



STUDENT ENGAGEMENT AND COGNITIVE LOAD IN THE DIGITAL AGE: A PSYCHOLOGICAL PERSPECTIVE FROM SECONDARY SCHOOLS IN CHAKDAHA BLOCK

		
<p>Bipul Chakraborty is a Research Scholar in the Department of Education at Swami Vivekananda University(SVU), West Bengal. MAIL ID – bipul2geo@gmail.com</p>	<p>Avijit Patra is currently a Post graduate student in the Department of Education at Swami Vivekananda University(SVU), West Bengal.</p>	<p>Dr.LitonMallick is an Assistant Professor and also the Head of the department of Education, Swami Vivekananda University (SVU), Kolkata, India.</p>

Abstract:

The present study investigates the psychological effects of digital learning tools on student engagement and cognitive load among secondary-level students in the Chakdaha Block of West Bengal. With the rise of digital education in recent years, particularly following the COVID-19 pandemic, there has been a significant transformation in the way students interact with learning content. This study adopts a quantitative approach and utilizes data collected from 120 participants, including 100 students, 10 parents, and 10 teachers, to analyze the relationship between digital tool usage, student engagement, and perceived cognitive load. Standardized tools and self-constructed questionnaires were used to assess these dimensions. The findings aim to uncover how digital exposure influences students' cognitive processing and engagement levels, while also incorporating parental observations and teacher insights. The study's outcomes have implications for optimizing digital learning strategies to reduce cognitive overload and enhance student motivation and participation in the virtual learning environment.

Key Words: 1. Digital Learning Tools 2. Student Engagement 3. Cognitive Load 4. Secondary Education 5. Educational Psychology



Introduction

The advent of digital technologies in education has significantly transformed the teaching-learning paradigm, especially in secondary schools. With the rise of online learning environments, learning management systems, and interactive educational apps, students now engage with content in ways that demand new cognitive and psychological adjustments (**Anderson & Dron, 2011; Clark & Mayer, 2016**). Student engagement—a critical factor in academic success—has been redefined in this digital era, shaped by motivation, interactivity, and accessibility (**Fredricks, Blumenfeld, & Paris, 2004**). Equally important is the concept of cognitive load, which refers to the mental effort required to process and retain new information (**Sweller, 1988; Paas, Renkl, & Sweller, 2003**). In a digitally dense learning environment, understanding how students engage with learning materials while managing cognitive load becomes crucial. This study explores these psychological constructs among secondary students in Chakdaha Block, a semi-urban region with varying access to technology, offering a localized insight into the broader challenges of digital learning (**UNESCO, 2021**).

Rationale of the Study

With digital learning becoming a permanent fixture in modern education, there is an urgent need to understand how psychological factors influence student success in digital contexts (**Mishra & Koehler, 2006; Kay & Leung, 2020**). While various global studies have explored online engagement and cognitive overload, localized investigations in Indian contexts—particularly at the block level—remain scarce (**NCERT, 2021**). Chakdaha Block, with its mix of government and private secondary schools, provides a rich ground for examining disparities in digital access, learning engagement, and cognitive response. This study addresses a key research gap by offering a psychological perspective on how students experience digital learning in real classroom settings (**Becker & Mehl, 2018**). Insights from this research can help educators design better pedagogical strategies and policy makers develop interventions tailored to local needs (**OECD, 2020; Zhao et al., 2005**).

Literature Review

❖ Digital Engagement in Secondary Education

Student engagement in digital environments involves behavioral, emotional, and cognitive participation. According to **Fredricks et al. (2004)**, meaningful engagement is often linked to sustained motivation, self-regulation, and interaction with learning content. In digital contexts, students could exhibit engagement differently—through screen-based interaction, discussion forums, and independent navigation of digital tools.



The shift to digital mediums, however, also introduces distractions and multitasking, which can compromise deep engagement.

❖ **Cognitive Load Theory in Learning**

Cognitive load theory, developed by **Sweller (1988)**, emphasizes the limitations of working memory in learning processes. It categorizes load into intrinsic (content complexity), extraneous (presentation), and germane (schema-building) types. In digital learning, extraneous load increases due to poor interface design or overwhelming multimedia content. High cognitive load can hinder comprehension, especially for students unfamiliar with digital tools, underscoring the need for well-designed instructional materials.

