Socio-Demographic Differences in Physical Access to Digital Technologies among Secondary School Students in Tanzania

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Abstract

This study examined secondary school students' physical access to digital technologies and the influence of selected socio-demographic characteristics on access. The study employed a cross-sectional survey design with 1,997 students from 39 secondary schools, selected using stratified and systematic sampling. Data were collected using a structured questionnaire guided by Jan Van Dijk's Resources and Appropriation Theory. Descriptive statistics were used to determine levels of physical access to digital technologies, while independent-samples t-tests and one-way ANOVA examined differences across students' socio-demographic characteristics. The findings indicate that 57.2% of students reported moderate physical access to digital technologies, and 23.5% reported high physical access. Access varied significantly across several socio-demographic factors, including school type, gender, age, students' education level, parental education, and parental employment status, though the effect sizes were relatively small (η^2 = 0.46%–3.64%). Interestingly, female and younger students reported slightly higher levels of physical access than their counterparts. Overall, the results show that students' access to digital technologies is generally greater at home than at school. The study concludes that many secondary school students still experience limited access to digital technologies, particularly within school environments.

Keywords: *digital divide, physical access, material access, secondary school students, digital technologies, Tanzania*

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1. Introduction

AAccess to digital technologies is a critical enabler of sustainable development at the individual, community, and national levels (ITU, 2024; Sharp, 2024; UNDP, 2022). Without equitable digital access, social and economic disparities are likely to deepen, undermining efforts toward achieving the Sustainable

Development Goals (SDGs) (Van Dijk, 2013; UNDP, 2022). The digital divide is linked to the growth and development of countries and regions, where highly developed countries also have greater access to digital technologies, specifically the internet. On the contrary, the marginalised regions have the lowest access (ITU, 2024). It is a global agenda to promote access to digital technologies for sustainable development. Physical access to digital technologies remains an area of interest in bridging the digital divide in education. While some studies suggest that the first-level digital divide, based on motivation and physical access gaps, is closing, material access, especially in developing countries, remains uncertain (Van Deursen & Van Dijk, 2019).

Earlier research often focused solely on device availability, overlooking the need for a sustainable supply of hardware, software, electricity, and internet connectivity. Without these, the first-level digital divide persists and underscores the need for ongoing research on physical access gaps. Digital technologies are important in education for preparing students for a rapidly evolving world (Oreku, 2022). Unlike traditional classroom teaching, digital learning provides an immediate learning environment, faster assessment, and greater engagement, enabling students to play a more productive role and be at the centre of the learning process (Dancsa, 2023). Ensuring equality in physical access is therefore crucial to enabling all students to develop the digital skills required for a digital age and to enhance their learning experiences with technology.

This paper examines whether secondary school students of varied demographic characteristics in Tanzania have reliable physical access to digital technologies for learning. The paper forms part of a broader study that investigates predictors of students' use of digital technologies for learning. While the broader study examines multiple factors influencing digital technology usage, the focus of the present paper is specifically on the first-level digital divide, that is, students' physical access to digital technologies. Accordingly, this paper reports descriptive statistics on levels of access and examines differences across key socio-demographic characteristics. The analysis, therefore, emphasises group comparisons rather than predictive modelling.

2. Literature Review

2.1. Physical Access

The most common meaning of access to digital technologies is physical access, referring to devices such as desktop computers, laptops, smartphones, and tablets (Van Deursen & Van Dijk, 2019). However, physical access involves not only purchasing a particular technology but a continual process of getting

access to new versions of hardware and software, peripheral equipment, and subscriptions (Resta et al., 2018; Van Dijk, 2013). Research suggests that simply supplying computers, smartphones, or other digital tools does not ensure physical access to technologies; societies, schools and individual families have to ensure a continual supply of necessary infrastructure like electricity supply, internet, hardware and software to enable digital learning (Resta et al., 2018; Wallet & Kimenyi, 2019).

2.2. Digital Technology Infrastructure in Tanzania

Tanzania has experienced significant digital transformation, driven by mobile technology due to its affordability and convenience (GSMA, 2019; Ministry of Works, Transport and Communication (MoWTC), 2016). Investments in fibre infrastructure, including the National ICT Broadband Backbone (NICTBB) and the Fibre Consortium, have expanded connectivity across major cities and regions (GSMA, 2019). By 2023, Tanzania had 70.3 million mobile subscriptions (111% penetration) and 35.9 million internet users (58% penetration), with internet adoption growing at 9.8% annually since 2019 (Tanzania Communications Regulatory Authority(TCRA), 2024). Given that Tanzania has two-thirds of its population under the age of 25, digital access is crucial for education and future workforce readiness (Nieminen, 2020). The Tanzanian government has prioritised digital education through policies like Tanzania National ICT Policy of 2024, the Education and Training Policy 2014 version 2023, National Digital Education strategy 2024/25-2029/30(draft), Tanzania Digital Economy framework 2024-2035, and the ICT policy for basic education of 2007 (MICT, 2024; MOEST, 2024; MOWTC, 2016; MoEVT, 2007). These initiatives are aligned with improved budgets allocated to education, focusing on promoting access to technologies covered by internal and external funds (Daily News, 2024, 2025; UNESCO, 2025). Nonetheless, the gap between policies and the actual integration of digital technologies in education has persisted, which implies a need for continuous research to close it.

