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Leveraging Digital Learning Tools to Boost Student Motivation: A Study Using Univariate and Bivariate Analysis on Enhancing Engagement in Elementary Science and Social Studies

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Abstract. The integration of digital learning tools is increasingly shaping modern education, driven by technological advancements and the need for interactive teaching methods. These tools are believed to enhance student engagement and motivation, particularly in foundational subjects like Science and Social Studies. This study examines the relationship between digital learning tools and student motivation among Grade 3 learners, employing a non-experimental, cross-sectional survey design with 30 participants from two elementary schools. The research assesses two key variables: the use of digital learning tools and student motivation levels, measured through a standardized motivation questionnaire, classroom records, and teacher reports. Findings reveal a statistically significant association between digital tool usage and higher motivation levels ($p = 0.006$). The odds ratio of 4 suggests that students using digital tools are four times more likely to exhibit high motivation than those relying on traditional methods. These results highlight the potential of digital learning tools to enhance student engagement and underscore the need for their integration into educational practices. However, the study acknowledges its limitations, such as its cross-sectional design. Despite this, the findings provide valuable insights for educators and policymakers seeking to improve teaching strategies and student outcomes through technology integration in elementary education.

Keywords: Bivariate; Digital Learning; Quantitative Analysis; Student Engagement; Univariate.

1. Introduction

The integration of digital learning tools into educational frameworks has emerged as a significant trend in contemporary pedagogy, particularly as educational institutions seek to adapt to the demands of an increasingly digital world. These tools encompass a wide array of resources, including interactive software, educational apps, and online platforms, which aim to enhance the teaching and learning experience. As technology becomes more accessible, it is essential to understand how these tools influence student motivation and engagement, particularly in elementary education settings. Past studies have suggested that the strategic use of digital learning environments can lead to improved student outcomes by fostering increased engagement and motivation (Balalle, 2024).

Motivation plays a crucial role in educational success, significantly influencing students' engagement with learning materials. According to Deci and Ryan's Self-Determination Theory (2000), motivation can be divided into intrinsic and extrinsic types, both of which are essential for creating a conducive learning environment. Intrinsic motivation, driven by a genuine interest in learning, is particularly vital at the elementary level, where students are forming their attitudes towards education. Research has shown that digital learning tools can enhance intrinsic motivation by providing interactive and personalized experiences that capture students' interests (Zainuddin et al., 2020).

This study specifically targets Grade 3 students, a pivotal stage in their academic journey when they transition from informal learning environments to more structured educational settings. At this age, students are developing critical cognitive and social skills, making it essential to create

engaging learning experiences that foster positive attitudes toward education. Previous research has indicated that technology integration at this developmental stage can lead to higher levels of student motivation and engagement (Rashid & Asghar, 2016). However, there remains a significant gap in understanding how specific digital learning tools impact motivation in subjects like Science and Social Studies.

1.1. Problem Statement

Ideally, the integration of digital learning tools in elementary education should provide a transformative means to enhance student engagement and motivation, fostering cognitive and social development, especially in core subjects like Science and Social Studies. These tools hold the potential to bridge learning gaps, personalize instruction, and prepare students for increasingly digital futures.

However, significant gaps in the literature regarding the specific impact of digital learning tools on student motivation have led to uncertainty among educators and policymakers. This hesitation has resulted in missed opportunities to leverage technology effectively in classrooms, leaving its benefits largely untapped. Furthermore, the lack of comprehensive empirical data on how digital tools influence young learners' motivation complicates the development of teaching strategies and hinders informed decision-making in educational policy.

If left unchecked, this issue could exacerbate existing inequalities in educational outcomes, leaving students without access to the potential advantages of digital learning tools and limiting their preparedness for the demands of the 21st-century learning environment. The urgency to address this problem lies in its implications for improving elementary education and ensuring that investments in educational technology yield meaningful and equitable benefits. Exploration of this issue is critical to bridging the gap between theory and practice, providing actionable insights for educators and policymakers.