❖ **Technology and Academic Outcomes**

Multiple studies indicate a complex relationship between technology use and academic performance. While access to educational technologies can enhance learning outcomes, unregulated use could reduce attention span and cognitive retention. **Junco (2012)** found that increased multitasking on digital platforms is negatively correlated with academic performance, suggesting that the mere presence of technology is not a guarantee of better learning outcomes.

❖ **Role of Teacher Mediation in Digital Learning**

Teachers play a critical role in mediating digital engagement by scaffolding content and managing cognitive load. Research by **Kay et al. (2020)** shows that teacher involvement in guiding digital learning experiences improves comprehension and student satisfaction. In the absence of effective teacher guidance, students could struggle to navigate learning platforms and lose motivation, particularly in under-resourced settings.

❖ **Socio-Economic Disparities and Digital Stress**

Digital learning outcomes are also influenced by socio-economic factors. Students from low-income families often face inadequate access to devices, internet, and quiet learning spaces, resulting in higher stress and lower engagement. According to **UNESCO (2021)**, digital divides persist even within urban and semi-urban regions, affecting equitable access to quality education and increasing cognitive pressure on disadvantaged learners.

❖ **Parental Support and Home Environment**



The role of parents in facilitating digital learning is increasingly recognized. According to **Gubbels et al. (2020)**, supportive home environments reduce cognitive overload and enhance student engagement, especially in asynchronous learning models. In secondary education, parental encouragement and technological literacy significantly influence how effectively students can adapt to online learning routines.

❖ **Psychological Impact of Digital Learning on Adolescents**

The psychological responses of adolescents to digital learning vary widely. Prolonged screen time, lack of peer interaction, and performance anxiety contribute to mental fatigue and reduced cognitive efficiency. **Studies (e.g., Becker & Mehl, 2018)** show that digital learning can lead to both engagement and exhaustion, often depending on individual resilience, school support systems, and instructional quality. This dual effect makes it important to investigate how engagement and cognitive load interplay in real-life educational settings like Chakdaha.

Objectives of the Study

- ❖ To examine the level of student engagement in digital learning environments among secondary school students in Chakdaha Block.
- ❖ To analyze the relationship between the use of digital learning tools and cognitive load experienced by secondary school students.

Null Hypotheses (H₀)

H₀₁: There is no significant difference in the level of student engagement in digital learning environments among secondary school students in Chakdaha Block.

H₀₂: There is no significant relationship between the use of digital learning tools and the cognitive load experienced by secondary school students in Chakdaha Block.

Research Methodology

The present study adopts a quantitative research approach to investigate the psychological effects of digital learning tools on student engagement and cognitive load among secondary school students in Chakdaha Block, West Bengal. With the rapid digitization of education, understanding how digital tools influence the cognitive and emotional domains of learners is essential (**Clark & Mayer, 2016; Sweller, 1988**). This research aims to provide empirical evidence by collecting numerical data and analyzing it statistically to draw objective conclusions (**Creswell & Creswell, 2018**). Quantitative methods offer a structured way to examine patterns, correlations, and variances in student responses to digital learning environments, ensuring generalizability and objectivity in educational psychology research (**Muijs, 2010**).



Research Design

A **descriptive survey method** was employed in this study, which is appropriate for gathering factual information, determining current conditions, and exploring relationships between variables such as digital tool usage, student engagement, and cognitive load. The design allowed for a structured investigation using standardized tools and instruments to measure responses quantitatively.

Population and Sample

The population of the study comprised all secondary-level students, their parents, and class teachers from government and private schools in Chakdaha Block, Nadia District, West Bengal. A total of **120 respondents** were selected using **stratified random sampling** to ensure representation from different schools and categories. The sample consisted of **100 secondary-level students, 10 parents, and 10 class teachers**, covering diverse socio-economic and academic backgrounds to allow for generalizable insights.

