

Explore the Significance of Digital Technologies on Map Reading and Interpretation Skills

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Abstract:

Background; The landscape of geography education has been revolutionized by digital technologies, which have enhanced map comprehension and analysis through platforms such as GIS, Google Maps, and Google Earth. This research investigates their influence on the geographical abilities of Form Three students, taking into account factors like availability and instructional integration.

Methods; The study employed a mixed-methods approach, utilizing purposive, convenience, and stratified sampling techniques to gather data via interviews, Likert scales, and open-ended questionnaires.

Findings; Results suggest that digital tools enhance spatial reasoning and practical problem-solving skills, but face obstacles in terms of access and effective implementation. Although digital literacy and student engagement were generally favorable, disparities in resource availability underscore the need for equitable adoption.

Conclusion; The study concludes that digital tools should be used to supplement traditional teaching approaches, with an emphasis on accessibility and teacher guidance to achieve meaningful educational outcomes.

Keyword: Digital technologies, Geography education, Map reading and Interpretation, Spatial thinking, Technological Content Knowledge

Introduction

Digital technologies have transformed the educational landscape, particularly in geography. Traditional methods of map reading and interpretation, once dependent on paper maps and manual techniques, are now augmented by digital tools such as Geographic Information Systems (GIS), Google Maps, and Google Earth. These innovations have created new opportunities for enhancing spatial thinking and analytical skills (Kilungeja, Shave, & Kigobe, 2023; Luhwela, 2023; Esri, 2024). This transition necessitates an evaluation of how digital technologies affect students' map reading and interpretation abilities. Research suggests that digital tools provide interactive, engaging learning experiences that foster a more comprehensive understanding of geographical concepts and their real-world applications (Botha et al., 2019; Shaban & Nzilano, 2024). The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) underscores the importance of integrating technology with teaching methods and subject matter to optimize learning outcomes. However, despite increasing recognition of digital technologies in education, there remains ongoing

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debate regarding their actual impact on geography students' learning outcomes (Selwyn, 2011; Masumbuko, 2021). This study explores the significance of digital technologies in enhancing map reading and interpretation skills among Form Three secondary school students. It aims to address the question: What are the significances of using digital technologies to enhance map reading and interpretation skills? Additionally, the research tests the hypothesis that there is no statistically significant correlation between digital technology use and the improvement of map reading and interpretation skills in Geography for Form Three secondary school students. Existing research presents diverse findings on the efficacy of digital tools in geography education. While some studies highlight the advantages of digital platforms in fostering interactive and inquiry-based learning (Minga & Ghosh, 2024; Smith, 2020), others identify challenges in transitioning from traditional to digital methods, including digital literacy gaps and accessibility issues (Mkubwa & Mhando, 2020; Mushi, 2018). Furthermore, research by Osborne et al. (2020) and Foster (2019) indicates that digital maps improve spatial reasoning and problem-solving skills, although their integration into secondary school curricula remains inconsistent. Understanding the importance of digital tools in geography education is crucial for policymakers, educators, and curriculum developers. This study contributes to the ongoing discourse by examining how digital technologies influence students' map-reading and interpretation abilities, ultimately informing best practices for geography instruction in secondary schools (Demirci, 2019; Buzo-Sanchez et al., 2022). The findings provide insights into optimizing digital learning resources to enhance pedagogical outcomes in geography (Lee, 2023; Kent & Foskett, 2020; Meyer et al., 2019; Musa & Lwoga, 2021; Mwakapenda & Ndalichako, 2018).

Methodology

The study employed a mixed-methods approach, incorporating both qualitative and quantitative data collection techniques. The combination of purposive, convenience, and stratified sampling ensures adequate representation of different groups. By utilizing interviews, Likert scales, and open-ended questionnaires, the study captures a wide range of perspectives, contributing to a comprehensive analysis of the role of digital technologies in enhancing geography education. Both descriptive and inferential statistical analysis was done. (Kothari, 2004, pp. 35-42; Creswell, 2014, Chapter 8; Yin, 2014. Pp. 82-83). The Figure 1. Presents the stage of conducting this study

Research procedures.

