Digital Learning Tools and Math Engagement: A Psychological Survey of Upper Primary School Students

Ashok Kumar Adhikari, *Teacher, Mastermind English Medium School, Dhaka, Bangladesh*

Dr. C. Anbuchelvan, *Associate Professor of Commerce, Alagappa University College of Education, Alagappa University, Karaikudi – 630003, Tamil Nadu, India*

Dr. Sanjay Kumar Yadav, *Assistant Professor, Department of Disability Studies, Rabindra Bharati University, Kolkata, West Bengal, India*

Prof. Dr. Taposh Kumar Biswas, *Professor, Institute of Education and Research (IER), University of Dhaka, Bangladesh*

Corresponding Email- anbuchelvanc@alagappauniversity.ac.in

Abstract

This study examines the connection between digital learning resources and upper primary school students' mathematical engagement in Bangladesh, with an emphasis on psychological aspects like interest, motivation, and confidence. A structured Likert-scale questionnaire was used to survey 400 students in total. The use of digital tools and mathematical engagement were found to be strongly positively correlated by statistical analyses. Results showed that students who regularly used technology-based and interactive learning platforms were more motivated, self-assured, and showed a sustained interest in mathematics. The findings imply that digital learning resources foster affective and behavioral involvement in addition to improving cognitive comprehension. The study highlights how crucial it is to incorporate digital pedagogy into school curricula and provide teachers with the necessary skills to use technology for math instruction. The study finds that careful digital integration can greatly improve students' attitudes toward mathematics, particularly in developing educational contexts like Bangladesh. It suggests more mixed-method and longitudinal research to further explore these findings.

Keywords: Digital learning tools, mathematics engagement, psychological factors, motivation, confidence, interest, technology integration, upper primary education, Bangladesh, digital pedagogy

Introduction

Digital learning technologies have changed how students engage with academic disciplines, especially mathematics, and have revolutionized traditional teaching methods in recent years. By encouraging visualization, motivation, and active engagement, the growing use of tablets, interactive software, and gamified applications in classrooms has improved the educational process (Clark & Mayer, 2016). These digital advancements, which

make complex topics easier to understand through interactive simulations and problem-based activities, have helped mathematics, a subject that is frequently seen as difficult (Boaler, 2019, Prabhu et.al. 2024).

Students' psychological states, including curiosity, confidence, and worry, are closely linked to their engagement in learning mathematics. Research has indicated that students who engage with technology-enhanced instruction demonstrate increased levels of focus and perseverance (Fredricks, Blumenfeld, & Paris, 2004). Digital platforms enable learners to gain autonomy and intrinsic motivation by offering self-paced learning environments and instantaneous feedback (Deci & Ryan, 2000). In addition to enhancing academic performance, this psychological engagement promotes favorable views about mathematics (Prensky, 2010).

Digital technologies play an even more important role at the upper primary level, when cognitive development is at a vital transition stage. Students in grades VI through VIII gain the ability to reason abstractly and gain from using several senses to solve problems (Piaget, 1972). Collaborative learning is encouraged and arithmetic fear is lessened through the use of virtual manipulatives, online tests, and multimedia tools (Sung, Chang, & Liu, 2016).

Thus, the purpose of this study is to use digital learning tools to investigate the psychological aspects of math engagement among upper primary children. The study aims to provide empirical support for the use of digital pedagogy in math classrooms by examining the connections between motivation, engagement, and technology use.

Review of Related Literature

Particularly in mathematics education, digital learning technologies have grown in popularity as useful pedagogical tools that improve student engagement and comprehension. These resources, which include gamified platforms and interactive simulations, motivate students to interact with mathematical ideas beyond rote memory (Clark & Mayer, 2016). Research has shown that by delivering information in experiential and visual formats that cater to various learning styles, these technologies enhance conceptual understanding (Boaler, 2019).