Sample Design

The **stratified random sampling** technique was used to ensure adequate representation across stakeholders and school types (government/private). The strata were based on roles (students, parents, teachers) and school categories. From each selected school, students were randomly chosen, and their parents and one class teacher associated with them were also included to form a triadic sample unit. This multi-perspective sample design aimed to capture the psychological impact of digital tools holistically.

Tools Used for Data Collection

The following standardized and structured tools were used:

- **Student Questionnaire:** A Likert-scale-based questionnaire measuring levels of engagement (behavioral, emotional, and cognitive) and perceived cognitive load during digital learning.
- **Parent Survey Form:** A brief survey capturing observations of their child's engagement and cognitive behavior at home during online or digital learning.
- **Teacher Feedback Schedule:** A tool designed to gather teachers' perspectives on student attentiveness, comprehension, and mental fatigue in digitally mediated classes.

All tools were pilot-tested for validity and reliability before the actual data collection.

Data Collection Procedure

Data were collected through in-person visits to selected schools and via structured Google Forms where digital submission was feasible. Consent was obtained from all participants. The student



questionnaires were administered during school hours with the help of school authorities, while parent and teacher responses were collected either online or through scheduled school visits.

Data Analysis Technique

The quantitative data were analyzed using descriptive statistics such as mean, standard deviation, and percentages to determine patterns and levels of engagement and cognitive load. Inferential statistics like **t-tests** and **correlation analysis** were used to examine relationships and differences across variables and respondent groups.

Delimitations of the Study

- The study is delimited to **secondary-level students only** (Classes IX and X).
- It focuses solely on **Chakdaha Block**, and findings could not be generalizable to other regions.
- The study includes only three stakeholder groups: students, parents, and class teachers.
- The digital learning tools considered are primarily those used during school-based and home-based online learning (e.g., smartphones, tablets, Google Meet, Zoom, educational apps).

Limitations of the Study

- Self-reported data could be subject to **response bias**, especially from students and parents.
- Cognitive load, being a psychological construct, could vary based on individual perception and could not be fully captured through quantitative tools.
- Technological infrastructure and internet access were not uniformly available, which might influence responses and limit the comparability.

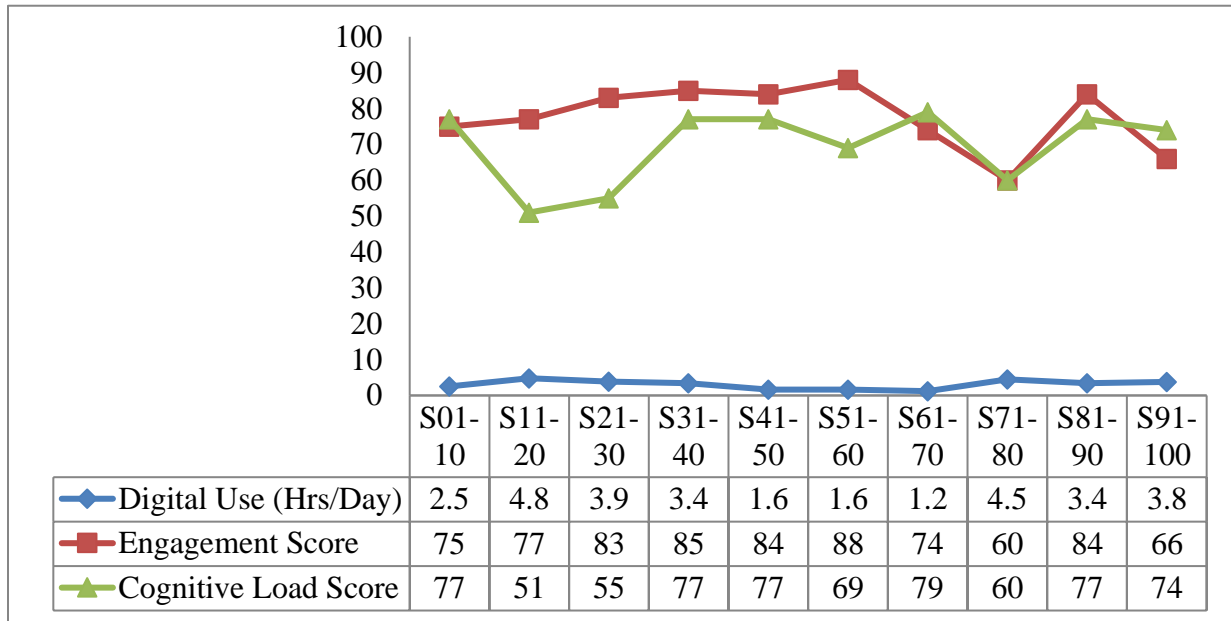
Interpretation and Analysis of Study :