It is reported that ICT integration in education remains uneven, primarily benefiting urban and private institutions (Jordan et al., 2021). While initiatives from telecommunication services such as Vodafone's "smart classrooms" and Tigo's school internet connectivity project have improved access, many public schools still lack sufficient ICT infrastructure and electricity (GSMA, 2019). The average student-to-device ratio in government schools is 1:129, compared to 1:11 in private schools, with regions like Geita having the highest disparity at 1:184 (MoEST, 2021). Despite government and donor-driven efforts, access to digital learning remains inequitable (Jordan et al., 2021). Alternative

solutions, such as e-learning platforms like Shule Direct, Halostudy, and the TIE e-library, have expanded educational access, especially during COVID-19 school closures (TIE, 2022; Mtebe & Kondoro, 2019). Nevertheless, disparities persist, influenced by factors such as socioeconomic status and school conditions. Understanding these challenges is essential to ensuring equitable access to digital technologies in Tanzania's education sector.

2.3 Secondary School Students' Physical Access to Digital Technologies

Studies in developed countries suggest that students have greater access to digital technologies at home than at school, often due to school-level restrictions on device use (Nowell, 2014). In the U.S., nearly all students taking the ACT in 2017 reported having internet access and at least one device at home, with smartphone ownership being the most common (Moore & Vitale, 2018). Access to devices also varied by family income and racial or ethnic background. Students perceived their home internet as more reliable than school connections. Similarly, findings from ICILS 2018 in countries such as Germany, Denmark, Finland, France, and South Korea showed that students in developed nations are generally better equipped with digital technologies at home than at school (Fraillon et al., 2020). In contrast, access in many African contexts remains limited. While over half of Rwandan schools reportedly have ICT infrastructure, issues such as power shortages in remote areas and high internet costs hinder effective technology use (Wallet & Kimenyi, 2019). Moreover, Muinde and Mbataru (2019) reported that teachers' ICT capacity and the availability of facilities significantly affected the implementation of the OLPC project in Kenya. Across Africa, limited access to mobile phones, network coverage, and electricity significantly contributes to the digital divide (Kronke, 2020).

In Tanzania, several studies report insufficient and faulty ICT infrastructure in schools, leading to high device-to-student ratios (Ndume et al., 2020; Ngeze, 2017). Students are often restricted from using personal devices at school (Daudi & Nzilano, 2019), but still engage with digital tools outside school, especially through mobile phones (Mtebe & Raphael, 2018; Kafyulilo et al., 2015). Mwakisole et al. (2018) found that over half of the students had access to mobile phones at home and used them to access the Internet. However, internet availability at school remained limited. Almasi et al. (2017) reported that while very few students accessed the Internet on school or personal computers, most did so via smartphones or internet cafes. The reviewed literature related to students' physical access to digital technologies has mostly been conducted in developed countries. Although some reviewed studies were conducted in Tanzania, they are limited in their ability to explain the factors

associated with physical access. It was not clear from these studies whether students have equal physical access to digital technologies regardless of the schools they attend, their families' socioeconomic status, theirs' and their parents' educational levels, or their age. Moreover, some studies are based in a single region, district, or purposively selected school, and the findings cannot be generalised. This study builds on prior Tanzanian studies but adds a multi-region scope and socio-demographic analysis.

The paper addressed two objectives, which are:

i) To assess students' physical access to digital technologies
ii) To examine the differences in students' physical access to digital technologies, considering their demographic characteristics.

3. Methods

3.1 Design and Participants

This article draws on data from a broader study that examined predictors of access to usage using hierarchical multiple regression and multilevel modelling. However, the present study focuses exclusively on describing levels of physical access to digital technologies and examining variations across socio-demographic characteristics. The study used a cross-sectional survey design within a quantitative approach, conducted in five regions of Tanzania with high connectivity to the National Grid and low device-student ratios. Two districts from each region (one urban and one semi-urban/rural) and four schools per district (two government and two non-government) are included. The targeted population was 3,077,355 secondary school students, of whom 90.2% were enrolled in Government schools in 2023. Using Yamane's sample size formula, around 400 questionnaires were distributed per region to ensure representation across various strata.

A multistage sampling procedure was employed, with stratified sampling used to first group the districts in the selected regions into urban (the city centre) and rural (council and Municipal councils). City councils manage large, densely populated urban centres with extensive infrastructure. District councils oversee wider, less populated rural areas and smaller towns within a district. Municipal councils govern medium-sized urban areas that are more developed than rural areas but smaller than cities. All city centres were selected because there was only one in each region. Then, one district from the list of rural/ semi-urban districts was selected using the random number method under the simple random sampling technique. The district councils represented different settlement contexts, including six urban councils (Mbeya City, Dar es Salaam

City, Temeke Municipal, Dodoma City, Mwanza City, and Arusha City), two semi-urban councils (Ilemela and Meru), and two rural councils (Rungwe and Kongwa). This distribution was intended to capture variation in students' access to digital technologies across diverse geographical and socioeconomic settings.

