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ASSESSING THE EFFECTS OF DIGITAL LEARNING ENVIRONMENTS ON THE COGNITIVE AND EMOTIONAL GROWTH OF STUDENTS IN KANCHRAPARA MUNICIPAL AREA, NORTH 24 PARGANAS, WEST BENGAL

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Abstract

This study investigates the multidimensional impact of digital learning environments (DLEs) on the cognitive and emotional development of students in the Kanchrapara Municipal Area, a semi-urban locality in North 24 Parganas, West Bengal. Employing a mixed-methods approach combining surveys, cognitive tests, interviews, and case studies, this research analyzes how digital platforms influence students' memory, attention span, analytical thinking, and emotional well-being. Findings reveal both the empowering potential of digital tools and the emotional and psychological challenges posed to learners, especially in resource-constrained settings. The study recommends strategies aimed at bridging the digital divide and fostering balanced, inclusive, and psychologically supportive digital education in semi-urban India.

Keywords: Digital Learning Environments (DLEs), Cognitive Development, Emotional Well-being, Semi-urban Education, Digital Divide.

1. Introduction

The integration of digital learning environments into mainstream education has transformed teaching and learning methods. Initiatives like DIKSHA, SWAYAM, and e-Pathshala reflect India's commitment to democratizing education through technology (Ministry of Education, 2020). The COVID-19 pandemic accelerated this digital shift (Jena, 2020), but infrastructural, technological, and socio-economic barriers continue to challenge semi-urban areas like Kanchrapara (Kumar & Singh, 2021).

DLEs potentially enhance memory, reasoning, and engagement (Mayer, 2009), yet prolonged screen time and reduced social interaction may negatively affect emotional health (Twenge, 2017; Singh & Dutta, 2021). This study explores whether digital tools enhance or undermine cognitive and emotional development in Kanchrapara's semi-urban context.

2. Objectives

- i. Evaluate cognitive development under digital learning conditions.
- ii. Analyze students' emotional responses to digital classrooms.
- iii. Assess the digital divide affecting access and pedagogical adaptation.
- iv. Explore stakeholder perspectives on digital education.
- v. Recommend strategies for optimized, balanced digital education.

3. Research Questions

- i. How does digital learning influence students' memory, attention span, and logical reasoning?
- ii. What emotional effects stem from prolonged digital tool engagement?
- iii. What infrastructural and pedagogical gaps hinder effective digital learning?
- iv. How do stakeholders perceive digital education?

4. Hypotheses

• Null Hypotheses (H₀):

- i. H₀₁: No significant difference in cognitive development between regular and irregular DLE users.
- ii. H₀₂: No significant association between DLEs and emotional well-being.
- iii. H₀₃: Socio-economic status does not significantly impact DLE access and cognitive performance.

• Alternative Hypotheses (H₁):

- i. H₁: Significant difference exists in cognitive development between regular and irregular DLE users.
- ii. H₂: Significant association exists between DLEs and emotional well-being.
- iii. H₃: Socio-economic status significantly impacts DLE access and cognitive performance.

5. Research Methodology

Research Approach: Convergent parallel mixed-method design.

Population and Sample: 150 students (Classes VI–XII), 20 teachers, and 30 parents in Kanchrapara Municipal Area, selected via purposive sampling.

Data Collection Tools:

- Cognitive tests (memory, attention, reasoning)
- Emotional response surveys
- Semi-structured interviews
- Case studies
- Classroom observations

Data Analysis:

- Quantitative: SPSS for descriptive/inferential statistics (t-tests, ANOVA, Chi-square).
- Qualitative: Thematic coding and triangulation.

6. Analysis and Interpretation

Table 1: Memory Retention Test (Maximum Score: 20)

Category	Number of Students	Average Score
Regular DLE Users	90	16.4
Irregular DLE Users	60	13.7

Students who regularly engaged with digital learning environments scored higher on memory retention tests, indicating that multimedia content supports information retention more effectively than traditional methods.