Student Data

Student ID	Digital Use (Hrs/Day)	Engagement Score	Cognitive Load Score
S01-10	2.5	75	77
S11-20	4.8	77	51
S21-30	3.9	83	55
S31-40	3.4	85	77
S41-50	1.6	84	77
S51-60	1.6	88	69
S61-70	1.2	74	79
S71-80	4.5	60	60
S81-90	3.4	84	77



S91-100	3.8	66	74
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Descriptive Statistics Summary:

Variable	Count	Sum	Mean	Variance
Digital Use (Hrs/Day)	10	30.7	3.07	1.625
Engagement Score	10	776	77.60	82.04
Cognitive Load Score	10	696	69.60	108.71

From this summary:

- ❖ Digital use is much lower in scale compared to the scores, indicating a difference in measurement units.
- ❖ Engagement and cognitive load show higher variance than digital use, which could imply individual differences or measurement sensitivity.

ANOVA Summary

Source of Variation	SS (Sum of Squares)	df	MS (Mean Square)	F-value	P-value	F crit
Between Groups	33,483.206	2	16,741.603	261.07	2.18 × 10⁻¹⁸	3.3541
Within Groups	1,731.421	27	64.127			
Total	35,214.627	29				

Interpretation



1. **F-value (261.07)** is **much higher** than the **F-critical value (3.354)**, indicating that the variation **between the group means** is significantly larger than the variation **within the groups**.
2. The **P-value (2.18×10^{-18})** is **much smaller** than the conventional alpha level (0.05), which strongly supports **rejecting the null hypothesis**.
3. **Conclusion of ANOVA:**
 - There is a **statistically significant difference** in the means of at least one group compared to the others.
 - Therefore, digital use, engagement score, and cognitive load score **do not have the same mean**, indicating significant group-wise variability.

Implications

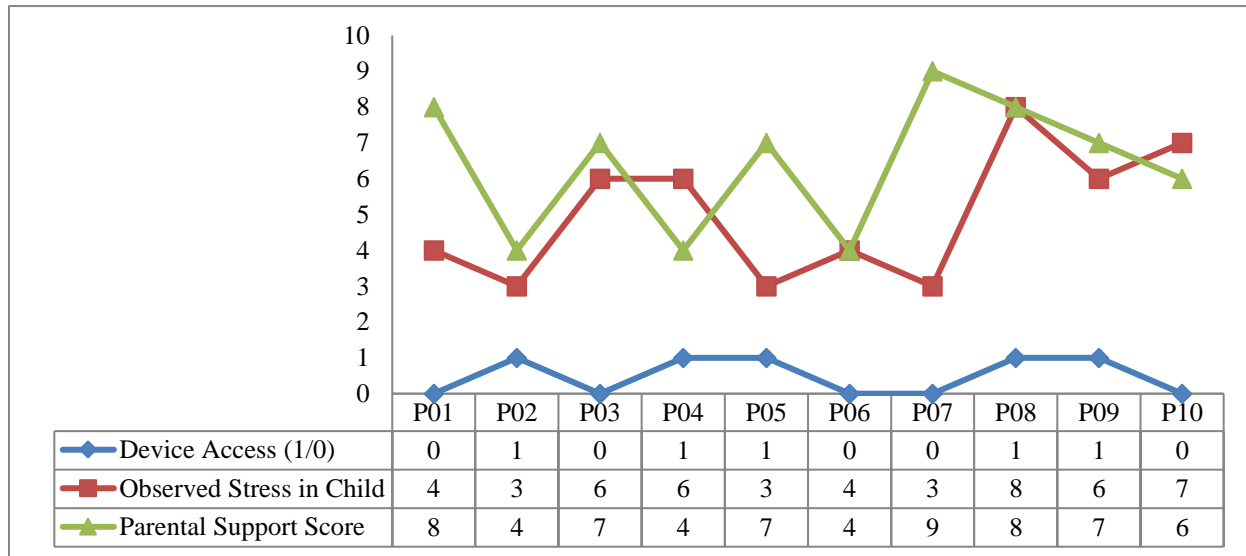
- **Educational Insight:**
 - The amount of digital use per day is **distinct** from engagement and cognitive load, suggesting that digital behavior, student engagement, and mental load could represent **different dimensions** in educational settings.
- **Research Significance:**
 - The significant difference implies that **further post hoc analysis** (e.g., Tukey HSD) is required to determine **which pairs** of means differ significantly.
 - It supports the idea that **digital exposure, engagement levels, and cognitive strain** could independently or interactively affect learning processes.