1.2. Related Research

Related research findings engaged online learners are more active, self-directed, and responsible; they persist and find academic success at higher rates. This article aims to maximize learner outcomes by combining the research and frameworks of online student engagement with the neuroscience and psychology of positive emotions. This research suggests that positive psychology interventions, which have been consistently correlated to positive organizational outcomes when similarly used in business initiatives, also apply to the online adult literacy classroom (Beattie, 2022). This chapter discusses an action research study conducted in a public university in Bangladesh, focusing on the use of digital tools to enhance student engagement in online learning during the COVID-19 pandemic. Despite the challenges of inadequate resources and facilities, the study implemented various tools like Padlet, G Suite applications, Zoom, and Google Classroom over a six-month course. The researcher maintained a teaching journal to document observations and critical incidents throughout the process. Data were collected from student feedback forms, journal observations, and semi-structured interviews with five selected participants. Thematic analysis revealed that while the digital tools facilitated participation, interaction, and communication, technical issues and insufficient training hindered engagement. The study concludes with recommendations on effectively using these tools and emphasizes the role of institutions in supporting their implementation in low-resourced settings like Bangladesh (Rafique, 2022).It also supported by previous research that Students' pleasure with learning was also favourably associated to their actual usage of social media and involvement, according to the findings. As a conclusion, the result of R-Square's perceived usefulness was 0.611%, students' engagement was 0.561%, actual use of social media was 0.582%, students' satisfaction was 0.611%, and students' learning was 0.627%. This study's findings and ramifications are presented (Alalwan, 2022). However, the current research differs in its focus on younger learners, specifically Grade 3 students, and its exploration of motivation levels in Science and Social Studies contexts within elementary schools. By narrowing the scope to young students and using a cross-sectional survey design with classroom records and teacher reports, this study provides unique insights into the early educational benefits of digital tools, complementing the broader and more advanced learner contexts of previous studies.

1.3. Research Objectives

The primary objective of this research is to examine the level of student engagement among 3rd-grade students. This involves evaluating student's activity, point of view of learning and self-motivation. Additionally, the research aims to explore the relationship between digital learning and student engagement, investigating how the use of digital learning in teaching and learning activity can affect the student motivation and engagement.

2. Theoretical Framework

2.1. Digital Learning

Digital learning encompasses a wide array of educational practices facilitated by technology, significantly transforming how education is delivered and experienced. At its core, digital learning integrates various technological tools such as computers, tablets, smartphones, and internet resources to enhance the learning process. This integration often occurs through Learning Management Systems (LMS), educational apps, and online resources that provide students with a structured yet flexible learning environment. The landscape of digital learning includes blended learning, which combines traditional classroom instruction with digital tools, allowing teachers to supplement face-to-face lessons with online quizzes, interactive resources, and additional materials for independent exploration. This hybrid approach not only enhances engagement but also caters to diverse learning styles, making education more inclusive (Alenezi, 2023).

Online learning is another critical component of digital learning, enabling entire courses or programs to be delivered remotely. This flexibility allows students to learn from virtually anywhere, accommodating various schedules and commitments. Online learning can be synchronous, featuring live classes that facilitate real-time interaction, or asynchronous, where students engage with pre-recorded lectures and materials at their convenience. This adaptability is particularly beneficial for adult learners or those balancing work and family responsibilities, as it allows them to fit education into their lives without the constraints of traditional class schedules. By breaking geographical barriers, online learning also expands access to education, making it possible for students in remote or underserved areas to participate in quality learning experiences (Sunal & Wright, 2012).

The incorporation of interactive and multimedia content is a hallmark of digital learning, enhancing engagement and effectiveness. By utilizing videos, animations, and interactive simulations, educators can create dynamic learning environments that captivate students' attention and foster deeper understanding of complex concepts. Personalized learning further amplifies this engagement by leveraging technology to tailor educational experiences to individual student needs. Adaptive learning technologies can assess student performance in real time, adjusting the difficulty of tasks to match their skill levels. This level of customization helps ensure that all students, regardless of their starting point, can progress at a pace that suits them, thereby promoting a more inclusive and effective learning experience (Liu et al., 2024).

