Global Sustainability Solutions Services

The Feasibility of Mapping ICT Initiatives to the UN Sustainable Development Goals

A comprehensive report prepared for

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Acknowledgements

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Abbreviations

ASU	Arizona State University
ICT	Information and Communication Technology
IOI	ICT Opportunity Index
HDI	Human Development Index
KPI	Key Performance Indicator
MDG	Millennium Development Goals
SDG	Sustainable Development Goal
UN	United Nations

Executive Summary

At the United Nations Sustainable Development Summit on September 25, 2015, world leaders adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice and tackle climate change by 2030. Each SDG has a set of specific targets,169 in total, and each target will be measured using one or more indicators, which are specific measures with which to assess progress.

Can information and communication technology (ICT) companies play a critical role in achieving these 17 ambitious goals? If so, how can that impact be measured? Specifically, is it feasible to connect ICT initiatives at the solution, company and/or industry level to the SDGs in a way that can be quantitatively and specifically measured? What barriers make this difficult or, potentially, impossible?

This report lays the initial groundwork for ICT companies looking to answer these questions so that they may join this global effort in a quantifiable way. Its purpose is to develop a process for mapping ICT solutions to the SDGs, measuring their effect and thus explore how ICT companies might make a meaningful impact on the achievement of these goals.

This research was funded by Dell Giving and implemented by the Global Sustainability Solutions Services, one of the Walton Sustainability Solutions Initiatives at Arizona State University.

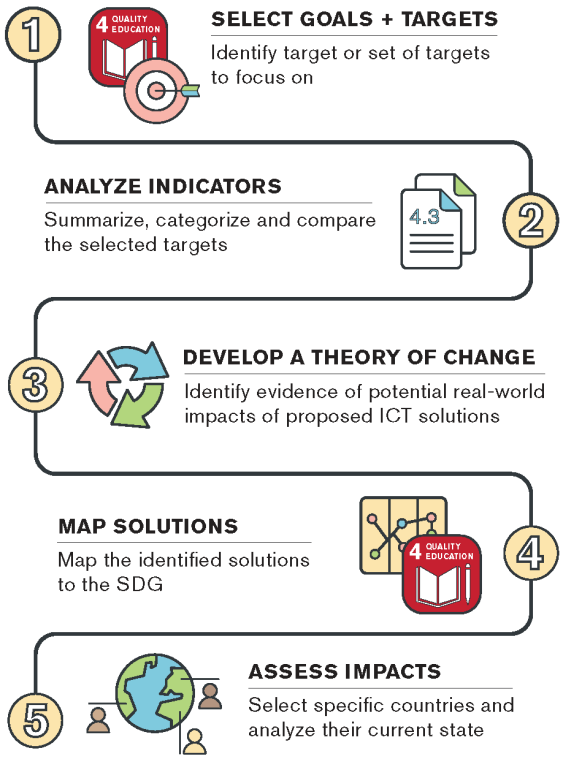
Research Agenda and Methodology

The Global Sustainability Solutions Services team developed the *ICT-SDG Impact Assessment Framework* for mapping an organization's goals and efforts to the SDGs.

1. **Select goals and targets.** For the purposes of this study, the team selected the fourth SDG: *Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (SDG-4)*.

2. **Analyze indicators.** Summarize, categorize and compare the selected SDG target(s) and their proposed indicators to identify gaps between them, assess the availability of data and likely future developments.

The ICT-SDG Impact Assessment Framework



3. **Develop a theory of change.** Develop a theory of change (TOC) based on the indicators and their leverage points (drawn from relevant literature) and then identify evidence of potential real-world impacts of proposed ICT solutions.

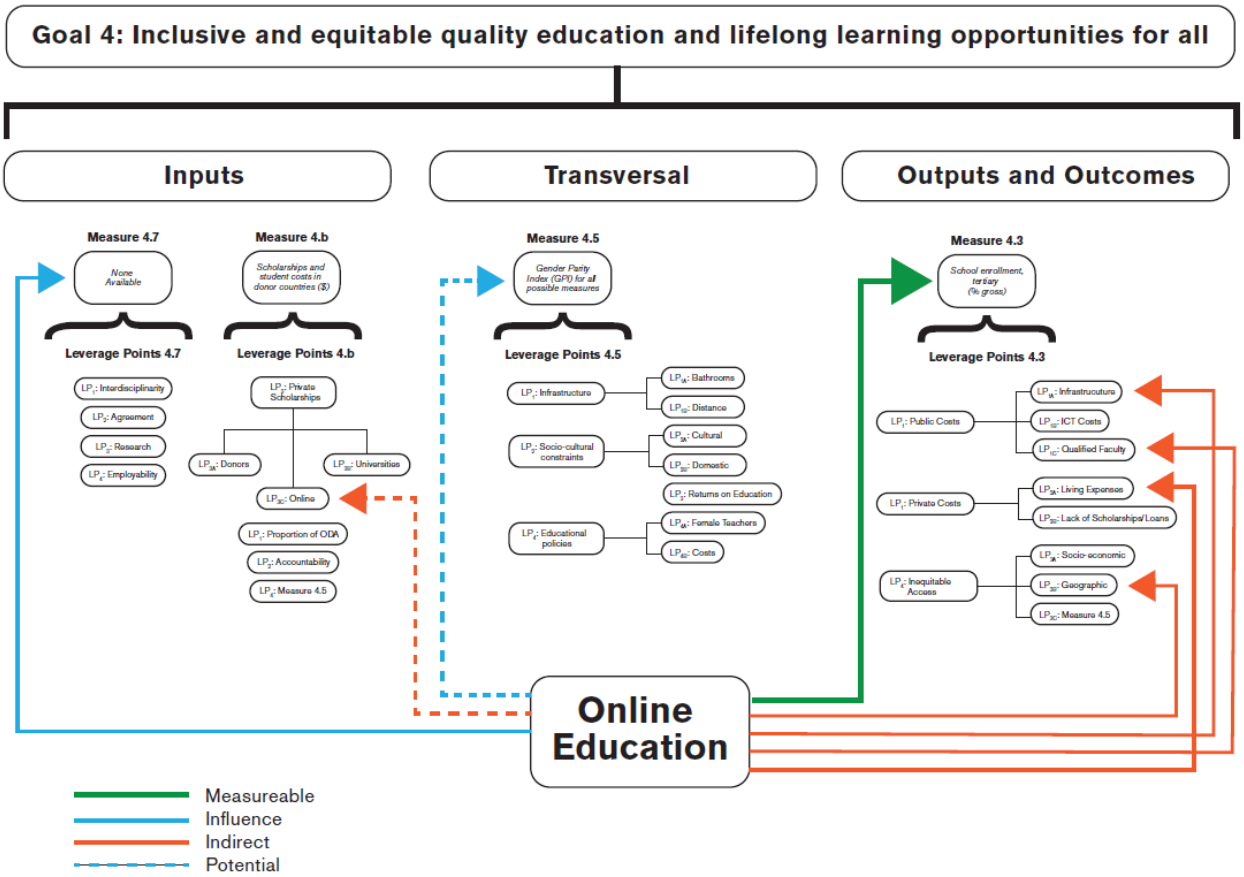
4. **Map solutions.** Map the identified solutions to the SDG target based on both direct and indirect impacts as laid out in the theory of change.

5. **Assess impacts.** Conduct an impact assessment by selecting specific countries and analyzing their current state, then using the links from the previous Step to estimate the impacts on the SDG target. The exemplar countries selected for this case study cover the different levels of development as characterized by the Human Development Index: USA (very high), Mexico (high), India (medium) and Nigeria (low).