Figure 1 *Illustrating research procedures*

Table 1 *Indicate Population, sampling Techniques and data collection technique*

Population	Sample Size	Sampling Techniques	Research tools
Head of Schools	4	Purposive Sampling	Interview
Geography teachers	15	Convenience Sampling	Likert scale and Interview
Form three students	149	Stratified Sampling	Likert scale and Interview
Parents	122	Stratified Sampling	Open-Ended questionnaire
Secondary schools	4	Stratified Sampling	

Data obtained in research field (2024)

The Table 1 analysed a multi-faceted sampling approach to gather data from various stakeholder groups, ensuring a comprehensive representation of viewpoints. The study population encompasses school principals, geography instructors, third-year students, parents, and secondary educational institutions, each sampled using

appropriate methods and research instruments. School principals were selected through purposive sampling, a method that allows researchers to intentionally choose participants based on their relevance to the study. Their administrative expertise and policy knowledge were captured through interviews, providing rich qualitative data on the research subject. Geography teachers were recruited using convenience sampling, based on their availability and willingness to participate. Their direct involvement in geography instruction made their perspectives crucial for assessing the impact of digital tools on map reading and interpretation. Data from this group was collected using both Likert scales for quantitative measurement and interviews for in-depth qualitative insights.

A larger cohort of Form Three students was sampled using stratified sampling to ensure proportional representation across different student groups. With map reading and interpretation being part of their curriculum, their input was vital for evaluating the effectiveness of digital tools in geography education. A total of 149 students participated, providing responses through Likert scales and interviews, enabling both statistical analysis and qualitative feedback.

Parents were also included in the study, as their perspectives on students' learning experiences and challenges in geography were deemed valuable. Stratified sampling was employed to ensure diverse parental representation, with 122 parents participating. Their views were gathered through open-ended questionnaires, allowing for free expression and providing qualitative data on the topic.

Lastly, four secondary schools were chosen using stratified sampling, ensuring the inclusion of various school types (urban and rural) in the study. While the specific research tools applied to these schools were not detailed, their selection was crucial for analyzing variations in teaching and learning environments.

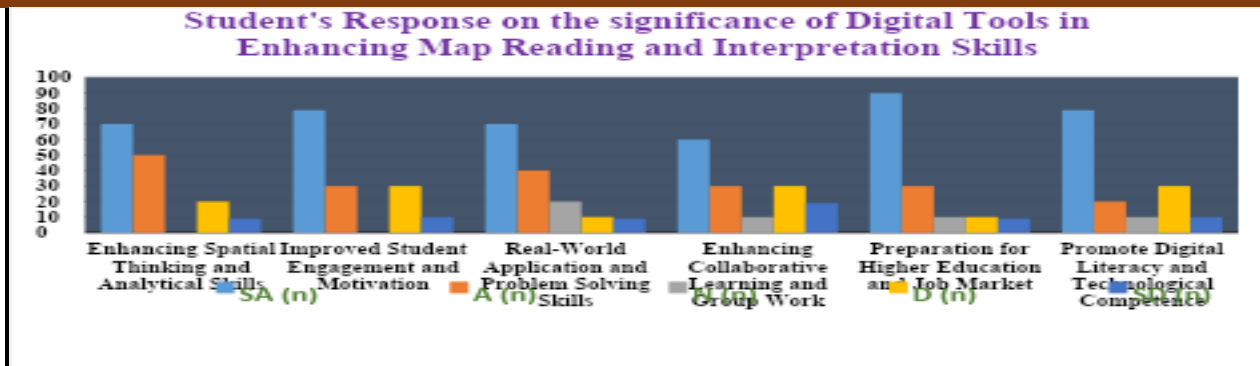
Result

Table 2

Students' Responses on the Significance of Digital Tools in Enhancing Map Reading and Interpretation Skills

Statement	SA (NR)	A (NR)	N (NR)	D (N)	SD (NR)
Enhancing Spatial Thinking and Analytical Skills	70	50	0	20	9
Improved Student Engagement and Motivation	79	30	0	30	10
Real-World Application and Problem Solving Skills	70	40	20	10	9
Enhancing Collaborative Learning and Group Work	60	30	10	30	19
Preparation for Higher Education and Job Market	90	30	10	10	9
Promote Digital Literacy and Technological Competence	79	20	10	30	10

