The importance of a mobile-first approach for measuring digital skills among low- and middle-income populations: a MICS-6 survey data analysis for 40 countries

Authors: Mayank Date, Kerry Scott, Anjora Sarangi, Osama Ummer, Arjun Khanna, Tanya Sinha, Sara Chamberlain, and Diwakar Mohan* and Amnesty LeFevre*

*Joint senior authors
Target journal: BMJ Global Health

Abstract: [Unstructured – up to 250 words]
Population-based data on digital skills are critical for measuring progress towards Sustainable Development Goal 4.4 and more broadly, designing effective digital innovations. Questions recommended by the International Telecommunication Union (ITU) and implemented through a range of population-based surveys, including UNICEF's Multiple Indicator Cluster Survey, provide the source data for SDG indicator 4.4.1 for several countries globally. This paper aims to assess digital skills data emanating from the implementation of the ICT questions through the MICS-6 survey in 40 countries from 2017-2023.

The study addresses four main questions related to skills measurement. Study methods included secondary analysis of MICS-6 data and in-depth qualitative interviews in Kenya (n=90) and Nigeria (n=90). The latter used cognitive interviewing techniques to understand men and women's comprehension and understanding of the digital questions in MICS.

The findings reveal that MICS-6's focus on computer skills, excluding mobile phone users, led to significant sample exclusion, particularly of women from lower socio-economic backgrounds. Expanding the scope to include both mobile phones and computers could have assessed digital skills in over 80% of the population, ensuring greater representation.

Secondary analyses highlight a low prevalence of digital skills, indicating the need to revisit the skill mix for low- and middle-income country populations. Qualitative interviews offer recommendations to improve the language of MICS-7 questions for better comprehension and data quality. This study contributes to the ongoing discourse on digital inclusion and provides valuable insights for policymakers and educators aiming to bolster digital skills in underserved populations.

Introduction

Digital competence is defined by the European Commission (EC) as "*the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society*" (1). The DigComp Framework, developed by the Joint Research Centre (JRC) of the EC, provides a descriptive model that defines 21 competences, classified within five key competence areas: i) Information and data literacy, ii) Communication and collaboration, iii) Digital content creation, iv) Safety, and v) Problem solving (1). Measuring across these competence areas requires assessing knowledge (theoretical understanding of information), skills (practical abilities and techniques), and attitudes (values, beliefs, dispositions) (2). The DigComp framework provides a reference model for categorizing and thinking about digital skills, allowing customization to meet specific needs and serving as a tool for standardizing ICT skills measurements (2).

Emerging evidence has shown the impact digital skills could have on educational outcomes (3), health and well-being (4), and in accelerating the digital economy (5). However, data from low- and middle-income countries are limited, especially those with the largest inequities by gender in technology access and use. Thus, women and marginalized groups are most at risk for being left behind as digitization expands (6,7).

The United Nations (UN) Sustainable Development Goal (SDG) 4.4[1] includes two underlying indicators on digital skills: 4.4.1 Proportion of youth/adults with information and communications technology (ICT) skills, by type of skill, and 4.4.2 Proportion of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills (8–10). As the custodian agency for SDG 4.4.1, the International Telecommunications Union (ITU) defines a core set of activities for measurement under SDG indicator 4.4.1, and routinely collects data on them from national statistics offices worldwide to provide data on progress towards 4.4.1 (9,10).

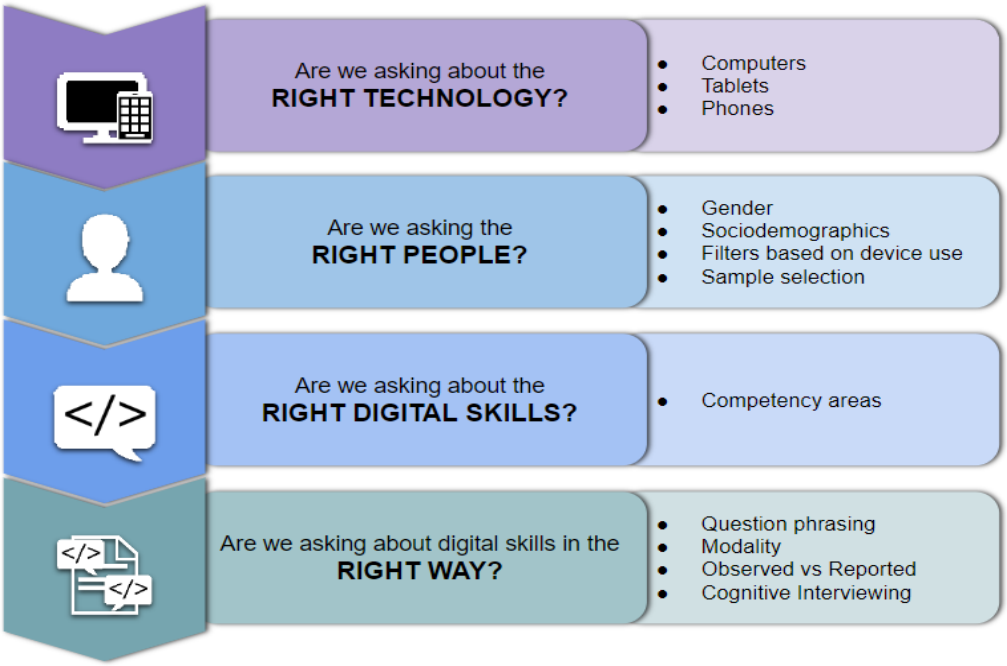
For many low- and middle-income countries (LMICS), UNICEF's Multiple Indicator Cluster Survey (MICS) (11) which is administered to men and women of reproductive age (15-49 years) and includes digital skills questions derived from SDG indicator 4.4.1, serves as the primary source for digital skills data. First developed in 2014, nine digital skills questions were included in the 6th round of MICS (MICS-6) (12). In 2020, three more digital skills questions where added to MICS-7 which is currently being launched globally (13).

This manuscript aims to assess digital skills data emanating from the implementation of the ICT indicator questions through the MICS-6 survey in 40 countries[2] from 2017-2023. The study addresses four main questions: 1. by focusing on computers, are we asking about the right technology?; 2. are we asking the right people?; 3. are we asking about the right digital skills?; and 4. are asking about digital skills in the right way? (Figure 1). To explore these questions, we draw from secondary analysis of MICS-6 data, augmented with insights from primary qualitative research in Kenya and Nigeria. This qualitative research used cognitive interviewing techniques (face and translational validity) to understand men and women's comprehension and understanding of the MICS questions.

[1] SDG 4.4: By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

[2] Of the currently available surveys included in round 6 of the MICS surveys, 9 do not have publicly available data, surveys for 10 countries do not measure ICT skills on an individual level and a few other countries have restricted or incomplete data.

Figure 1. Approach to analyzing population based digital skills data from MICS-6



Are we asking about the right technology?

Table 1 summarizes the current technologies that surveys presently assess digital skills on, across 6 competency areas (2). Supplementary Tables 1 and 2 provide detailed breakdown of specific skills measured in each survey. Similar to the ICT module, most "computer-first" surveys have sought to focus on the measurement of professionally and academically relevant skills such as copying and pasting , use of professional software for analysis and presentation and even writing of computer programs (14). To best our knowledge the only major global survey to take a mobile first approach was that conducted by the GSM Association (GSMA) as part of a module on digital skills added to their 2020 State of Mobile Internet Connectivity survey (15). While some surveys, including Global Kids Online, Eurostat, and the G20 (16–18), do include some device agnostic skill questions, these tend to focus on knowledge rather than technical skills while many of the mobile phone specific skills assess device-specific features and basic media usage.

Table 1. ICT Skills measured by large global surveys focusing on computer, tablet, mobile phone and device agnostics skills

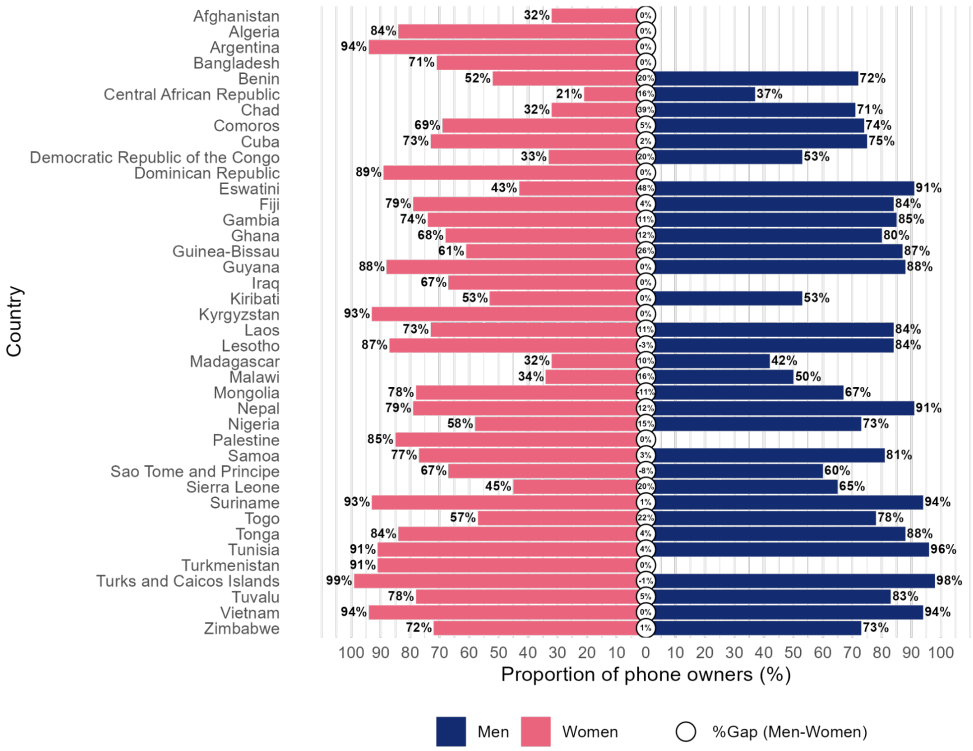
Survey	Digital competence area					
	Information and data literacy	Communication and collaboration	Digital content creation	Safety	Problem Solving	Hardware and software operations
DigCompSAT	🖵	🖵	🖵	🖵	🖵	-
EU Survey on ICT Use	🖵	-	🖵	-	-	🖵📱
Global Kids Online	🖵	🖵	🖵	🖵	-	🖵📱
MICS-6	🖵	🖵	🖵	🖵	-	🖵📱
MICS-7	🖵📱	🖵📱	🖵📱	🖵📱	-	🖵📱
GSMA Consumer Survey	📱	📱	-	📱	📱	-

2023						
Young Lives Module on Computer Skills	🖵	🖵	🖵	🖵	-	🖵

🖵 *questions covering computer\tablet-based skills,* 📱 *questions covering cell phone-based skills*

Within MICS' sampling frame of men and women of reproductive age (15-49 years), survey questions on digital skills are restricted to the sub-sample of men and women that report ever having used a computer within the preceding 3 months.[3] The singular focus of digital skills measurement on computers lies in contrast with the predominant device through which individuals in low- and middle-income countries use technology and access the internet: the mobile phone (7,19,20).

Figure 2. National proportion of men and women 15-49 years who report owning a mobile phone across 40 MICS-6 countries



In MICS-6 data, <20% women and <25% men report ever having used a computer and an even smaller proportion report having used a computer in the preceding 3 months (Supplementary Figure 2). By comparison, phone ownership among men ranges from 21% to 99% and among women from 37% to 98%. Mobile use in the preceding 3 months among men ranges from 16% to 100% and among women from 37% to 98%. (Figures 2). In focusing digital skills measurement singularly on computers, 75% of the total sample, and 82% of any device (computer or mobile owners) were excluded. If the ICT module were to have assessed digital skills on computer *and* mobile phone users, nearly 84% of sampled men and 80% of sampled women would have been included. This greater access to and use of mobile phones in low- and middle-income countries, suggests that digital skills measurement should take a mobile first approach. It is worth noting that the ICT module in MICS-6 did not distinguish phone ownership by type phone. Given that the mobile internet is still used by a minority of women in LMICs (21), identification of device type would enable more equitable

[3] Question MT4 asks the respondents "Have you ever used a computer or a tablet from any location?" Only those who respond "Yes" are asked the following question, MT5, "During the last 3 months, did you use a computer or a tablet at least once a week, less than once a week or not at all?" Any participant responding "No" to either of these questions is excluded from administration of the ICT module. Meaning that anyone who has not had access to or used a computer in the last 3 months is not eligible to answer the ICT skills questions.

measurement of digital skills, for example, use of IVR-based digital financial services such as mPesa on basic or feature phones, versus use of digital financial services on smartphones. Further, as smartphone ownership continues to grow in LMICs, and as the next billion comes online, many will bypass using personal computers (PCs) and feature phones altogether, moving directly to powerful handheld computers, i.e. smartphones (22). It is therefore important that future surveys consider these technologies as essential tools in assessment and performance of digital competencies (7,23).

Are we asking the right people?

The objective of MICS surveys is to obtain unbiased and precise estimates of key indicators at the population level that are representative of the entire population of the country. Individual questionnaires are administered to women between aged 15-49 years in each household and men age 15-49 years in every second household[4].