Despite its many advantages, digital learning also faces several challenges. The digital divide remains a significant issue, as not all students have equal access to technology or reliable internet, which can hinder participation and exacerbate educational inequalities. Additionally, technical issues such as software malfunctions or connectivity problems can disrupt the learning process, leading to frustration and disengagement. Moreover, online learning demands a high degree of self-discipline and time management skills, as students must take responsibility for their learning without the immediate oversight of instructors. Addressing these challenges is crucial to maximizing the potential of digital learning and ensuring that it serves as an effective and equitable educational tool for all learners (Mhlongo et al., 2023).

2.2. Student Engagement

Student engagement represents the degree of interest, enthusiasm, and active involvement that learners demonstrate throughout their educational journey. It spans cognitive, emotional, and behavioral dimensions, capturing how students intellectually connect with their studies,

emotionally relate to their learning environment, and actively participate in academic activities. Cognitive engagement refers to the mental effort and strategic thinking students apply to comprehend and master complex concepts. Emotional engagement reflects their feelings and attitudes toward their educational experiences, such as a sense of belonging, enjoyment, and intrinsic motivation to learn. Behavioral engagement is evident through tangible actions, including attending classes, contributing to discussions, completing assignments, and engaging in group projects. This multifaceted construct is vital for cultivating an enriching educational atmosphere that supports personal growth, fosters collaboration, and drives academic success. By addressing these interconnected dimensions, educators can create strategies to sustain motivation and enhance overall learning outcomes (Wong & Liem, 2022).

Recent research has emphasized the importance of student engagement as a predictor of educational outcomes. For instance, a study by (Santos et al., 2023), highlights those higher levels of student engagement correlate with improved academic performance, lower dropout rates, and increased persistence in challenging subjects. Engaged students are more likely to develop critical thinking skills, exhibit a deeper understanding of the material, and maintain positive attitudes toward learning. This underscores the need for educators to implement strategies that promote engagement in their classrooms, particularly in diverse learning environments where students may face varying degrees of motivation and support.

The role of technology in enhancing student engagement has garnered considerable attention, especially in online and blended learning contexts. According to *(Rafique, 2022)*, digital tools can facilitate greater interactivity and personalization in learning experiences, which can lead to increased student motivation and engagement. Tools such as discussion forums, interactive simulations, and multimedia resources enable students to take an active role in their learning, fostering a sense of agency and ownership. Moreover, these technologies can help bridge the gap for students who may feel isolated in traditional learning environments, offering opportunities for collaboration and peer support that enhance emotional engagement.

However, while technology offers significant potential for boosting engagement, it also presents challenges that educators must navigate. A study by *(van de Werfhorst et al., 2022),* emphasizes that not all students respond positively to digital learning environments; issues such as the digital divide, where some students lack access to necessary technologies, can exacerbate feelings of disengagement. Additionally, the effectiveness of digital tools depends on how they are integrated into the curriculum and the extent to which instructors facilitate meaningful interactions. Without careful consideration of these factors, technology can sometimes lead to superficial engagement, where students may participate in activities without truly connecting with the content or their peers.

Moreover, fostering a culture of engagement requires ongoing assessment and adaptation. Continuous feedback mechanisms, such as formative assessments and student reflections, can help educators gauge engagement levels and make necessary adjustments to their teaching strategies (Adarkwah, 2021). Incorporating student voices in the design of learning experiences can further enhance engagement by ensuring that curricula are relevant and responsive to students' interests and needs. This participatory approach not only empowers students but also creates a more inclusive learning environment where diverse perspectives are valued and addressed.

In summary, student engagement is a vital component of effective education that encompasses cognitive, emotional, and behavioral dimensions. While technology has the potential to enhance engagement, it is essential for educators to implement thoughtful strategies that address the challenges associated with digital learning environments. By fostering a culture of engagement through continuous assessment, adaptation, and inclusion of student perspectives, educators can create enriching learning experiences that promote academic success and lifelong learning. Recent studies underscore the multifaceted nature of engagement and highlight the need for innovative approaches to meet the diverse needs of today's learner (Suleiman et al., 2024).