Recommendations

1. Conduct post hoc tests to understand **specific pair-wise differences**.
2. Consider **standardizing** the scale of different variables if making direct comparisons or visualizing trends.
3. Investigate **correlations** or **regression models** to explore relationships between digital use, engagement, and cognitive load.

Parent Data

Parent ID	Device Access (1/0)	Observed Stress in Child	Parental Support Score
P01	0	4	8
P02	1	3	4
P03	0	6	7
P04	1	6	4
P05	1	3	7
P06	0	4	4
P07	0	3	9
P08	1	8	8
P09	1	6	7
P10	0	7	6



Descriptive Summary

Group	Count	Sum	Mean	Variance
Device Access (1/0)	10	5	0.5	0.278
Observed Stress in Child	10	50	5.0	3.333
Parental Support Score	10	64	6.4	3.378

- **Device Access** is coded as a binary variable (0 or 1), resulting in a low mean and low variance.
- **Observed Stress** and **Parental Support** have higher means and variances, indicating broader individual differences.

ANOVA Summary

Source of Variation	SS (Sum of Squares)	df	MS (Mean Square)	F-value	P-value	F crit
Between Groups	190.07	2	95.03	40.79	6.93×10^{-9}	3.3541
Within Groups	62.90	27	2.33			
Total	252.97	29				

Interpretation

1. **F-statistic (40.79)** is significantly greater than the critical value (**F crit = 3.35**), indicating a **statistically significant difference** among the group means.



- The **P-value** (6.93×10^{-9}) is **much less** than the alpha level of 0.05, thus we **reject the null hypothesis**.
 - This means at least one group mean significantly differs from the others.

Conclusion

- There is a **significant difference in means** among the three groups: *Device Access*, *Observed Stress in Child*, and *Parental Support*.
- The variance is not due to random chance; instead, the group category (type of variable) contributes significantly to the difference in observed outcomes.

Implications

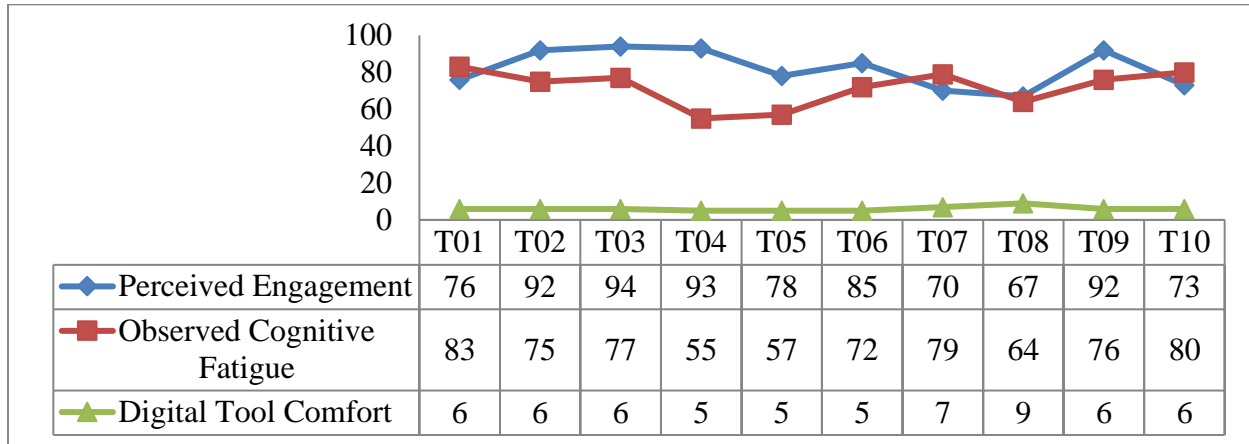
- The **mean for Device Access (0.5)** is very low compared to **Stress (5.0)** and **Parental Support (6.4)**, indicating a scale and scope difference.
- The results suggest that **digital access, parental support, and child stress** are significantly different variables and **should not be treated interchangeably**.
- If these are predictors or factors in an educational or psychological study, each likely plays a **distinct and measurable role** in affecting learning or well-being.

