowledge into pre-existing mental models (Rumelhart, 1980). Because they offer dynamic and interactive content, digital tools can both help and hinder this process. They can also overwhelm cognitive capacities or divert students' attention (Sweller, Ayres, & Kalyuga, 2011).

Memory processes are similarly affected by screen-based learning. Memory, particularly working memory and long-term retention, plays a central role in learning by enabling the encoding, storage, and retrieval of information. Digital learning environments can both support and hinder these processes. On one hand, features such as visual aids, repetition, and interactive simulations can enhance encoding and facilitate memory retention. On the other hand, excessive reliance on digital devices for information storage—often referred to as “digital offloading”—may reduce the need for active memory engagement. Additionally, superficial processing of information, encouraged by skimming and scrolling behaviours, may limit the depth of encoding required for long-term retention. The potential negative impact of digital devices on social development is supported by empirical research. For example, a study by Twenge and Campbell (2018) reported that increased screen time was associated with lower psychological well-being, including higher levels of loneliness.

The present study seeks to explore these complexities by investigating how screen-mediated learning influences key cognitive processes. By focusing on attention and memory, the study aims to contribute to a deeper understanding of the mechanisms through which digital technologies shape learning outcomes. This research is particularly relevant in educational settings where technology integration is rapidly expanding, yet pedagogical strategies for its effective use are still evolving.

LITERATURE REVIEW:

A literature review is a systematic examination of existing research, theories, and studies related to a specific topic. It helps identify research gaps, establish theoretical foundations, avoid duplication, and provide direction for the study. A literature review also strengthens the credibility and relevance of the research by connecting it with previous scholarly work. Here is some review of literature related to the study:-

Kundra, S., Dhiman, S., Jha, N., Ailawadi, B., Arya, P. S., & Shrivastava, A. (2026) this review explores the impact of screen-based activities on cognitive learning in early childhood. Ten selected studies indicate largely positive outcomes across attention, memory, and executive functions. Notable improvements were

observed in inhibitory control, self-regulation, task switching, sustained attention, and working memory. EEG findings suggested enhanced cognitive engagement during screen-based reading. Overall, the evidence supports that well-designed screen-based, especially combined with physical activities, can effectively enhance multiple cognitive domains in young children.

Qayyum, A., Fatima, M., Kashif, Shahid, R. (2024) This mixed-methods study explores smartphone impacts on attention span, academic performance, and learning engagement amid rising device prevalence. Surveys, interviews, observations, and assessments with 100 children, parents, and teachers from DHA Lahore revealed significant negative correlations: higher usage linked to shorter attention spans, lower scores, and entertainment preferences over educational content. Recommendations include limiting screen time, prioritizing educational apps, and fostering offline activities. Parents and educators must balance access to mitigate cognitive risks, with calls for longitudinal research on long-term effects.

Small et al. (Small, Lee, Kaufman, Jalil, Siddarth, Gaddipati, Moody, & Bookheimer, 2020) review emerging evidence on digital technology's dual impact on brain function and behaviour. Excessive screen time risks attention deficits, emotional/social impairments, addiction, isolation, brain development issues, and sleep disruption. Conversely, online tools, videogames, and apps enhance neural activity, memory, multitasking, fluid intelligence, and mental health via interventions. Functional imaging supports benefits in internet-naive adults; further research is urged to clarify mechanisms.

Bhutta, Firdoos, Malik, Abbas, and Kanwal (2026) examine the impact of rapid digital technology integration on students' learning processes, focusing on engagement, cognitive schemas, and screen-based resources. Grounded in constructivism and schema theory, their study highlights both benefits and challenges of digital learning. While technology enhances interactivity and personalized learning, it may also lead to distraction, cognitive overload, and reduced deep learning. The authors emphasize the role of teachers in aligning digital tools with learners' prior knowledge. They conclude that effective technology integration requires a balanced, research-informed approach to support meaningful cognitive development and knowledge retention in modern classrooms.

Mehta (2018) employed mixed-methods to probe prolonged screen use's effects on cognitive flexibility in adolescents/young adults. Moderate, purposeful digital engagement (e.g., educational apps) enhanced set-shifting and reduced WCST errors ($\Delta RT = -8\%, -12\%$), while excessive passive consumption and multitasking impaired task-switching and working memory ($p < .01$), persisting post-covariates. Recommends curbing unstructured media, integrating challenging digital tools in curricula for balanced habits.