Table 2 presents differences in the sample population characteristics for men and women from Nigeria who (a) report ever using computers in the preceding 3 months, (b) are mobile phone owners, (c) are a combined group of mobile phone owners and/or computer users. The demographic characteristics of computer users is significantly different from phone users, and from individuals who report not having used a computer or owning a phone. We observe a pattern demonstrating a significantly higher proportion of mobile ownership (30 - 70%), compared to recent computer use (1-10%) especially in lower education and economic strata. A similar gap is also observed in rural areas. Supplementary Table 3 provides detailed proportions for all countries included in the study. The restriction of the sample resulting from screening for computer use tends to bias the estimates towards the haves (vs have nots) and reduces the available effective sample size resulting in lower precision.

While gender gaps in mobile ownership persist, they are narrowing in some geographies. However, data on women's digital skills, particularly on mobile phones, is limited (20). The absence of primary data on women's digital skills, risks exacerbating underlying inequalities in women's access to and use of technology – hampering the design of effective digital skills training programs, and the development of programmatic strategies to foster women's use of technology for high impact use cases such as health, education, and economic activities.

Table 2. Proportion of Device use by demographics for Nigeria

	NIGERIA												
	WOMEN							MEN					
Sample Proportion	**Overall**	**No Computer use in 3 months**	**Computer Use in Last 3 Months**	**Phone Ownership**	**Phone Use In Last 3 Months**	**Any Device in last 3 months**	**No Device in last 3 months**	**Overall**	**No Computer use in 3 months**	**Computer Use in Last 3 Months**	**Phone Ownership**	**Phone Use In Last 3 Months**	**Any Device in last 3 months**	**No Device in last 3 months**
	100.0%	93.6%	6.4%	58.2%	78.6%	78.8%	0.7%	**100.0%**	87.9%	12.1%	73.4%	88.4%	88.6%	0.3%
Wealth Index														
Q1 - Poorest	**17.7%**	18.9%	0.7%	6.0%	10.9%	10.9%	31.5%	**17.5%**	19.7%	1.3%	11.9%	14.6%	14.6%	14.0%
Q2	**18.7%**	19.8%	1.4%	12.2%	16.4%	16.4%	24.1%	**18.6%**	20.6%	3.3%	16.0%	17.5%	17.5%	33.5%
Q3	**19.5%**	20.4%	5.3%	19.8%	20.3%	20.3%	18.7%	**19.3%**	20.8%	8.4%	19.3%	19.8%	19.8%	18.7%
Q4	**21.4%**	21.7%	17.3%	28.0%	24.6%	24.6%	16.6%	**22.2%**	22.5%	20.8%	25.4%	23.6%	23.6%	7.9%
Q5 - Richest	**22.7%**	19.2%	75.4%	34.1%	27.8%	27.8%	9.1%	**22.4%**	16.4%	66.2%	27.3%	24.5%	24.6%	25.9%
Education Level														
None	**26.6%**	28.3%	0.6%	12.7%	18.7%	18.7%	39.7%	**15.7%**	17.8%	0.1%	11.4%	13.0%	13.0%	10.0%
Primary/Secondary	**58.9%**	61.2%	24.9%	63.2%	63.1%	63.1%	55.8%	**64.4%**	69.2%	30.0%	62.3%	64.9%	64.9%	75.9%
Tertiary/Higher	**14.6%**	10.5%	74.5%	24.1%	18.2%	18.2%	4.5%	**19.9%**	13.0%	69.9%	26.3%	22.1%	22.1%	14.1%
Age Groups														
Age 15-19	**21.9%**	22.2%	17.8%	13.1%	19.1%	19.2%	45.2%	**25.1%**	26.7%	13.4%	14.8%	21.4%	21.5%	45.5%
Age 20-24	**16.3%**	15.8%	23.5%	17.1%	16.7%	16.6%	12.1%	**16.8%**	16.3%	20.5%	16.9%	17.0%	17.0%	32.1%
Age 25-29,	**15.3%**	15.2%	17.8%	16.5%	15.7%	15.7%	17.8%	**13.0%**	12.2%	18.8%	14.7%	13.5%	13.5%	11.4%
Age 30-34	**13.7%**	13.6%	14.9%	15.5%	14.1%	14.1%	8.6%	**11.0%**	10.7%	13.1%	12.7%	11.7%	11.7%	2.0%

[4] Of the countries analyzed for this study, men's data is not available for Bangladesh, Iraq, Algeria, Turkmenistan, Argentina, Afghanistan, Palestine, Kyrgyzstan , DominicanRepublic. Therefore proportions are not presented for men's demographics in those countries.

Age 35-39	**13.5%**	13.4%	14.4%	15.8%	14.2%	14.2%	5.3%	**12.5%**	12.2%	14.5%	15.2%	13.4%	13.4%	4.5%
Age 40-44	**10.8%**	11.1%	7.6%	12.5%	11.4%	11.4%	6.9%	**11.6%**	11.5%	12.2%	14.2%	12.4%	12.4%	3.7%
Age 45-49	**8.5%**	8.8%	4.0%	9.5%	8.7%	8.7%	4.2%	**10.0%**	10.4%	7.5%	11.6%	10.5%	10.5%	0.8%
Area of residence														
Rural	**45.9%**	43.2%	85.5%	61.3%	52.8%	52.8%	31.3%	**44.9%**	40.1%	79.4%	52.0%	47.7%	47.7%	45.6%
Urban	**54.1%**	56.8%	14.5%	38.7%	47.2%	47.2%	68.7%	**55.1%**	59.9%	20.6%	48.0%	52.3%	52.3%	54.4%

Are we asking about the right digital skills?

Table 1 summarizes the competency areas measured in MICS-6, and Supplementary Table 4 presents primary data on population level coverage for each digital skill assessed. The ICT Module in MICS-7 is anticipated to measure the same set of digital skills (Supplementary Table 1) among computer and phone users. The ICT questions, which also make up SDG Indicator 4.4.1, predominantly focus on skills associated with computer use. The survey asks participants if they have performed the following ICT skills within the last 3 months: i) Copy or move a file or folder, ii) Use a copy and paste tool, iii) Send e-mail with attached file, iv) Use a basic arithmetic formula, v) Connect and install a new device, vi) Find, download, install and configure software, vii) Create an electronic presentation, viii) Transfer a file, and ix) Write a computer program.

On average only 20% of men and 17% of women in low- and middle-income countries report being able to perform one or more of the 9 skills assessed. Across the countries, 3% to 49% among men and 1% to 51% among women reported ever having performed at least one of 9 skills assessed. Skills such as writing computer program overall prevalence estimates were even lower, ranging from 0.1% to 10% across countries (Supplementary Figure 3).

The low prevalence of these skills underscores not just significant gaps in digital skills in LMICs, but that the skill mix included within the ICT module and its appropriateness for low- and middle-income countries needs to be revisited. More broadly, on a global level, SDG Indicator 4.4.1 needs to be revised to accommodate the broader range of technologies used, particularly mobile phones.

Are these skills being measured in the right way?

Supplementary table 3 compares the measurement methods used to assess digital skills within large global surveys. MICS Surveys were implemented by trained enumerators and respondents were asked about their self-reported practice using a series of “Have you ever…[insert task]”.The primary limitation is that interviewers do not evaluate demonstration of these skills and proficiency is self-reported. This can lead to overestimation of expertise among respondents of lower education or those who may not be entirely familiar with the skills.

Our sub-group analysis of MICS-6 data reveals inconsistencies in estimates by wealth mainly caused by an over-representation of those in the richer categories (Supplementary figure 7.1-7.2). In Supplementary figure 5, the proportion of computer/tablet users who report having ever programmed a computer is presented for those with and without education. Estimates from Benin, Samoa, and Tonga, suggest that those with no education report a higher or similar level of programming than those with. These inconsistencies may be attributed to the small sample size within sub-groups and low response rates due to device filtering, but additionally also indicate a need for better methods of assessing these skills. Supplementary figures 6.1-6.4 highlight similar concerns for other skills, as well as comparisons between richest and poorest wealth quintiles.

How might we improve the measurement of digital skills in LMICs?

Efforts to cognitively assess MICS-7 questions in Kenya and Nigeria raise important concerns about the next iteration of digital skills questions proposed for implementation. Our team conducted 180 cognitive interviews (90 per country) in Kenya and northern Nigeria. The interviews in Kenya tested questions in Kiswahili and included nine respondents in urban slums of Nairobi and 81 rural respondents in Kajiado County, Makueni County and Murang’a County. The interviews in Nigeria tested questions in Hausa and included nine respondents in urban slums of Kano city and 81 rural respondents in three districts near Kano city: Kano North, Kano Central and Kano South.

Respondents in both countries oversampled those with lower education levels and included a balance of smartphone and basic phone users. Our findings are summarized in table 3, below.

Table 3. Issues in skill measurement identified through cognitive interviewing in Kenya and Nigeria

Issue	Explanation	Example of the issue	Proposed solution
1. Problematic recall expectations	Skill questions that ask respondents to recall whether they have performed activities over long periods of time may be difficult for respondents to answer, particularly for routine or non-memorable activities. Placing activities within a predetermined time horizon (e.g., "Within the last three months have you...?") is cognitively burdensome. It is easier for respondents if they can anchor their activities to time periods that are meaningful to them (i.e., "I did it last week")	"I will now ask you about activities that you may have done on a computer or phone during the last 3 months. Did you... Create an electronic presentation with presentation software, including text, images, sound, video, or charts?"	A) Have you ever created a presentation (i.e. Microsoft PowerPoint) with text, images, audio or and video? B) [If, yes] When was the last time you did this?
2. Preamble and stem and leaf style questions are not well retained	In questions with preambles and stem and leaf style construction, many respondents did not retain the preamble or stem. Key information in the preamble and stem should be integrated so that each "leaf," or sub-question, serves as a stand-alone question.	In the above example, as the enumerators proceeded through the "leaf" sub-questions, the respondents did not recall that they were being asked about whether they had done the activity in the last three months.	See above.
3. Overly long and complex question structures	Respondents struggle to retain multiple clauses and lose track of what the question is asking.	"Did you… Use a copy and paste tool to duplicate or move data, information, and content in digital environments, for example within a document, between devices, or on the cloud?"	"Have you ever used a copy and paste tool/function?" Note: we found that respondents who had used the copy/paste function did not need examples, while those who had never used the function found the examples confusing.
4. Separating having done an activity on one's own versus only with assistance	Some respondents considered themselves to have performed skills when in fact they could only perform the skill with another person's assistance. Binary response options (yes/no) allowed accurate reporting for activity completion but over reporting for the possession of the digital skills necessary to do the activity.	Did you... Use a basic arithmetic formula in a spreadsheet? 1. Yes 2. No	A) Have you ever used any formula on a spreadsheet, for example on Excel, on a mobile phone or computer? 1. Yes 2. No 9999. Don't know/Refused/I don't

			understand B) [If, yes] Have you used any formula on a spreadsheet on your own or only with help/assistance? 1. Done this on your own 2. Done this only with help/assistance Note: Mentioning brand names related to spreadsheets (e.g., Excel anchored the question. Also, reiterating "on a computer or a phone" was helpful for this question to remind respondent that we are focused on digital skills
5. Avoid computer-centric language	Questions must use common and easily understood words for activities on computers *and* phones. Sometimes, different words are used for activities on computers versus on phones.	"Did you… Send a message, for example by e-mail, messaging service, or SMS, with an attached file, for example a document, picture, or video?" Note: Although people commonly refer to sending emails "with attachments," they do not refer to sending messages/SMS "with attachments."	"Have you ever added a text file, picture, or video to an email or message?" Note: We have also reduced the number of clauses; respondents tended to think the original question was asking whether they had sent a message, rather than whether they had sent an attachment.
6. Measure one skill per question	Attempting to measure multiple skills in one question leads to overly long sentences and can confuse respondents. Each question should measure one skill.	"Did you… Set up effective security measures, for example strong passwords or log-in attempt notification, to protect devices and online accounts?" Note: We also suggest removing the words such as "strong", "effective" from the original, since respondents may not know what this means, and these are subjective variables, which will be. difficult to interpret.	Have you ever created or changed a password or lock (e.g. PIN, finger print, face recognition) on your phone, computer (desktop), laptop or tablet? Have you ever changed a password on an online account (e.g. Facebook, Instagram or Email password)? Note: We have also separated the

			questions for changing password on a device and online account.
7. Remove questions as they become obsolete due to technology advancement	Some ICT skills are increasingly irrelevant due to technology and regulatory advances. For instance, asking about setting “strong” passwords may be increasingly irrelevant as devices and accounts create pre-set parameters that require the use of letters, numbers and symbols. It is no longer a skill to set a strong password if the device or account simply refuses to accept weak passwords.	“Did you... Transfer a file or application between a computer and other device?”	[Consider removing] There is already a question about sending files, pictures or videos (above). Transferring files between devices on USB keys or disks is no longer commonplace; the special skills required for these transfers are no longer worth measuring. Note: Concept of "between two devices" is a more modern update, because most people are transferring files between phones.
8. Prioritize measurable and fundamental skills for participation in modem society	Questions that assess special skills not required for engagement in most employment or communication should be deprioritized. Questions that have ambiguous outcome interpretation should be deprioritized.	“Did you... Write a computer program using a specialised programming language, including programming or coding in digital environments, for example computer software or app development?	Have you ever written a computer program? Note: Programming is not a widely needed skill to leverage the advantages of digital technology; maybe it it is a low priority to assess this skill

Our first finding was the use of problematic recall expectations. The MICS-7 questions invite respondents to consider whether they have conducted activities within the last three months. Respondents reflected that recalling ICT activities over such a long-time horizon was not feasible, given that activities on the computer or mobile are not very memorable. The preamble to the MICS-7 skills questions (“I will now ask you about activities that you may have done on a computer or phone during the last 3 months.”) was not retained by respondents; after reading this preamble and then proceeding through the questions, respondents rapidly forgot that they were being asked to recall activities within the last three months. We recommend asking respondents if they have ever done each activity and then asking them when they last did the activity. The enumerator can then place the response in the appropriate category.