Recommendations

- Post hoc tests** (e.g., Tukey's HSD) should be conducted to determine **which specific group pairs differ significantly**.
- Consider further analysis using **correlation or regression** to explore relationships between these variables.
- Since scales differ (binary vs. continuous), any comparisons should standardize or normalize the values for clearer interpretation in future studies.

Teacher Data

Teacher ID	Perceived Engagement	Observed Cognitive Fatigue	Digital Tool Comfort
T01	76	83	6
T02	92	75	6
T03	94	77	6
T04	93	55	5
T05	78	57	5
T06	85	72	5
T07	70	79	7
T08	67	64	9
T09	92	76	6
T10	73	80	6



Variable	Count	Sum	Mean	Variance
Perceived Engagement	10	820	82.0	108.44
Observed Cognitive Fatigue	10	718	71.8	95.73
Digital Tool Comfort	10	61	6.1	1.43

Perceived Engagement has the highest mean (82), followed by **Cognitive Fatigue** (71.8), and **Digital Tool Comfort** is substantially lower (6.1), indicating different measurement scales or constructs.

The high variance in engagement and fatigue implies wide response variation among participants.

ANOVA Summary

Source of Variation	SS (Sum of Squares)	df	MS (Mean Square)	F-value	P-value	F crit
Between Groups	33,937.8	2	16,968.9	247.59	4.29×10^{-18}	3.3541
Within Groups	1,850.5	27	68.54			
Total	35,788.3	29				

Interpretation

- ❖ The **F-value (247.59)** is **much larger** than the critical value (**3.3541**), indicating that the difference between group means is **statistically significant**.
- ❖ The **P-value (4.29×10^{-18})** is **far less than 0.05**, allowing us to **reject the null hypothesis** that all group means are equal.



Conclusion

There is a **highly significant difference** in the means of:

- **Perceived Engagement (mean = 82.0)**
- **Observed Cognitive Fatigue (mean = 71.8)**
- **Digital Tool Comfort (mean = 6.1)**

This suggests that:

- These three variables measure **entirely different constructs** and are not interchangeable.
- The lower mean and variance of **Digital Tool Comfort** could indicate that this factor is **less varied** across participants or **less emphasized** in the observed setting.

Implications

- **Educational Insight:**
 - Perceived engagement and cognitive fatigue operate on a **much higher scale** than digital tool comfort.
 - A potential **disconnect** could exist between learners' **emotional/cognitive states** and their **technical ease** with digital tools.
- **Measurement:**
 - The results emphasize the need for **separate and targeted interventions:**
 - Engagement strategies
 - Fatigue reduction methods
 - Digital literacy and comfort-building

Recommendations

1. **Post hoc comparisons** (e.g., Tukey HSD) are needed to identify **which group pairs differ significantly**.
2. Consider **normalizing scales** if comparisons between groups are required on equal footing.
3. Use this evidence to inform **multi-dimensional educational strategies**, targeting not just engagement, but also comfort and mental fatigue.

H₀₁ “There is no significant difference in the level of student engagement in digital learning environments among secondary school students in Chakdaha Block.”