Key Considerations and Constraints

- **Targets and indicators are not necessarily aligned.** The U.N. will measure progress on the SDGs with specific indicators (currently still in draft form) that are not necessarily aligned closely to their targets. In all cases the indicators are narrower in scope than their targets.
- **The targets fall on different points of the TOC model**. Solutions that are targeting inputs will be much easier to implement and measure but have the least impact, while targeting outputs and outcomes will be the more impactful but more difficult to implement
- **The major constraint is lack of good data.** Very few of the proposed SDG indicators have good data and almost none have thresholds. There are also few quality studies on the impact of ICT on relevant education outcomes.
- **Selecting targets and countries will get easier over the next few years.** As the coordinated global effort to achieve the SDGs ramps up, the process will get easier. More data will come online as countries and international agencies release reports.
- **For some SDG targets (and their indicators) a rigorous mapping will likely never be possible.** Some of the targets will never be measured sufficiently, in enough places and over long enough periods of time to meaningfully assess impact. For others, the connection to ICT is just too distant and/or weak. Finally, many possible ICT solutions will lack sufficient evidence about their relevant real-world impacts.
- **The SDGs are interlinked.** There are numerous links between the targets. Several other groups of researchers are currently working on systematically analyzing and mapping the links between all of the SDG targets, and taking advantage of their work will be critical in the future to conduct more holistic mapping.

The following page includes an example mapping of an ICT Solution to SDG-4.



Conclusions

Based on what is known today, ASU Global Sustainability Solutions Services can draw the following conclusions:

- **Mapping ICT solutions to the SDGs is possible in many cases.** Some cases are more direct and easier to map than others, but overall the process is currently very difficult.
- **Insufficient data is the primary barrier.** A lack of meaningful data about the specifics of the SDGs and the relevant impacts of ICT solutions are the main barriers to meaningful mapping and measurement.
- **SDG impact is measured at the country level.** To measure progress on the SDGs, solutions and their impacts must be studied on a country by country basis.
- **Evaluation of the leverage points independent of specific solutions is critical.**
- **An unexpected and valuable result of the study was identification of the possibility of using a strategic approach to the SDGs.** This could be essential in order to have projects with meaningful and measurable impact on the SDGs. The tools developed in this study can assist in strategically selecting targets and countries.

Next Steps

Next steps for practitioners and researchers:

- Fully quantify the impact of one case study against all of the SDGs.
- Map the impact of all corporate activities of one ICT company against a selection (or all) of the SDGs.
- Expand the analysis on the impacts of the ICT sector on SDG-4 from this report to the impacts of the ICT sector on all 17 of the SDGs.

Next steps for the ICT sector:

- Gather and share better ICT data.
- Find evidence of the impact of ICT solutions on specific SDG goals, targets and especially indicators.
- Create sector-wide alliances to establish standards for mapping solutions to the SDGs, collect more reliable data and collaborate on having a greater impact.

1. Introduction

“Let us harness the power of ICTs to create a new era of Sustainable Development,” proclaimed United Nations (UN) Secretary-General Ban Ki-moon in a recent speech (UN News Centre, 2015). Building on the Millennium Development Goals (MDGs) the nations of the world came together in September 2015 to agree on an ambitious global program for human development. The aforementioned agreement, Agenda 2030, consists of 17 Sustainable Development Goals (SDGs), shown in Figure 1, which seek to end poverty, protect the planet and ensure prosperity for all. The achievement of these goals will require not only the enabling power of Information and Communication Technology (ICT) but also the innovation, scale and reach of the private sector as well.

Figure 1: The 17 Sustainable Development Goals (source: UN)

The SDGs have been designed with a very purposeful structure. The goals are the 17 categories or domains that have been deemed essential for global sustainability; for example SDG-4 is “Quality Education for all”. They are meant to be broad, all-encompassing and inspiring. Each goal has been assigned a set of targets which are meant to address the most pressing areas of concern for each of the goals. For education, targets range from adult literacy to early childhood development. Progress against each of these target areas of concern will be measured using indicators. The structure for SDG-4 is illustrated in Figure 2.

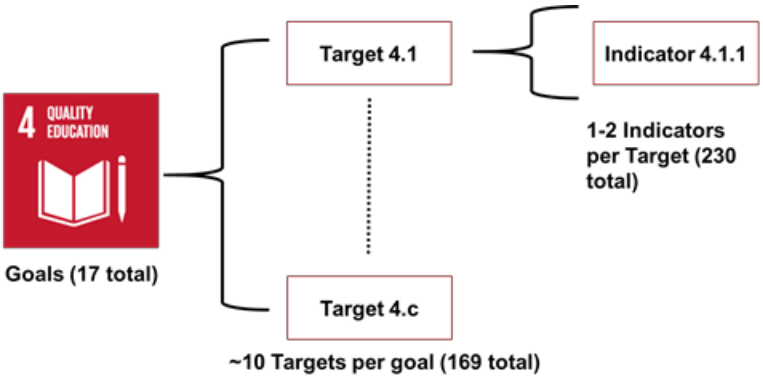


Figure 2: Illustration of the Structure of the Sustainable Development Goals

The UN has proposed an initial set of indicators of one or more for each of the 169 targets, currently totaling 230 indicators. Information about the indicators and how each is proposed to be measured can be found at http://unstats.un.org/sdgs/iaeg-sdgs/metadata-compilation/

These indicators are of key importance for any entity intending to measure the impact of their products, services, projects or programs against the SDGs.

Can information and communication technology (ICT) companies play a critical role in achieving these 17 ambitious goals? If so, how can that impact be measured? Specifically, is it feasible to connect ICT initiatives at the solution, company and/or industry level to the SDGs in a way that can be quantitatively and specifically measured? What barriers make this difficult or, potentially, impossible?

This report lays the initial groundwork for ICT companies looking to answer these questions so that they may join this global effort in a quantifiable way. Its purpose is to develop a process for mapping ICT solutions to the SDGs, measuring their effect and thus explore how ICT companies might make a meaningful impact on the achievement of these goals.

Attempting to target certain aspects or segments of the global, diverse ICT sector would be challenging and arbitrary. This report, therefore, takes a holistic and inclusive perspective, with analysis relevant for ICT companies ranging from global enterprises to start-ups. Specifically, the following steps were taken to explore mapping of ICT solutions to the SDGs:

1. **Private sector and the SDGs.** A literature review covered academic publications, government/NGO reports as well as private sector publications and websites.

2. **SDGs, ICT and Data Availability.** Reviewed all SDG targets and indicators, as related to ICT, and availability of data.
3. **The ICT-SDG Impact Assessment Framework.** Developed the ICT-SDG Impact Assessment Framework using SDG-4, Quality Education, for in-depth analysis. Many experts see a lot of potential for ICT solutions in the education sector and education is being described as a fundamental cross-cutting SDG for human development.
4. **Framework application and impact assessment.** Applied the framework to four representative countries to reflect a diversity of demographics, culture, geography and development trajectories, as well as the diversity of human development index (HDI) groups.

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2. Private Sector and the SDGs

Unlike with previous development agendas there has been an immediate interest by the private sector in contributing to the SDGs. In addition the UN has been making a concerted effort to include businesses from inception. However, it has yet to be determined how the private sector can actually attempt to achieve the SDGs. The SDG Compass (http://sdgcompass.org/) is one of many approaches being explored, (for more resources see Appendix B).

SDG Target 4.6:
Ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy

↕

SDG Compass Indicator:
*Actions taken to empower audiences through **media** literacy skills development*

Figure 3: Comparison of a SDG with its SDG Compass Indicator

This approach reframes a business' current sustainability related goals and practices against the SDGs. The SDG Compass approach does not call for companies to measure contribution towards achieving the SDGs, but instead organize their goals and KPIs (Key Performance Indicators) by the SDGs and their targets. Figure 3 shows the type of unbridged gap that results from this approach (see Appendix B for more examples and explanations).

The other emphasis of reports focused on the role of the private sector in contributing to the SDGs focus mostly on profitability. One example is the #SystemTransformation report (https://www.accenture.com/us-en/insight-global-esustainability-initiative-joint-

report), which forecasts the impacts of particular solutions such as e-learning by 2030. The potential connection of these solutions to specific targets is explained in one line but no effort is made to illustrate even a hypothetical pathway for how the solutions would lead to meaningful impact towards achieving the SDG targets, let alone evidence of such pathways.