Our second finding was the use of overly long and complex question structures. For example, MICS-7 includes the question: “Did you… Use a copy and paste tool to duplicate or move data, information, and content in digital environments, for example within a document, between devices, or on the cloud?” We found that respondents were unable to retain so many clauses and rapidly lost track of what the question was asking. Moreover, we found that respondents who had used the copy/paste function did not need examples while those who had never used the function found the examples confusing. We recommended simplified questions. For instance, the example above could be simplified as: “Have you ever used a copy and paste tool/function?”

Our third finding was the importance of separating having done an activity by one's self versus having done the activity only with assistance. We found that the binary response option in MICS-7 (yes/no) allowed respondents who had only ever done an activity with assistance to report "yes", which over reports ICT skills. We have thus recommended to add a sub question, if respondent report "yes" with the response options "1. Done this on your own / 2. Done this only with help/assistance /." The example is shown in the table 3.

Our fourth finding was the importance of using easily understood words for activities on the computer and phone. MICS-7 skill questions accommodate activities on phones. However, the language is still computer-centric. For example, MICS-7 asks "Did you… Send a message, for example by e-mail, messaging service, or SMS, with an attached file, for example a document, picture, or video?" Although people commonly refer to sending emails with attachments, they do not refer to sending messages/SMS with attachments. Instead, people think about attachments by messages/SMS as "sending photos, videos, images, etc." not as sending attachments. (Respondents also did not absorb the question's focus due to the length and number of clauses. They tended to think the question was asking whether they had sent a message, rather than understanding that the question was asking whether they had sent an attachment.) We recommend modifying the question to reflect the language used: "Have you ever added a text file, picture, or video to an email or message?"

Our fifth finding was the need to assess only one skill per question. In the above example, on sending attachments, respondents are asked about two fairly distinct skills, which require different processes: sending an email with attachments and sending documents, images or videos by messages/SMS. We have suggested that the question focus on the skill of attaching files/uploading files rather than sending emails or messages to which files are attached/uploaded to differentiate the skill of adding attachments from the skill of forwarding emails that have attachments or forwarding messages that contain images or files. Another question asks "In the last three months did you… Set up effective security measures, for example strong passwords or log-in attempt notification, to protect devices and online accounts?" Setting a password and setting a log-in attempt notification are distinct activities.

Conclusion

Global surveys should consider digital skills questions which accommodate mobile phones as the predominate technology used in low- and middle-income countries. This mobile first approach will cover the right people, those whose lives are expected to change for the better with improving technology. Excluding them disproportionately represents higher socio-economic status (SES) groups, leading to estimates that may not accurately reflect the target populations. By asking about the "right technology" and including mobile phone-based skills, we can achieve a more inclusive and representative measurement of digital competencies.

The update to ITU's ICT module from 2020 which is to be implemented in MICS-7 to accommodate digital skills assessment amongst mobile phone and computer users are promising in that they will include a far greater proportion of the population, particularly among women. The current approach of assessing digital skills, which relies heavily on self-reported data, introduces potential biases and inaccuracies. The survey may benefit from modifications to the language recommended based on cognitive interviews in Kenya and Nigeria. Further discussions are needed on the framing of and composition of SDG 4.4.1.

Summary Points:

- Current global surveys are mostly focused on measuring computer specific skills with little to no emphasis on mobile or device agnostic skills.
- ICT module in MICS-6 only covered those who have reported using a computer in the last 3 months, thereby excluding a large proportion of the sample population.
- The ICT module in MICS-7 updated the questionnaire to be more descriptive and device agnostic and added questions on type of phone.
- A mobile first approach in ICT skills measurement is needed since mobile coverage far outweighs computer ownership in LMICs and is a primary device for internet access for many.

- Indicator architecture should be informed by qualitative methodologies to ensure superior data quality.

References:

1. DigComp Framework - European Commission [Internet]. [cited 2024 Mar 3]. Available from: https://joint-research-centre.ec.europa.eu/digcomp/digcomp-framework_en

2. Vuorikari R, Kluzer S, Punie Y. JRC Publications Repository. 2022 [cited 2024 May 2]. DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes. Available from: https://publications.jrc.ec.europa.eu/repository/handle/JRC128415

3. Pagani L, Argentin G, Gui M, Stanca L. The impact of digital skills on educational outcomes: evidence from performance tests. Educational Studies. 2016 Mar 14;42(2):137–62.

4. Livingstone S, Mascheroni G, Stoilova M. The outcomes of gaining digital skills for young people's lives and wellbeing: A systematic evidence review. New Media & Society. 2023 May 1;25(5):1176–202.

5. Dalloshi P, Kyqyku D. Digital skills as an impetus for the acceleration of economic digitalization: EU perspective. Corporate Governance and Organizational Behavior Review. 2023 Aug 22;7:365–74.

6. Anna Alejo, Haogen Yao, Bassem Nasir, Rachel Cooper, Manuel Cardoso. Innovative tools help fill data gaps on skill development [Internet]. 2022 [cited 2024 Feb 25]. Available from: https://www.unicef-irc.org/evidence-for-action/innovative-tools-help-fill-data-gaps-on-skill-development

7. Lani Jacobs, Isabelle Carboni, Bryce Hartley, Dominica Lindsey, Claire Sibthorpe, Melle Tiel Groenestege. Developing mobile digital skills in low- and middle-income countries [Internet]. GSMA; 2021 Nov [cited 2024 May 2]. Available from: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2021/11/Developing-mobile-digital-skills-in-low-and-middle-income-countries.pdf

8. United Nations. United Nations. [cited 2024 Feb 25]. Goal 4 | Department of Economic and Social Affairs. Available from: https://sdgs.un.org/goals/goal4#targets_and_indicators

9. ITU [Internet]. [cited 2024 May 22]. About ITU. Available from: https://www.itu.int:443/en/about/Pages/default.aspx

10. ITU [Internet]. [cited 2024 May 22]. About the ITU-D and the BDT. Available from: https://www.itu.int:443/en/ITU-D/Pages/About.aspx

11. Khan S, Hancioglu A. Multiple Indicator Cluster Surveys: Delivering Robust Data on Children and Women across the Globe. Stud Fam Plann. 2019 Sep;50(3):279–86.

12. Manual for measuring ICT access and use by households and individuals - 2014 Edition [Internet]. International Telecommunication Union; 2014. Available from: https://www.itu.int/en/ITU-D/Statistics/Pages/publications/manual.aspx

13. Manual for measuring ICT access and use by households and individuals - 2020 Edition [Internet]. International Telecommunication Union; 2020. Available from: https://www.itu.int/en/ITU-D/Statistics/Pages/publications/manual.aspx

14. National Bureau of Statistics (NBS) and United Nations Children's Fund (UNICEF). Multiple Indicator Cluster Survey 2021, Survey Findings Report. [Internet]. Abuja, Nigeria: National Bureau of Statistics and United Nations Children's Fund; 2022 Aug [cited 2024 Feb 25]. Available from: https://mics-surveys-prod.s3.amazonaws.com/MICS6/West%20and%20Central%20Africa/Nigeria/2021/Survey%20findings/Nigeria%202021_MICS_SFR_English.pdf

15. Anne Delaporte, Kalvin Bahia. The State of Mobile Internet Connectivity Report 2022 [Internet]. GSMA; [cited 2024 Mar 6]. Available from: https://www.google.com/url?q=https://www.gsma.com/r/wp-content/uploads/2022/12/The-State-of-Mobile-Internet-Connectivity-Report-2022.pdf&sa=D&source=docs&ust=1709770230731458&usg=AOvVaw2qCW4Gv20Dtk2X_xaFZEQQ

16. Vuorikari, R., Jerzak, N., Karpinski, Z., Pokropek, A., Tudek, J. Measuring digital skills across the EU: digital skills indicator 2.0. [Internet]. LU: Publications Office; 2022 [cited 2024 Jun 6]. Available from: https://data.europa.eu/doi/10.2760/897803

17. Quantitative tools | Global Kids Online [Internet]. [cited 2024 Jun 6]. Available from: http://globalkidsonline.net/tools/survey/

18. G20 Toolkit for Measuring Digital Skills and Digital Literacy: Framework and Approach [Internet]. [cited 2024 Jun 6]. Available from: https://www.csis.or.id/publication/g20-toolkit-for-measuring-digital-skills-and-digital-literacy-framework-and-approach/

19. Layton R. Allconnect. 2023 [cited 2024 Mar 2]. Can You Use Your Cell Phone as Home Internet and Cut the Cord? Available from: https://www.allconnect.com/blog/using-phone-data-for-home-internet

20. Isabelle Carboni, Nadia Jeffrie, Dominica Lindsey, Matthew Shanahan, Claire Sibthorpe. GSMA – Connected Women – The Mobile Gender Gap Report 2021 [Internet]. GSMA; 2021 [cited 2024 Mar 2]. Available from: https://www.google.com/url?q=https://www.gsma.com/r/wp-content/uploads/2021/07/The-Mobile-Gender-Gap-Report-2021.pdf&sa=D&source=docs&ust=1709770230731045&usg=AOvVaw0QLaJMnuVspLiGqgHVGuxY

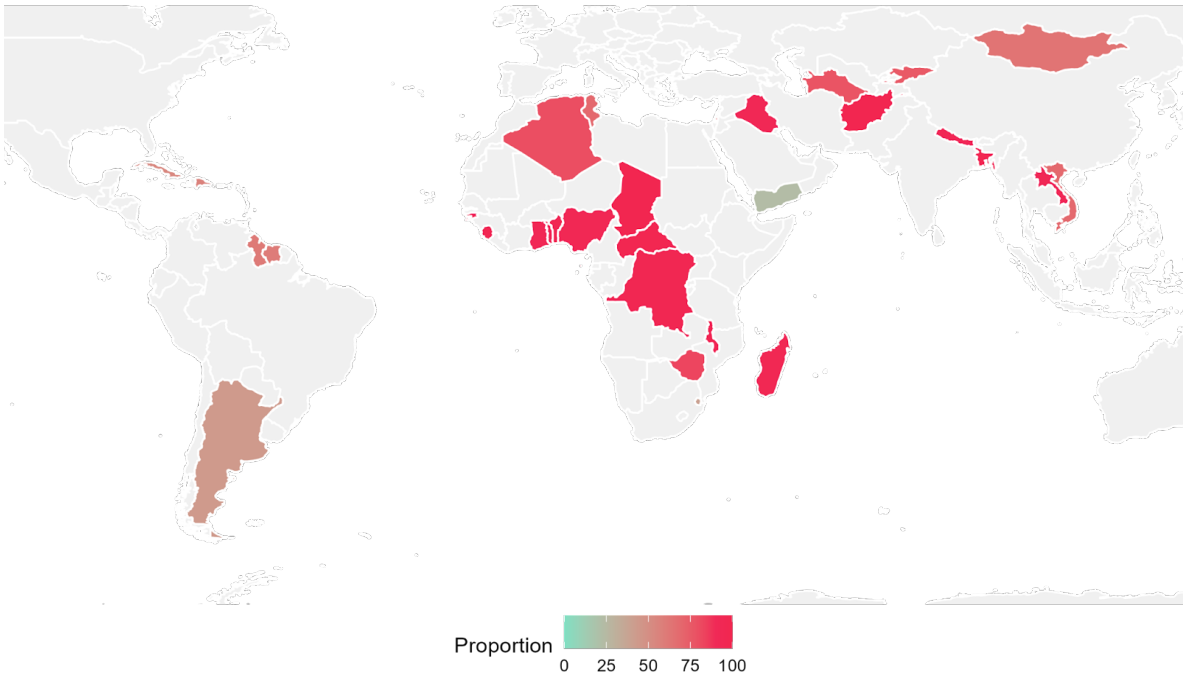
21. Nadia Jeffrie, Kalvin Bahia, Dominica Lindsey, Anna-Noémie Ouattara Boni, Claire Sibthorpe, Jakub Zagdanski. The Mobile Gender Gap Report 2024 [Internet]. London: GSMA; 2024 May [cited 2024 Jul 5]. Available from: https://www.gsma.com/r/wp-content/uploads/2024/05/The-Mobile-Gender-Gap-Report-2024.pdf?utm_source=website&utm_medium=button&utm_campaign=gender-gap-2024