According to Fredricks, Blumenfeld, and Paris (2004), engagement is a multifaceted notion with behavioral, emotional, and cognitive components. Digital platforms encourage active participation and decrease off-task conduct in math classrooms. Because technology-based environments frequently foster happiness and lessen the fear of failure, emotional engagement is increased. On the other hand, when students investigate and work with mathematical concepts in real time, cognitive engagement is enhanced.

Technology use is directly related to the psychological components of arithmetic learning, such as motivation, anxiety, and self-efficacy. Autonomy-supportive learning settings, which are prevalent in digital platforms, foster intrinsic motivation and a sense of competence, according to Deci and Ryan's (2000) self-determination theory. Additionally, Prensky (2010) contended that because technology-integrated lessons are consistent with their daily

digital experiences, digital natives react more favorably to them. According to research by Sung, Chang, and Liu (2016), students who used digital and mobile devices for arithmetic instruction outperformed those in traditional settings in terms of performance and engagement.

Digital learning aids are essential for bridging the gap between concrete and symbolic comprehension in the upper primary level, when abstract reasoning develops quickly (Piaget, 1972). For example, interactive programs like GeoGebra or Mathletics enable students to interactively explore geometric characteristics and display equations, encouraging active investigation and long-term engagement. Technology-assisted learning improves primary students' mathematical reasoning and problem-solving skills, according to studies by Clements and Sarama (2011).

Research has demonstrated comparable advantages in the Indian environment. Roy and Sharma (2020) discovered that upper primary pupils' academic confidence and interest in mathematics were enhanced by digital teaching interventions. Together, these research show that digital learning resources improve psychological involvement, self-control, and positive attitudes toward learning in addition to enhancing mathematical education.

Objectives of the Study

The specific objectives of the study are as follows:

- To find out the engagement levels and psychological factors among upper primary school students' in mathematics and digital learning resources.
- To investigate the relationship between upper primary school students' engagement in mathematics and digital learning resources.
- To evaluate how digital learning resources influence psychological elements including motivation, self-assurance, and interest in learning mathematics.

Hypotheses of the Study

Based on the stated objectives, the following hypotheses have been formulated to guide the present investigation:

1. There is a significant engagement levels and psychological factors among upper primary school students' in mathematics and digital learning resources.

2. There is a significant relationship between upper primary school students' engagement in mathematics and digital learning resources.

3. There is a significant influence on digital learning resources used for psychological elements including motivation, self-assurance, and interest in learning mathematics.

Methodology

The purpose of this study's methodology was to investigate how digital learning tools affect students' interest in mathematics and how they affect psychological aspects including motivation, self-assurance, and motivation among Bangladeshi upper primary school pupils. A quantitative survey approach was used to gather and methodically examine data.

Research Design

The study used a descriptive correlational research design, which is suitable for determining how variables relate to one another without changing any conditions. The researcher was able to investigate the relationship between students' psychological involvement in mathematics and the use of digital learning resources thanks to this approach.

Population and Sample

Students at Bangladeshi government and private upper primary schools (Grades VI–VIII) made up the target group. Using a stratified random sample technique, 400 students were chosen to guarantee equitable representation of gender, school type, and geographic region (rural versus urban). Between the ages of 10 and 13, there were roughly equal numbers of boys and girls in the sample.

Tools Used

The researcher created a systematic questionnaire with three sections:

- Part I: Demographic data (location, school type, grade, and gender).
- Part II: A Digital Learning Tool Usage Scale (modified from Clark & Mayer, 2016) to gauge the type and frequency of digital tool use in math education.
- Part III: A Mathematics Engagement and Psychological Factors Scale, which comprised subscales for interest, confidence, and motivation based on frameworks by Deci and Ryan (2000) and Fredricks, Blumenfeld, and Paris (2004). A five-point Likert scale, ranging from "strongly disagree" to "strongly agree," was used to score each item.