Darshan Hosaholalu Sarvajna et al., (2025) This study investigated screen time's differential impacts on working memory (WM) in 81 adolescents (13-16 years), distinguishing active screen time (AST) from background screen time (BST). Using auditory/visual reverse digit span and Corsi backward tasks, it revealed

higher AST exposure across participants, with AST positively correlating to superior WM performance, while BST showed no significant effects. These findings underscore AST's potential cognitive benefits amid adolescence's WM development, though causality remains inconclusive in this cross-sectional design.

Eliana Neophytou, Laurie A. Manwell, and Roelof Eikelboom (2019) conducted a scoping review showing that excessive screen time negatively impacts neurodevelopment, learning, memory, and mental health. Their analysis of 44 studies linked prolonged screen exposure to increased risks of anxiety, addiction, cognitive decline, and potential early-onset neurodegeneration, emphasizing the need for more comprehensive research to guide policy and intervention strategies.

Yacouba Ouattara, Prisca Joëlle Djoman Doubran, Koffi Mathias Yao, Niemtiah Ouattara, Taki Romaric Yian, and Soualiho Ouattara (2025) found that screen-based tasks significantly improved visuospatial working memory among Ivorian primary students compared to print. While no urban–rural differences appeared in screen conditions, rural students outperformed urban peers in print tasks, indicating that cognitive benefits of digital learning interact with socio-economic and geographical contexts.

Renata Maria Silva Santos, Camila Guimarães Mendes, Débora Marques Miranda, and Marco Aurélio Romano-Silva (2022) conducted a systematic review showing that excessive screen time in children is generally associated with attention difficulties. While most studies indicated negative effects, limited evidence suggested occasional benefits. The review emphasizes the need for monitoring children's screen exposure, particularly post-pandemic, and calls for further longitudinal research to understand long-term attentional impacts.

Ch. Mahmood Anwar, Khunsa Hayat, and Hafiz Abbas (2024) highlight that structured smartphone use in education can enhance attention, engagement, and short-term memory through interactive tools. However, unregulated use leads to distraction, cognitive overload, and poorer academic outcomes. Their review stresses the need for policy reforms, teacher training, and digital literacy to ensure balanced and effective smartphone integration in learning environments.

RATIONAL OF THE STUDY:

In the digital era, screen-based learning has become ubiquitous among adolescents, transforming educational paradigms through platforms like online classes, educational apps, and interactive media. However, this shift raises critical concerns about its cognitive implications, particularly on attention and memory—core faculties underpinning learning and academic success. While screens offer unprecedented access to information, emerging evidence links excessive exposure to diminished attention control, working memory deficits, and reduced executive functioning, potentially exacerbating developmental vulnerabilities in this age group.

Adolescence represents a crucial developmental stage characterized by significant neurological, psychological, and behavioural changes. During this period, the brain undergoes substantial maturation, particularly in regions

associated with executive functions such as sustained attention, working memory, and information processing. Prolonged screen time disrupts these processes via mechanisms like rapid sensory overload, which fragments attention spans. Moreover, the multitasking nature of digital platforms, constant notifications, and hyperlinked content structures may fragment attention, potentially reducing the depth of cognitive processing. At the same time, multimedia elements and interactive features may enhance engagement and facilitate certain types of memory encoding, suggesting a complex and non-linear relationship between screen exposure and cognitive outcomes. Existing literature provides mixed evidence on the cognitive effects of screen-based learning. Some studies suggest that digital learning environments can support memory retention through multimodal representations and adaptive feedback mechanisms. Others indicate that excessive screen time and divided attention can impair working memory and reduce the ability to sustain focus over extended periods. However, much of this research remains quantitative and outcome-oriented, often neglecting the subjective experiences and contextual factors that shape how adolescents interact with screen-based content. There is a clear need for qualitative inquiry that explores the lived experiences, perceptions, and cognitive strategies of adolescents within these environments.