22. Zavazava DCL. Global Digital Regulatory Outlook 2023.

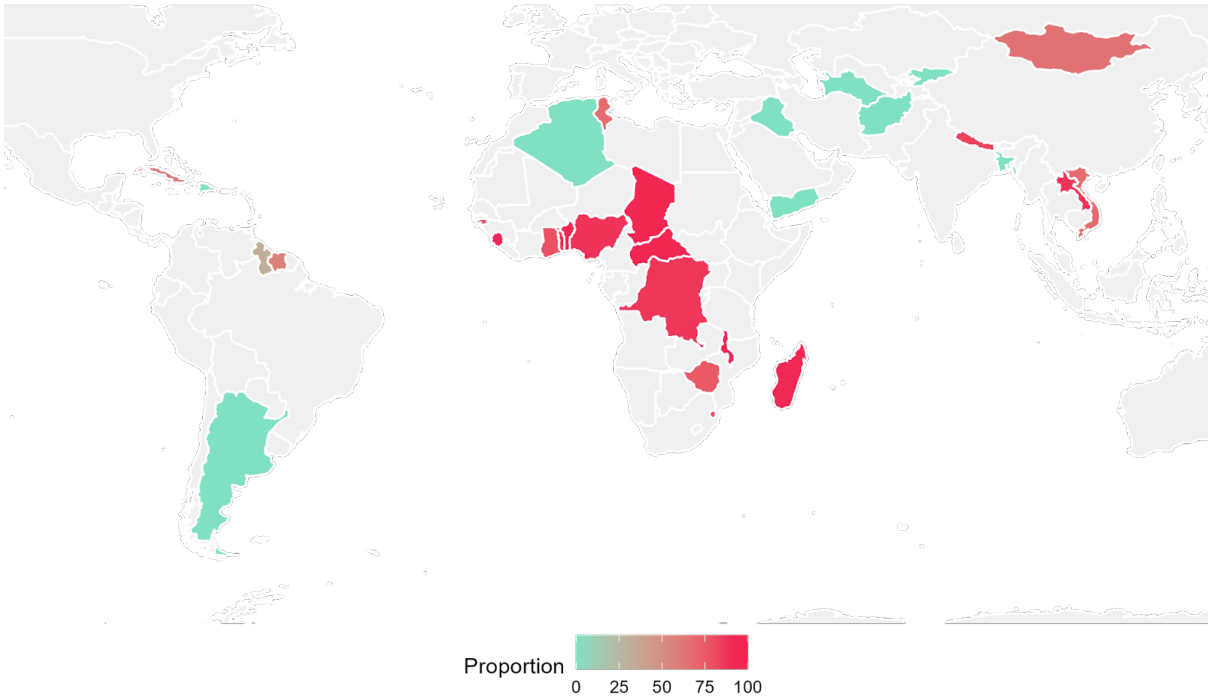
23. Suguru Mizunoya, Sakshi Mishra, Diogo Amaro, Cecilia Venturini. UNICEF DATA. 2019 [cited 2024 Feb 25]. ICT skills divide: Are all of today's youth prepared for the digital economy? - UNICEF Data for Action Blog. Available from: https://data.unicef.org/data-for-action/ict-skills-divide-todays-youth-prepared-digital-economy/

Supplementary:

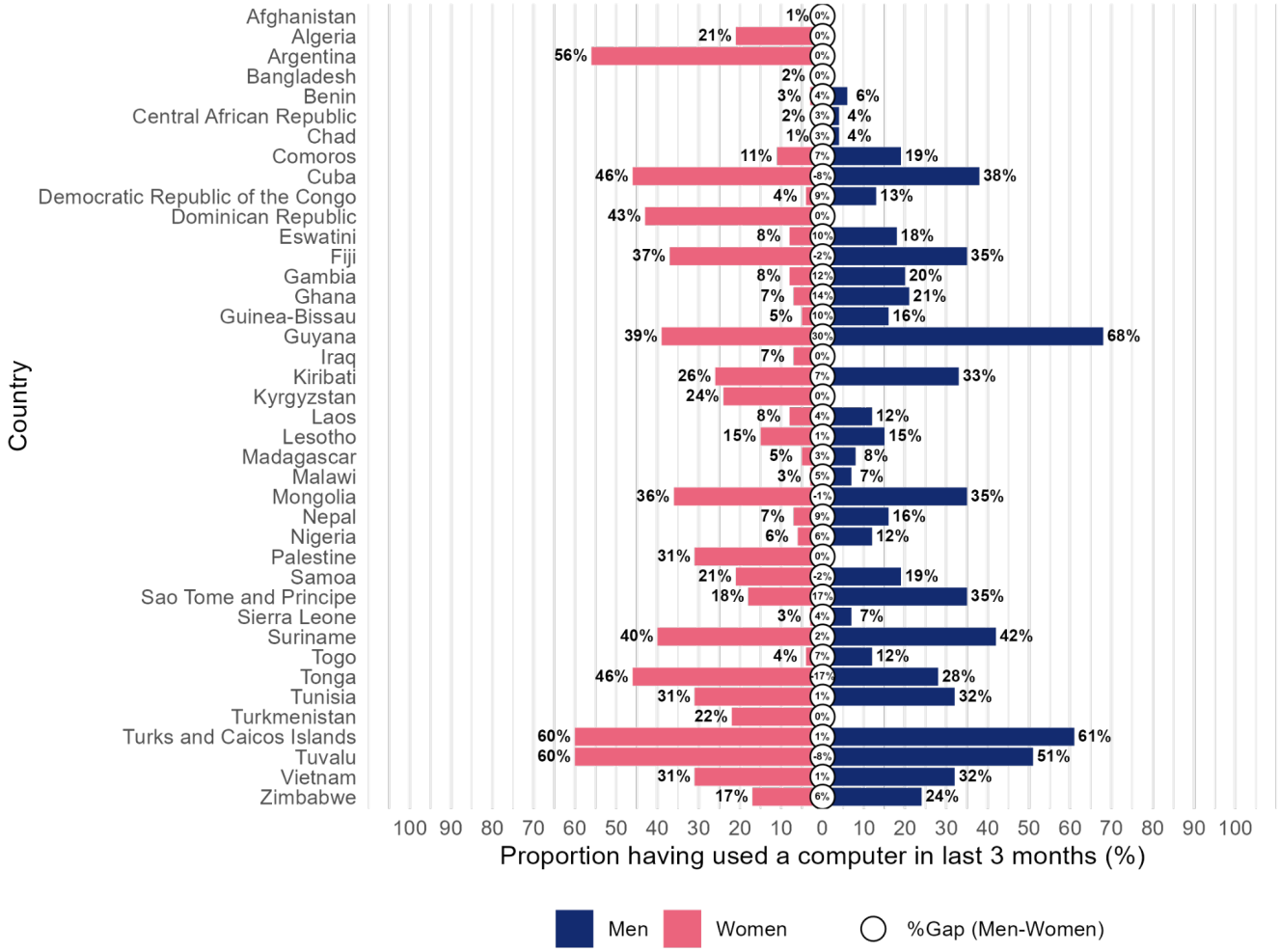
Supplementary Figure 1.1. Geographical representation of proportion of women who have not used a computer in the last 3 months (Ineligible for ICT Module)



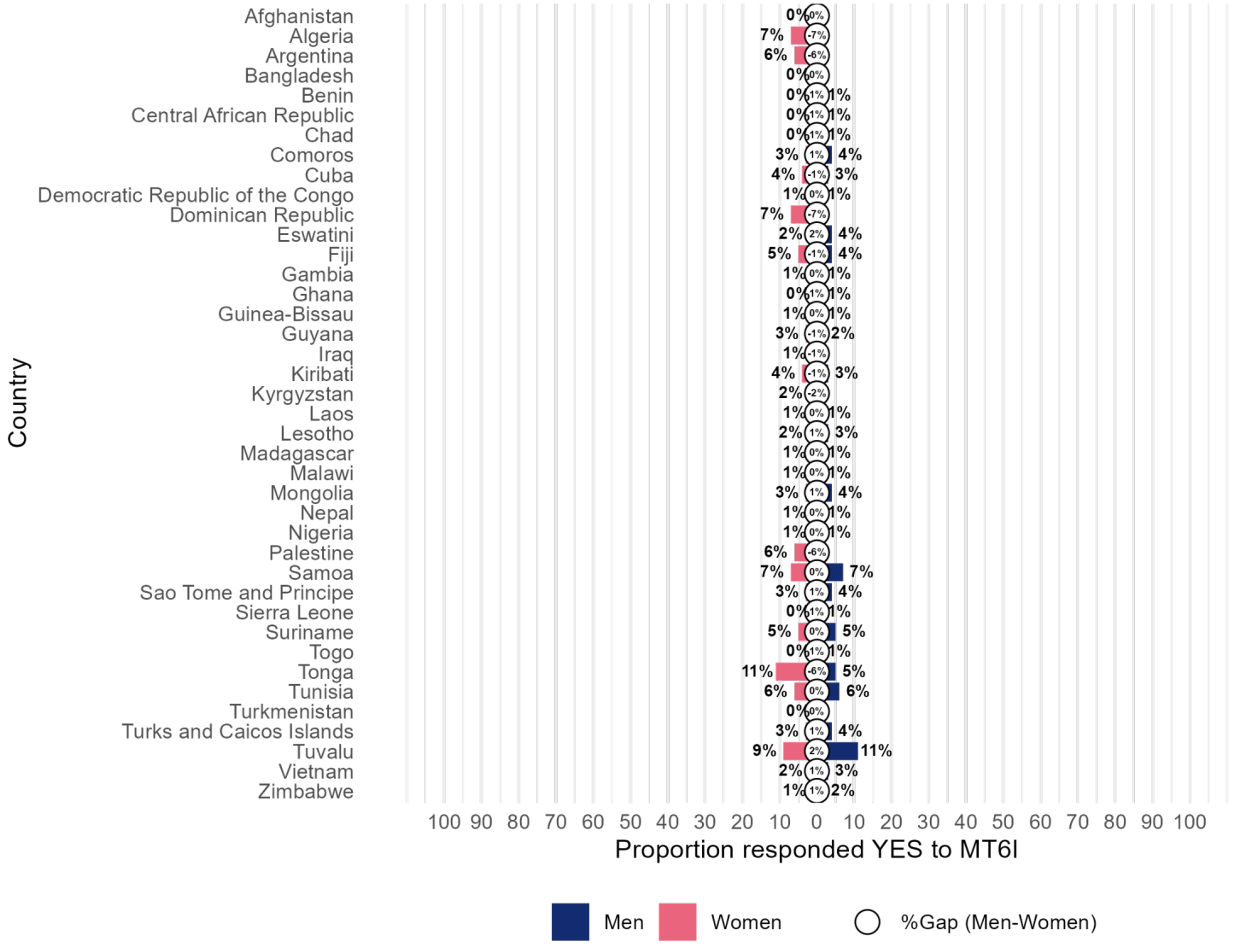
Supplementary Figure 1.2. Geographical representation of proportion of men who have not used a computer in the last 3 months (Ineligible for ICT Module)



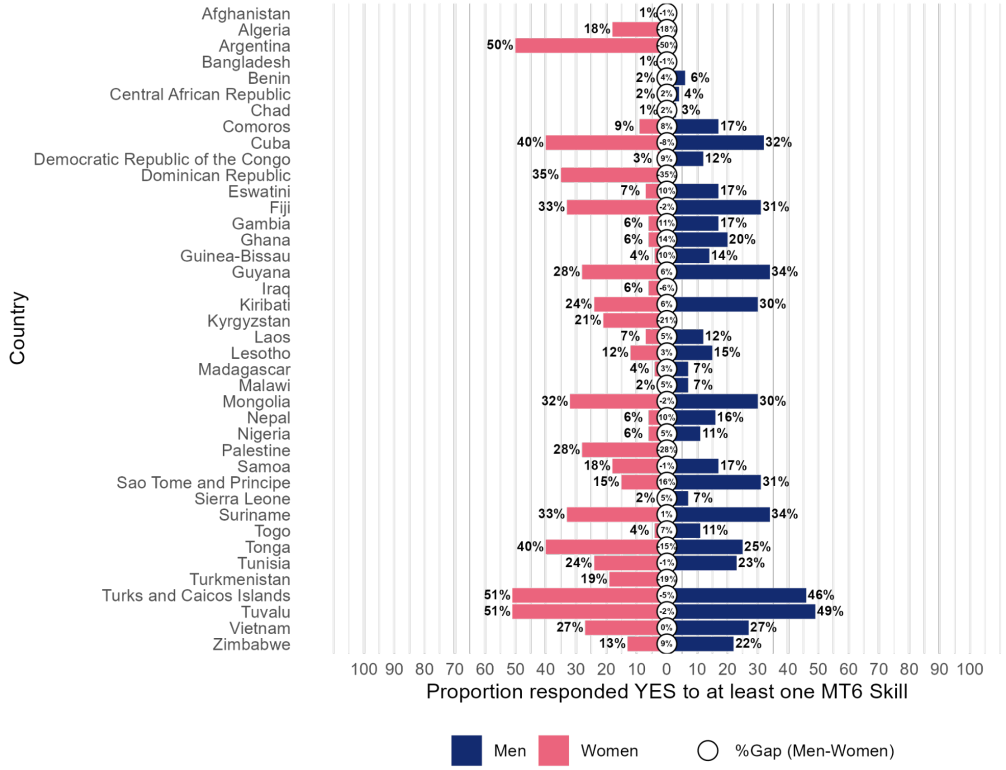
Supplementary Figure 2. National proportion of men and women 15-49 years who report ever use of a computer in preceding 3 months across 40 MICS-6 countries