The interest by business leaders in the SDGs is a promising development as the private sector's involvement will be critical to the success of Agenda 2030. So far the efforts in this area look more like a rebranding of the status quo. The key missing piece is an attempt to concretely link the activities of a business (and its products and services) to changes in the actual SDG targets and indicators. Bridging this gap will be critical for business to be able to make real and measurable contributions. Given that the official SDG indicators (i.e. how the SDGs will be measured) are still only in development, this report is one of the first attempts to concretely fill this need.

Takeaways:

- *Business must play a major role if the SDGs are to be achieved.*
- *Approaches proposed so far are superficial and fail to assess the real-world impact of business towards achieving the SDGs.*
- *To measure impact and drive transformations, the key challenge is to bridge the gap between business solutions and activities and the actual SDG*

3. SDGs, ICT and Data Availability

"ICT is the most powerful new tool we have for solving the world's major challenges … yet technology by itself is never a solution. It must be properly deployed," wrote Jeffery Sachs, Director of Columbia's Earth Institute in the report *ICT & SDGs* (Sachs et al, 2016). This important report focused on the role of ICT as an enabler and accelerator of the transformations necessary to achieve the SDGs. In order to take advantage of ICT's cross-cutting potential purposeful actions by both the government and the private sector will be necessary. Many were

ICT is referenced in only 6% of all the indicators and their descriptions.

Explicit ICT inclusion included:

- Indicator 4.4.1: ICT skills
- Indicator 4.a.1: Computers & internet in Schools
- Target 4.b: Scholarships for ICT fields of study
- Indicator 5.b.1: Ownership of mobile phones
- Indicator 17.6.1: Technology agreements
- Indicator 17.6.2: Broadband internet
- Target 17.7 Environmentally Sound Tech
- Target 17.8/Indicator 17.8.1: Internet use (%)

Figure 4: Specific Mention of ICT in the SDGs

disappointed at the “almost complete omission of ICTs from the final agreed SDGs (Unwin, 2015).” Analysis of the SDGs, their targets and the proposed indicators shows that specific references to ICT are limited to 6%, as summarized in Figure 4.

The lack of either an ICT related goal or substantial direct mention of ICT is the reason that the line of research initiated by this study is so necessary. ICT’s impacts on the SDGs will be widespread and both direct and indirect. Therefore, it will be necessary to construct evidence-based maps linking ICT solutions and the SDGs in order to validate any claims of impact.

The importance of ICT for sustainable human development is broadly accepted. For 2016, the World Bank dedicated their annual World Development Report to the vital role ICT plays in accelerating economic and human development (World Bank, 2016). Looking at the SDGs, the #SystemTransformation report identified specific “digital solutions (that) can contribute directly to the achievement of each and every one of the 17 SDGs and to over half of the 169 targets within them (GeSI & Accenture Strategy, 2016).” The extent of possibilities that ICT solutions present for solving the world’s most urgent sustainability problems is impressive. What is less impressive is evidence that these solutions are impacting the most urgent sustainability problems in the places and at the scale required. In general, there is good reason to be cautious about claims of ICT solutions for the SDGs (see Appendix C for details).

3.1. Data Availability for Countries

A broad search for publicly available data was conducted regarding the progress individual countries were making in ICT adoption and infrastructure.

The World Bank currently publishes two relevant indicators yearly for nearly every country in the world: mobile cellular subscriptions (per 100 people) and internet users (per 100 people).

“Cellphone subscription” data for inter-country comparisons was not used for this study because it does not sufficiently represent the key issue - what percentage of the population actually has a cellphone. For structural reasons, in some countries, people with cellphones have many different subscriptions, substantially skewing the data. As a result, the World Bank is shifting to directly measuring the percent of population with a cellphone rather than their current practice of counting the cellphones in the country.

The “internet users” indicator is a measure of what percent of people in a given country have used the internet (in any way) in the previous twelve months. Although a poor indicator, it does provide an indication of how much of the population has at least minimal access to, knowledge of and ability to use the internet.

The following two graphs capture the situation in the world with regards to internet access.

Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development. This system was used for sorting the countries of the world into the HDI groups.

Figure 5 is a smoothed histogram of all the countries in the world divided into four groups by Human Development Index (HDI) status.

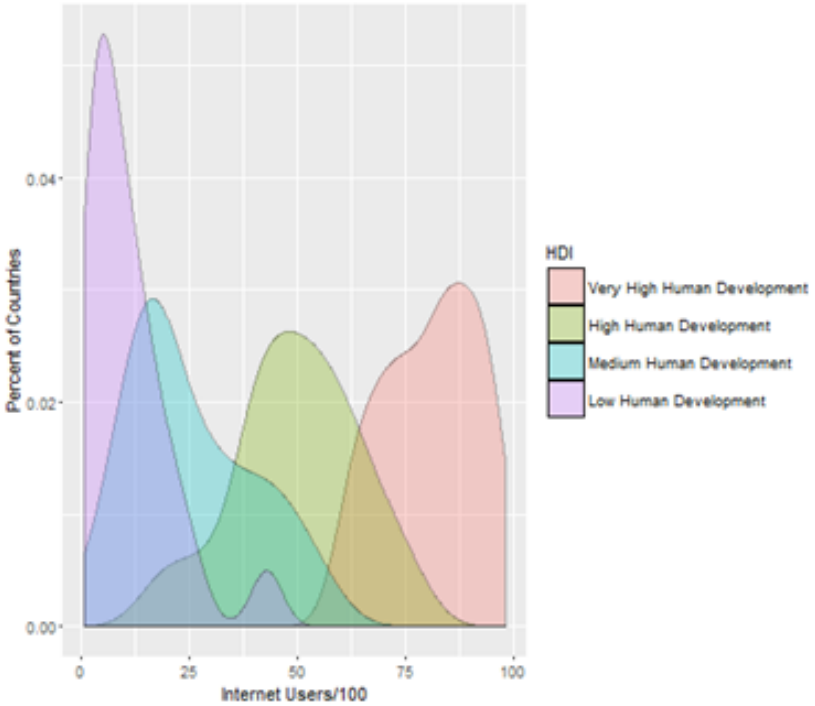


Figure 5: Density Plot Histogram of Internet Users with countries grouped by HDI

Although there is overlap between the groups (e.g. some medium countries have more internet users than some high countries), on the whole, there is a clear progression of increasing internet users as one moves up HDI levels. This leaves a huge gap between the Very High Human Development Countries where an average of 80% of people are online to the Low Human Development countries were only an average of 11% are online. These countries clearly have vastly different capabilities to take advantage of the potential that ICT has to offer. As a result, we selected four countries representing each of the four HDI groups (Very High to Low): USA, Mexico, India and Nigeria.

Figure 6 shows the differential progress made by these four countries in the adoption of the internet. Internet use is increasing everywhere but the rate in a country like India is too slow to expect that by 2030 much more than a bare majority of the country will have ever even been online.