Data obtained from Research Field (2024)

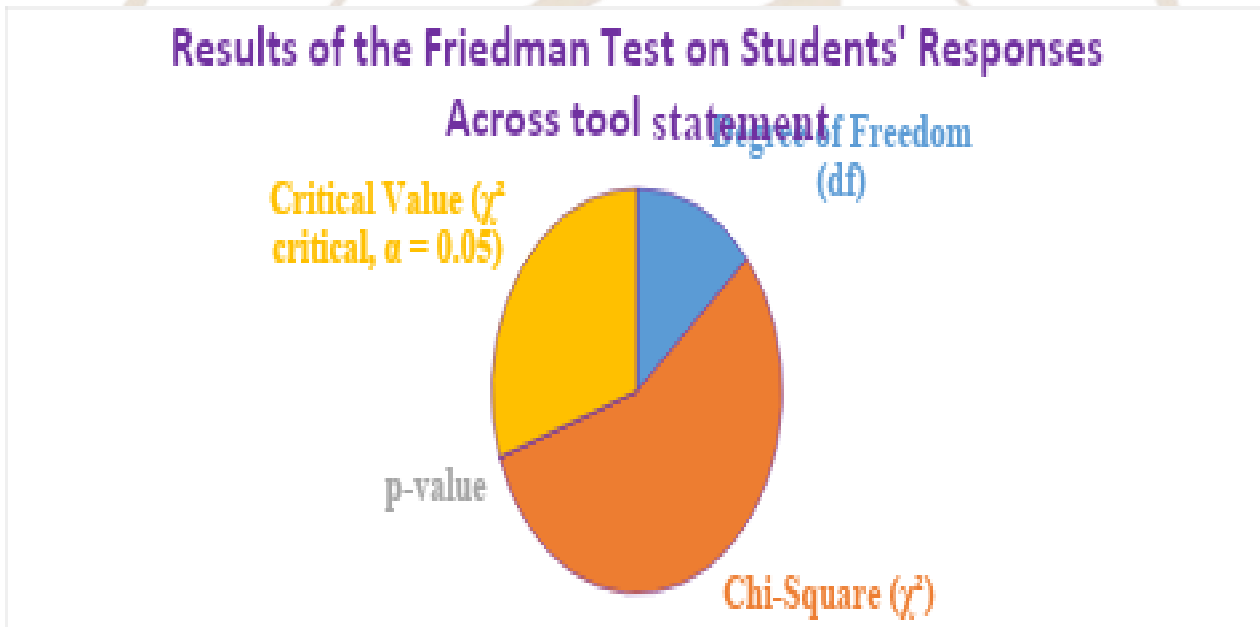


Data obtained from Research Field (2024)

Figure 2 Results of the Friedman Test on Students' Responses across Digital Tool Statements

Degree of Freedom (df)	Chi-Square (χ^2)	p-value	Critical Value (χ^2 critical, $\alpha = 0.05$)
5	20.45	0.00041	11.07

Data obtained from Research Field (2024)



Data obtained from Research Field (2024)

Figure 2 Results of the Friedman test on students' responses across tool statement