Likewise, in each district council, stratified sampling was used to group schools into government and non-government secondary schools, and from each group, two schools were randomly selected, resulting in 4 schools per district and 8 schools per region. In each school, stratified sampling was used to first group the students based on their level of education (Form 1-VI), and then, for each level, stratified sampling was used to group the students into boys and girls. Students were chosen systematically based on their sitting position in the classroom, with specific numbers selected per class stream: three boys and three girls from two-stream classes, and five boys and five girls from one-stream classes, aiming for about 10 students per education level per school. Due to tight school timetables and examination preparations, adjustments were made in the sample selection to accommodate levels that could not participate. For example, in some schools, Form II students could not participate due to examination schedules. To maintain the sample size, additional students were selected from other levels (e.g., Form I or III) in the same school or from Form II in other sampled schools within the district. A total of 2200 questionnaires were distributed; 1997 valid responses were retained after excluding incomplete submissions. No systematic response pattern suggesting non-response bias was observed. Table 1 presents the distribution of respondents by demographic characteristics.

Table 1

Students' Demographic Characteristics based on Field Data Collected in 2023

Characteristic	Category	n	%
Gender	Male	981	49.4
	Female	1006	50.6
Age Group	10-15 years	737	37.1
	16-20 years	1250	62.9
Student's education level	Form I	350	17.6
	Form II	365	18.4
	Form III	403	20.3
	Form IV	418	21.1
	Form V	104	5.2
	Form VI	345	17.4
Father's Education	STD VII and below	393	23.1
	Form IV	369	21.7
	Form VI, Certificate & Diploma	348	20.5
	Degree and above	590	34.7
Mother's Education	STD VII and below	515	30
	Form IV	383	22.3
	Form VI, Certificate & Diploma	380	22.2
	Degree and above	436	25.4
Father's Employment	Employed	675	34.4
	Self-Employed/Entrepreneur	1169	59.6
Mother's Employment	Employed	455	23.3
	Self-Employed/Entrepreneur	1296	66.4
School Location	Urban	19	48.7
	Semi-urban/Rural	20	51.3
School Type	Government	20	51.3
	Non-Government	19	48.7

Number of Students' Access to Digital Devices at Various Places

Device	*Home*	*School*	*Other*
Smartphone	1623	63	434
Desktop PC	351	687	237
Laptop	768	210	313
Tablet	534	189	267
TV	1454	272	309
Radio	1227	98	256

Students' Ownership of Digital Devices Accessed at Home

Device	*personal*	*Parents'*	*Siblings'*	*shared*
Smartphone	879	882	244	246
Desktop PC	102	298	146	257
Laptop	266	393	236	246
Tablet	190	302	170	212
TV	218	744	121	737
Radio	323	553	103	514

Status of Internet connection at home, school and other places

	Home		*School*		Other	
	N	%	N	%	N	%
No access	206	10.7	419	31.4	200	16.1
Very bad	88	4.6	116	8.7	53	4.3
Bad	127	6.6	164	12.3	114	9.2
Good	849	44.2	424	31.7	521	41.8
Very good	652	33.9	213	15.9	357	28.7
Total	**1922**	**100**	**1336**	**100**	**1245**	**100.0**

Students' Internet costs at home

	N	%
I don't access the internet	125	6.4
I don't know	535	27.6
Less than 1000 Tsh	174	9.0
Between 1000 and 2000 Tsh	369	19.0
Between 2000 and 3000 Tsh	308	15.9
More than 3000 Tsh	428	22.1
Total	**1939**	**100.0**

3.2 Instrument Development and Validation

A questionnaire was appropriate, given the large number of students involved. It consisted of closed-ended questions on demographic information and students' physical access at home and at school. The items measuring students' physical access were adapted from other studies, including Van Deursen and Van Dijk (2019) and Moore and Vitale (2018), and modified based on the reviewed literature, peer-checked, and expert-reviewed to ensure content validity. The items captured different aspects of access, including availability

of ICT equipment, access to digital learning resources, internet connectivity, and financial or institutional support for ICT use.

The items include "my school does not have enough ICT equipment (e.g., computers)", "my school does not have access to digital learning resources", "my school does not have internet connection", "my school has limited connectivity (e.g., slow or unstable speed) to the internet", "the computer equipment in our school is out of date "there is no sufficient provision for me to develop expertise in ICT at school", "I don't have sufficient access to ICT equipment (e.g., computer, smartphone) at home", "I do not have access to digital learning resources at home", "I do not have access to the internet at home", "I have limited connectivity (e.g., slow or unstable speed) to the internet at home", "the computer equipment at home is out of date", "there is no sufficient provision for me to develop expertise in ICT at home", and "there is no sufficient financial support to maintain ICT resources at home".

Respondents rated each item on a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Since the statements were phrased as barriers to access, the responses were reverse-coded so that higher scores indicated greater physical access to digital technologies. Composite scores were averaged, and access levels were categorised into low, moderate, and high using Likert-scale interpretations by Hussain (2022). Given that composite scores ranged from 1 to 5, the range (5) was divided into 3 equal-width categories, yielding intervals of 1.33. This ensured mutually exclusive and exhaustive classification categories (1-2.33 (Low), 2.34-3.37 (Moderate), 3.38-5 (High)). The average score approach was preferred because it preserves the original 1-5 metric, facilitating interpretation and comparisons. The instrument was piloted in May 2023 to ensure its validity and reliability and data collection occurred from July to August 2023. The reliability coefficient (Cronbach's alpha) for the physical access scale was 0.834 during the pilot study and 0.839 in the final dataset, indicating acceptable internal consistency.