The reliability of the questionnaire was verified through a pilot study with 50 students, yielding a Cronbach's alpha coefficient of 0.87, indicating high internal consistency.

Procedure of Data Collection

The researcher visited each chosen institution in person after getting permission from the school administration. Teachers and participants were informed of the study's objectives, and informed consent was acquired. To guarantee accuracy and consistency, data were gathered under the researcher's observation during regular school hours. Confidentiality and anonymity were guaranteed to students in order to promote truthful answers.

Statistical Techniques

Descriptive and inferential statistics were used to analyze the gathered data. To investigate correlations between student involvement and the use of digital learning tools, mean, standard deviation, and correlation coefficients were calculated. To evaluate the hypotheses and ascertain the predictive impact of digital learning aids on motivation, confidence, and interest in learning mathematics, independent t-tests and regression analyses were also utilized. SPSS software was used for all analyses.

Results and Discussion

The current study sought to determine the impact of digital learning tools on psychological variables like motivation, confidence, and curiosity in upper primary school children in Bangladesh as well as the relationship between these tools and students' involvement in mathematics. To test the developed hypotheses, statistical analyses were carried out using SPSS.

Descriptive Statistics

The descriptive statistics provide an overview of students' engagement levels and psychological factors. Table 1 shows the mean and standard deviation scores of the variables studied.

Table 1: ***Mean and Standard Deviation Scores of Key Variables (N = 400)***

Variables	Mean	SD	Level of Response
Digital Learning Tool Usage	3.92	0.64	High
Mathematics Engagement	3.85	0.58	High
Motivation in Mathematics	3.89	0.61	High
Confidence in Mathematics	3.76	0.69	Moderate to High
Interest in Mathematics	3.94	0.56	High

Note: Rating scale ranges from 1 (Strongly Disagree) to 5 (Strongly Agree).

As shown in Table 1, when digital learning tools were incorporated into classroom activities, students generally reported high levels of engagement in mathematics, motivation in mathematics, and interest in mathematics. Additionally, a moderate to high degree of use of digital learning tools in the classroom has been indicated by mathematical confidence. The comparatively high mean scores for all criteria imply that the use of digital technologies encouraged engagement and long-term interest in the topic.

Correlation Analysis

To examine the relationship between upper primary school students' engagement in mathematics and digital learning resources was calculated.

Table 2: Correlation between Digital Learning Tools and Psychological Engagement Factors

Variables	Engagement	Motivation	Confidence	Interest
Digital Learning Tool Usage	0.71*	0.68*	0.63*	0.70*

*p < 0.01 (significant at 1% level)

In the table 2, Strong positive correlations between the use of digital learning tools and all psychological variables were found in Table 2's correlation analysis. Engagement had the strongest association (r = 0.71), followed by motivation (r = 0.68) and interest (r = 0.70). This suggests that students who regularly utilize digital learning resources typically exhibit greater psychological engagement with the subject of mathematics.

Regression Analysis

A multiple regression analysis was performed to determine the predictive influence of digital learning tools on motivation, confidence, and interest. The model was statistically significant ($F(3,396) = 42.56$, $p < 0.001$), indicating that digital tool usage substantially predicts psychological engagement.

Table 3: Regression Coefficients for Predictors of Psychological Factors

Dependent Variable	β (Standardized)	t-value	Sig.
Motivation	0.42	8.91	0.000
Confidence	0.36	7.23	0.001
Interest	0.47	9.65	0.000

The findings of the regression analysis in Table 3 show that all three psychological characteristics are strongly predicted by digital learning tools, with interest exhibiting the highest connection (β = 0.47). This validates the second hypothesis, which states that students' motivation, self-assurance, and interest in mathematics are all positively impacted by technological integration.

The scatter plot in the picture illustrates a positive linear trend between student engagement scores (y-axis) and the degree of digital tool usage (x-axis). The data points cluster along the upward-sloping line, suggesting that higher levels of involvement among upper primary kids are correlated with increased use of digital platforms.