Therefore, this study seeks to investigate the nuanced interplay between screen-based learning, attention, and memory among adolescents through a qualitative lens. By focusing on cognitive dynamics rather than merely outcomes, the research aims to generate context-sensitive insights that can inform pedagogical strategies, digital literacy practices, and policy interventions. Ultimately, the study aspires to contribute to a more balanced and evidence-based understanding of technology's role in shaping adolescent cognition in contemporary educational settings.

3. RESEARCH QUESTIONS:

- (a) How do students perceive digital learning environments?
- (b) How do adolescents perceive the impact of screen-based learning on their attention during academic tasks?
- (c) What challenges do adolescents encounter in sustaining attention and retaining information in digital learning contexts?
- (d) What is the impact on memory retention?
- (e) How do contextual factors like type of content, duration of screen exposure, learning environment, influence adolescents' cognitive engagement?

4. OBJECTIVES:

- (a) To examine students' perceptions of digital learning environments in terms of usability, engagement, and overall learning experience.

- (b) To investigate adolescents' perceptions of the impact of screen-based learning on attention during academic tasks.
- (c) To identify the challenges adolescents face in sustaining attention and retaining information within digital learning contexts.
- (d) To assess the impact of screen-based learning on adolescents' memory retention, particularly short-term and long-term memory processes.
- (e) To analyse the influence of contextual factors including type of content, duration of screen exposure, and learning environment on adolescents' cognitive engagement.

5. LIMITATION OF THE STUDY:

The study is limited to 100 students from selected private Higher Secondary schools in the Sonarpur-Narendrapur area of South 24 Parganas, West Bengal. Therefore, the findings may not be generalizable to students from government schools, other districts, or different educational and socio-cultural contexts.

6. RESEARCH METHODOLOGY:

Research methodology is the systematic framework that guides the collection, analysis, and interpretation of data in a study. It defines research design, sampling, tools, procedures, and ethical considerations to ensure validity, reliability, and rigor in addressing research questions and achieving credible, meaningful findings for academic or practical purposes and application. Following are the methods that will help lead to the result of the study: -

6.1 Research design

A Qualitative method has been chosen for the study, because the cognitive dynamics of screen-based learning among the adolescents cannot be measured empirically but requires an in-depth understanding from various aspects related to this area.

6.2 Population:

For the study, private schools will be selected from the Sonarpur-Narendrapur area under South 24 Parganas, West Bengal.

6.3 Sample:

To achieve the study purpose, 10 Higher Secondary private schools have been chosen in the South 24 Parganas district, in which 100 students from class IX-XII of the respective schools will be identified.

6.4 Tool:

- (f) Attention rating scale

(ii) Structured questionnaire

(iii) Semi structured interviews.

6.5 Data analysis:

The study will use – (i) Interviews

(ii) Observations

(iii) Thematic analysis.

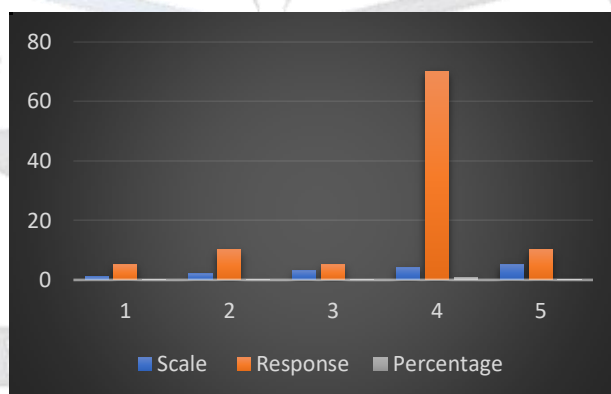
7. RESULTS AND DISCUSSION:

The present study was conducted in 10 Higher Secondary private schools situated in the South 24 Parganas district. A total of 100 students studying in classes IX to XII participated in the study. Data were collected through the Attention Rating Scale, Structured Questionnaire, and Semi-Structured Interviews to understand the influence of screen-based learning on adolescents' attention and memory processes. Following percentage analysis is representing the research questions and consequently the results out of them.