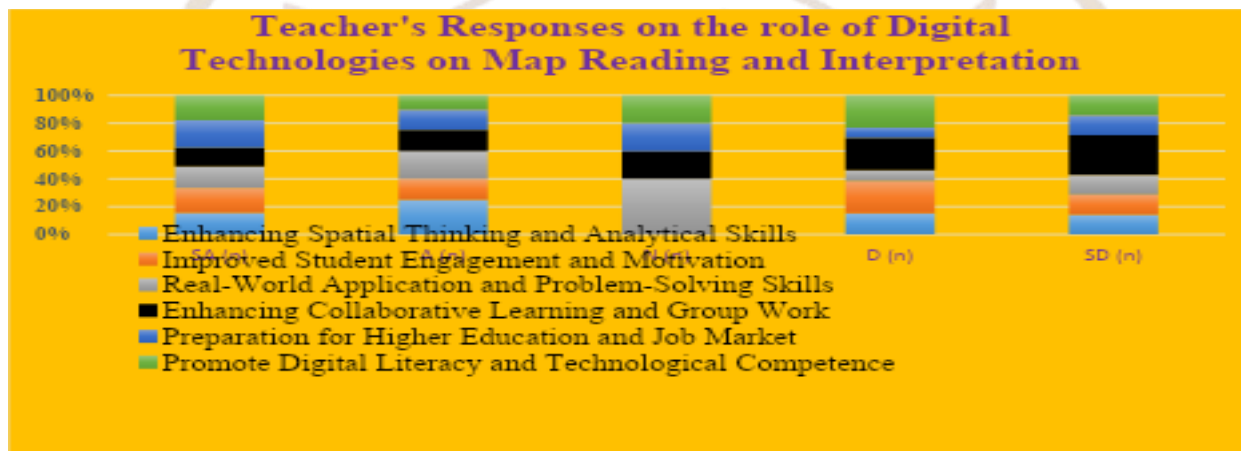
Table 3

Teachers' Responses on the role of Digital Tools on Map Reading and Interpretation

Statement	SA		A		N		D		SD	
	NR	%	NR	%	NR	%	NR	%	NR	%
Enhancing Spatial Thinking and Analytical Skills	07	46.66	05	33.33	00	00	02	13.33	01	6.66
Improved Student Engagement and	08	53.33	03	20	00	00	03	20	01	6.66

Motivation										
Real-World Application and Problem Solving Skills	07	46.66	04	26.66	02	13.33	01	6.66	01	6.66
Enhancing Collaborative Learning and Group	06	40	03	20	01	6.66	03	20	02	13.33
Preparation of higher Education and job market	09	60	03	20	01	1.66	01	1.66	01	6.66
Promote Digital Literacy and Technological Competence	08	53.33	02	13.33	01	6.66	03	20	01	6.66

Data obtained from Research Field (2024)



Data obtained from Research Field (2024)

Figure 3 Teacher's response on the role of digital technology on Map reading and Interpretation

Discussion

Figure 1 Student's response on significance of Digital Tools in Enhancing Map reading and Interpretation. The Table 1 presents student responses regarding the impact of digital technology on various educational aspects. Most students strongly agreed or agreed that digital tools enhance spatial thinking (SA = 70, A = 50) and real-world problem-solving skills (SA = 70, A = 40). The highest approval was for preparation for higher education and the job market (SA = 90, A = 30), indicating that students see digital tools as essential for future success. However, perceptions of collaborative learning were mixed, with 30 students disagreeing, suggesting that digital tools may not always promote group work effectively. While many students found digital tools engaging (SA = 79, A = 30), some disagreed (D = 30, SD = 10), implying that digital tools alone may not be enough to boost motivation. Digital literacy and technological competence also received strong agreement (SA = 79, A = 20), though some students were neutral or disagreed. Overall, the findings indicate a positive perception of digital tools, with some variation depending on the specific aspect being evaluated. This results align with Kilungeja, Shave & Kigobe, 2023; Luhwela, 2023; Botha et al., 2019 who examine the significance of digital technology in teaching and learning

The Figure 1 presents a bar chart illustrating student responses to different aspects of digital technology integration in education. The categories on the x-axis represent six key educational benefits, while the y-axis measures the number of responses for each category. The blue bars (SA - Strongly Agree) are consistently the highest across most statements, indicating a strong positive perception of digital tools, particularly for preparation for higher education and the job market and spatial thinking and analytical skills. The orange bars (A - Agree) also show substantial support, but some statements, such as collaborative learning and engagement, have notable disagreement (yellow and gray bars for D and SD), suggesting mixed views. Neutral responses (N - Gray bars) are relatively low, indicating that most students had a clear stance on each aspect. The chart highlights that while digital technology is largely viewed as beneficial, some aspects, like collaborative learning and engagement, may require further improvement for greater effectiveness.

Both Table 2 and Figure 2 present the results of the Friedman test, which was conducted to determine whether there were statistically significant differences in students' responses across the six statements. The test results indicated a significant difference among the response categories, $\chi^2(5) = 20.45, p = .00041$. Given that the p-value was below the conventional threshold of .05, the null hypothesis stating that students rated all statements similarly was rejected. This suggests that students' perceptions varied significantly depending on the specific aspect of digital technology integration being assessed.