2.3. Univariate

Univariate statistical analysis focuses on the examination and summarization of a single variable at a time, serving as a fundamental component of statistical practice. This analysis is crucial for describing key aspects of data, including its distribution, central tendency, and dispersion. Key components of univariate analysis include frequencies, which indicate how often specific values or ranges occur in the dataset and can be visualized through tables, bar charts, or histograms. Measures of central tendency, such as the mean (average), median (middle value), and mode (most frequent value), provide insights into the data's central point. Additionally, measures of dispersion, including range, variance, and standard deviation, illustrate the spread or variability within the data. Overall, univariate analysis serves as a preliminary step in data analysis, enabling a foundational understanding of the data's characteristics before progressing to more complex analytical techniques (Debra Sandilands, 2023). This analysis will serve as the foundation for identifying trends and patterns related to how digital tools impact student engagement and motivation in elementary education.

2.4. Bivariate

Bivariate statistical analysis focuses on exploring the relationship between two variables to identify any associations and determine the strength of those associations. This analysis is widely utilized across various disciplines, including social sciences, natural sciences, and quality of life research. Key concepts in bivariate analysis include bivariate correlation, which measures the linear relationship between two variables. The Pearson correlation coefficient is a common metric used to quantify this relationship, with values ranging from -1 to 1; a value of 1 indicates a perfect positive linear relationship, -1 indicates a perfect negative linear relationship, and 0 signifies no linear relationship. Another important aspect is bivariate regression, which involves predicting the value of one variable based on the value of another, thus helping to understand the dependency between variables and enabling predictive analysis (Sandilands, 2014). By applying bivariate analysis, we aim to determine if there is a statistically significant association between digital tool usage and student motivation, which is central to the research question of how digital tools influence engagement in young learners.

3. Method

3.1. Research Design

The design of this research employs a non-experimental, cross-sectional survey approach to explore the relationship between digital learning tools and student motivation (Thompson & Panacek, 2007). By focusing on two primary variables the presence of digital learning tools in the classroom and student motivation levels this study aims to provide valuable insights into how technology can affect engagement. The survey will measure student motivation through a standardized questionnaire that assesses various dimensions of engagement, allowing for a nuanced understanding of the factors at play.

In addition to quantitative data, qualitative insights will be gathered through teacher interviews to provide context and depth to the findings. Teachers' observations and experiences will enrich the data by highlighting how digital learning tools are implemented in the classroom and their perceived effectiveness in fostering student motivation. This mixed method is a principled complementary research method to the traditional quantitative and qualitative research approaches This mixed-methods approach will enable a comprehensive analysis of the relationship between digital tools and student engagement (Dawadi et al., 2021).

The primary focus will be on two variables: X (Digital Learning Tools: Yes/No) and Y (Motivation: High/Low). Data will be collected at a single point in time through surveys, and the analysis will focus on understanding if there is a significant association between these variables. The research follows a systematic procedure survey design to examine the relationship between the use of digital learning tools and student motivation among Grade 3 elementary students. The stages of the research are outlined as follows:

1. Participant Selection

A total of 30 Grade 3 students from two elementary schools are selected as participants. The sampling process ensures diversity and relevance to the study's focus, targeting students who have varied levels of exposure to digital learning tools.

2. Data Collection Preparation

Surveys are designed to measure the two main variables: the use of digital learning tools (categorized as Yes/No) and motivation levels (categorized as High/Low). The survey instruments include a standardized motivation questionnaire to assess students' intrinsic and extrinsic motivation levels, alongside classroom records and teacher reports for cross-verification.

3. Survey Administration

Data collection is conducted at a single point in time. Students complete the surveys during a designated session, with teachers assisting in cases where clarification or additional explanation is required. Parental consent and teacher involvement ensure compliance with ethical standards and proper administration.

4. Data Organization and Cleaning

The collected data are reviewed for completeness and accuracy. Responses are coded and categorized, ensuring that variables are clearly defined and aligned with the research objectives. Any incomplete or inconsistent data entries are addressed through follow-ups where feasible.