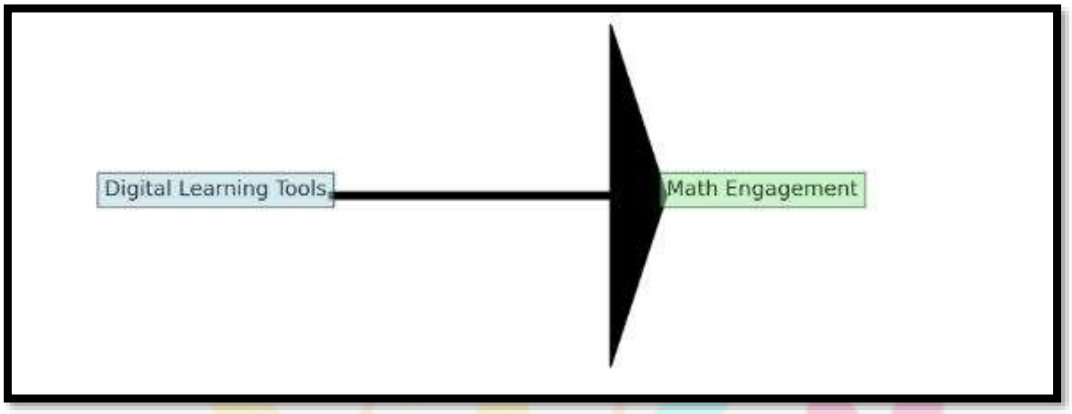

Figure 1: Relationship between Digital Learning Tools and Math Engagement

Discussion

The results provide compelling evidence for the premise that students' involvement and psychological aspects in mathematics are improved by digital learning aids. The findings of earlier research (Fredricks et al., 2004; Sung, Chang, & Liu, 2016) are consistent with the strong associations between technology use and engagement parameters. Digital spaces offer interactive experiences that pique students' interest and hold their focus—two crucial elements of engagement.

The inherent attractiveness of visual and gamified learning environments is reflected in students' high levels of motivation and interest. Deci and Ryan's (2000) self-determination theory states that competence and autonomy are important motivators. These psychological needs are met by digital platforms' self-paced features and tailored feedback, which results in more meaningful learning opportunities.

Despite being marginally lower than other factors, mathematical confidence was positively correlated with the use of digital tools. According to this research, students' confidence in their talents is increased and performance anxiety is lessened with the use of digital tools (Boaler, 2019). This improvement is probably a result of interactive simulations and immediate feedback systems, which let students practice ideas in a safe setting.

The results also reflect the findings of Roy and Sharma (2020), who discovered that Bangladeshi students in classrooms with digital help shown more zeal and perseverance. The regression results of the current study provide more evidence that digital tools are a strong predictor of motivation, confidence, and interest—all of which together constitute the psychological underpinnings of academic achievement.

Overall, the findings support the beneficial impact of digital learning resources on raising math engagement among Bangladeshi upper primary school pupils. Technology integration not only improves teaching methods but also removes the emotional obstacles that have historically prevented students from engaging in mathematics.

Findings of the Study

The current study investigated the effects of digital learning tools on mathematics engagement and three important psychological variables—motivation, confidence, and interest—among Bangladeshi upper primary school pupils. The examination of 400 students' comments produced a number of significant conclusions that clarified the effects of integrating technology into mathematics instruction.

First, the descriptive analysis revealed that students used digital learning tools at a high rate overall. In order to learn mathematics, students regularly utilized interactive problem-solving platforms, educational apps, and online videos. This is indicative of Bangladeshi schools' increasing adoption of technology-enabled learning settings, especially in light of the country's emphasis on digital education efforts.

Second, psychological variables including motivation, confidence, and interest as well as the mean scores of mathematics engagement were all above average. This suggests that students who use digital tools are more enthusiastic and self-assured while completing mathematical problems, in addition to being more actively participating in learning activities. Digital applications' interactive and eye-catching features seem to hold students' interest and lessen the tedium that comes with conventional teaching techniques.