As illustrated in Figure 2, the variations in students' responses are visually represented, highlighting differences in agreement levels across the six digital tool statements. The figure provides a clear comparative view of how students rated each statement, reinforcing the statistical findings in Table 4.66. Specifically, the distribution of responses shows that certain aspects, such as digital literacy and real-world application, received stronger positive ratings compared to collaborative learning, which exhibited more varied responses.

These findings align with studies by Shaban and Nzilano (2024) and Minga and Ghosh (2024), who found that while many students held positive attitudes toward digital technology integration, their perceptions varied based on their experiences and challenges. For instance, some students reported difficulties in accessing digital resources, which influenced their overall perception of its effectiveness in learning. The combination of the statistical table and the graphical representation enhances the understanding of how students' views differ based on specific aspects of digital tool integration."

Post-Hoc Analysis Using Wilcoxon Signed-Rank Test

To identify which specific response categories differed, the researcher conducted Wilcoxon signed-rank tests for pairwise comparisons between Likert-scale responses, adjusting for multiple comparisons using the Bonferroni correction ($\alpha = .005$). Although no pairwise comparisons reached statistical significance after correction, differences were observed between: Strongly Agree (SA) and Neutral (N), Disagree (D), and Strongly Disagree (SD), suggesting that students generally had positive attitudes toward digital technologies. Agreement (A) vs. Strongly Disagree (SD), indicating that some aspects of collaborative learning and problem-solving might not have been equally well-received.

The significant variation in responses suggests that while students strongly recognize the benefits of digital tools in spatial thinking and career preparation, they may experience challenges in collaboration and engagement when using these tools in classroom settings. This aligns with previous research indicating that digital literacy and teacher guidance play a crucial role in effective technology integration (Mishra & Koehler, 2006; Selwyn, 2021).

The researcher administered the same the questionnaire to teachers to assess their perspectives on the impact of digital tools on students' map reading and interpretation skills. The results are presented in Table

Enhancing Spatial Thinking and Analytical Skills

The findings reveal that the majority of respondents (46.66%) strongly agree and 33.33% agree that digital technologies are useful in enhancing map reading and interpretation skills. Notably, there were no neutral responses, indicating a clear understanding of the statement, with only 6.66% strongly disagreeing. This suggests that digital tools are seen as effective in developing spatial thinking and analytical skills.

A male Geography teacher from School B supported this claim, stating: *“If we allow Form Three students to use digital technologies in learning this topic, and other topics, it will help them think critically. Students can access a variety of geographical features on maps such as isotherms, isohyets, isobars, and isonephs and make evaluations themselves.”* (Male Geography teacher, Interview, Thursday 15th October 2024). However, a female Geography teacher from School A expressed skepticism, particularly regarding students' ability to engage with spatial thinking at this age, stating: *“While digital technologies are useful, for students, particularly at this age, they may not be effective for developing spatial thinking. Students tend to focus more on social matters than analytical concerns.”* (Female Geography teacher, Interview, Monday 30th September 2024). This contrasting view highlights the ongoing debate regarding the role of digital technologies in fostering critical geographical skills. Similar viewpoints are supported by scholars such as Masumbuko (2021), Smith (2020), Mkubwa & Mhando (2020), and Mushi (2018).

Improved Student Engagement and Motivation

The data indicates that over half of the respondents (53.33%) strongly agree, and 20% agree that digital technologies improve student engagement and motivation. Notably, there were no neutral responses, which suggests that the statement was clear to all respondents. Only 6.66% disagreed, further emphasizing the positive impact of digital tools on student engagement.

A female Geography teacher from School C noted: *“Students engage more and enjoy the lesson when we integrate digital technologies in Geography topics, including map reading. Digital tools also help control truancy because students enjoy learning through real-world objects.”* (Female Geography teacher, Interview, Tuesday 29th October 2024). This view is corroborated by the students themselves. One Form Three student from School B shared: *“I am happy to have studied today using the computer. It is very easy to understand because the notes are well-organized, clear, and easy to comprehend.”* (Form Three student, Interview, Friday 11th October 2024). Another student from the same school added: *“Please allow us to use electronic devices so that we can learn better. We feel very happy when we learn through digital tools.”* (Form Three student, Interview, Friday 11th October 2024). Such student feedback highlights the motivational benefits of using digital tools in the classroom.