3.3 Data Analysis

Data collected from student questionnaires were analysed using SPSS version 25. Descriptive statistics reported levels of students' physical access to digital technologies. An independent-samples t-test compared mean physical access scores across gender, school type, location, age group, and parental employment status. At the same time, a one-way ANOVA analysed the effects of students' and parents' education on students' mean physical scores.

3.4 Ethical Considerations

The University of Dar es Salaam provided ethical clearance, and the local administrative and educational authorities provided permission to access schools. All participants, comprising 1,997 respondents in the main analysis, were provided with clear, accessible information about the study's purpose, procedures, and benefits. Each questionnaire was preceded by a consent form in clear language that participants could understand. Moreover, before administering the questionnaires, the researcher reminded respondents of their right to withdraw from the study at any time without consequences. The data was anonymised to protect identities. Ethical considerations were adhered to in this study (Creswell & Creswell, 2018; Gay et al., 2012).

3.5 Limitations

This paper reports findings on one objective within a broader research project examining students' use of digital technology for learning. Consequently, the analysis focuses on descriptive patterns of access and group comparisons rather than predictive modelling. Moreover, the regions were selected based on relatively higher connectivity to the national electricity grid and internet infrastructure, which may limit the generalisability of findings to less connected regions. However, the selection of districts included 2 rural councils. Among the 39 schools involved in the study, 8 schools (about 20%) are situated in rural councils.

4. Results

4.1 Students' Physical Access to Digital Technologies

Table 2 illustrates the frequencies and percentages of students' responses.

Table 2

Frequencies and Percentages of Students' Responses Regarding their Physical Access to Digital Technologies

PHYSICAL ACCESS	SD		D		NS		A		SA		
	n	%	n	%	n	%	n	%	n	%	N
My school does not have enough ICT equipment (e.g., computers).	458	23.4	291	14.8	294	15	415	21.2	503	25.7	1961
My school does not have access to digital learning resources.	371	19.2	378	19.5	384	20	433	22.4	370	19.1	1936

PHYSICAL ACCESS	SD		D		NS		A		SA		
	n	%	n	%	n	%	n	%	n	%	N
My school does not have an internet connection	445	23	373	19.3	458	24	330	17.1	326	16.9	1932
My school has limited connectivity (e.g., slow or unstable speed) to the internet	316	16.4	257	13.3	623	32	403	20.9	329	17.1	1928
The computer equipment in our school is out of date	366	18.9	272	14	635	33	325	16.8	339	17.4	1937
There is no sufficient provision for me to develop expertise in ICT at school	344	17.8	269	13.9	420	22	404	20.9	495	25.6	1932
I don't have sufficient access to ICT equipment (e.g., a computer or smartphone) at home.	569	29.2	444	22.8	168	9	412	21.1	358	18.3	1951
I do not have access to digital learning resources at home.	486	25.1	520	26.8	228	12	415	21.4	291	15	1940
I do not have access to the internet at home	523	27.2	517	26.8	254	13	353	18.3	279	14.5	1926
I have limited internet connectivity (e.g., slow or unstable speeds) at home.	388	20.1	396	20.5	367	19	477	24.7	304	15.7	1932
The computer equipment at home is outdated.	467	24.2	396	20.5	449	23	323	16.7	296	15.3	1931
There is no sufficient provision for me to develop expertise in ICT at home.	396	20.5	385	19.9	336	17	470	24.3	345	17.9	1932
There is no sufficient financial support to maintain ICT resources at home.	375	19.3	354	18.3	367	19	440	22.7	403	20.8	1939

Further analysis, as presented in Figure 1, shows that, generally, the majority (51%) of students have moderate physical access, followed by 20.9% with high access and 17.2% with low access. 32% of students have high access at home, compared to 20.8% at school. This means more students are highly accessing digital technologies at home than at school. Nevertheless, the majority of

students only moderately access digital technologies at school (43.6%) and at home (37.2%). Considerable numbers of students have equally low access at home (23.7%) and school (23.6%).

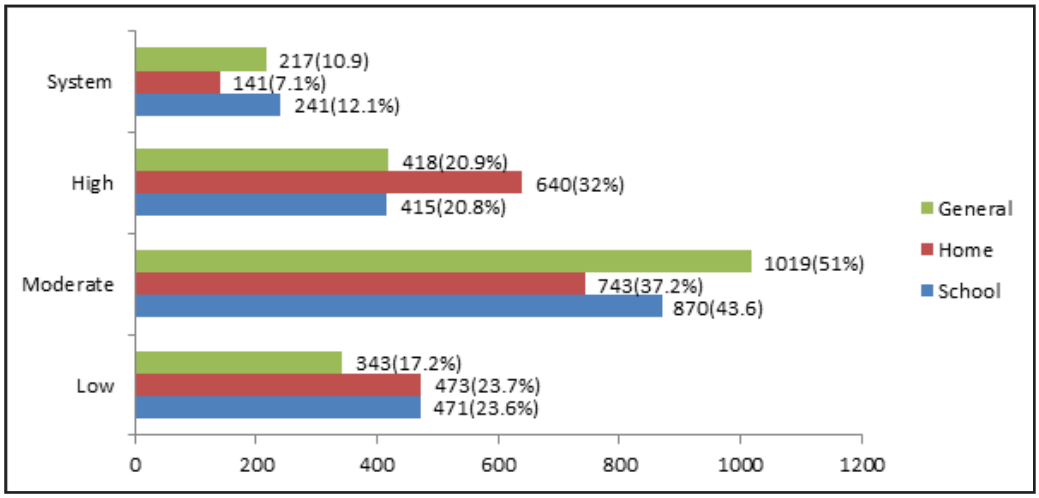


Figure 1: *Students' Physical Access to Digital Technologies at School, Home, and General (Both Home and School)*