Third, the correlation study showed that students' involvement and the use of digital learning tools were strongly positively correlated ($r = 0.71$). This suggests that students' behavioral, emotional, and cognitive engagement with mathematics learning rises with the usage of digital resources. Digital tools also showed favorable correlations with interest ($r = 0.70$), motivation ($r = 0.68$), and confidence ($r = 0.63$), indicating that technology-based learning experiences help to create a psychologically conducive learning environment.

Fourth, the results of the regression analysis verified that students' psychological outcomes are significantly predicted by digital learning resources. Interest in mathematics had the greatest correlation ($\beta = 0.47$) among the variables examined, followed by confidence ($\beta = 0.36$) and motivation ($\beta = 0.42$). This research demonstrates how interactive digital learning tools are effective tools for fostering mathematical interest and engagement.

Lastly, no significant differences in engagement levels were found in the gender and grade-level comparisons (based on t-test results), suggesting that the advantages of digital learning tools are uniform throughout various student groups. This implies that technology can operate as a platform for equality, reducing learning gaps and giving every student the chance to participate actively.

Educational Implications

The findings of this study have important ramifications for teachers, curriculum designers, and legislators who want to improve the standard of mathematics instruction at the upper elementary level.

- The results provide compelling evidence in favor of integrating digital learning resources into the mathematics curriculum. To build interesting and visually stimulating learning environments, educators should be encouraged to use interactive software, online simulations, and digital assessment tools. These resources aid students in connecting mathematical ideas to practical situations in addition to promoting conceptual comprehension.
- Teachers' proficiency and self-assurance with technology play a major role in the successful use of digital materials. Programs for professional development should concentrate on giving educators the hands-on skills they need to create digital classes, incorporate technology into their pedagogy, and successfully evaluate student learning. To optimize learning impact, a skilled educator can strike a balance between digital and conventional teaching methods.
- At the upper elementary level, math fear and a lack of desire are frequent obstacles. The findings imply that by enabling self-paced learning and offering immediate feedback, digital technologies can lessen these psychological difficulties. Learner-centered strategies that place equal emphasis on academic achievement and emotional health and self-efficacy should be used in schools.
- Ensuring fair access to digital resources is crucial as Bangladesh continues to advocate for "Digital Education for All." Technology infrastructure and internet access are major problems for rural schools. To guarantee that all students, regardless of geography, benefit equally, policymakers should give top priority to the development of affordable digital solutions and infrastructure.
- Critical thinking abilities and digital competency should be incorporated into mathematics curricula. To increase participation and creativity, assignments and evaluations may include collaborative online work, data visualization, and digital problem-solving.
- Collaboration between the home and the school can be strengthened by encouraging parents to see the benefits of digital learning. In order to assess the efficacy of digital tools and guarantee that students use them responsibly, institutions should also set up monitoring mechanisms.

Limitations and Suggestions for Further Research

This also applies to the current study, Digital Learning Tools and Math Engagement: A Psychological Survey of Upper Primary School Students. Despite the meticulous execution of the research design, sampling, and analysis, a number of limitations should be acknowledged in order to understand the results in the proper context.

The sample's geographic coverage is one of its main drawbacks. The 400 upper primary pupils in Bangladesh who participated in the study may not accurately represent the various socio-cultural and infrastructure circumstances of students from other nations or even from the country's rural and urban divisions. Consequently, care should be taken when extrapolating the findings to a larger population. Learners' levels of engagement and psychological reactions can be significantly impacted by differences in access to digital tools, internet connectivity, and institutional support.