1. Perceptions of digital learning environments in terms of usability, engagement, and overall learning experience.

Table: 1

Scale	Response	Percentage
1	5	5%
2	10	10%
3	5	5%
4	70	70%
5	10	10%



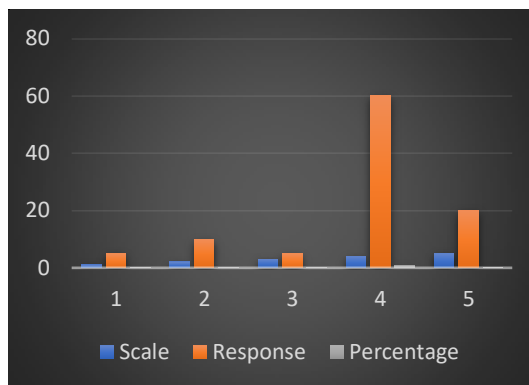
Source: Primary data

Data shown in Table 1 depicts the data representation taken in Likert scale taking 100 students for the Response and Percentage representation. Only 5% strongly disagreed to the good engagement with the digital learning environment, 10% of the adolescent section disagreed to the fact, 5% again kept them neutral. 70% of the selected students agreed and 10% of the students remained stick to the strongly agreed area.

2. Perceptions of the impact of screen-based learning on attention during academic tasks.

Table: 2

Scale	Response	Percentage
1	5	5%
2	10	10%
3	5	5%
4	60	60%
5	20	20%



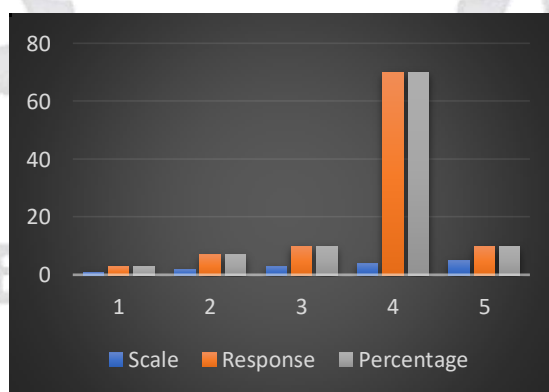
Source: Primary data

Data shown in Table: 2 symbolize the data representation taken in Likert scale taking 100 students for the Response and Percentage representation. Here, 5% represents the students who have strong disagreement regarding the perceptions of the impact of screen-based learning on attention during academic tasks. 10% of the students had disagreement with this perception, 5% kept neutral opinion, 60% agreed that screen-based learning has great impact on attention during academic tasks and 20% of them strongly agreed with the same.

2. Challenges adolescents face in sustaining attention and retaining information within digital learning contexts.

Table: 3

Scale	Response	Percentage
1	3	3
2	7	7
3	10	10
4	70	70
5	10	10



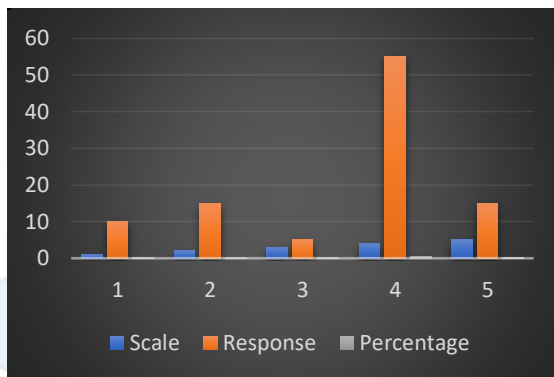
Source: Primary data

Data shown in Table: 3 depict that only 3% of the students interviewed went with strong disagreement with the challenges they face in sustaining attention and retaining within digital learning contexts, 7% had disagreement, 10% had no opinion, whereas, 70% had a sharp positive response towards this challenge they face and only 10% strongly agreed with the mentioned fact.