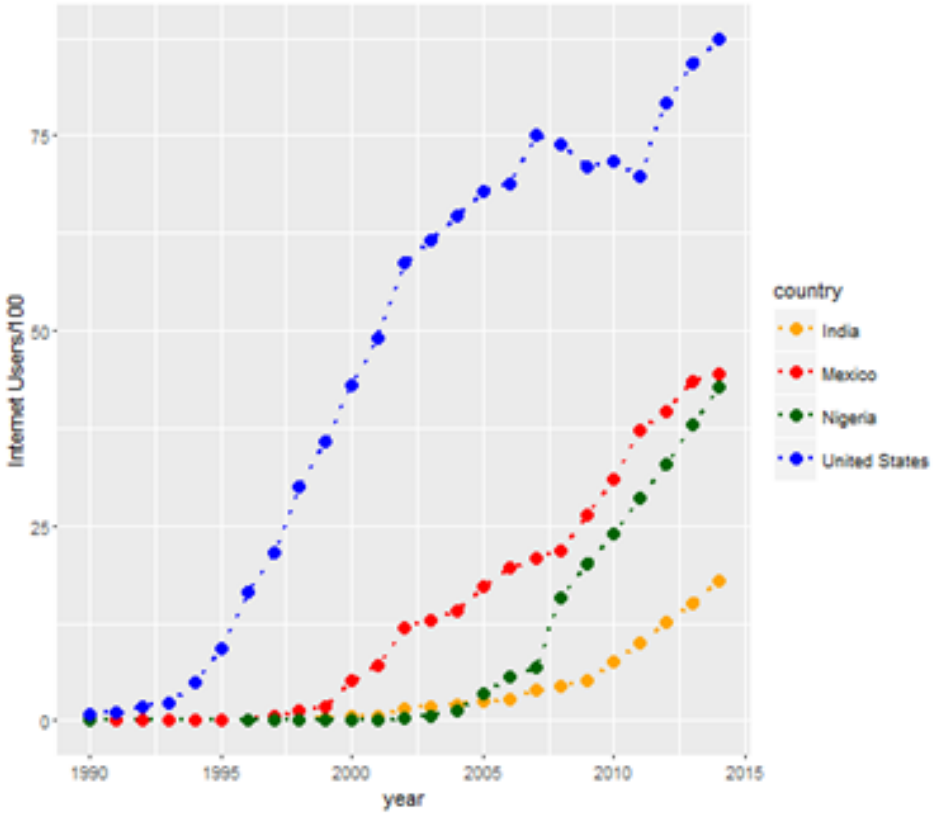


Figure 6: Internet Users in Four Countries over time

The UN and others have pointed to the critical role that ICT could play in enabling the measurement, collection and reporting of data on 230+ indicators in 193 nations. The first place to start would be with data currently collected within the ICT industry. The ICT sector collects enormous amounts of useful data about users from which trends in ICT usage in different countries can be estimated and the greatest potential for ICT can be identified. Unfortunately, the two World Bank indicators appear to be the only publically available datasets on ICT for the world's countries.

Takeaways:

- *While there is broad agreement on the importance of ICT, it nonetheless plays a very small role in the explicit text of the SDGs.*
- *ICT is seen as an enabler and accelerator of solutions for the SDGs.*
- *There is an enormous array of ICT solutions that proponents believe could directly impact the SDGs.*
- *Extreme caution should be taken in accepting claims of the impact of any particular ICT solution on the SDGs for many reasons including the lack of rigorous evaluation and quality evidence.*
- *Percentage of internet users was the best indicator available to track the progress and status of countries with regards to ICT.*
- *The ICT sector must provide better public databases of ICT related indicators to support the deployment of ICT solutions for the SDGs.*

Appendix C discusses some of the other options which, while not used for this study, could be informative for future analysis.

4. The ICT-SDG Impact Assessment Framework

The Global Sustainability Solutions Services team developed the *ICT-SDG Impact Assessment Framework* for mapping an organization's goals and efforts to the SDGs.

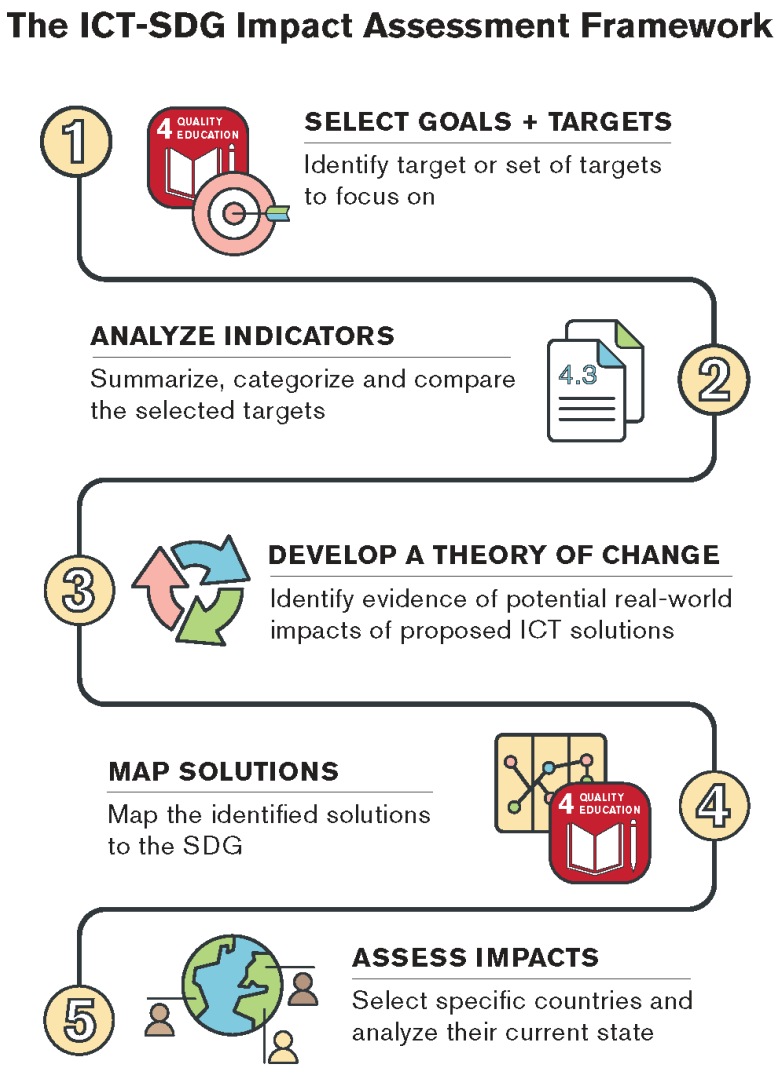


Figure 7: The ICT-SDG Impact Assessment Framework

Using this process, organizations can evaluate the viability of correlating the organization's ICT solutions to the targeted SDG(s).

4.1. STEP 1: Select Goals and Targets

With 169 targets, to comprehensively map the impact of an ICT solution to the entire breadth (and depth) of the SDGs could become overwhelming. Additionally, this broad approach could become ineffective as countries unaffected by any single ICT solution might be functionally neglected from the analysis. As such, it will be important to utilize

this framework via an iterative process to begin with a larger set of applicable SDG targets and then refine the list to identify and assess the most relevant.

For the purposes of this study SDG-4 was selected for in-depth analysis, with its full list of 10 targets shown in Figure 8.

SDG-4: *Ensure inclusive and quality education for all and promote lifelong learning*
Targets:
4.1 *By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes*
4.2 *By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education*
4.3 *By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university*
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*
4.5 *By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations*
4.6 *By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy*
4.7 *By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development*
4.a *Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all*
4.b *By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries*
4.c *By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States*

Figure 8: SDG-4 and its 10 Targets

4.2. STEP 2: Analyze Indicators

For this step the objective is to summarize, categorize and compare the selected SDG target(s) and their proposed indicators to identify gaps between them, assess the availability of data and likely future developments. Overall, the goal of analyzing the indicators is to assess their functionality for use in concretely mapping ICT solutions to the selected SDG targets.

4.2.1. Measuring the SDGs

The indicators for the Millennium Development Goals took several years to be finalized and some were adjusted as more knowledge was gained.

For the SDGs, several studies have attempted to measure the status of the SDGs by self-selecting representative measurements. Some assessed the goals with a handful of data points (GeSI & Accenture Strategy, 2016; Sachs, Schmidt-Traub & Durand-Delacre, 2016) while another study looked specifically at two targets per SDG (Kroll, 2015). As of this research, there are no published studies which attempted to use the UN's proposed (March 2016 draft) indicators and measurements for assessing progress on the SDGs.

In selecting the indicators, the UN explicitly decided not to consider data availability (Dunning & Kalow, 2016). The result is that, while still under development, in their current state these SDG indicators range widely, from easily measurable today to those that will require significant data collection infrastructure to be effectively measured before 2030.