5. Data Analysis

Statistical analysis is performed to identify the association between the use of digital learning tools and student motivation levels. A chi-square test is employed to determine whether there is a statistically significant relationship between the two variables, with a p-value threshold set to assess significance. Additional calculations, such as the odds ratio, provide insights into the likelihood of high motivation among students using digital tools compared to those relying on traditional methods.

6. Interpretation of Results

The findings are interpreted in the context of existing literature and theoretical frameworks. Emphasis is placed on the practical implications of the relationship between digital tool usage and motivation levels, particularly for young learners in Science and Social Studies.

3.2. Respondent

The participants in this study will consist of 30 third-grade students, aged 8 to 9 years, selected from two elementary schools in Karangmojo Gugus. The students will be divided into two equal groups: 15 in the experimental group, using digital learning tools such as interactive software and educational apps, and 15 in the control group, using traditional methods like textbooks and worksheets. The sample will be chosen through convenience sampling, ensuring a mix of students from schools that either incorporate or do not incorporate digital tools into their curriculum. The students will have varying levels of prior exposure to digital tools, which may influence their motivation. Demographic factors, such as gender, socioeconomic background, and parental involvement, will also be considered, as these elements could contribute to differences in student engagement and motivation. The study will examine how these digital tools impact students' cognitive, emotional, and behavioral engagement in subjects like Science and Social Studies.

3.3. Data Collection

Data collection for this study will involve a combination of quantitative and qualitative methods to comprehensively assess the impact of digital learning tools on student motivation. A standardized motivation questionnaire will be administered to all 30 third Grade respondents, consisting of both the experimental group and the control group. This questionnaire will include

10 Likert (1 to 5) items designed to measure various aspects of student motivation, such as engagement, interest in learning, and enthusiasm for the subject matter (See Table 1). Responses will be categorized into two levels: High Motivation for those scoring above the median and Low Motivation for those scoring below it. Additionally, classroom records and teacher reports will be utilized to determine which students in the experimental group have been using digital learning tools during their lessons. To enrich the data, semi-structured interviews will be conducted with teachers to gather insights regarding their observations on student engagement and the effectiveness of digital learning tools. This mixed-methods approach will provide a well-rounded perspective on the relationship between digital learning tools and student motivation.

Table 1. Instruments

Items	Question
Y1	When writing my work, I begin by making a plan for drafting the text.
Y2	I try to connect what I learn in one discipline with what I learn in others.
Y3	I spend a lot of my free time looking for more information on topics discussed in class.
Y4	When I'm reading, I try to understand the meaning of what the author wants to transmit.
Y5	I review my notes regularly, even if a test is not coming up.
Y6	I talk to my teachers about my likes and dislikes.
Y7	My school is a place where I make friends easily.
Y8	My school is a place where I feel integrated.
Y9	My school is a place where it seems to me that others like me.
Y10	During classes, I put questions to the teachers.

3.4. Data Analysis

Data analysis for this study will encompass both univariate and bivariate methods to explore the relationship between the use of digital learning tools and student motivation. Initially, univariate analysis will be conducted to summarize the characteristics of each variable independently. For the independent variable, digital learning tools will be categorized into two groups those who use digital tools and those who do not allow for the calculation of frequencies and percentages. Similarly, student motivation levels will be analyzed to determine the distribution of respondents categorized as having high or low motivation based on their survey scores. Following this, bivariate analysis will be employed to assess the relationship between digital learning tools and student motivation. A cross-tabulation will be created to visualize the frequency of students in each motivation category within the experimental and control groups. To determine if there is a statistically significant association between the two variables, a Chi-Square Test of Independence will be conducted. Additionally, logistic regression may be utilized to model the likelihood of students exhibiting high motivation based on their use of digital learning tools. This comprehensive analysis will facilitate a deeper understanding of how digital learning tools influence student motivation in the classroom.