Supplementary Figure 3. Proportion reported YES to MT6I: Have you written a computer program in any language by gender



Supplementary Figure 4. Proportion reported YES to at least one of the MT6 Skills by gender



Supplementary Figure 5. National proportion of women who responded "Yes" to MT6I "Have you ever written a computer program in any language" among all participants

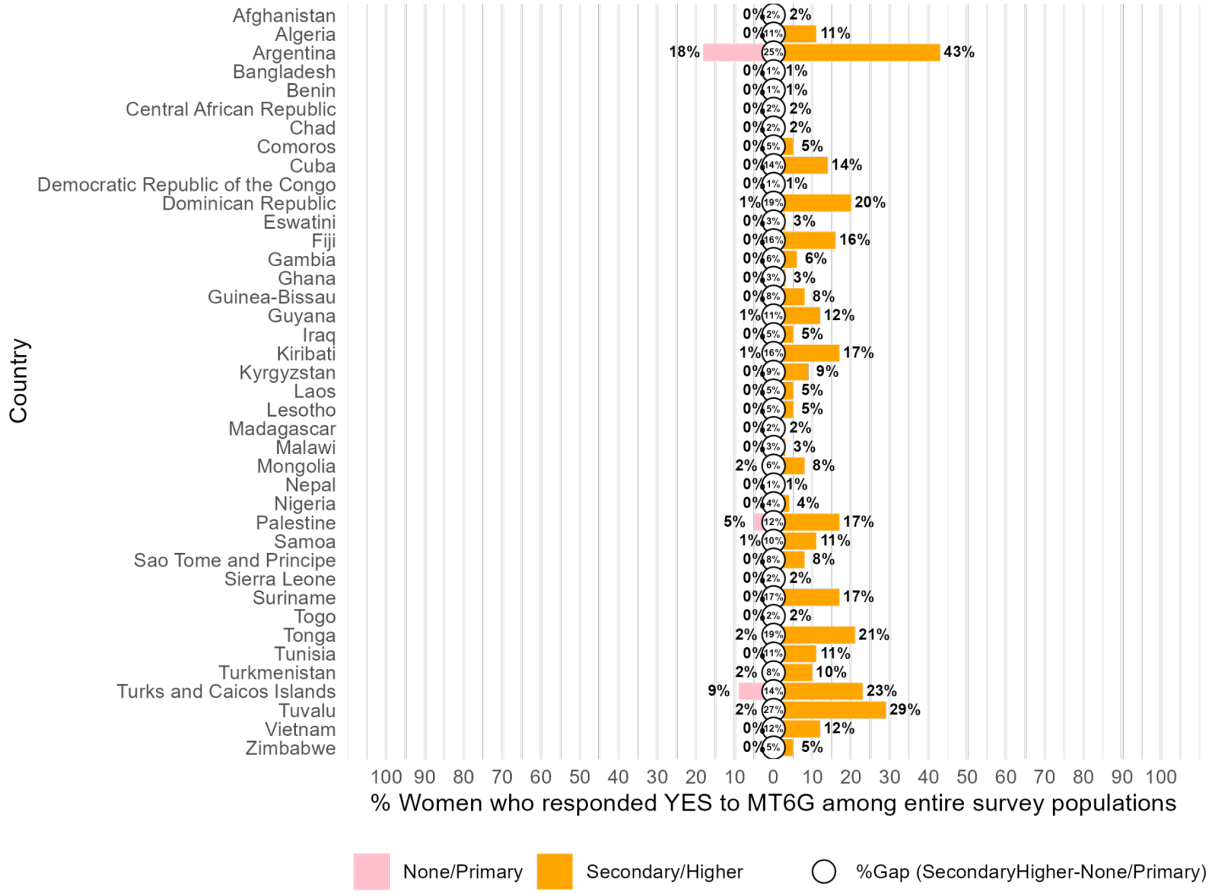


Figure 6.1. National proportion of women who responded "Yes" to MT6I - "Have you ever written a computer program in any language" among those who used a computer in the last 3 months.

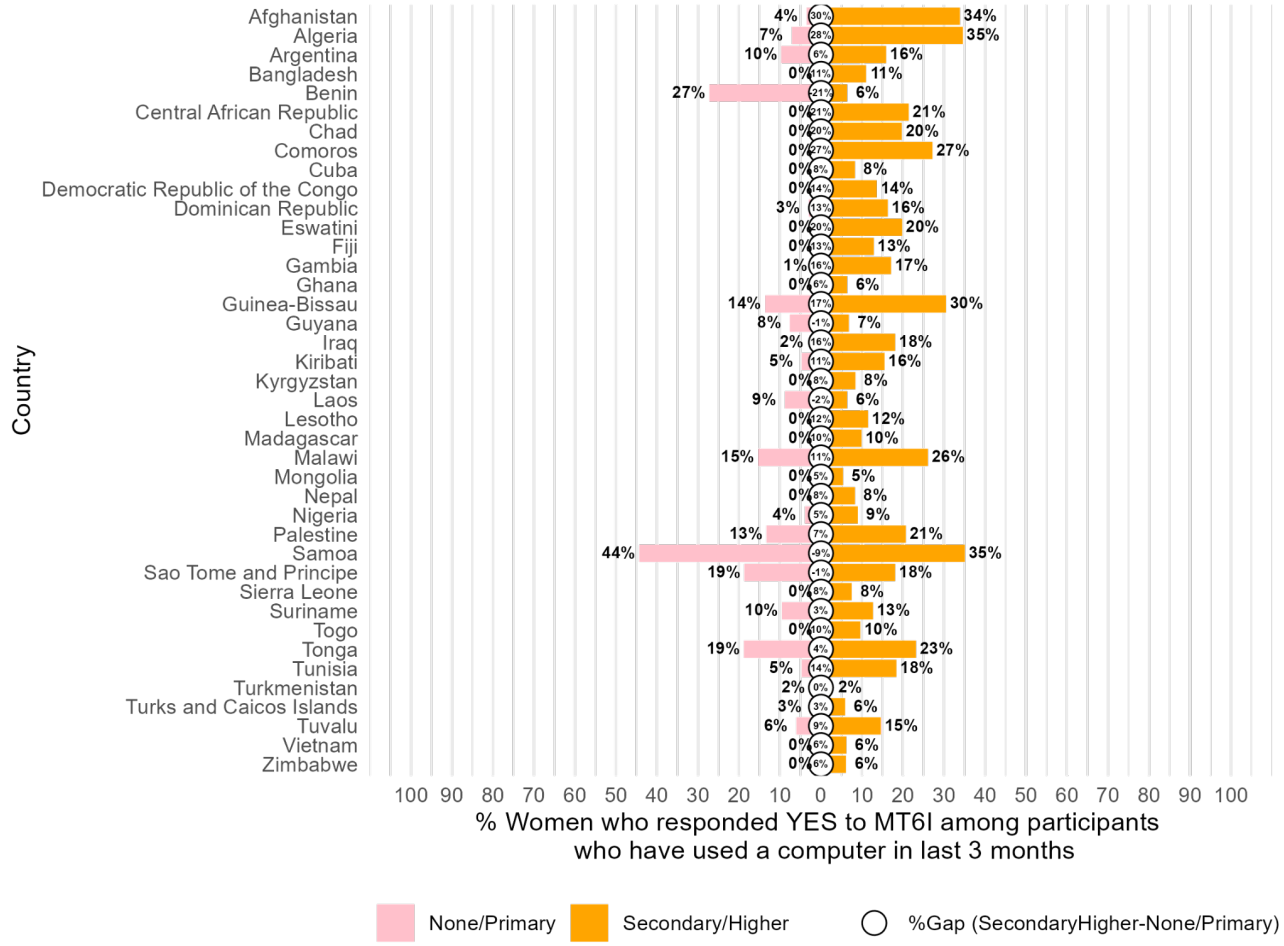


Figure 6.2. National proportion of women who responded “Yes” to MT6G - “Have you ever created an electronic presentation in the last 3 months” by education

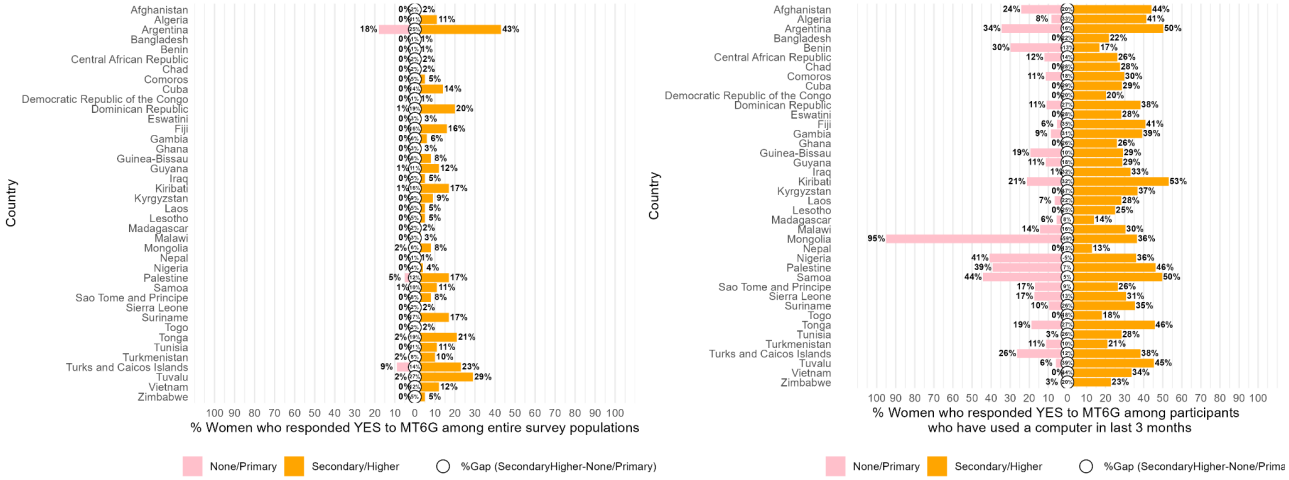


Figure 6.3. National proportion of women who responded “Yes” to MT6I - “Have you ever written a computer program in any language” by wealth

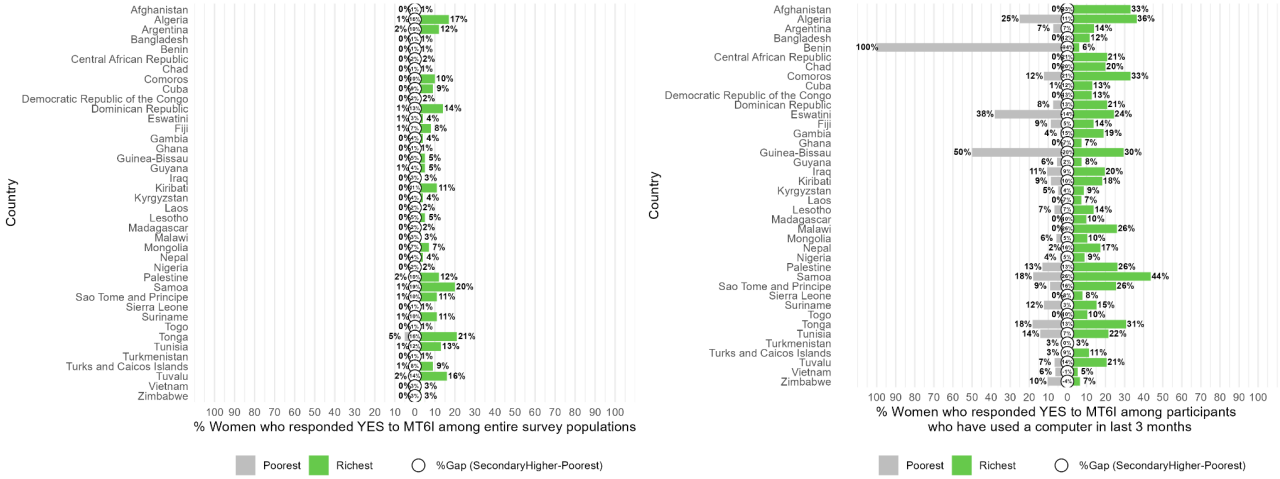


Figure 6.4. National proportion of women who responded "Yes" to MT6G - "Have you ever created an electronic presentation in the last 3 months" by wealth