4.2.2. Rating the Indicators and Data

Overall, there is significant variability between targets for all of the aspects studied. Indicators could be different from or similar to the target while there is good data for some indicators and no data for others. A traffic light style chart was created in order to capture the overall situation for the indicators and data of SDG-4. Each of the eleven indicators was rated as poor (red), reasonable (yellow) and good (green) for three criteria:

- **Target-Indicator**: How well does the indicator capture all of what the target describes?
- **Current Data**: How well does currently available public data match the proposed indicator?
- **Future Data**: What are the prospects for data availability for measuring this indicator in the future (by ~2020)?

The justifications for these ratings can be found under each indicator in Appendix D.

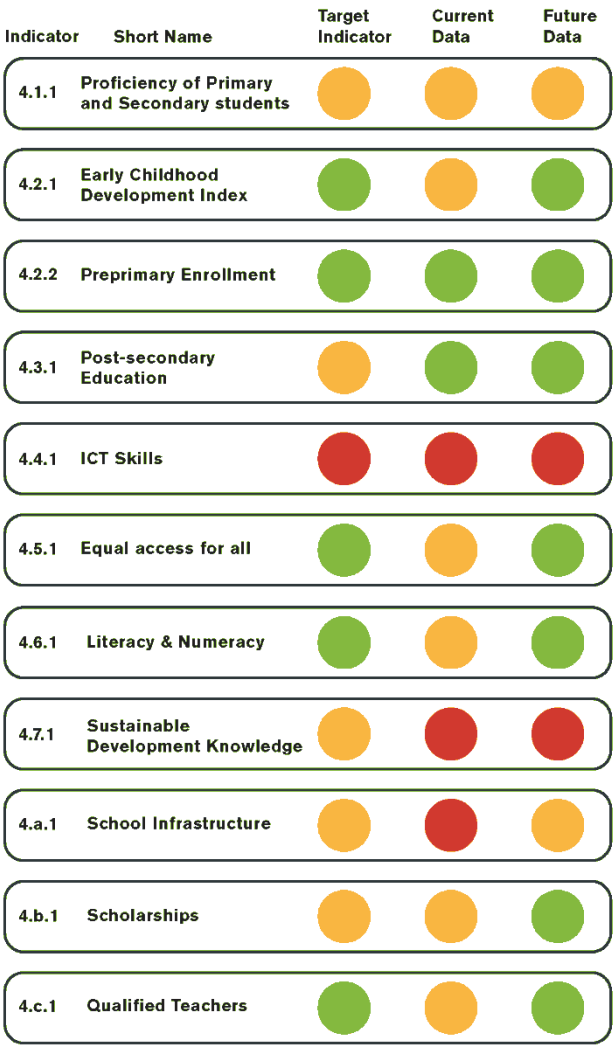


Figure 9: Rating the Data for 11 Indicators of SDG-4

Takeaways:

- *The UN will measure the progress on the SDGs with specific indicators.*
- *These indicators are in draft form and currently there are no published analyses which utilized them.*
- *Analysis of all ten targets for SDG-4 revealed substantial variation in the alignment of the target and the indicator and whether there was good data available or not (in some cases no data is available).*
- *It is very likely that some indicators will never have good data and thus it is impossible to rigorously assess impacts to those targets.*
- *Because of these differences and variations, it is not sufficient to map solutions to the goals or the targets - the indicators are essential.*

4.3. STEP 3: Develop a Theory of Change

In order to legitimately qualify an organization's activities towards impacting any particular SDG, it is necessary to develop a robust theory of change which clearly demonstrates how these activities led to the measured impact. The theory of change will be based on the indicators and their leverage points and evidence of potential real-world impacts of proposed ICT solutions. In Step 3 of the framework, the theory of change is developed by focusing on three separate aspects which are then brought together for the actual mapping of ICT solutions onto the SDGs:

1. Categorize the target and indicators as inputs, outputs or outcomes.
2. Identify the most important leverage points for the targets independently of any specific solutions.
3. Based on the leverage points specify the solutions and operations of interest for this analysis and gather evidence.

4.3.1. Categorizing the Targets and Indicators

One critique of the SDGs is that a large portion actually measure inputs and outputs and not the outcomes and impacts targeted by Agenda 2030. It is argued that some outcome- and impact-oriented targets can only be achieved via intermediate steps that require measuring inputs and outputs. This dynamic is clear when studying the targets and indicators for SDG-4.

Target 4.a is input-oriented and includes various school infrastructure metrics including computers and internet. Quality school infrastructure is widely agreed upon as a necessary element for Target 4.1 of getting all youth through lower secondary education and both of those feed into Target 4.4 of creating an outcome where all youth have the needed ICT skills. Target 4.5 is cross-cutting, directly affecting inputs, outputs and

outcomes. This interrelationship of input-output-outcome is shown in Figure 10, for all the targets and indicators for SDG-4.

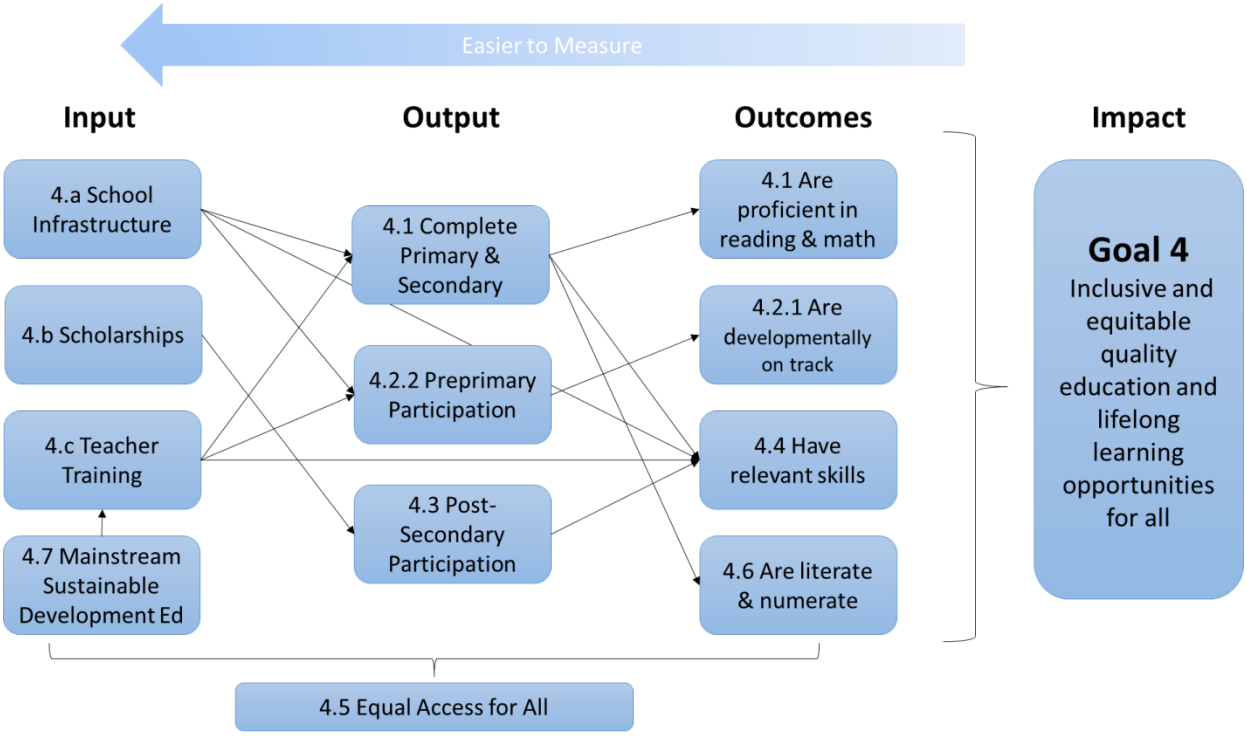


Figure 10: Categorization and Pathways of SDG-4 Targets and Indicators

Input-based targets will be the easiest to measure, but attributing impact towards achieving an SDG may be difficult. For example, by building 100 computer labs connected to the internet, 4.a is directly improved. However, how will launching a first grade computer program to teach reading in those labs change pre-primary participation (4.2.2 – output) or the graduation rate of those students eight years later (4.1 – output)? How about change to their proficiency in reading and math eight years later (4.1 - outcome)? Ultimately, the input indicators are the easiest to measure and achieve but also the least meaningful in terms of social outcomes.