Table 2: Attention Span Evaluation (Self-Reported Scale: 0–5)

Score Range	Interpretation	Number of Students
0–2	Low Concentration	56
3	Moderate Concentration	48
4–5	High Concentration	46

Approximately 37% of students reported low attention during digital sessions due to distractions such as mobile notifications and gaming. Only 30% maintained high attention spans, suggesting the need for structured, supervised online sessions.

Table 3: Logical Reasoning Task (Maximum Score: 20)

Gender	Average Score
Boys	14.8
Girls	15.5

Both genders benefitted from digital learning in reasoning tasks. Girls slightly outperformed boys, possibly due to more consistent engagement as reported in interviews.

Table 4: Emotional Responses (Strengths and Difficulties Questionnaire)

Emotional Indicator	Percentage of Students
Felt Motivated	32%
Reported Digital Fatigue	41%
Felt Isolated	38%
Experienced Anxiety	27%
Reported Enjoyment	24%

While digital platforms motivated a subset of students, emotional strain was widespread. Digital fatigue and emotional isolation were significant concerns.

Table 5: Parental Observations (30 Parents)

Observation	Percentage of Parents
Positive Behavior Change	20%
Increased Irritability	43%
Lack of Physical Activity	76%
Decline in Social Behavior	52%

Parents observed predominantly negative emotional and behavioral shifts due to prolonged digital learning, emphasizing the necessity of limiting screen time and encouraging physical/social engagement.

Table 6: Teacher Feedback Summary (20 Teachers)

Observation	Number of Teachers
Students Show Initial Enthusiasm	16
Difficulty Maintaining Discipline	14
Positive Academic Performance Growth	12
Signs of Student Stress or Anxiety	11

Although digital tools sparked initial enthusiasm, maintaining engagement proved difficult over time. Teachers observed growing stress and emotional fatigue among students.

The analysis indicates that digital learning environments improve cognitive outcomes, particularly in memory retention and reasoning. However, they pose serious emotional risks, especially when overused without structured guidance. Access disparities further widen learning outcomes, with students from disadvantaged backgrounds facing technological and psychological barriers.

The findings suggest a need for balanced, human-centered digital pedagogies that consider both cognitive advancement and emotional well-being in semi-urban educational contexts like Kanchrapara.

7. Hypothesis Testing and Statistical Analysis

Hypothesis 1 (H_{01}): No significant difference in cognitive development between regular and irregular DLE users.

Test Used: Independent Samples t-test

Variables: Cognitive development scores between regular and irregular DLE users.

Results:

- Regular Users ($n = 90$): $M = 16.4$, $SD = 2.1$
- Irregular Users ($n = 60$): $M = 13.7$, $SD = 2.5$
- $t = 6.12$
- $df = 148$
- $p\text{-value} = 0.000$ ($p < 0.05$)

Conclusion: Since $p < 0.05$, the null hypothesis (H_{01}) is rejected. There is a significant difference in cognitive development between regular and irregular DLE users. Regular users performed better.

Remark: Digital learning environments positively influence cognitive development when used consistently.

Hypothesis 2 (H_{02}): No significant association between DLEs and students' emotional well-being.

Test Used: Chi-square Test of Association

Variables: Emotional well-being (fatigue, anxiety, motivation) vs. daily DLE exposure.

Results:

- $\chi^2 = 11.76$
- $df = 2$

- p-value = 0.003 ($p < 0.05$)

Conclusion: Null hypothesis (H_{02}) is rejected. There is a significant association between DLE exposure and emotional well-being.

Remark: Prolonged digital learning use correlates with emotional strain and digital fatigue.

Hypothesis 3 (H_{03}): Socio-economic status does not significantly impact DLE access and cognitive performance.

Test Used: One-Way ANOVA

Groups Compared: Low, Middle, and High Socio-economic Status (SES)

Results:

- $F = 4.88$
- p-value = 0.009 ($p < 0.05$)

Conclusion: Null hypothesis (H_{03}) is rejected. SES significantly impacts both DLE access and cognitive outcomes.

Post-Hoc Analysis:

- Significant differences observed between Low and High SES groups.

Remark: Students from higher SES backgrounds exhibit superior cognitive outcomes due to better digital access and uninterrupted learning.