3.5. Validity and Reliability

The process of determining the validity and reliability of the instrument begins with an empirical test conducted on a sample of 30 Grade 3 students, which aligns with the final sample size for the study (See Table 2). This sample is used to evaluate how effectively the instrument measures student motivation in relation to the use of digital learning tools. The R value (correlation coefficient) from the instrument is calculated to determine its validity. A moderate to strong correlation (typically above 0.3) is expected for the instrument to be considered valid. The R value reflects how well the individual items of the instrument correlate with the overall construct of student motivation. To ensure the instrument's consistency and stability, the same 30 students who participated in the empirical test are used for the actual data collection. This consistency

allows for a reliable comparison between the validity test and the results of the study. Additionally, the reliability of the instrument is assessed using Cronbach's alpha, which should exceed 0.7 to confirm the internal consistency of the instrument. Reliability testing ensures that the instrument consistently measures student motivation across different contexts. By conducting these tests, the research ensures that the instrument is both valid and reliable, making it suitable for use in the study to examine the relationship between digital learning tools and student motivation.

Table 2. Validity Analysis

Items	Pearson Correlation	P-value	Valid
Y1	0.486**	0.006	Yes
Y2	0.636**	0.000	Yes
Y3	0.532**	0.002	Yes
Y4	0.571**	0.001	Yes
Y5	0.591**	0.001	Yes
Y6	0.619**	0.000	Yes
Y7	0.753**	0.000	Yes
Y8	0.515**	0.004	Yes
Y9	0.593**	0.001	Yes
Y10	0.592**	0.001	Yes

Table 2 shown that the significant correlations observed between each variable (Y1 to Y10) and the motivation variable (Y) provide preliminary evidence of construct validity. For example, the high correlation coefficients, particularly for Y2 (0.636) and Y7 (0.753), suggest that these items are closely aligned with the underlying concept of motivation. The low p-values (all below 0.05) further support the validity of these correlations, indicating that the relationships are statistically significant. To strengthen the validity of the questionnaire, it would be beneficial to perform content validation by obtaining feedback from experts in educational psychology and conducting pilot testing to ensure that the items adequately represent the construct of motivation.

Reliability refers to the consistency and stability of the measurement results over time. In this study, the Cronbach's alpha of 0.792 signifies good internal consistency among the items in the questionnaire. A Cronbach's alpha value above 0.7 is generally regarded as acceptable, indicating that the items are measuring a similar underlying construct and that respondents tend to provide consistent answers across related items. The reliability of the instrument is crucial, as it assures researchers that the measurement yields dependable results, which is particularly important when assessing student motivation. Given the combination of satisfactory validity and strong reliability, the questionnaire is well-suited for evaluating the impact of digital learning tools on student motivation, providing confidence in the results obtained from this study.

4. Findings

Univariate analysis involves examining the distribution of each individual variable to better understand their individual characteristics. In this study, the univariate analysis was used to explore the characteristics of key variables such as student engagement, use of digital learning tools, and student motivation. The following provides a detailed explanation of the findings based on these variables. Bivariate analysis examines the relationship between two variables to determine if any significant association exists between them. In this study, we conducted bivariate analysis to explore the relationship between student engagement (as a dependent variable) and use of digital learning tools (as an independent variable).

4.1. Univariate Analysis

Univariate analysis shows the data distribution of each varaible independently. This analysis Shown in Table 3.

Table 3. Univariate Analysis

Variable	Category	Frekuency	(%)
Digital Learning	No	15	50
	Yes	15	50
Student Engagement	Low	14	46.7
	High	16	53.3

Table 3 provides an overview of the data distribution for each variable independently, offering insight into the proportion of respondents across different categories. For the Digital Learning variable, the data shows an equal split among students: 50% (15 students) are in the "No" category, indicating they do not use digital learning tools, while the other 50% (15 students) are in the "Yes" category, meaning they do use digital learning tools in their learning activities. This balanced distribution allows for a straightforward comparison between students who have access to digital learning resources and those who rely on traditional methods.

For the Student Engagement variable, the data is also relatively balanced but leans slightly towards high engagement. About 53.3% (16 students) of the respondents are categorized as having "High" engagement, while 46.7% (14 students) fall into the "Low" engagement category. This distribution suggests a slight tendency toward higher engagement levels among students, though there is still a significant portion of students with lower engagement. The univariate analysis provides a foundational understanding of the dataset and highlights the diversity of engagement and access to digital learning among the students surveyed.