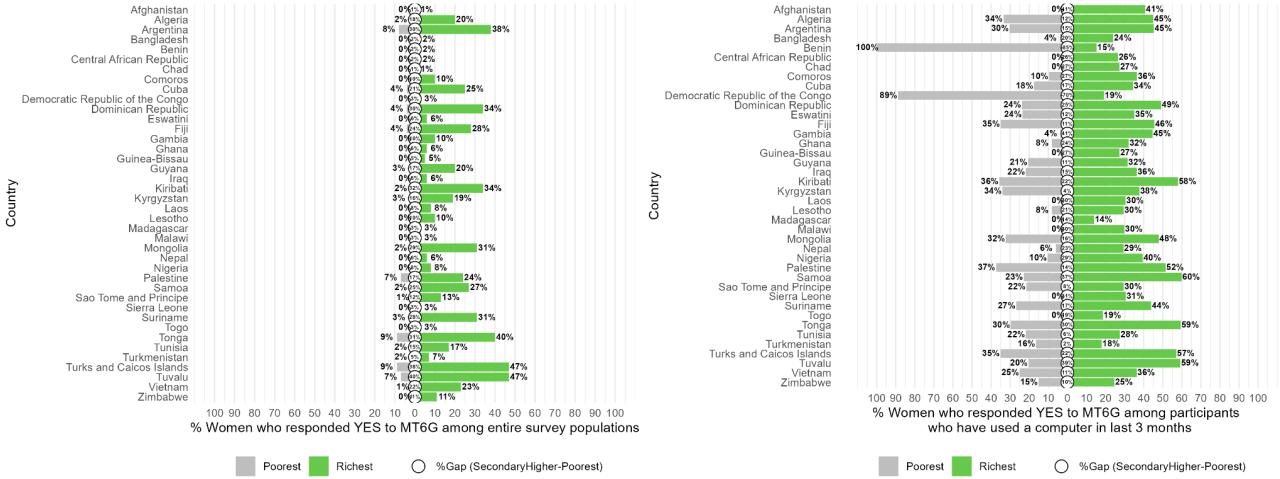


Figure 7.1. Subgroup analysis of selected skills from Nigeria MICS-6 data

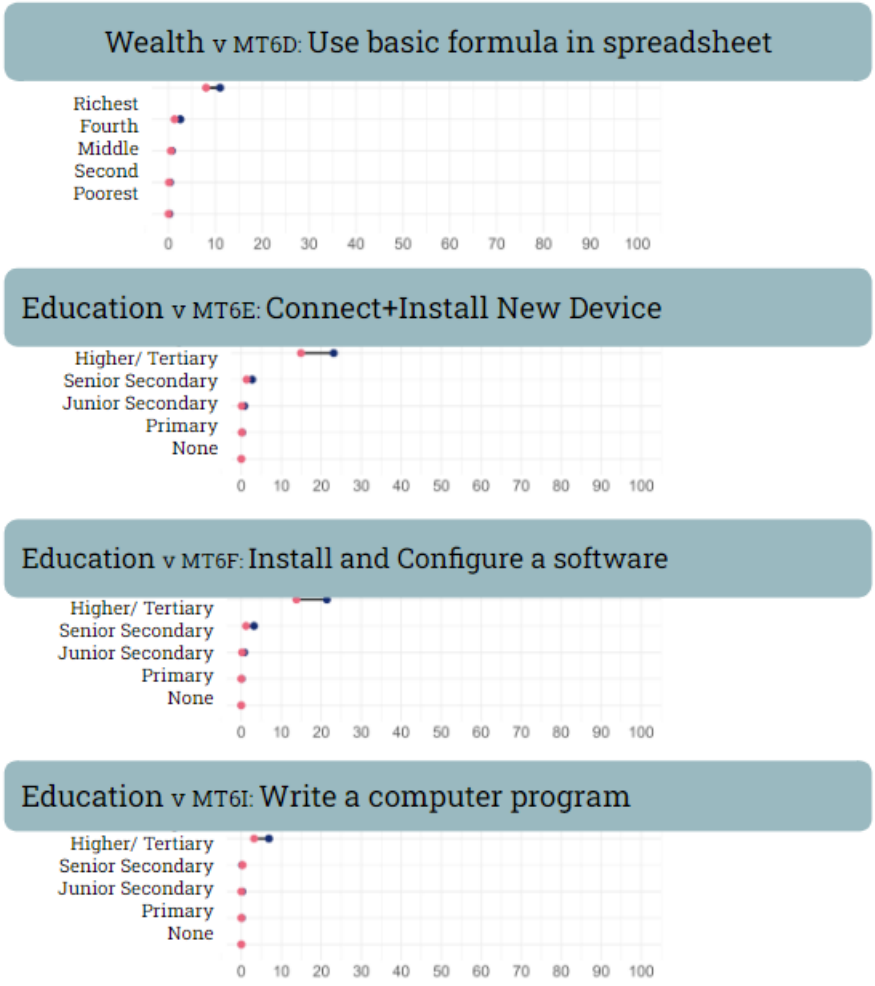
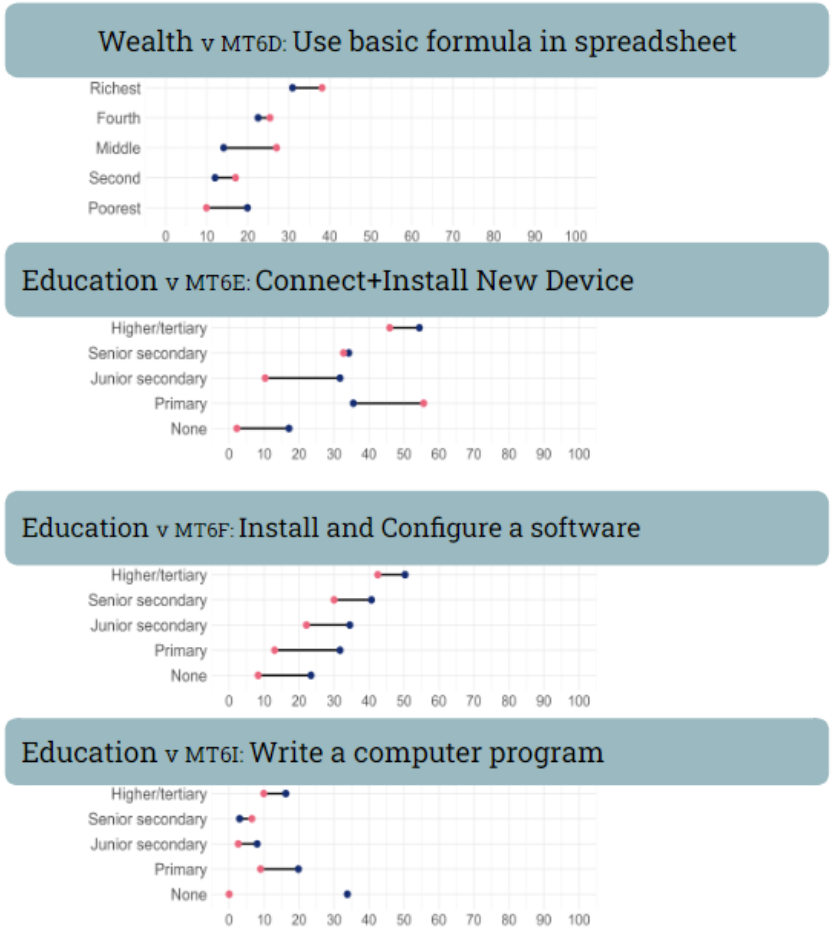


Figure 7.2. Subgroup analysis of selected skills from Nigeria MICS-6 data



Supplementary Table 1. Digital competencies measured in global surveys

DigComp 2.2 Competency Area	Competency	Sub-competences	DigCompSAT (MyDigiSkills)	Eurostat	Global Kids Online	MICS 7	The Digital Competence Wheel	GSMA Mobile digital Skills Module 2020
Information and data literacy	Searching for information through search engines	Using suitable keywords for online searches			x		x	x
		Taking advantage of advanced features of a search engine	x					
		Making use of search filters to limit the number of search results					x	
	Searching for information online	Doing an in-depth search for information and the digital footprints of oneself and others					x	
	Checking for truthfulness / trustworthiness / credibility / reliability of information online	Checking for truthfulness / trustworthiness / credibility / reliability of information online		x	x	x		
				x	x			
	Identifying the purpose of an online information source	Identifying the purpose of an online information source	x					
	Finding a website visited before	Finding a website visited before	x					
	Referencing the source of documents	Referencing the source of documents	x					

	Finding a website visited before	Finding a website visited before			x			
	Organizing digital content	Organizing digital content	x					
	Storing digital content	Choosing the most appropriate format to store data					x	
		Using databases to store large amounts of data					x	
	Copying and moving files	Copying and moving files between folders, devices or on the cloud	x	x		x		
	Managing and analyzing data	Managing and analyzing data using software (e.g. sorting, filtering, calculations)	x	x				
	Opening a tab in a browser	Opening a tab in a browser			x			
	Configuring the settings in the internet browser	Configuring the settings in the internet browser	x					
Communication and Collaboration	Using email for communication	Sending, replying and forwarding e-mails.	x			x		
	Using communication tools and services	Using advanced videoconferencing features	x					
	Communicating through written language	Communicating through written language					x	
	Sharing content	Change who you share content with	x		x			

	Using cloud services	Using cloud services to share files	x					
	Applying for a job using digital platform	Applying for a job using digital platform	x					
	Editing shared documents	Editing shared, online documents	x					
	Collaborating on shared documents	Inviting others and giving appropriate permissions to collaborate on a shared document	x					
	Creating a profile in digital environments	Creating a profile in digital environments for personal or professional purposes	x					
	Evaluating the recipients and carefully tailor the communication accordingly	Evaluating the recipients and carefully tailor the communication accordingly					x	
	Creating communities and making new friends online	Making new friends online	x					
Digital content creation	Creating and editing digital text files	Creating and editing digital text files	x					
	Expressing by creating digital content on the internet	Expressing by creating digital content on the internet	x					
	Producing multimedia content	Producing multimedia presentations with text, images, audio and video elements	x			x	x	

	Creating a photo/video on a mobile phone that you shared with several people at the same time	Creating a photo/video on a mobile phone that you shared with several people at the same time						x
	Creating files	Creating files (e.g. document, image, video) incorporating several elements, e.g. text, picture, table, chart, animation, sound		x				
	Creating new digital content	Creating something new from different types of content	x		x			
	Editing digital content	Editing or making changes to digital content that others have created	x	x	x			
		Editing media such as photos/videos/documents or other files on a mobile phone						x
	Detecting illegally available digital content	Detecting illegally available digital content	x					
	Using / writing computer programs for specialised tasks	Creating content or enhance functionalities through advanced use of programming					x	
		Using a programming language			x			
		Writing a computer program using a specialised programming language	x	x		x		
	Using spreadsheet	Using spreadsheet		x		x		

	Using word processing software	Using word processing software		x				
	Posting self-created videos / music online	Posting online a video or music that you have created yourself			x			
	Designing a website	Designing a website			x			
	Choosing the most suitable type of media (e.g. text, photo, video, animation etc.) to achieve the desired result	Choosing the most suitable type of media (e.g. text, photo, video, animation etc.) to achieve the desired result					x	
Safety	Reporting negative content relating to you or a group to which you belong	Reporting negative content relating to you or a group to which you belong			x			
	Configuring the settings of a firewall on different devices	Configuring the settings of a firewall on different devices	x					
	Making backup and recovering digital information and other content from backup	Making backups and restoring data on all relevant digital devices					x	
		Recovering digital information and other content (e.g. photos, contacts) from a backup	x					
	Restricting or refusing access to my geographical location	Restricting or refusing access to my geographical location	x					

	Checking if the website asking for personal data is secure	Checking if the website asking for personal data is secure	x					
	Protecting oneself from malicious online encounters	Protecting oneself from malicious online encounters	x					
	Identifying phishing and malware	Identifying phishing and malware					x	
	Using digital technologies in a more environmentally friendly ways	Reducing the energy consumption of devices	x					
	Setting up and / or changing security / privacy measures	Setting up effective security measures to protect devices and online accounts				x		
		Setting a password or PIN for a mobile phone						x
		Changing privacy settings on your device, account, or app to limit the sharing of personal data and information				x		
		Changing app security/privacy permissions on a mobile phone from the default settings						x
		Encrypting, password-protecting or otherwise securing access to data when it is sent or stored					x	
	Differentiating between personal information and sensitive data	Differentiating between personal information and sensitive data					x	

	Addressing online messages and behaviors that attack groups or individuals	Recognising online messages and behaviors that attack certain groups or individuals	x					
		Developing strategies for handling the improper behaviour of others					x	
	Differentiating between inappropriate and illegal behavior	Differentiating between inappropriate and illegal behavior					x	
Problem solving	Finding solutions to technical problems	Being able to find solutions on the Internet for technical problems	x					
		Editing the configurations of the operating system of your digital devices to solve technical problems	x					
		Using data tools that manage and organize complex information to make decisions and solve problems	x					
		Step-by-step, locating a problem and searching for a solution					x	
	Using technology solutions to address personal or professional needs	Selecting the right tool, device or service to perform a given task	x					
	Using new digital devices and applications	Figuring out new technologies and applications					x	

	Using online learning tools to improve digital skills	Using online learning tools to improve digital skills	x					
	Paying for goods and services online	Paying for goods and services online	x					
Hardware and Software Skills	Downloading, installing and updating software	Downloading or installing software		x				
		Installing and updating all applications					x	
	Changing settings of software, app or device	Changing settings of software, app or device		x			x	
		Changing the settings on a mobile phone to set a limit on its data usage						x
	Keeping track of the costs of mobile app use	Keeping track of the costs of mobile app use			x			
	Making in-app purchase	Making in-app purchase			x			
	Using tools within documents	Using the copy and paste tool to duplicate or move information within a document				x		
	Connecting and installing new devices	Connecting and installing new devices				x		
	Using shortcut keys / hot keys	Using shortcut keys (e.g. CTRL-C for copy, CTRL-S for save)			x			
		Using advanced hotkeys for relevant applications					x	