4.3.2. Leverage Points

Research into the ten education targets should be conducted to reveal the most important leverage points for each one. In other words, what are the critical issues, barriers and problems which are holding countries back from doing well on this target/indicator. Summary reports from the World Bank, UNESCO and other international agencies and review articles by academic experts were key sources of information on leverage points. When working in a particular country it is critical to tailor

the target and indicator research to that particular context, as the most important leverage points will vary widely.

Some of the targets are actually leverage points for other targets as illustrated by the previous the example of computer labs. There will also certainly be interactions with the targets of other SDGs. The goal of the framework at this point is to focus on SDG-4 and not to attempt to capture the interactions between the SDGs. Researchers have begun to work on a framework for understanding these interactions (Nilsson, Griggs, Visbeck & Ringler, 2016) which will ultimately be essential to expanded efforts to fully map private sector activities to the SDGs. The leverage points for all SDG-4's targets are described in Appendix E.

4.3.3. ICT Solutions

A wide range of ICT solutions have been proposed and attempted to improve education. Many of these are variations on the same theme. The selection criteria for ICT solutions will depend on the interests of the organization. For this study, a set of ICT solutions was selected based on the following criteria:

- Is the solution either a corporate activity of an ICT company or of the type typically supported by their foundations?
- Is the solution primarily ICT-based, or does ICT form an essential component?
- Can the solution impact one or more of the SDG indicators?
- Does the solution have the potential to be scaled within the same country, or to more than one region or country?
- Is there some robust evidence of the real-world impact of the solution?

One of the principal constraints in selecting solutions is the paucity of evidence about their impact. Evidence was not evenly distributed across types of solutions. For example, there are a lot of studies about computer labs but little about initiatives to teach girls programming. Additionally, SDG-4 targets only attempt to measure some aspects of a high quality education and many of the solutions are only distantly related to the specific SDG targets and indicators. Appendix F has descriptions of all six case studies examined for this report.

Takeaways:

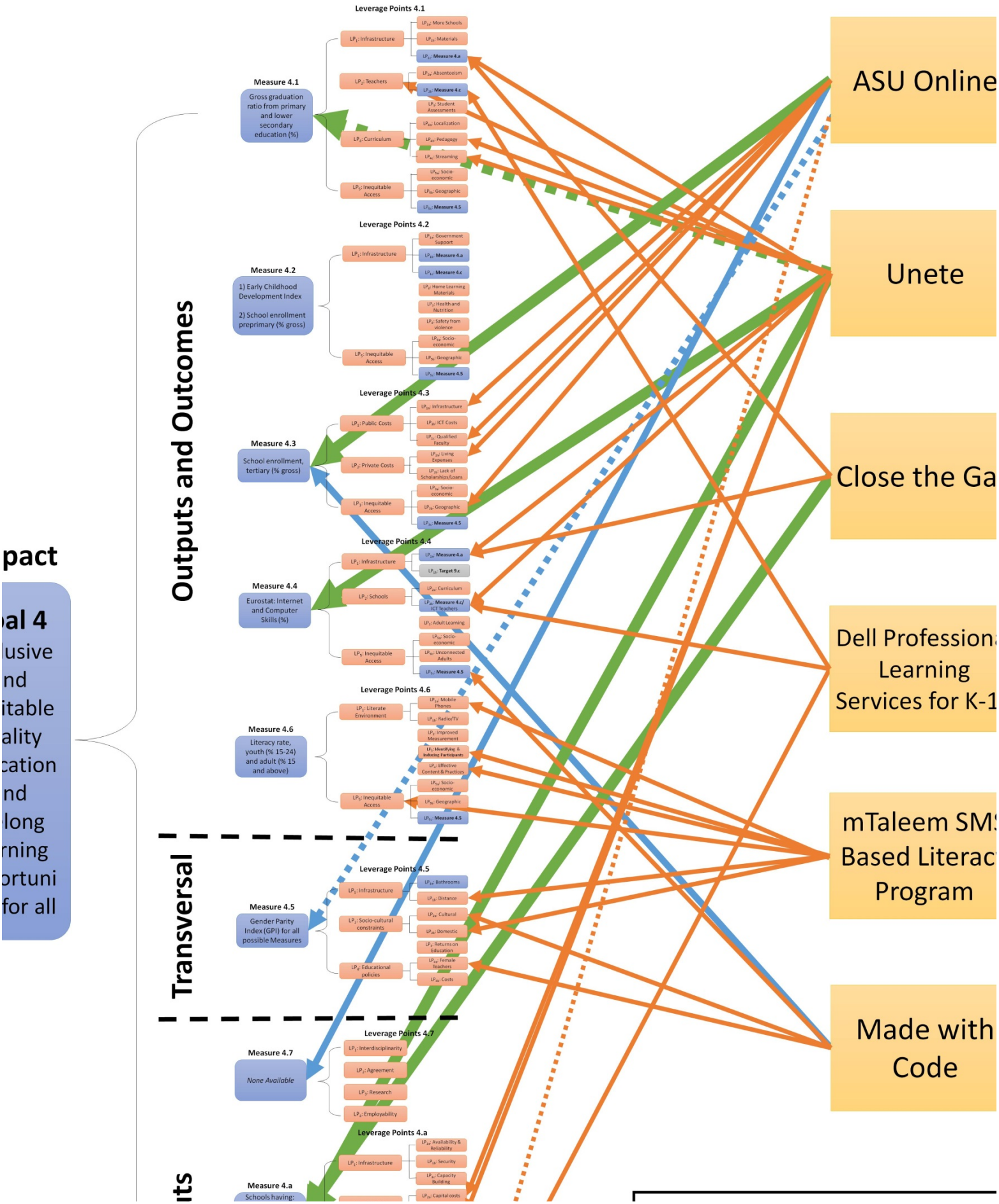
- *The SDG targets and associated indicators actually measure different points on the causal pathways: inputs, outputs and outcomes are included.*
- *SDG indicators focused on inputs are much easier to measure and attribute impacts than other types.*
- *Independently researching the leverage points for each target and indicator is an essential step in creating reliable causal maps.*
- *Relevant and robust impact data is one of the key constraints to rigorously assessing the impact of ICT solutions on the SDGs.*

4.4. STEP 4: Map Solutions

With the leverage points, descriptions, and evidence from case studies, the mapping can be completed, as seen in Figure 11. There are four ways that the case studies were mapped to the SDGs:

- **Directly measurable:** The impact of the ICT solution on the SDG indicator can be directly measured as part of the project; for example building computer labs in schools (Indicator 4.a).
- **Indirectly measureable:** Indirect links were mapped when the ICT solution impacted a relevant leverage point therefore having an indirect, but traceable and attributable impact on the SDG indicator. For example, providing electronic resources may improve classroom pedagogy, a leverage point for primary and secondary student graduation (Indicator 4.1).
- **Influence:** In these cases, the ICT solution's impact cannot be traced via one of the leverage points and won't be attributable in a quantitative sense (at least with currently available data). For example, providing online resources for girls to learn to code might increase the number that enroll in tertiary education, or at least those that enroll in computer science degrees (Indicator 4.3).
- **Potential:** New opportunities for impacting the SDGs were identified for these ICT solutions.