Table 7: Summary Table of Hypothesis Testing

Hypothesis	Test Applied	Result	Conclusion	Remark
H_{01}	Independent Samples t-test	$p = 0.000$ (<0.05)	Rejected	Regular DLE users show better cognition.
H_{02}	Chi-square	$p = 0.003$ (<0.05)	Rejected	DLE exposure linked to emotional strain.
H_{03}	One-Way ANOVA	$p = 0.009$ (<0.05)	Rejected	SES impacts DLE access and outcomes.

The statistical results strongly validate that while digital environments enhance cognitive learning under optimal access conditions, excessive exposure without emotional regulation leads to psychological stress. Socio-economic disparities amplify these effects.

- **Cognitive Development:** Consistent DLE usage significantly improves memory, attention, and reasoning skills.
- **Emotional Impact:** Emotional strain, including digital fatigue and isolation, increases with prolonged, unregulated screen time.

- **Digital Divide:** Socio-economic background dictates both access to devices/internet and subsequent cognitive benefits.

8. Findings

Cognitive Development Enhancement:

Students regularly engaging with digital tools demonstrated higher memory retention, improved attention spans, and enhanced logical reasoning.

Structured multimedia content significantly contributed to academic performance.

Emotional Challenges:

Over 40% of students reported digital fatigue, anxiety, and emotional disengagement.

Limited peer interaction and excessive screen exposure contributed to emotional strain.

Parents observed behavioral shifts, reduced physical activity, and social withdrawal.

Digital Divide Evident:

Socio-economic factors significantly influenced device availability and internet connectivity.

Students from higher-income families reported better cognitive outcomes due to consistent access and structured study environments.

Pedagogical Gaps:

Teachers lacked sufficient ICT training, limiting the effectiveness of digital education delivery.

Blended teaching approaches were found to be more effective but remained underutilized.

Stakeholder Perspectives:

Students and parents displayed mixed perceptions, balancing appreciation of digital access with concerns over emotional health and learning consistency.

Infrastructure Barriers:

Poor internet reliability, device sharing, and lack of parental digital literacy impeded equitable learning.

9. Recommendations

Hybrid Learning Implementation:

Combine digital and face-to-face instruction to balance cognitive stimulation with human interaction and emotional engagement.

Limit Screen Time:

Design short, engaging, and interactive modules to reduce continuous screen exposure and prevent digital fatigue.

Promote Peer Interactions:

Integrate collaborative virtual projects and discussion forums to nurture social-emotional skills alongside academic learning.

Ensure Digital Equity:

Provide free or subsidized devices and internet access to underprivileged students through government and community initiatives.

Develop Local Language Content:

Ensure availability of digital content in regional languages to foster inclusivity and improve comprehension.

Train Educators:

Conduct regular teacher training programs focused on digital pedagogy, content creation, and blended teaching methods.

Parental Guidance Programs:

Organize workshops for parents to help monitor screen time, encourage offline activities, and support emotional well-being.

Establish Counselling Support:

Integrate school-based psychological support services to address emotional fatigue and anxiety arising from digital learning.

Community-based Learning Hubs:

Develop neighbourhood digital learning hubs to mitigate internet and device-sharing issues.

Continuous Monitoring and Feedback:

Implement periodic assessments of cognitive and emotional outcomes to adapt digital learning strategies effectively.

10. Conclusion

Digital Learning Environments hold significant potential to transform education in semi-urban settings like Kanchrapara by enhancing cognitive development. However, emotional side effects, infrastructural limitations, socio-economic disparities, and pedagogical inadequacies undermine optimal outcomes. While digital tools can democratize access to knowledge, their overuse or misapplication can impair students' emotional well-being. Hence,

digital education should not be viewed as a substitute for traditional schooling but rather as a complementary tool requiring strategic integration.

The research underscores the importance of developing comprehensive support systems that address cognitive needs while safeguarding emotional health. Equitable infrastructure, inclusive policies, teacher training, and emotionally supportive teaching frameworks are essential for maximizing the benefits of DLEs.

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