Based on the data presented in Table 1 on access and ownership of digital devices, the majority of students reported having access to a variety of devices at home; however, findings revealed that they use them only moderately. The reason could be that most of them do not own the devices, so they perceive they have only moderate physical access to digital technologies. For example, among the 1623 students who indicated having access to smartphones at home, only 879 (44%) own them. The majority (882 students) access their parents' smartphones. Others access their siblings', and others share smartphones. In addition, only 266 (13.3%), 190 (0.1%), and 102 (0.05%) students own laptops, tablets, and desktop PCs, respectively. Apart from device ownership, another hindering factor for students' limited physical access to digital technologies is internet costs. The majority (75.1%) of the students indicated that the internet connection at home was good or very good; however, 21.4% indicated that it costs them more than 3000 per week, 15.4% between 2000 and 3000, and 18.5% between 1000 and 2000. The students who have more physical access to digital technologies at home are also the ones incurring more than 3000 Tsh per week on the internet.

4.2 Effects of Socio-Demographic Characteristics on Students' Physical Access to Digital Technologies

This sub-section reports findings on the effects of socio-demographic characteristics on students' physical access to digital technologies. Table 3 summarises the independent t-test results for students' physical access scores.

Table 3

Independent t-Test Results on Students' Physical Access Mean Scores

Variables	Category	*N*	*M*	*SD*	*t*	*p*	η^2
Gender	Male	883	3.01	0.86	-2.846	.004	0.005
	Female	896	3.12	0.79			
School	Public	1004	2.97	0.82	-5.489	< .001	0.017
	Private	776	3.19	0.83			
location	City council	849	3.10	0.87	1.698	.09	0.002
	Municipal/council	931	3.03	0.79			
age	10-15	636	3.18	0.78	4.32	< .001	0.010
	16-20+	1141	3.00	0.85			
Fathers' Employment	Employed	601	3.16	0.83	3.462	.001	0.007
	Self employed	1054	3.02	0.82			
Mothers' Employment	Employed	397	3.20	0.87	3.841	< .001	0.009
	Self Employed	1183	3.02	0.81			

Eta squared (**η^2**)

Data in Table 3 show that girls have slightly higher physical access to digital technologies than boys. Moreover, private school students have slightly greater physical access to digital technologies for learning than public school students; however, there is no significant difference in mean physical access scores between students' schools located in city councils and those in Municipalities/ councils. Interestingly, students aged 10-15 have slightly greater physical access to digital technologies than students aged 16-20+. Moreover, students whose parents/guardians are employed have slightly higher physical access to digital

technologies than those whose fathers/male guardians are self-employed or entrepreneurs. Nonetheless, the magnitude of the differences in the means, as indicated by eta-squared values, is small.

The effects of students' and parents' education on students' mean physical access scores were assessed using a one-way ANOVA. Table 4 summarises the results.

Table 4

One-Way ANOVA Test Results on the Students' Mean Physical Access Scores

Attribute		***SS***	***df***	***MS***	***F***	***p***	**η²**
Students' education	Between Groups	27.841	4	6.96	10.266	< .001	0.023
	Within Groups	1200.728	1771	0.678			
	Total	1228.569	1775				
Father's education	Between Groups	38.305	3	12.768	19.117	< .001	0.036
	Within Groups	1013.866	1518	0.668			
	Total	1052.171	1521				
Mothers' education	Between Groups	33.911	3	11.304	16.906	< .001	0.032
	Within Groups	1025.671	1534	0.669			
	Total	1059.582	1537				

Based on ANOVA results in Table 4 and robust tests of equality of means (Welch and Brown-Forsythe), there is a significant difference in students' physical access to digital technologies by education level ($F(4, 1771) = 10.266$, $p < .001$). However, the effect size is small (eta squared = 0.023, which equals to 2.3%). Moreover, as illustrated in Tables 5 and 6, there is a significant difference in students' physical access to digital technologies between A-level students and Form I ($p < .001$) and between A-level students and Form IV ($p = 0.004$). However, there are no significant differences between A-level students and Form II and Form III students in their physical access to digital technologies. Interestingly, Form I students have the highest physical access to digital technologies, followed closely by Form IV, but access varies significantly with Form II and Form III students, who differ slightly and insignificantly, and last is A-level students, who vary significantly with Form I in physical access to digital technologies.