This statement was echoed by another student: *“The use of computers for teaching was clear, and the process felt collaborative.”* (Form Three student, Interview, Friday 11th October 2024).

When parents were asked about the significance of digital technologies in enhancing learning experiences for Form Three students in Kisarawe, one young male parent, who completed the open-ended questionnaire, stated: *“Kutumia vifaa vya kidigitali katika kujifunzia kuna faida ambayo ni ikitokea mwanafunzi anaumwa yupo nyumbani anaweza kupata masomo kwa njia ya mitandao na hatoweza kurudi nyuma kimaendleo.”*

The English translation of this response is:

"Using digital tools in learning has the advantage that if a student falls ill and is at home, they can still access lessons online and will not fall behind in their progress."

This response underscores the potential of digital technologies to ensure continuity in education, even in circumstances where students are unable to attend school physically, thus preventing setbacks in their academic progress. These responses align with research by Osborne et al. (2020), Foster (2019), Esri (2024), and Demirci (2019), which underscores the role of digital technologies in fostering student engagement and motivation.

Real-World Application and Problem-Solving Skills

The findings also demonstrate that 46.66% of respondents strongly agree, and 26.66% agree that digital technologies enhance learners' abilities to apply their knowledge to real-world situations and solve problems. There were also 13.33% neutral responses, indicating some uncertainty or lack of experience with real-world applications. A female Geography teacher from School D emphasized the value of digital technologies in connecting classroom learning to real-life situations, stating: *"In schools where digital technologies are integrated, students solve problems more effectively and can transfer their knowledge to real-world applications. I have a son in a private school where digital technologies are used across subjects. Students there learn a variety of materials, making it easier to practice what they have learned."* (Female Geography teacher, Interview, Wednesday 30th October 2024).

When parents were asked about the significance of digital technologies in enhancing map reading and interpretation skills in geography for Form Three students in Kisarawe, one young female parent, who completed the open-ended questionnaire, stated: *"Humsaidia Mwalimu kupunguza muda wa kuandika hivyo inakuwa ni raisi Zaidi kufundisha na wanafunzi kuelewa Zaidi kwani wakati mwingine hujifunza kwa vitendo na kupanua Zaidi uelewa."* The English translation of this response is: *"It helps the teacher reduce the time spent on writing, making it easier to teach and for students to understand more, as sometimes they learn through practical experience, thus expanding their understanding further."* This response highlights the perceived benefits of digital technologies in the classroom, emphasizing their role in enhancing teaching efficiency and student comprehension through practical learning experiences, which ultimately contributes to a deeper understanding of the subject matter. This insight aligns with the work of Buzo-Sanchez et al. (2022), who argue that the integration of digital technologies fosters problem-solving skills and prepares students to apply knowledge in diverse contexts. These findings suggest that digital technologies not only improve engagement and spatial thinking but also play a key role in helping students apply their learning to real-world scenarios, enhancing both problem-solving skills and overall academic competence.

Promoting Digital Literacy and Technological Competence

The findings suggest that digital technologies play a significant role in promoting digital literacy and technological competence. According to the data, 8 respondents (53.33%) strongly agreed, 2 (13.33%) agreed, 1 (6.66%) was neutral, 3 (20%) disagreed, and 1 (6.66%) strongly disagreed. The majority of respondents (66.66%) affirmed that digital technologies enhance digital literacy and competence. However, the neutral response (6.66%) suggests a possible misunderstanding of the statement. One Geography teacher from School D emphasized the importance of digital tools, stating: *"Using technological tools promotes and encourages digital literacy. Teachers frequently attend digital technology training. By doing so, digital technologies enhance digital literacy, making teachers more competent in using them in the classroom."* (Male Geography teacher, Interview, Wednesday, 30th October, 2024, morning).