This mapping exercise was done by mapping the ICT solutions not to the targets but to the proposed indicators as they are measured today. These measurements were determined as part of Step 2. In total, 95 leverage points were identified for SDG-4 targets, 14 of those being other targets. Ten target-measures could be mapped to directly. Of the 81 leverage points unrelated to other SDG targets, only 19 were relevant to the 6 ICT solutions studied here.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Measure 4.1
Gross graduation ratio from primary and lower secondary education (%)
Leverage Points 4.1
Measure 4.2
1) Early Childhood Development Index
2) School enrollment preprimary (% gross)
Leverage Points 4.2
Measure 4.3
School enrollment, tertiary (% gross)
Leverage Points 4.3
Measure 4.4
Eurostat: Internet and Computer Skills (%)
Leverage Points 4.4
Measure 4.6
Literacy rate, youth (% 15-24) and adult (% 15 and above)
Leverage Points 4.6
Measure 4.5
Gender Parity Index (GPI) for all possible Measures
Leverage Points 4.5
Measure 4.7
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Analyzing additional solutions would touch on more of the leverage points but ultimately there are many for which ICT solutions are irrelevant. The interconnection of the targets is very important, particularly 4.5—as eliminating disparities improves the overall situation. Finally, for some targets such as 4.2 (early childhood), ICT is unlikely to have much of an impact.

Given the current data insufficiency, data relevance and scientific evidence issues, quantifiable attributions or simple correlations cannot currently be made to fully link ICT solutions and the SDGs. For many solutions, some impacts can be quantified as long as relevant data is reported. In other words, monitoring and evaluation of ICT solutions needs to link to the relevant SDG indicators so that impact can be assessed.
It is worth noting that most ICT solutions are similar, so mapping the solutions to the SDGs, their targets and indicators, and possibly leverage points will not need to be as extensive. Also, as more mapping is completed it will become clear which leverage points are most important.

Takeaways:

- *There are three ways that we mapped ICT solutions to the SDGs; measurable, indirect and influence. Some potential impacts were also identified.*
- *The directness of the impact of an ICT solution on the SDGs, and the availability of data and evidence, will determine the ability to confidently attribute successes.*
- *Even with this small set of case studies, patterns began to emerge on types of ICT solutions relevant for SDG-4, the key leverage points for ICT and identifying where the greatest potential is for impact.*

4.5. STEP 5: Assess Impacts

In the final step, an impact assessment is conducted by selecting specific countries and analyzing their current state, then using the links from the previous step to estimate the impacts on the SDG target. The exemplar countries selected for this case study cover the different levels of development as characterized by the Human Development Index: USA (very high), Mexico (high), India (medium) and Nigeria (low). This was illustrative because it showed that while there is great variability between countries in terms of both data and their specific needs, there is also much in common which could be leveraged for global impact.

5. Applying the Framework to SDG 4.3

5.1. Select Goals and Target

For this example application of the ICT-SDG Impact Assessment Framework, Target 4.3 of SDG-4 was chosen.

Target 4.3: *By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.*

5.2. Analyze Indicators

Indicator 4.3.1*: Participation rate of youth and adults in formal and non-formal education and training in the last 12 months, by sex*

Figure 12: Rating of Indicator 4.3.1

The indicator proposed for Target 4.3 captures much of its elements but does not mention affordability, accessibility or quality. These aspects are certainly difficult to measure given current information about post-secondary education but it is feasible.

Measure: School enrollment, tertiary (% gross)

School enrollment in tertiary education is available for a many countries for most years, making it one of the more reliable measures analyzed in this study. Yet it is much simpler than what the indicator requires, in particular not being properly disaggregated by age group and by type of degree. These shortcomings are expected to be resolved in the next few years making it highly like that the full data for indicator 4.3.1 will be comprehensive and robust.

5.3. Develop a Theory of Change

Target 4.3 is an output type of target because it is not assessing what the students learned, but only that the system was able to output so many of them. Based on extensive research the following leverage points were identified:

- **Public Costs**: This refers to costs borne by the higher education system and government. For low-income countries, it costs an average of 100% of GDP/capita to educate one student.
    - **Infrastructure**: Many low-income countries have large and rapidly growing youth populations and a sudden influx of secondary graduates from improved

K-12 systems. This is creating a demand which far outstrips the limited infrastructure which exists.
    - **ICT costs**: While university operating costs are generally lower in less developed countries, ICT costs are the same or higher than in developed countries. This means that as a proportion of university budgets, ICT capital expenditures and maintenance are quite large and are often delayed for too long.
    - **Qualified Faculty:** To meet demand and this target, countries need to vastly grow their enrollments which does not just mean infrastructure but also qualified faculty to teach the classes. Many of these countries have too few PhD-trained citizens and it can be difficult to locate them where new universities are being built (often peri-urban, remote or rural areas).
- **Private Costs**: Even though many countries make higher education free or virtually so, families and students still have to bear significant costs to attend school. A reliance on private universities to expand enrollment increases these costs.
    - **Living Expenses**: In many developing countries young people live with family. The cost difference between living at home and on one's own is very large. In addition, new universities are often built on the periphery of cities leading to significant transportation costs.
    - **Lack of scholarships/loans**: Most low income countries have no system for students to get loans; and especially when university is heavily subsidized, few scholarships are available. The advantage of these systems is that they could be used to target low-income families instead of free tuition being captured mostly by middle and upper income students. Also apples to Target **4.b** (Appendix E).
- **Inequitable access**: Beyond being partly Target 4.5, inequitable access will be a barrier to raising participation rates because it means a portion of the population is excluded.
    - **Socio-economic**: Middle- and upper-income students are over-represented in higher education the world over. In addition, certain indigenous and other social groups have been marginalized out of the system in many places.
    - **Geographic**: Typically, national universities are located in the capitals of countries, leaving other parts of the country with much lower quality (or no) higher education opportunities. This is a significant barrier for students from those regions.

Based on these leverage points, online higher education emerged as an obvious ICT solution which could have a big impact on Target 4.3.

5.4. Map Solutions

In Figure 14, the online higher education (OHE) case study is mapped to SDG-4 Targets and its leverage points. As shown, OHE maps directly to only Target 4.3, but also maps indirectly to 4 leverage points that affect Target 4.3, and has the potential to

indirectly influence a leverage point of Target 4.b. OHE also influences Target 4.7, has the potential to influence Target 4.5.

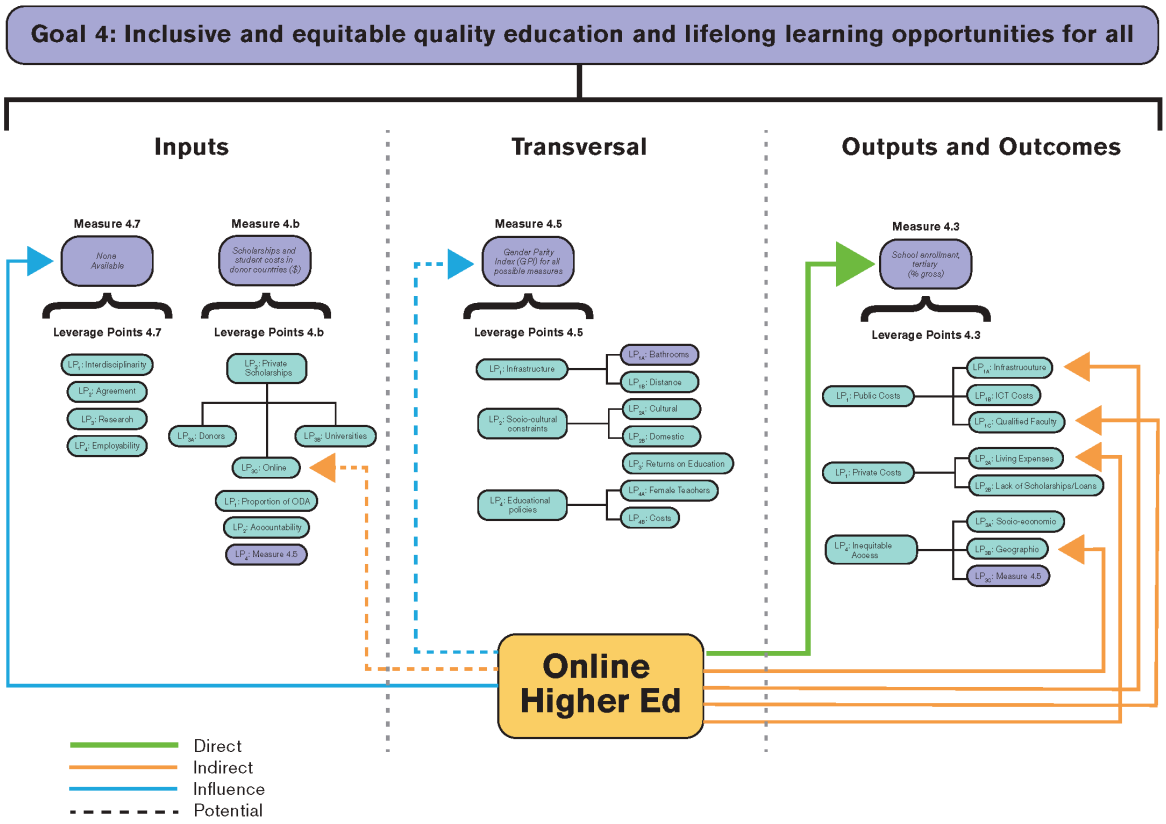

Figure 13: Online Higher Education Impacts Mapped to SDG-4 Targets and Leverage Points