Table 5

Mean Physical Access Scores by Student's Education Level

Education	*N*	*M*	*SD*	*SE*	95% CI
Form 1	308	3.29	0.85	0.048	[3.19, 3.38]
Form II	309	3.02	0.74	0.042	[2.94, 3.11]
Form III	354	3.03	0.78	0.042	[2.95, 3.11]
Form IV	389	3.12	0.83	0.042	[3.04, 3.21]
A Level	416	2.91	0.89	0.043	[2.82, 2.99]
Total	1776	3.29	0.85	0.048	[3.19, 3.38]

Table 6

Mean Physical Access Scores by Students' Education Level: Games-Howell Post Hoc Results

Education	Education	*MD*	*SE*	*p*	95% CI
Form 1	Form II	0.265*	0.064	<.001	[0.09, 0.44]
	Form III	0.261*	0.064	<.001	[0.09, 0.43]
	Form IV	0.166	0.064	.074	[–0.01, 0.34]
	ALevel	0.380*	0.065	<.001	[0.20, 0.56]
Form II	Form 1	-0.265*	0.064	<.001	[–0.44, –0.09]
	Form III	-0.005	0.059	1.000	[–0.17, 0.16]
	Form IV	-0.099	0.060	.458	[–0.26, 0.06]
	ALevel	0.115	0.061	.322	[–0.05, 0.28]
Form III	Form 1	-0.261*	0.064	<.001	[–0.43, –0.09]
	Form II	0.005	0.059	1.000	[–0.16, 0.17]
	Form IV	-0.095	0.059	.501	[–0.26, 0.07]
	ALevel	0.119	0.060	.276	[–0.05, 0.28]
Form IV	Form 1	-0.166	0.064	.074	[–0.34, 0.01]
	Form II	0.099	0.060	.458	[–0.06, 0.26]
	Form III	0.095	0.059	.501	[–0.07, 0.26]
	ALevel	0.214*	0.061	.004	[0.05, 0.38]
A Level	Form 1	-0.380*	0.065	<.001	[–0.56, –0.20]
	Form II	-0.115	0.061	.322	[–0.28, 0.05]
	Form III	-0.119	0.060	.276	[–0.28, 0.05]
	Form IV	-0.214*	0.061	.004	[–0.38, –0.05]

4.3 Students' Parents' Education Level

Levene's statistic indicate that the test of homogeneity of variances has been violated hence the use of robust tests of equality of means (Welch and Brown-Forsythe) which shows significant difference in students' physical access to digital technologies based on the education of their father/male guardian ($F(3, 1518) = 19.117$, $p < .001$) (Table 4). In addition, descriptive statistics presented in table 7 and post hoc results in table 8 show that there is significant difference in students' physical access to digital technologies between students with education of their father/male guardian at degree level and above and STD VII with $p < 0.001$; and Form IV with $p < 0.001$; and Form VI, Certificate and Diploma at 0.002. Students whose fathers/male guardians have a degree or higher level of education have greater physical access to digital technologies than those whose fathers/male guardians have a Form VI or equivalent certificate/diploma. However, there is no significant difference in students' physical access with fathers'/male guardians' education STD VII and below, Form IV and Form VI, Certificate and Diploma.

Table 7

Descriptive Statistics on Students' Mean Physical Access Scores by Father's Education Level

Father's Education	***N***	***M***	***SD***	***SE***	**95% CI**
STD VII and below	355	2.88	0.88	0.046	[2.79, 2.97]
Form IV	332	2.93	0.74	0.040	[2.85, 3.01]
Form VI, C & D	301	3.05	0.81	0.047	[2.96, 3.14]
Degree+	534	3.26	0.83	0.036	[3.19, 3.33]
Total	1522	3.06	0.83	0.021	[3.02, 3.10]

Table 8

Games-Howell Post Hoc Results on Students' Mean Physical Access Scores by Father's Education Level:

Father education	**Father education**	***MD***	***SE***	***p***	**95% CI**
STD VII and below	Form IV	-0.051	0.062	.838	[–0.21, 0.11]
	Form VI, C & D	-0.165	0.066	.059	[–0.33, 0.00]
	Degree+	-0.380*	0.059	<.001	[–0.53, –0.23]

Father education	Father education	*MD*	*SE*	*p*	95% CI
Form IV	STD VII and below	0.051	0.062	.838	[–0.11, 0.21]
	Form VI, C & D	-0.114	0.062	.252	[–0.27, 0.04]
	Degree+	-0.328*	0.054	<.001	[–0.47, –0.19]
Form VI, C & D	STD VII and below	0.165	0.066	.059	[0.00, 0.33]
	Form IV	0.114	0.062	.252	[–0.04, 0.27]
	Degree+	-0.214*	0.059	.002	[–0.37, –0.06]
Degree+	STD VII and below	0.380*	0.059	<.001	[0.23, 0.53]
	Form IV	0.328*	0.054	<.001	[0.19, 0.47]
	Form VI, C & D	0.214*	0.059	.002	[0.06, 0.37]

*. The mean difference is significant at the 0.05 level.

Moreover, data in Table 4 show that there is a significant difference in students' physical access to digital technologies based on mothers'/female guardians' education ($F(3, 1534) = 16.906$, $p < .001$); however, the effect size is small. In addition, Table 10 shows Tukey HSD post hoc results indicating a significant difference in students' physical access to digital technologies by their mother's/female guardian's education. Students whose mothers/female guardians have a degree and higher level of education have greater physical access than those whose mothers/female guardians have Form IV and below. However, there is no significant difference in physical access between students whose mothers'/female guardians' education is a degree or higher and those whose mothers'/female guardians' education is Form VI or an equivalent certificate/diploma. Also, there is no significant difference between students' physical access to students whose mothers/female guardians' education is STD VII and below and students whose mothers/female guardians' education is form IV.