	Using a mobile phone	Learning different things through a mobile phone						x
		Learning how to do something new on a mobile phone						x
	Using digital self-service options	Knowledge about relevant digital self-service options and understanding how to use them					x	
	Deleting files/apps	Deleting files/apps to ensure sufficient memory/space on a mobile phone						x
	Inserting a SIM card into a mobile phone	Inserting a SIM card into a mobile phone						x

Supplementary Table 2. ICT Skills measured by large global surveys focusing on computer, tablet, mobile phone and device agnostics skills

Global Survey	Computer/Tablet	Mobile Phone	Device agnostic
DigCompSAT	Includes skills about storage options, organizing digital content, copying and moving folders, editing shared documents, configuring settings of a firewall, editing configurations of OS, using programing language		Includes questions on seach engines, checking for truthfulness of information, finding websites, using communication tools, using cloud services, using digital public services, understanding digital identity, creating digital content, understanding privacy and security (applicable to all devices)
Eurostat	Similar to DigCompSAT		Similar to DigCompSAT
Global Kids Online	Similar to DigCompSAT + Designing a website, using shortcut keys (ctrl-c, ctrl-s)	Removing people from contact list, keeping track of costs of mobile app use	Similar to DigCompSAT
MICS 7	Copy or move a file or a folder, send email with attached file, create electronic presentation, write a computer program, use the copy and paste tool within a document		Verifying reliability of information, setup passwords, change privacy settings of devices,
The Digital Competence Wheel	Storing data in appropriate format, use databases to store large amounts of data, creating multimedia (e.g. photoshop), write programs, backing up and restoring data, use advanced hotkeys,		Differentiating between personal information and sensitive data, edit advanced settings on devices e.g. change wifi password,
GSMA Mobile Digital Skills Module 2020		Looking for information on mobile phone, creating photo/video on mobile phone and shared, editing photo/video on mobile phone, setting up a pin for mobile phone, changing settings on a mobile phone, learning new	

		things on mobile phone, inserting a sim in mobile phone	

Supplementary Table 3: National ICT Skills coverage

Women's National Coverage of ICTs										
Country	Atleast one Skill	Copy or move a file or folder (MT6A)	Use a copy and paste tool (MT6B)	Send e-mail with attached file (MT6C)	Use a basic arithmetic formula (MT6D)	Connect and install a new device (MT6E)	Find, download, install and configure software (MT6F)	Create an electronic presentation (MT6G)	Transfer a file (MT6H)	Write a computer program (MT6I)
Afghanistan	0.9%	0.6%	0.6%	0.6%	0.4%	0.3%	0.4%	0.4%	0.6%	0.3%
Algeria	17.8%	15.4%	15.4%	12.4%	8.6%	9.6%	10.5%	8.3%	11.1%	7.4%
Argentina	49.7%	40.8%	40.2%	43.0%	23.1%	26.0%	26.1%	21.5%	33.5%	6.3%
Bangladesh	1.4%	0.9%	0.8%	0.7%	0.4%	0.5%	0.9%	0.4%	0.6%	0.2%
Benin	2.4%	2.0%	1.9%	1.4%	0.9%	0.6%	0.7%	0.5%	1.3%	0.2%
Central African Republic	1.5%	1.2%	1.2%	1.1%	0.7%	0.6%	0.8%	0.5%	0.8%	0.4%
Chad	0.7%	0.5%	0.5%	0.4%	0.2%	0.2%	0.4%	0.3%	0.4%	0.2%
Comoros	9.3%	7.9%	7.4%	6.1%	4.6%	4.0%	4.6%	3.4%	5.8%	3.1%
Cuba	40.4%	35.0%	31.4%	20.9%	12.2%	17.8%	8.2%	13.3%	30.2%	3.8%
Democratic Republic of the Congo	3.2%	2.3%	2.4%	1.6%	1.3%	1.0%	0.9%	0.8%	1.6%	0.5%
Dominican Republic	34.8%	26.2%	26.8%	27.0%	15.0%	16.3%	11.6%	16.0%	18.7%	6.8%
Eswatini	7.1%	4.7%	5.2%	4.8%	3.5%	2.4%	3.6%	2.2%	3.6%	1.6%
Fiji	32.6%	25.8%	26.6%	27.1%	16.8%	17.3%	16.1%	15.1%	23.9%	4.8%
Gambia	6.0%	4.1%	4.0%	3.8%	2.6%	3.0%	3.7%	2.8%	3.6%	1.2%
Ghana	5.9%	4.1%	3.9%	3.3%	2.0%	2.8%	2.7%	1.7%	3.1%	0.4%

Guinea-Bissau	4.1%	2.4%	2.3%	2.0%	1.3%	1.3%	2.1%	1.4%	2.4%	1.4%
Guyana	27.6%	19.4%	19.6%	16.9%	11.2%	11.0%	15.1%	11.0%	18.1%	2.6%
Iraq	5.6%	4.6%	4.6%	3.0%	2.1%	2.8%	2.2%	2.2%	3.7%	1.2%
Kiribati	23.7%	18.7%	21.0%	16.4%	13.8%	10.4%	10.4%	13.7%	14.4%	4.0%
Kyrgyzstan	21.0%	17.1%	16.9%	15.4%	9.7%	6.2%	5.8%	8.9%	8.4%	2.0%
Laos	7.3%	5.6%	5.7%	2.9%	5.1%	1.7%	2.5%	2.4%	4.1%	0.5%
Lesotho	12.0%	8.4%	8.5%	6.0%	5.0%	5.9%	5.8%	3.6%	8.6%	1.7%
Madagascar	4.3%	2.7%	3.0%	2.0%	1.8%	1.5%	2.0%	0.7%	2.5%	0.5%
Malawi	2.3%	1.9%	1.6%	1.6%	1.0%	1.0%	1.2%	0.8%	1.7%	0.7%
Mongolia	31.6%	23.5%	27.0%	21.3%	19.8%	14.4%	15.3%	15.9%	17.7%	3.1%
Nepal	5.9%	5.2%	4.7%	3.7%	3.0%	2.0%	2.9%	1.8%	3.5%	1.1%
Nigeria	5.8%	4.6%	4.5%	4.5%	2.2%	2.7%	2.5%	2.3%	3.8%	0.6%
Palestine	28.3%	22.6%	22.4%	17.1%	14.3%	8.1%	12.7%	14.3%	18.2%	6.3%
Samoa	18.3%	13.5%	15.3%	12.5%	15.3%	11.4%	11.3%	10.5%	11.6%	7.4%
Sao Tome and Principe	15.1%	10.7%	11.0%	9.0%	6.0%	5.3%	6.9%	4.7%	9.9%	3.3%
Sierra Leone	2.3%	1.7%	1.6%	1.8%	0.8%	1.1%	0.9%	0.8%	1.4%	0.2%
Suriname	32.5%	25.0%	27.8%	23.9%	15.3%	11.4%	12.9%	13.9%	17.0%	5.0%
Togo	3.7%	2.8%	2.9%	2.1%	1.4%	1.2%	1.6%	0.8%	1.9%	0.4%
Tonga	39.6%	27.3%	30.2%	30.6%	25.0%	10.7%	13.5%	20.9%	25.0%	10.6%
Tunisia	24.1%	18.4%	17.2%	17.3%	10.8%	7.8%	9.2%	8.6%	12.9%	5.6%

Turkmenistan	19.5%	16.8%	15.7%	6.2%	7.5%	6.0%	3.4%	3.4%	14.3%	0.4%
Turks and Caicos Islands	51.5%	43.8%	46.4%	48.8%	37.3%	31.4%	31.3%	22.7%	31.6%	3.5%
Tuvalu	50.9%	41.5%	44.6%	41.6%	26.4%	24.1%	28.8%	26.2%	32.6%	8.5%
Vietnam	27.2%	22.5%	21.9%	22.6%	20.9%	13.8%	16.9%	10.3%	13.2%	1.9%
Zimbabwe	13.1%	9.3%	9.1%	6.3%	3.8%	5.2%	6.2%	3.8%	9.1%	1.0%

Men's National Coverage of ICTs

Country	Atleast one Skill	Copy or move a file or folder (MT6A)	Use a copy and paste tool (MT6B)	Send e-mail with attached file (MT6C)	Use a basic arithmetic formula (MT6D)	Connect and install a new device (MT6E)	Find, download, install and configure software (MT6F)	Create an electronic presentation (MT6G)	Transfer a file (MT6H)	Write a computer program (MT6I)
Afghanistan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Algeria	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Argentina	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bangladesh	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benin	5.9%	5.3%	5.1%	4.1%	2.8%	2.5%	3.0%	2.0%	4.7%	1.4%
Central African Republic	4.1%	3.6%	3.5%	2.8%	1.3%	1.5%	2.2%	1.2%	2.9%	0.7%
Chad	3.4%	2.7%	2.5%	2.0%	0.9%	1.3%	1.8%	1.0%	2.0%	0.8%
Comoros	17.1%	15.7%	14.7%	8.6%	6.5%	5.5%	6.9%	5.0%	10.0%	3.9%
Cuba	32.5%	29.1%	23.3%	13.6%	9.3%	12.3%	9.7%	9.6%	27.2%	3.5%
Democratic Republic of the Congo	11.6%	9.5%	9.6%	6.7%	4.1%	4.3%	4.0%	2.0%	7.1%	1.0%
Dominican Republic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Eswatini	16.6%	13.8%	14.0%	8.7%	7.1%	8.3%	11.4%	5.9%	9.9%	3.5%
Fiji	31.2%	27.5%	27.0%	26.3%	16.1%	12.7%	13.4%	14.5%	23.2%	3.8%
Gambia	17.3%	13.8%	13.1%	9.9%	6.6%	6.6%	9.3%	6.1%	13.8%	1.0%
Ghana	19.6%	16.6%	14.1%	9.7%	4.6%	9.9%	11.9%	3.6%	14.2%	0.7%
Guinea-Bissau	14.4%	11.9%	8.5%	8.1%	3.0%	5.2%	9.4%	3.2%	13.0%	1.4%
Guyana	34.1%	22.7%	20.1%	19.2%	10.2%	13.1%	22.3%	12.1%	21.8%	2.2%
Iraq	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kiribati	29.9%	25.0%	27.0%	14.3%	13.3%	11.4%	15.1%	13.4%	21.2%	3.4%
Kyrgyzstan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Laos	11.8%	9.1%	8.7%	4.5%	7.6%	4.3%	5.9%	4.8%	7.4%	0.6%
Lesotho	14.5%	12.8%	12.2%	8.7%	7.1%	7.7%	9.3%	4.5%	12.7%	3.4%
Madagascar	7.4%	6.3%	6.6%	3.7%	3.5%	4.0%	4.0%	1.7%	6.3%	0.9%
Malawi	6.9%	5.9%	5.2%	2.6%	2.1%	4.6%	3.2%	1.5%	6.1%	0.8%
Mongolia	29.7%	22.8%	25.3%	20.0%	15.6%	13.4%	18.4%	13.4%	19.3%	3.8%
Nepal	15.5%	14.6%	12.5%	10.2%	7.1%	5.9%	9.8%	4.8%	12.3%	1.5%
Nigeria	11.4%	9.4%	9.0%	8.9%	3.3%	5.8%	5.7%	3.0%	8.4%	1.5%
Palestine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Samoa	16.9%	14.3%	14.6%	13.2%	13.3%	11.4%	11.1%	9.9%	10.8%	6.5%
Sao Tome and Principe	30.6%	23.2%	20.6%	14.9%	8.1%	7.2%	12.9%	6.9%	24.9%	4.2%
Sierra Leone	6.7%	5.9%	5.3%	4.5%	2.9%	4.4%	4.1%	1.9%	5.5%	1.0%

Suriname	34.4%	24.1%	27.7%	25.4%	14.6%	15.3%	17.5%	13.3%	18.7%	4.6%
Togo	11.2%	9.1%	9.2%	7.4%	3.4%	4.2%	6.5%	2.7%	8.6%	1.3%
Tonga	25.4%	17.1%	15.7%	19.8%	12.6%	7.2%	7.2%	13.1%	17.5%	5.2%
Tunisia	22.8%	16.7%	14.7%	15.9%	9.2%	8.9%	9.4%	7.7%	13.0%	5.8%
Turkmenistan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Turks and Caicos Islands	46.2%	37.5%	36.3%	40.4%	22.8%	31.1%	32.4%	20.1%	34.1%	4.1%
Tuvalu	48.7%	41.5%	40.3%	30.4%	17.4%	18.9%	17.0%	16.6%	41.8%	11.4%
Vietnam	27.4%	22.1%	20.4%	21.0%	18.0%	14.1%	20.0%	7.7%	16.0%	2.8%
Zimbabwe	21.6%	17.7%	16.2%	10.5%	8.0%	11.5%	13.8%	7.1%	18.0%	2.5%