Students, however, raised concerns about limited access to technological resources. A male Form Three student from the experimental group revealed: *“Today is my first day entering the computer room for learning. Teachers tend to prohibit students from using the computer room. How can digital literacy and technological competence be promoted under these circumstances?”* (Male student, Interview, Friday, 11th October, 2024). Another female student expressed discomfort, stating that the computer rooms are primarily for teacher use: *“Teachers benefit from the computer rooms while students are left behind. Teachers are very strict about its use, and we feel unwelcome.”* (Female student, Interview, Friday, 11th October, 2024). When the Head of School (HoS) from the experimental school was interviewed, they explained: *“These computers are new and intended only for computer subjects. The upcoming Form One cohort in 2025 will start using them.”* (HoS, Interview, Friday, 11th October, 2024).

These findings align with studies by Lee (2023), Kent and Foskett (2020), and Meyer et al. (2019), which emphasize that digital literacy and technological competence are critical components of 21st-century education. However, the research highlights a gap between teacher-centered access to digital tools and the opportunities provided for students, raising questions about equity in promoting digital literacy. Addressing these disparities is essential to ensure that both teachers and students benefit from technological advancements in education.

Enhancing Collaborative Learning and Group Work

The data reveals that digital technologies contribute to enhancing collaborative learning and group work. According to the table, 6 respondents (40%) strongly agreed, 3 (20%) agreed, 3 (20%) disagreed, 2 (13.33%) strongly disagreed, and 1 (6.66%) was neutral. The majority of respondents (60%) affirmed that digital technologies support collaborative learning, while a significant proportion (33.33%) disagreed with the statement. The neutral response (6.66%) suggests possible misunderstanding of the statement.

A Geography teacher from School B highlighted how digital tools foster collaboration, stating: *“In our district, we have a Geography WhatsApp group where teachers share lesson notes, teaching methods, and past exams. This has significantly enhanced collaborative learning and group work.”* (Male teacher, Interview, 15th October 2024, morning).

This observation aligns with findings from studies by Musa and Lwoga (2021) and Mwakapenda and Ndalichako (2018), which emphasize the role of digital platforms in promoting teamwork, knowledge sharing, and mutual support among educators and students. These results reinforce the potential of digital technologies to create collaborative learning environments and foster peer interaction, which are essential for improving educational outcomes.

Preparation for Higher Education and the Job Market

The data from the survey indicates the role of digital technologies in preparing students for higher education and the job market. According to the table, 9 respondents (60%) strongly agreed, 3 (20%) agreed, 1 (6.66%) was neutral, while 1 (6.66%) disagreed, and 1 (6.66%) strongly disagreed. The majority (80%) affirmed that digital technologies play a significant role in equipping students with skills necessary for higher education and the job market. One respondent, a young male Geography teacher from School D, emphasized the importance of integrating digital technologies in education, stating: *“It is true what you are saying. Now, unemployment is a big issue many young men and women complete various levels of education with no employment. If we integrate digital technologies in teaching, it will help students become self-employed.”* (Interview, School D, Wednesday, 30th November 2024). Similarly, a female Geography teacher from the same school highlighted her experience

in higher education, saying: “I remember when I was in university, the majority of lecturers liked to teach via online platforms and used projectors. I agree with the statement that teachers should use digital technologies in teaching and learning because it prepares students to join higher education.” (Interview, School D, Wednesday, 30th November 2024).

These responses underscore the consensus that integrating digital technologies into the education system is pivotal in preparing students not only for academic progression but also for adapting to the demands of the modern job market. This finding aligns with the broader discourse on the role of digital skills in fostering employability and lifelong learning.