Table 9

Students' Mean Physical Access Scores by Mother's Education Level

Mother's education	*N*	*M*	*SD*	*SE*	95% CI
STD VII and below	469	2.91	0.82	0.038	[2.83, 2.98]
Form IV	345	2.98	0.78	0.042	[2.89, 3.06]
Form VI, C, D	332	3.15	0.80	0.044	[3.06, 3.23]
Degree+	392	3.28	0.87	0.044	[3.19, 3.36]
Total	1538	3.07	0.83	0.021	[3.03, 3.11]

Table 10

Students' Mean Physical Access Scores by Mother's Education Level: Tukey HSD Post Hoc Test Results

Dependent Variable: Physical access					
Tukey HSD					
Mother's education	**Mother's education**	***MD***	***SE***	***p***	**95% CI**
STD VII and below	Form IV	-0.068	0.058	.648	[–0.22, 0.08]
	Form VI, C & D	-0.237*	0.059	<.001	[–0.39, –0.09]
	Degree+	-0.368*	0.056	<.001	[–0.51, –0.22]
Form IV	STD VII and below	0.068	0.058	.648	[–0.08, 0.22]
	Form VI, C & D	-0.169*	0.063	.036	[–0.33, –0.01]
	Degree+	-0.301*	0.060	<.001	[–0.46, –0.15]
Form VI, C & D	STD VII and below	0.237*	0.059	<.001	[0.09, 0.39]
	Form IV	0.169*	0.063	.036	[0.01, 0.33]
	Degree+	-0.131	0.061	.138	[–0.29, 0.03]
Degree+	STD VII and below	0.368*	0.056	<.001	[0.22, 0.51]
	Form IV	0.301*	0.060	<.001	[0.15, 0.46]
	Form VI, C & D	0.131	0.061	.138	[–0.03, 0.29]

*. The mean difference is significant at the 0.05 level.

5. Discussion

This study examined secondary school students' physical access to digital technologies and differences across socio-demographic characteristics. Overall, the findings indicate that many students have moderate levels of access, but access remains uneven across home and school environments. Consistent with the concept of the first-level digital divide, access to devices and internet connectivity continues to shape students' opportunities to engage with digital learning resources. The findings reveal that students rely more on digital technologies at home than at school. Smartphones are the most commonly owned devices, reflecting their affordability and multi-functionality compared with laptops or desktop computers. However, many students depend on shared devices provided by family members, which may restrict their learning time. Limited access to digital devices in schools further intensifies this challenge, particularly for students from low-income households who rely on schools as their primary opportunity to engage with digital technologies.

These patterns support Jan van Dijk's Resources and Appropriation Theory, which argues that inequalities in material and social resources lead to differences in digital access and participation. Students with greater economic resources, supportive family environments, and access to devices are more likely to engage with digital learning opportunities. Restricting smartphone use in schools may hinder learning opportunities; instead, schools should promote guided use to ensure all students develop digital skills equally. Without equitable access, students continue to use devices outside school without supervision, leading to deepening existing divides. The present study aligns with previous studies that reported that the majority of secondary school students in Tanzania are accessing digital devices outside the school environment (Mtebe & Raphael, 2018; Mwakisole et al., 2018schools have been investing heavily on information and\ncommunications technology (ICT; Almasi et al., 2017; Kafyulilo et al., 2015). Similarly, other studies have reported on insufficient ICT infrastructure in some of Tanzanian schools (Ndume et al., 2020; Ngeze, 2017; Tarimo & Kavishe, 2017)and teachers in terms of knowledge, skills and possession of ICT devices. Data were collected from 202 teachers selected from 32 Secondary Schools from all the Educational Zones in Tanzania. The study revealed that most schools do not have ICT infrastructure in place. In schools where ICT infrastructure is present, student to computer ratio is very high. On the other hand, teachers are ready to use ICT in their teaching and learning activities if and only if they have the skills and knowledge to do so. The findings revealed that most of the secondary school teachers (77.0%. In contrast, Moore and Vitale (2018) found that nearly all high school students who sat for the American College Testing (ACT) tests in 2017 had access to home internet and at least one electronic device for home use.

Socio-demographic factors significantly influence students' physical access to digital technologies. However, the effect sizes are small, ranging from 0.46% (gender) to 3.64% (father's education), as indicated by eta-squared values. Although the observed differences are small, female students reported slightly higher levels of physical access than male students. This finding contrasts with some earlier studies that reported male advantages in access to digital technology. These findings align with Van Dijk's (2013) theory of resources and appropriation, which links digital access to disparities in material and social resources. The results may indicate growing efforts to promote girls' participation in STEM through STEM programs, educational policies, and school practices aimed at reducing gender gaps. Additionally, female students may be more engaged with, or have more structured access to, digital tools at school, possibly due to behavioural differences or institutional support.

Likewise, programmes and interventions that support the empowerment of women and girls must include men and boys as well (Moraa, 2018; Philemon, 2024). In contrast, it is still observed elsewhere that male students are more likely than female students to access digital devices. Mendoza-Lozano et al. (2021)the digital divide evolution over time and its determinants are analyzed using a probabilistic model and the calculation of georeferenced concentration indexes. The topic is relevant as previous studies have shown a positive relationship between access to ICTs (Information and Communication Technologies in Colombia found that male students have a slight advantage in access to a computer at home compared to female students. Perhaps this alerts regions to focus more on the data specific to their area, as the theory suggests that there will be variations across regions.