National Gender Gap (Men-Women) of Coverage of ICTs

Country	Atleast one Skill	Copy or move a file or folder (MT6A)	Use a copy and paste tool (MT6B)	Send e-mail with attached file (MT6C)	Use a basic arithmetic formula (MT6D)	Connect and install a new device (MT6E)	Find, download, install and configure software (MT6F)	Create an electronic presentation (MT6G)	Transfer a file (MT6H)	Write a computer program (MT6I)
Afghanistan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Algeria	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Argentina	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bangladesh	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benin	3.5%	3.3%	3.3%	2.7%	1.9%	1.8%	2.3%	1.5%	3.4%	1.2%
Central African Republic	2.6%	2.4%	2.3%	1.7%	0.7%	0.9%	1.4%	0.7%	2.1%	0.4%
Chad	2.6%	2.2%	2.0%	1.6%	0.7%	1.1%	1.4%	0.8%	1.6%	0.6%
Comoros	7.8%	7.8%	7.4%	2.5%	1.9%	1.5%	2.4%	1.6%	4.2%	0.8%

Cuba	-7.9%	-5.9%	-8.1%	-7.3%	-2.9%	-5.5%	1.5%	-3.7%	-3.0%	-0.4%
Democratic Republic of the Congo	8.3%	7.3%	7.2%	5.1%	2.8%	3.3%	3.0%	1.2%	5.5%	0.4%
Dominican Republic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Eswatini	9.6%	9.1%	8.9%	3.9%	3.5%	5.9%	7.8%	3.6%	6.2%	2.0%
Fiji	-1.4%	1.8%	0.5%	-0.8%	-0.7%	-4.5%	-2.7%	-0.6%	-0.7%	-1.0%
Gambia	11.3%	9.7%	9.1%	6.1%	4.1%	3.6%	5.6%	3.3%	10.2%	-0.2%
Ghana	13.7%	12.5%	10.2%	6.3%	2.6%	7.1%	9.2%	1.9%	11.1%	0.2%
Guinea-Bissau	10.3%	9.5%	6.3%	6.1%	1.7%	3.9%	7.4%	1.8%	10.6%	0.0%
Guyana	6.5%	3.3%	0.5%	2.2%	-1.0%	2.1%	7.2%	1.1%	3.6%	-0.4%
Iraq	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kiribati	6.2%	6.3%	6.0%	-2.1%	-0.5%	1.0%	4.7%	-0.3%	6.7%	-0.5%
Kyrgyzstan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Laos	4.5%	3.5%	3.0%	1.5%	2.5%	2.6%	3.4%	2.4%	3.3%	0.1%
Lesotho	2.5%	4.4%	3.7%	2.8%	2.1%	1.8%	3.5%	0.8%	4.1%	1.8%
Madagascar	3.1%	3.7%	3.6%	1.7%	1.8%	2.4%	2.0%	1.0%	3.9%	0.4%
Malawi	4.6%	4.0%	3.6%	1.1%	1.2%	3.6%	2.0%	0.8%	4.3%	0.1%
Mongolia	-1.9%	-0.7%	-1.8%	-1.3%	-4.2%	-1.0%	3.0%	-2.5%	1.6%	0.7%
Nepal	9.6%	9.4%	7.8%	6.5%	4.1%	4.0%	6.9%	3.1%	8.8%	0.4%
Nigeria	5.6%	4.8%	4.5%	4.4%	1.0%	3.1%	3.2%	0.7%	4.5%	0.9%
Palestine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Samoa	-1.4%	0.8%	-0.7%	0.7%	-2.0%	-0.1%	-0.2%	-0.6%	-0.8%	-0.9%
Sao Tome and Principe	15.5%	12.6%	9.6%	5.9%	2.0%	1.9%	6.0%	2.2%	15.1%	1.0%
Sierra Leone	4.4%	4.2%	3.7%	2.7%	2.2%	3.3%	3.2%	1.1%	4.2%	0.8%
Suriname	1.9%	-1.0%	-0.1%	1.5%	-0.7%	4.0%	4.6%	-0.6%	1.7%	-0.4%
Togo	7.4%	6.3%	6.3%	5.3%	1.9%	3.0%	4.9%	1.9%	6.8%	0.9%
Tonga	-14.2%	-10.3%	-14.6%	-10.8%	-12.4%	-3.6%	-6.3%	-7.7%	-7.5%	-5.3%
Tunisia	-1.3%	-1.7%	-2.4%	-1.3%	-1.6%	1.1%	0.1%	-0.9%	0.0%	0.2%
Turkmenistan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Turks and Caicos Islands	-5.3%	-6.2%	-10.1%	-8.5%	-14.5%	-0.4%	1.1%	-2.6%	2.5%	0.6%
Tuvalu	-2.2%	0.0%	-4.3%	-11.2%	-9.1%	-5.2%	-11.8%	-9.5%	9.3%	2.9%
Vietnam	0.3%	-0.4%	-1.5%	-1.6%	-2.9%	0.2%	3.1%	-2.6%	2.8%	0.9%
Zimbabwe	8.5%	8.5%	7.1%	4.2%	4.2%	6.3%	7.5%	3.3%	8.9%	1.5%

Supplementary Table 4: Technology Use estimates in included countries in MICS 6

Women's Overall use of technologies						
Country	**No Computer use in 3 months (Eliminated from ICT skills questions)**	**Computer Use in Last 3 Months**	**Phone Ownership**	**Phone Use In Last 3 Months**	**Any Device (Computer use in 3 months or Phone ownership)**	**No Device**
Afghanistan	99.04%	0.96%	32.18%	57.34%	57.42%	0.35%
Algeria	79.71%	20.52%	84.41%	88.70%	89.42%	0.98%
Argentina	43.82%	56.18%	94.42%	97.19%	97.86%	0.68%
Bangladesh	98.13%	1.87%	71.40%	97.78%	97.79%	0.03%
Benin	97.33%	2.67%	52.13%	67.45%	67.52%	0.54%
CAR	98.26%	1.74%	20.57%	26.28%	26.35%	1.72%
Chad	98.98%	1.10%	31.83%	48.14%	48.22%	1.09%
Comoros	88.52%	11.48%	69.20%	78.60%	79.48%	1.24%
Cuba	53.51%	46.49%	73.25%	77.15%	80.99%	3.15%
DominicanRepublic	57.19%	42.81%	89.36%	96.55%	97.00%	0.54%
DRCongo	96.04%	3.96%	33.44%	42.17%	42.36%	1.50%
Eswatini	39.64%	8.06%	43.04%	44.69%	44.79%	0.23%
Fiji	62.91%	37.09%	79.44%	92.03%	93.54%	0.88%

Gambia	92.41%	7.59%	74.10%	90.95%	91.07%	0.37%
Ghana	93.23%	6.77%	67.96%	81.84%	82.27%	1.12%
GuineaBissau	94.89%	5.38%	60.71%	89.44%	89.53%	0.10%
Guyana	61.30%	38.70%	87.94%	89.76%	91.52%	1.38%
Iraq	93.03%	6.97%	67.22%	84.65%	84.86%	0.34%
Kiribati	73.51%	26.49%	52.72%	59.69%	64.40%	5.14%
Kyrgyzstan	75.95%	24.05%	93.28%	92.66%	93.09%	0.04%
LaoPDR	91.54%	8.46%	73.13%	79.63%	79.68%	0.20%
Lesotho	85.23%	14.77%	86.86%	90.13%	90.69%	0.70%
Madagascar	94.62%	5.38%	32.04%	49.39%	49.56%	0.37%
Malawi	97.41%	2.59%	34.04%	52.94%	53.02%	0.36%
Mongolia	63.78%	36.22%	77.89%	97.24%	97.54%	0.37%
Nigeria	93.65%	6.35%	58.16%	78.64%	78.75%	0.68%
Samoa	78.86%	21.14%	77.38%	88.57%	90.07%	0.33%
SaoTome	82.07%	17.93%	67.13%	80.90%	81.78%	2.30%
SierraLeone	97.36%	2.64%	45.23%	61.37%	61.42%	0.77%
stpalestine	68.67%	31.33%	84.89%	94.46%	95.63%	1.55%

Suriname	60.28%	39.73%	93.06%	95.08%	95.97%	0.63%
Togo	95.61%	4.39%	56.65%	64.56%	64.71%	0.66%
Tonga	54.40%	45.60%	84.40%	91.36%	95.11%	0.12%
Tunisia	69.15%	30.85%	91.37%	93.65%	93.98%	0.39%
Turkmenistan	78.36%	21.64%	91.06%	97.87%	98.27%	0.41%
Turks Caico	40.40%	59.60%	98.98%	99.57%	99.70%	
Tuvalu	40.49%	59.51%	77.83%	70.54%	83.00%	3.06%
VietNam	69.15%	30.85%	94.31%	96.79%	97.03%	0.12%
Zimbabwe	82.90%	17.10%	72.02%	89.54%	89.90%	0.62%

Men's Overall use of technologies

Country	No Computer use in 3 months (Eliminated from ICT skills questions)	Computer Use in Last 3 Months	Phone Ownership	Phone Use In Last 3 Months	Any Device (Computer use in 3 months or Phone ownership)	No Device
Benin	0.94	0.06	0.72	0.79	0.80	0.00
CAR	0.96	0.04	0.37	0.41	0.41	0.01
Chad	0.96	0.04	0.71	0.78	0.78	0.01
Comoros	0.81	0.19	0.74	0.88	0.88	0.01
Cuba	0.62	0.38	0.75	0.79	0.82	0.03

DRCongo	0.87	0.13	0.53	0.65	0.65	0.01
Eswatini	0.82	0.18	0.91	0.93	0.93	0.01
Fiji	0.65	0.35	0.84	0.93	0.94	0.02
Gambia	0.80	0.20	0.85	0.95	0.95	0.00
Ghana	0.79	0.21	0.80	0.88	0.89	0.02
GuineaBissau	0.84	0.16	0.87	0.92	0.92	0.00
Guyana	0.32	0.68	0.88	0.93	0.94	0.01
Kiribati	0.67	0.33	0.53	0.53	0.63	0.04
LaoPDR	0.88	0.12	0.84	0.87	0.87	0.00
Lesotho	0.85	0.15	0.84	0.88	0.89	0.00
Madagascar	0.92	0.08	0.42	0.56	0.56	0.00
Malawi	0.93	0.07	0.50	0.71	0.71	0.01
Mongolia	0.65	0.35	0.67	0.94	0.95	0.01
Nigeria	0.88	0.12	0.73	0.88	0.89	0.00
Samoa	0.81	0.19	0.81	0.92	0.92	0.02
SaoTome	0.65	0.35	0.60	0.72	0.79	0.05
SierraLeone	0.93	0.07	0.65	0.47	0.54	0.04

Suriname	0.58	0.42	0.94	0.96	0.96	0.01
Togo	0.88	0.12	0.78	0.83	0.83	0.00
Tonga	0.72	0.28	0.88	0.92	0.94	0.00
Tunisia	0.68	0.32	0.96	0.96	0.97	0.00
Turks_Caico	0.39	0.61	0.98	0.98	0.98	
Tuvalu	0.49	0.51	0.83	0.89	0.93	0.01
VietNam	0.68	0.32	0.94	0.97	0.97	0.00
Zimbabwe	0.76	0.24	0.73	0.89	0.89	0.01
Togo	95.61%	4.39%	56.65%	64.56%	64.71%	0.66%
Tonga	54.40%	45.60%	84.40%	91.36%	95.11%	0.12%
Tunisia	69.15%	30.85%	91.37%	93.65%	93.98%	0.39%
Turkmenistan	78.36%	21.64%	91.06%	97.87%	98.27%	0.41%
Turks Caico	40.40%	59.60%	98.98%	99.57%	99.70%	
Tuvalu	40.49%	59.51%	77.83%	70.54%	83.00%	3.06%
VietNam	69.15%	30.85%	94.31%	96.79%	97.03%	0.12%
Zimbabwe	82.90%	17.10%	72.02%	89.54%	89.90%	0.62%

Supplementary Table 5. Digital skills surveys

Global survey	Digital competency area				
	Study population and size	Sample selection	Survey implementation	Phrasing of skills questions	Analytic time horizon
DigCompSAT	Pilot in Spain and Latvia, 460 people between age 25-54 years	Pre-sampling questionnaire		"I know that..."	
Eurostat	Representative of EU population aged 16-74 years	Varied sampling designs	Structured, facilitated survey which captures self-reported skills		3-12 months
Global Kids Online	Children aged 9-17 years who have used internet at least once in last 3 months	simple random sampling (SRS), cluster sampling, stratified sampling and multi-stage stratified cluster sampling	Structured, facilitated survey which captures self-reported skills. Where possible - Paper based and in-person	"I know how to..."	3 months
MICS7		Multistage indicator sampling	Structured, facilitated survey which captures self-reported skills	"Have you ever..."	3 months
GSMA Mobile Digital Skills Module	2,000 men and women 18 years of age or older	Quota sampling	Structured, facilitated survey which captures self-reported skills	“have you ever...”	3 months

Young Lives Module on Computer Skills	over 463 participants between 9-19 years of age	Selection by age groups	Structured, facilitated survey which captures self-reported skills	"How old were you..." "how often have you.."	12 months