4. Impact of screen based learning on adolescents' memory retention, particularly short-term -term and long memory processes

Table: 4

Scale	Response	Percentage
1	10	10%
2	15	15%
3	5	5%
4	55	55%
5	15	15%



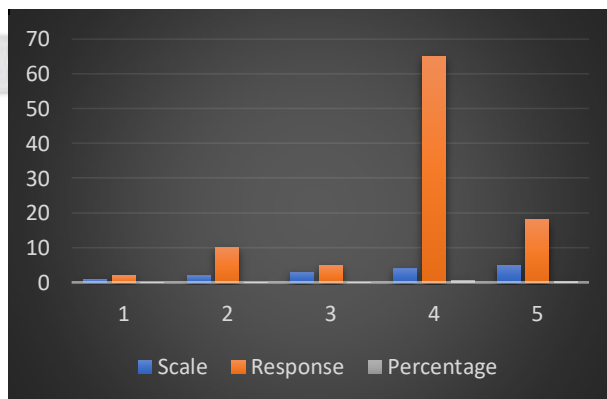
Source: Primary data

Data given in Table: 4 illustrate the students the Response and Percentage collected from 100 students through questionnaire presented by Likert scale. Here, 10% of the students strongly disagreed with the impact of screen based learning – on their memory retention, particularly short-term -term and long memory. 15% had disagreement with this fact, 5% of them kept neutral. On the other hand, 55% of the students strongly agreed to the impact of this type of learning on their memory retention and the rest 15% only strongly agreed to this.

5. Influence of contextual factors including type of content, duration of screen exposure, and learning environment on adolescents' cognitive engagement.

Table: 5

Scale	Response	Percentage
1	2	2%
2	10	10%
3	5	5%
4	65	65%
5	18	18%



Source: Primary data

Data given in Table: 5, exemplifies illustrate the students the Response and Percentage collected from 100 students through questionnaire presented by Likert scale. Over here, only 2% of the entire students strongly opposed the influence of contextual factors including type of content, duration of screen exposure, and learning environment on adolescents' cognitive engagement. Among them 10% opposed to this but not strongly, 5% did not give any reaction. Again, 65% had a high opinion and agreed to this influence of contextual factors and the rest 18% strongly agreed to this.

8. FINDINGS OF THE STUDY:

From the result the findings reveal that most adolescents perceive digital and screen-based learning as significantly affecting their cognitive engagement, attention, and memory retention. A large majority of students across all five tables agreed or strongly agreed that digital learning environments influence academic focus, sustained attention, and both short-term and long-term memory. Contextual factors such as screen exposure duration, content type, and learning environment were also considered influential by most respondents. Only a small percentage of students expressed disagreement or neutrality. Overall, the study indicates a strong positive perception among adolescents regarding the cognitive impact of screen-based learning in educational contexts.

9. CONCLUSION:

The study concludes that screen-based learning has a significant influence on adolescents' cognitive functioning, particularly in relation to attention and memory processes. Most participants acknowledged that digital learning environments affect their academic focus, sustained attention, and both short-term and long-term memory retention. The findings further indicate that factors such as duration of screen exposure, type of digital content, and learning context play an important role in shaping cognitive engagement. While screen-based learning offers opportunities for interactive and accessible education, excessive or unstructured exposure may also create cognitive challenges. Therefore, the study emphasizes the need for balanced and well-designed digital learning practices that enhance attention and memory while minimizing potential negative effects, thereby supporting effective and meaningful learning experiences among adolescents.

REFERENCES:

Bjornsen, C.A., Archer, K.J., 2015. Relations between college students' cell phone use during class and grades. *Scholarsh. Teach.* 1, 326–336. *Learn. Psychol*

Korte, M. (2020). The Digital revolution and its Impact on Human brain and behavior

Dialogues Clinical Neuroscience, 22(2). in <https://doi.org/10.31887/dcns.2020.22.2>

Selwyn, N. (2016). Education and technology: Key issues and debates (2nd ed.).

Bloomsbury Academic.

Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of*

Psychology, 45(3), 255–287.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Zhao, Y. (2019). Catching up or leading the way: American education in the age of globalization. ASCD.

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers.

Proceedings of the National Academy of Sciences, 106(37), 15583–15587.

Ramya KR. Screen time behaviors among school going adolescents residing in a selected

district, Kerala. *IJPEN* 2018;117.

Darshan Hosaholalu Sarvajna, Winston, J. S., Deepak Puttanna, Somraj Odeyar, Ravindran,

R., Kumar, S., & Avani Klaykote Vettil. (2025). Screen-time exposure and

working memory capacity in adolescents. *International Journal of Adolescent*

Medicine and Health, <https://doi.org/10.1515/ijamh-2025-0148>

TGJCT
EST. 2025