4.2. Bivariate Analysis

Bivariate analysis using logistic regression shows the the effect of learning independence to performance. This analysis Shown in Table 4.

Table 4. Bivariate Analysis

Variable		Engagement		Total	(%)	P-value	Odds Ratio
		Low	High				
Digital Learning	Low	11	4	15	50	0.006	4
	High	3	12	15	50		

The bivariate analysis in Table 4 examines the relationship between digital learning and student engagement levels. Among the 30 students in the study, 50% (15 students) did not use digital learning tools, and of these, the majority (11 students) exhibited low engagement, with only 4 showing high engagement. Conversely, of the 15 students who used digital learning tools, a significant portion (12 students) reported high engagement, while only 3 had low engagement. This distribution suggests a possible association between the use of digital learning tools and higher engagement levels among students.

The p-value in the table is 0.006, indicating a statistically significant association between digital learning and student engagement at the 0.05 significance level. A p-value below this threshold suggests that the observed relationship is unlikely to be due to random chance, implying that the use of digital learning tools is significantly associated with student engagement levels. This finding provides strong evidence to support the hypothesis that digital learning tools have a positive impact on student engagement.

The odds ratio for digital learning and engagement is 4, which indicates that students using digital learning tools are four times more likely to have high engagement than those who do not use these tools. This odds ratio quantifies the strength of the association, showing that digital learning tools significantly increase the likelihood of high engagement. Therefore, the findings suggest that digital learning tools are a strong predictor of increased student engagement, underscoring the value of these tools in enhancing learning experiences

5. Discussion

The findings from this study underscore the significant role that digital learning tools play in enhancing student engagement. The univariate analysis reveals an even distribution between students who use digital learning resources and those who do not, enabling an insightful comparison of engagement levels across these two groups. Given that educational engagement is a crucial factor in the learning process, these results provide a strong foundation for understanding the influence of digital learning on student motivation and involvement. Research in educational psychology suggests that digital learning environments can foster active participation and self-regulated learning, thus positively impacting engagement (Balalle, 2024).

The validity and reliability assessments conducted on the survey instrument strengthen the credibility of these findings. The validity analysis shows that each item used to measure motivation, as associated with digital learning, has a significant correlation with the overarching construct. High correlation coefficients, particularly for items Y2 (I try to connect what I learn in one discipline with what I learn in others) and Y7 9My school is a place where I make friends easily), indicate that these items effectively capture aspects of motivation related to digital learning, a critical factor in maintaining engagement in virtual and blended learning contexts (Chiu, 2021). Such validity suggests that the instrument aligns well with established educational theories on motivation.

Moreover, the reliability analysis, with a Cronbach's alpha of 0.792, reflects strong internal consistency among the items measuring student motivation. This high reliability assures that the instrument consistently captures students' motivation levels, aligning with findings from (Morad et al., 2021), which emphasize the importance of reliable measurement tools in educational research. Consequently, the high reliability and validity support the instrument's capacity to generate dependable insights, bolstering the study's overall integrity.

The logistic regression analysis further highlights the significance of digital learning tools in relation to student engagement, with a p-value of 0.006 indicating a statistically significant association between these variables. This finding aligns with previous studies demonstrating that digital learning resources can positively impact engagement by providing students with interactive and personalized learning experiences (Li et al., 2024). Such tools offer unique opportunities for self-directed learning, which is associated with greater motivation and sustained engagement in academic settings.

In examining the odds ratio of 4, it is evident that students using digital learning tools are four times more likely to report high engagement compared to their peers who do not use these tools. This substantial effect size suggests that digital tools can act as an effective intervention for enhancing student engagement, as supported by studies in digital pedagogy that advocate for technology integration to foster active learning and student-centered instruction (Kerimbayev et al., 2023). By promoting increased engagement, digital learning tools contribute to a supportive and motivating learning environment, essential for academic success.