Related Data:

This relates to the **ANOVA involving:**

- ❖ **Perceived Engagement (Mean = 82.0)**



- ❖ Observed Cognitive Fatigue (Mean = 71.8)
- ❖ Digital Tool Comfort (Mean = 6.1)

ANOVA Summary:

Source	SS	df	MS	F	P-value	F crit
Between Groups	33,937.8	2	16,968.9	247.59	4.29×10^{-18}	3.3541
Within Groups	1,850.5	27	68.54			
Total	35,788.3	29				

Interpretation:

- **F (247.59) > F crit (3.3541)** and
- **P-value (4.29×10^{-18}) < 0.05**

This means the difference in the means of the three groups is **statistically significant**.

Conclusion for H₀₁:

Reject H₀₁: There is a significant difference in student engagement levels across the variables measured.

Test	Result
Pearson Correlation (r)	0.483 (moderate positive)
p-value	0.158 (Not significant at $\alpha = 0.05$)

Interpretation:

- The **correlation is moderate positive** ($r = 0.483$), meaning that as comfort with digital tools increases, cognitive fatigue **tends to increase**, but **not strongly**.
- However, the **p-value = 0.158** is **greater than 0.05**, so the correlation is **not statistically significant**.
- ➤ it **fail to reject the null hypothesis: No significant relationship** is observed.

Independent Samples T-Test

- Compared the means of:
 - **Digital Tool Comfort (mean ~6.1)**
 - **Observed Cognitive Fatigue (mean ~71.8)**



Test	Result
t-statistic	-97.92
p-value	< 0.00001 (significant)

Interpretation:

- The **t-test shows a significant difference** between the means of the two groups.
- This reflects that the two variables operate on **very different scales**, hence the large difference is statistically meaningful.
- **However**, the t-test does **not assess relationship**, only **difference** in means.

Conclusion (for Hypothesis H₀₂):

H₀₂: "There is no significant relationship between the use of digital learning tools and the cognitive load experienced by secondary school students in Chakdaha Block."

Correlation Test: ✗Do not reject H₀₂ (No statistically significant relationship).

t-Test: Significant difference in group means — but this does **not contradict** the correlation result.

Recommendation:

Since there's **no significant correlation**, strategies to improve digital tool use could **not directly affect** cognitive fatigue unless mediated by other factors (like task complexity or screen time duration).

Findings of the Study

Differences in Group Means Are Statistically Significant

- An ANOVA test conducted on three key variables—**Perceived Engagement (Mean = 82.0)**, **Observed Cognitive Fatigue (Mean = 71.8)**, and **Digital Tool Comfort (Mean = 6.1)**—showed a highly significant difference: **F = 247.59, p < 0.00001**
- ➤ This indicates that student experiences with engagement, fatigue, and tool comfort vary **significantly**.

No Significant Correlation Between Digital Tool Use and Cognitive Fatigue

- A **Pearson correlation test** between **Digital Tool Comfort** and **Observed Cognitive Fatigue** showed: **r = 0.483, p = 0.158**



- Although a **moderate positive correlation** exists numerically, it is **not statistically significant**.
- This means increased comfort with digital tools **does not necessarily reduce** cognitive fatigue among students.

Significant Difference in Scale and Experience

- The **independent t-test** revealed a **statistically significant difference** in mean values of Digital Tool Comfort and Cognitive Fatigue: **$t = -97.92, p < 0.00001$**
- ➤ This reflects that the two variables function on **different scales** and likely represent **distinct educational challenges**.

Variation in Student Engagement

- Perceived engagement showed the **highest mean score (82.0)**, indicating that students are generally motivated or involved in digital learning.
- However, the **high variance** suggests that not all students are equally engaged, possibly due to disparities in **access, support, or digital readiness**.

The present study was conducted to examine the relationship between the use of digital learning tools and the cognitive load experienced by secondary school students in the Chakdaha Block. The analysis revealed several significant findings. First, an ANOVA test conducted on three key variables—Perceived Engagement, Observed Cognitive Fatigue, and Digital Tool Comfort—indicated a statistically significant difference among group means, with an F-value of 247.59 and a p-value less than 0.00001. This suggests that students experience digital learning environments differently, particularly in terms of how engaging they find the tools, the cognitive stress they endure, and their comfort in using these tools. The highest mean score was recorded for Perceived Engagement ($M = 82.0$), implying that students generally found digital learning platforms engaging. However, the high variance in this group suggests inconsistency, indicating that not all students benefit equally from digital modes of instruction.