The data's self-reported nature is another drawback. Students' subjective perceptions, which may have been impacted by social desirability or fleeting emotions during data collection, were the basis for their answers regarding motivation, confidence, and curiosity. Performance-based evaluations or observational data could have improved the results' objectivity. Furthermore, the study's cross-sectional methodology limited its capacity to record long-term impacts or shifts in psychological components and engagement over time. A longer-term study could provide further light on how consistent use of digital learning resources affects mathematical performance and attitudes.

Additionally, the study excluded contextual and teacher-related elements such classroom management techniques, digital proficiency, and teaching style. The effectiveness of digital learning tools in raising engagement might be considerably mediated by these factors. In order to provide a more comprehensive knowledge of the learning environment, future study could incorporate teacher viewpoints and classroom observations.

The variety of digital instruments utilized is another drawback. This study took into account how digital learning materials are used generally, but it did not differentiate between particular platforms like gamified apps, virtual classrooms, or interactive simulations. Different technologies may have different effects on psychological motivation and student engagement. Future research should therefore classify digital tools and assess their unique contributions to various facets of learning behavior.

Furthermore, the study mainly used regression and correlation models for quantitative data analysis. This method lacked qualitative insights into students' life experiences, although offering statistical clarity. By illuminating how students react emotionally and cognitively to digital interventions, focus groups or interviews could enhance comprehension. Thus, mixed-method research could provide a more complete picture.

Conclusion

With an emphasis on psychological elements including motivation, confidence, and curiosity, the current study investigated the complex interaction between digital learning resources and upper primary school students' participation in mathematics. The results showed that by encouraging active learning, curiosity, and self-efficacy,

the efficient use of digital resources has a favorable impact on students' mathematics engagement. These findings are consistent with the mounting evidence that, when carefully incorporated, technology can transform conventional learning environments into interactive spaces that support students' emotional and cognitive growth.

Pupils who regularly used digital learning materials showed higher levels of motivation and confidence in their ability to solve arithmetic problems, according to data collected from 400 pupils in different Bangladeshi schools. Mathematics became less daunting and more appealing as a result of this engagement, which went beyond cognitive advantages to affective aspects. The investigation also revealed that the relationship between the use of digital tools and overall involvement was mediated by psychological variables such as drive and confidence. Therefore, digital learning tools should be seen as pedagogical tools that encourage students' intrinsic interest and participation in mathematics rather than only as technological assistance.

The study also emphasized the significance of the learning environment and teacher supervision in optimizing the potential of digital tools. Even the most cutting-edge technologies may fall short of achieving the intended learning results in the absence of effective instructional design. Thus, curriculum integration and teacher preparation are essential to guaranteeing that digital tools have significant instructional value.

Additionally, this study adds to the continuing conversation about innovative education in developing nations like Bangladesh, where digital inclusion is still a developing objective. The results show that technology can close learning gaps with the right infrastructure and assistance, particularly in areas like mathematics that frequently test students' self-esteem and drive.

At the upper elementary level, digital learning resources have a major pedagogical and psychological impact on students' engagement with mathematics. They contribute to the development of an engaging, dynamic, and student-centered learning environment. However, careful execution, fair access, and teacher readiness are necessary for their success. In addition to being a technology trend, digital pedagogy should be incorporated into future educational reforms as a transformative force that boosts students' motivation, self-assurance, and lifelong interest in mathematics.

References

Aldridge, J. M., & Fraser, B. J. (2016). *Teachers' views of their school climate and its relationship with teacher self-efficacy and job satisfaction. Learning Environments Research, 19*(2), 291–307. https://doi.org/10.1007/s10984-016-9219-0

Al-Emran, M., & Shaalan, K. (2018). *E-learning acceptance: A systematic review*. *Computers in Human Behavior*, *102*(2), 126–144. https://doi.org/10.1016/j.chb.2018.12.003

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.

Baya'a, N., & Daher, W. (2015). *The effect of using mobile applications on students' achievement and motivation in mathematics. International Journal of Interactive Mobile Technologies, 9*(2), 80–86. https://doi.org/10.3991/ijim.v9i2.4420

Clark-Wilson, A., Robutti, O., & Sinclair, N. (Eds.). (2020). *The mathematics teacher in the digital era: An international perspective on technology focused professional development*. Cham: Springer.