Ethical Consideration. The researcher ensured that participants were fully informed about the study’s objectives, procedures, risks, and benefits before voluntarily consenting to participate (Creswell & Creswell, 2018; Flick, 2022; Kumar, 2011). Confidentiality and privacy were maintained by anonymizing responses and securely storing data, ensuring that participants' identities remained protected (Babbie, 2020; Wiles, 2013; Saunders et al., 2019). Voluntary and participation was upheld, allowing participants to withdraw at any time without facing any consequences (Kothari, 2004; Neuman, 2020; Bryman, 2021). The researcher adhered to integrity and honesty by collecting, analyzing, and reporting data accurately, avoiding any form of manipulation or misrepresentation (Mugenda & Mugenda, 2019; Israel, 2015). Respect for participants was prioritized by recognizing their dignity and cultural values, with Kiswahili used to ensure effective communication and understanding (Bryman, 2021; Yin, 2014. Pp. 82-83; Kitchin & Tate, 2013). Transparency was maintained by disclosing the research aims, methodology, funding sources, and any potential conflicts of interest (Saunders et al., 2019; Flick, 2022; Wiles, 2013). Participants were fairly selected based on research needs, ensuring inclusivity and preventing bias (Neuman, 2020; Cohen et al., 2018; Creswell & Creswell, 2018). Special precautions were taken to protect vulnerable populations, particularly minors, by securing parental or guardian consent before their participation (Wassenaar, 2006; Mkhize, 2021; Israel, 2015). After data collection, debriefing was conducted to provide participants with a summary of the study’s findings, clarify any misconceptions, and allow them to ask questions (Saunders et al., 2019; Kitchin & Tate, 2013). Finally, ethical approval was secured from the institutional review board (IRB), with official permission obtained from Kisarawe District before data collection commenced

Implications

This research's results have substantial ramifications for incorporating digital technologies into secondary education, especially in improving map reading and interpretation abilities. The investigation demonstrated that digital tools are essential in nurturing spatial reasoning, analytical capabilities, and practical problem-solving skills. Students broadly recognized these tools' value in readying them for advanced education and future careers. Nevertheless, despite the predominantly positive feedback, issues such as restricted technology access, insufficient teacher guidance, and obstacles in promoting collaborative learning were identified.

A primary implication of the study concerns digital tools' role in boosting students' digital literacy and technological proficiency. Most participants acknowledged digital tools' potential for developing crucial technological skills necessary in today's digital age. However, students' access to digital resources remains a considerable obstacle, with some reporting limited chances to use technology in class. This indicates a need for institutional policies ensuring equitable access to digital tools, thus creating a more inclusive learning environment. Additionally, the varied perceptions regarding digital tools' impact on collaborative learning

suggest that while these technologies can improve individual learning, they may not inherently foster group-based learning experiences without well-designed instructional approaches.

Conclusion

This research underscores the transformative capacity of digital technologies to enhance geography education by improving spatial thinking, engagement, and real-world application abilities. The statistical analysis, including the Friedman test and post-hoc Wilcoxon signed-rank test, verified that students' views differed significantly across various aspects of digital learning. Although students largely endorsed the integration of digital tools, their effectiveness depended on several factors, such as accessibility, teacher facilitation, and the nature of digital engagement. The study reinforces the argument that digital tools should be viewed not as standalone solutions but as complementary resources requiring effective pedagogical integration.

Recommendations

The study's results prompt several proposals to boost the efficacy of digital tools in high school education. Firstly, educational institutions should focus on enhancing accessibility to digital resources, ensuring all students have equal chances to interact with technology. This could involve expanding the use of computer labs beyond IT classes and integrating digital tools into various subjects, including geography. Secondly, it is crucial to prioritize teacher training programs that equip educators with the skills needed to effectively incorporate digital tools into their teaching methods. These programs should cover both technical aspects and pedagogical approaches that promote collaborative learning through technology. Thirdly, education policymakers should consider developing comprehensive digital curricula that provide guidance to both teachers and students on optimal ways to utilize digital tools in geography education. This includes incorporating interactive and practical applications of digital maps, such as Google Earth and GIS software, to enhance students' problem-solving abilities.

Moreover, addressing students' concerns about engagement and motivation necessitates a more interactive and learner-centered approach to digital education. Schools should explore blended learning models that combine conventional and digital teaching techniques to accommodate diverse learning styles. Additionally, fostering collaboration in digital learning environments can be achieved through group-based digital projects, online discussion platforms, and interactive classroom activities that encourage teamwork. Lastly, additional research is needed to investigate the long-term effects of digital technologies on students' academic performance, particularly in resource-limited settings. Future studies should also examine how factors such as gender differences, socioeconomic status, and teacher attitudes influence the adoption and effectiveness of digital tools in education.

Conflict of interest. This study has any type of conflict interest

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