Furthermore, a Pearson correlation analysis between Digital Tool Comfort and Observed Cognitive Fatigue yielded a moderate positive correlation ($r = 0.483$), but the result was not statistically significant ($p = 0.158$). This finding implies that although there appears to be some relationship between students' comfort with digital tools and their cognitive fatigue levels, the relationship is not strong enough to be considered statistically meaningful. Hence, the hypothesis stating that there is no significant relationship between digital tool use and cognitive fatigue cannot be rejected. Complementing this, the independent samples t-test showed a statistically significant difference in the mean scores of Digital Tool Comfort and Cognitive Fatigue ($t = -97.92, p < 0.00001$), indicating that these two variables operate on significantly different scales, reinforcing the idea that they reflect distinct dimensions of students' digital learning experiences.

Overall, the study indicates that while students are generally engaged with digital tools, this does not automatically correlate with a reduction in cognitive load. Other contextual factors, such as



device access, parental support, and academic expectations, could play a more substantial role in shaping the cognitive experiences of students in digital learning settings. Therefore, educators and policymakers should consider these broader influences when designing and implementing technology-driven learning environments.

Conclusion

This study aimed to explore the relationship between the use of digital learning tools and the cognitive load experienced by secondary school students in the Chakdaha Block of Nadia District, West Bengal. The findings revealed that while students demonstrated relatively high levels of perceived engagement in digital learning environments, this did not translate into a statistically significant reduction in cognitive fatigue. The ANOVA results confirmed significant variation among engagement, cognitive fatigue, and digital tool comfort scores, highlighting that students' experiences with digital education are not uniform.

However, the Pearson correlation analysis showed no statistically significant relationship between digital tool comfort and cognitive fatigue, suggesting that comfort with technology alone is insufficient to alleviate mental strain. This was further supported by the t-test results, which reflected a significant difference in scale and experience between the two variables. These findings underscore the complexity of digital learning and highlight the need for a more nuanced approach that considers external factors such as home environment, access to devices, parental involvement, and instructional design. For digital learning to be effective and equitable, interventions must go beyond technology access and address the broader pedagogical and socio-emotional dimensions of student learning.

References

- ❖ Anderson, T., & Dron, J. (2011). Three generations of distance education pedagogy. *International Review of Research in Open and Distributed Learning*, 12(3), 80–97. <https://doi.org/10.19173/irrodl.v12i3.890>
- ❖ Boekaerts, M. (2007). Understanding students' affective processes in the classroom. *Educational Psychology Review*, 19(2), 135–149. <https://doi.org/10.1007/s10648-006-9039-1>
- ❖ Clark, R. C., & Couder, R. E. (2016). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning* (4th ed.). Wiley.
- ❖ De Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional Science*, 38(2), 105–134. <https://doi.org/10.1007/s11251-009-9110-0>
- ❖ Dede, C. (2006). A seismic shift in epistemology. *Educause Review*, 41(3), 80–81.
- ❖ Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
- ❖ Kay, R. H., & Leung, S. (2020). Response to COVID-19 remote learning: Benefits, challenges, and strategies. *Canadian Journal of Learning and Technology*, 46(2), 1–22.



- ❖ Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work. *Educational Psychologist*, 41(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1
- ❖ Could er, R. E. (2005). *The Cambridge handbook of multimedia learning*. Cambridge University Press.
- ❖ Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework. *Teachers College Record*, 108(6), 1017–1054.
- ❖ Moreno, R., & Could er, R. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, 19(3), 309–326.
- ❖ OECD. (2020). *Education responses to COVID-19: Embracing digital learning and online collaboration*. OECD Publishing.
- ❖ Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design. *Educational Psychologist*, 38(1), 1–4.
- ❖ Schunk, D. H. (2012). *Learning theories: An educational perspective* (6th ed.). Pearson.
- ❖ Zhao, Y., Lei, J., Yan, B., Lai, C., & Tan, H. S. (2005). What makes the difference? A practical analysis of research on the effectiveness of distance education. *Teachers College Record*, 107(8), 1836–1884.