The significant association between digital learning and engagement also sheds light on the potential for digital tools to support various learning preferences and promote autonomous learning. Studies on digital literacy and educational technology suggest that such tools empower students to take greater ownership of their learning, leading to higher motivation

and engagement levels (Haleem et al., 2022). This empowerment can be especially valuable in fostering engagement among diverse learners, offering customized learning paths that traditional methods may not adequately provide. Previous reseach also finds that digital tools, including artificial intelligence and learning analytics, promote greater understanding, motivation, and participation among students. Teachers can further strengthen engagement by rethinking their practices, overcoming barriers, and using these tools for personalized learning and effective classroom management (Girdzijauskienė et al., 2022).

In summary, these findings indicate that integrating digital learning tools in educational settings can be a powerful means of enhancing student engagement and motivation. The high validity and reliability of the instrument, along with the robust statistical results, underscore the value of digital resources in creating enriched and interactive learning experiences. Future studies might consider exploring specific types of digital tools and their differential impacts on engagement, as well as the long-term benefits of digital learning in various educational contexts. By expanding our understanding of the role of digital tools in education, educators and policymakers can better support student success and engagement in an increasingly digital world.

In this study, while the findings demonstrate the significant impact of digital learning tools on student engagement, there are certain weaknesses that should be acknowledged. One limitation is the relatively small sample size of only 30 students, which may limit the generalizability of the results. Additionally, the study only focuses on elementary school students from one region, potentially restricting the applicability of the findings to a broader student population or different educational settings. Future research could address these limitations by including larger and more diverse samples from various educational levels and geographic locations, allowing for a more comprehensive understanding of the role digital tools play across different contexts. Another area for further exploration could involve investigating the long-term effects of digital learning tools on student engagement, motivation, and academic performance over extended periods. Furthermore, while the study highlights the positive relationship between digital tools and engagement, it would be valuable to explore which specific tools or features have the most impact, and how these tools can be tailored to meet the needs of diverse student populations. In reaffirming the significance of the study's findings, it is clear that integrating digital learning tools can play a pivotal role in enhancing student engagement and motivation. These results have important implications for educators and policymakers, suggesting that the strategic incorporation of technology can provide more interactive, personalized, and motivating learning experiences. As digital tools continue to evolve, their potential to shape the future of education becomes even more pronounced, offering exciting opportunities for fostering greater student success in an increasingly digital world.

6. Conclusion

This study provides compelling evidence for the positive impact of digital learning tools on student engagement in Grade 3 Science and Social Studies. The use of digital learning tools was significantly associated with higher levels of student engagement, with students using these tools being four times more likely to exhibit high engagement compared to those who did not. This finding highlights the potential of digital learning tools to create more interactive, personalized, and motivating learning experiences, ultimately contributing to a more engaging and effective learning environment for young learners.

Limitation

This study was limited by its cross-sectional design and convenience sampling method, which may limit the generalizability of the findings. Future research could employ longitudinal designs and more representative samples to further investigate the relationship between digital learning tools and student engagement. Additionally, the study focused on a specific grade

level and subject area, so further research is needed to explore the impact of digital learning tools across different grade levels and subjects.

Recommendation

Based on the findings, it is recommended that educators and schools consider integrating digital learning tools into their Grade 3 Science and Social Studies curricula. This could involve incorporating interactive software, educational apps, and other digital resources into lesson plans to enhance student engagement and learning outcomes. Further research could explore the specific types of digital tools that are most effective in promoting engagement and investigate the long-term benefits of digital learning in various educational contexts.

Additionally, given the limitation of the study's small and specific sample, it is recommended that future research include a more diverse participant pool, incorporating students from various grade levels, school types, and geographic regions. This would help to enhance the external validity of the findings and provide a more comprehensive understanding of the impact of digital learning tools across different educational contexts. Expanding the sample size and diversity could also allow for comparisons between different demographic groups, further informing the development of inclusive and effective digital learning strategies.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. This includes, but is not limited to, funding sources, employment relationships, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other research support.

Declaration of Generative AI-assisted Technologies

This manuscript was prepared without the assistance of Generative AI. All intellectual contributions, critical analyses, and final revisions were conducted by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the content presented in this work.

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