Parental education and employment were also associated with students' access to digital technologies. Students from households with higher educational attainment or stable employment reported greater access to devices and home internet connectivity. These findings support previous research indicating that socioeconomic resources influence students' opportunities to engage with digital technologies for learning. These findings support Van Dijk's (2013) theory, which highlights the importance of material resources in shaping digital access. Families with higher parental education are better positioned to provide their children with devices and reliable technology. This study aligns with that of Mendoza-Lozano et al. (2021), who found that parents' education is positively associated with access to ICTs at home. As argued by Riyan Rizaldi et al. (2021), parental support is important whether parents can use technology or not; they can guide students' learning at home, including the time spent on digital devices for learning. However, it is observed that parents who use technology appreciate it more and are likely to provide or share technological devices with their children (Goodall, 2016; Katz et al., 2019).

Parents' employment status significantly affects students' physical access at home, with children of employed parents having greater access than those of self-employed parents. This may be due to the financial stability of salaried employment, which allows for better investment in devices and internet connectivity. These findings support Van Dijk's (2013) theory that differences in material resources, like stable income, lead to access gaps. However, no significant differences were found at school, suggesting that school environments may help level the differences through shared resources and infrastructure. Despite this, gender disparities persist, with girls having greater access, possibly due to STEM-focused initiatives or educators' efforts to promote gender equity

in technology use. This study aligns with other scholars including Gobena (2018) who conducted a similar study in Ethiopia and Treviño et al. (2021) who based the study in 19 countries during COVID-19 pandemic, both agree that physical access influences how much learners can engage with digital learning environments, with employed parents having better financial means to support their children's access to computers, internet, and other technological resources at home than their counterparts. Moreover, employed parents, who may have higher educational backgrounds, are more likely to emphasise digital literacy and provide the necessary resources to ensure their children have better access to learning tools (Yang et al., 2023).

Younger students reported slightly greater levels of physical access than older students. Although the differences are small, this pattern may reflect changing technology adoption trends among younger cohorts, who often encounter digital devices earlier in their educational experience. This unexpected trend can be partly explained by Van Dijk's theory, which suggests that younger generations tend to have greater access to newer technologies. Older students may also face stricter rules due to concerns about distractions during exam years. At school, younger students might benefit from more flexible schedules and curricula that integrate digital tools, while older students face academic pressures that limit their time with technology. Overall, this trend indicates a systemic imbalance where technology is more embedded in the lives of younger students, potentially disadvantaging older students in developing essential digital skills for higher education and future careers. Equitable access across all grade levels is, therefore, necessary. Moreover, it should not be ignored that, without proper guidance, younger and lower students are at a higher risk of misusing devices. In contrast, according to Mendoza-Lozano et al. (2021), a low-level student in Colombia experiences less access to the internet at home than their counterpart. Nonetheless, it is argued that every stage of education, from pre-primary to higher education, must prioritise digital equity and inclusion (Gottschalk & Weise, 2023).

School location did not significantly affect overall physical access at school. However, students in urban areas reported slightly greater access at home. This may reflect stronger internet infrastructure and higher household incomes in urban settings. It is also important to note that the study included relatively few schools from remote rural areas, which may limit the generalisability of this finding. The lack of significant differences in physical access at school may also be a positive sign that educational systems are mitigating geographic disparities; nonetheless, equity in schools should be extended to older and male students. Similarly, school location is typically associated with facilities in urban

areas, including access to electricity and a good internet connection, and with proximity to technology hubs (Gobena, 2018; Treviño et al., 2021). However, all visited schools, whether in urban, semi-urban, or rural areas, had electricity.

School type was another factor associated with access. Students attending private schools reported greater access both at home and at school, which may reflect differences in institutional resources, infrastructure, and family socioeconomic backgrounds. Private schools generally have more financial resources, better infrastructure, trained staff, and specialised programs that support technology use. These advantages align with Van Dijk's theory, which links access to material and social resources. Additionally, private school students often come from higher-income families with employed or educated parents who can afford devices and a stable internet connection. In contrast, public schools attended mostly by students from lower-income households rely on limited government or donor support for technology. Agreeing with Mendoza-Lozano et al. (2021), who found that students who belong to public secondary educational establishments in Colombia are less likely to access ICTs, compared to their peers who study in private establishments.

6. Conclusion and Recommendations

This study examined secondary school students' physical access to digital technologies in Tanzania and differences across socio-demographic groups. The findings suggest that although many students have some access to digital technologies, access remains uneven, particularly within school environments. Smartphones represent the most widely used devices at home, highlighting the potential for mobile-supported learning initiatives. Efforts to improve digital learning opportunities should prioritise expanding school ICT infrastructure while supporting equitable access among students from diverse socioeconomic backgrounds. Schools should be supported with sustainable technology infrastructure, while families and communities should aim to provide at least one device for digital learning. Efforts to close the gender gap must ensure both boys and girls benefit equally; giving girls more access will have boys left behind, creating further gender divides. Future research should include a broader range of rural schools and explore how differences in physical access influence students' actual use of digital technologies for learning.

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