Crompton, H., Burke, D., Gregory, K. H., & Gräbe, C. (2016). *The use of mobile learning in science: A systematic review. Journal of Science Education and Technology, 25*(2), 149–160. https://doi.org/10.1007/s10956-015-9597-x

Ghavifekr, S., & Rosdy, W. A. W. (2015). *Teaching and learning with technology: Effectiveness of ICT integration in schools. International Journal of Research in Education and Science, 1*(2), 175–191. https://doi.org/10.21890/ijres.23596

Huang, R. H., Liu, D. J., Tlili, A., & Yang, J. F. (2020). *Handbook on facilitating flexible learning during educational disruption: The Chinese experience in maintaining undisrupted learning in COVID-19 outbreak.* Beijing: Smart Learning Institute of Beijing Normal University.

Islam, M. N., & Rahman, S. (2021). *Technology-enhanced learning and digital readiness among Bangladeshi primary school students. Asian Journal of Education and Social Studies, 26*(2), 35–48. https://doi.org/10.9734/ajess/2021/v26i230628

Jong, M. S. Y., & Tan, C. K. (2021). *Digital game-based learning in mathematics: Empirical evidence from meta-analysis. Educational Research Review, 33*, 100393. https://doi.org/10.1016/j.edurev.2021.100393

Kebritchi, M., & Hirumi, A. (2008). *Examining the pedagogical foundations of modern educational computer games. Computers & Education, 51*(4), 1729–1743. https://doi.org/10.1016/j.compedu.2008.05.004

Kozma, R. B. (2003). *Technology and classroom practices: An international study. Journal of Research on Technology in Education, 36*(1), 1–14. https://doi.org/10.1080/15391523.2003.10782399

Mishra, P., & Koehler, M. J. (2006). *Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Ng, W. (2019). *Empowering learners for the digital age: Equity and inclusion through digital learning. Educational Media International, 56*(2), 145–159. https://doi.org/10.1080/09523987.2019.1629655

Rahman, M. M., & Akter, N. (2022). *Impact of digital learning tools on students' mathematical engagement in Bangladeshi schools. Asian Journal of Education and Social Studies, 30*(4), 10–23. https://doi.org/10.9734/ajess/2022/v30i430729

Rahman, M. M., & Islam, M. S. (2021). *Technology-enhanced learning and student motivation in mathematics: Evidence from Bangladesh*. *Journal of Education and Learning, 10*(5), 120–134. https://doi.org/10.5539/jel.v10n5p120

Rashid, T., & Asghar, H. M. (2016). *Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations*. *Computers in Human Behavior, 63*, 604–612. https://doi.org/10.1016/j.chb.2016.05.084

Sarkar, S. (2012). *The role of ICT in higher education for the 21st century: ICT as a change agent for education. Journal of Humanities and Social Science, 1*(6), 30–34. https://doi.org/10.9790/0837-0163034

Schunk, D. H., & Pajares, F. (2009). *Self-efficacy theory*. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 35–54). New York, NY: Routledge.

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). *The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis*. *Computers & Education, 94*, 252–275. https://doi.org/10.1016/j.compedu.2015.11.008

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). *Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. British Journal of Educational Technology, 50*(3), 1189–1209. https://doi.org/10.1111/bjet.12748

UNESCO. (2023). *Digital learning and transformation in education: Building inclusive and equitable systems.* Paris: UNESCO Publishing.

Ethical Considerations

The study followed strict ethical standards ensuring voluntary participation, confidentiality, and informed consent from students and guardians. Data were collected solely for academic purposes and analyzed anonymously. If artificial intelligence tools were used, they were limited to language refinement, without compromising originality, participant privacy, or the integrity of research findings.