5.5. Assess Impacts

5.5.1. Current State

Figure 14 is a smoothed histogram of the tertiary enrollment level of all the countries in the world divided into four groups by HDI. There is significant overlap between each of the groups, demonstrating that achieving high levels of post-secondary education is not necessary linked to HDI performance. The notable exception is for lowest HDI countries which average 7.5% enrollment versus 65% in the very high human development countries.

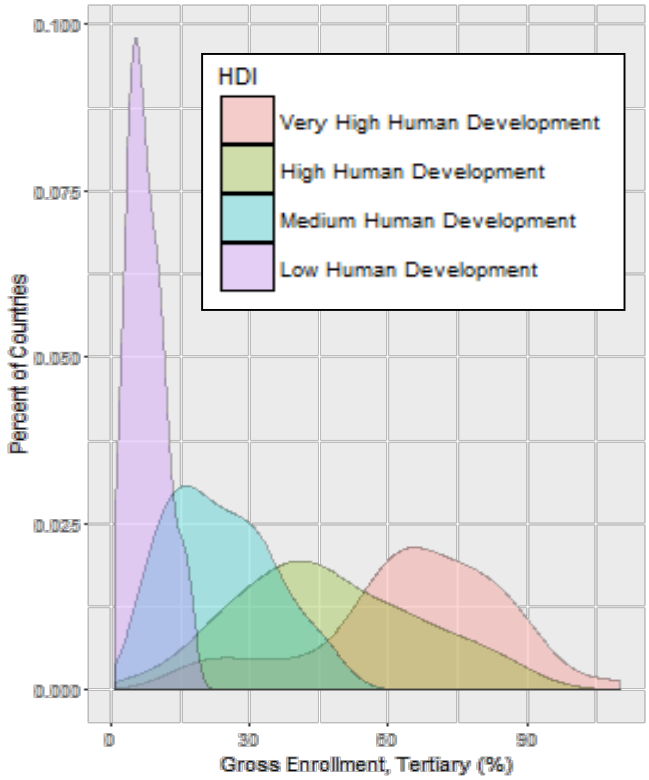

Figure 14: Histogram of Tertiary Enrollment by HDI Groups

For the four selected countries, Figure 15 shows the scatter of internet users and tertiary enrollment. Despite the wide scatter of the data, the average line shows that in general countries with more internet users have higher enrollment rates.

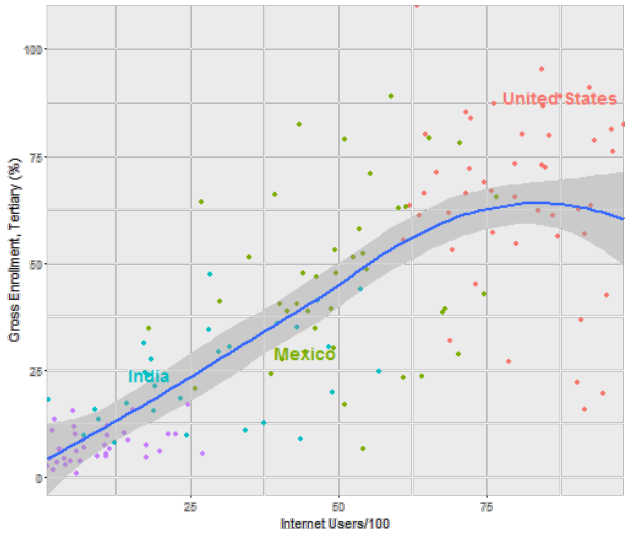

Figure 15: Smoothed Average Line of Internet Users and Tertiary Enrollment Rates

Figure 16 shows the yearly enrollment rates for the four selected countries. Across the board there has been a growth in enrollment yet over the last 40 years the USA has actually grown the gap in enrollment between it and the rest of the countries. Overall, given current trends, it will be difficult for India, Mexico and Nigeria to achieve SDG 4.3 by 2030 without significant intervention.

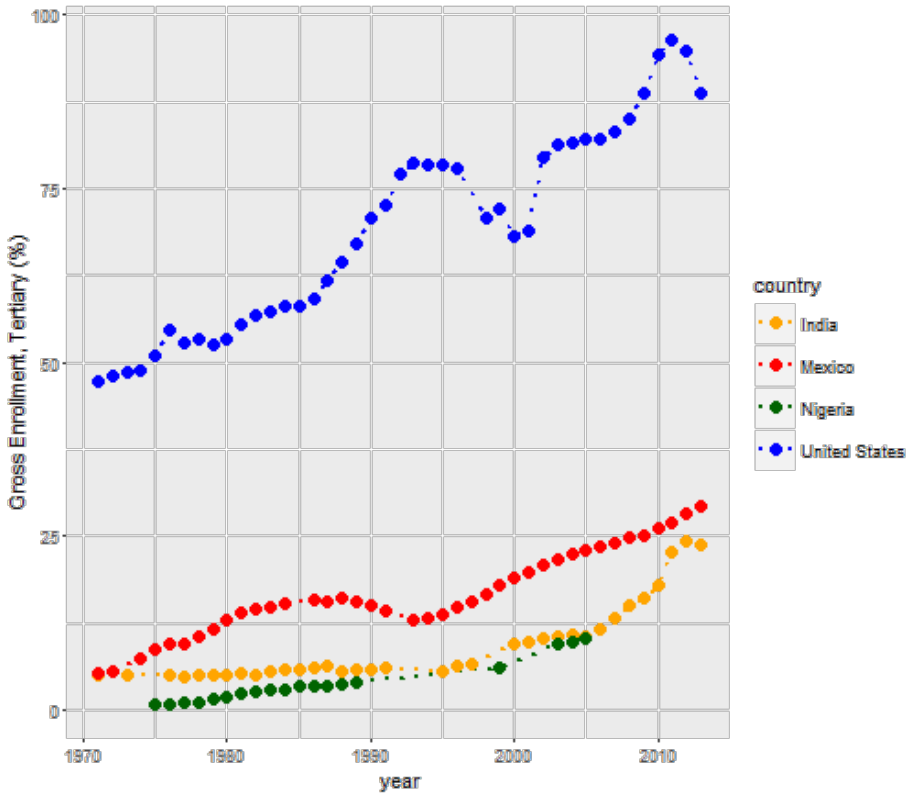

Figure 16 Tertiary Enrollment Rates

5.5.2. Impact Assessment for Nigeria

Nigeria has only 10% tertiary enrollment (in 2005) and yet 43% of its population is online, making it a good candidate for online higher education. Current estimates note that at least one million students are applying to university who are unable to secure admission (http://wenr.wes.org/2013/07/an-overview-of-education-in-nigeria/). Substantial expansion of university infrastructure has been proposed, but 40% of faculty positions are currently unfilled.

As an example of a potential intervention, Nigeria sends the second most students overseas of any African country, as degrees from abroad are highly valued. The associated impacts are:

- **Cost**: $12 million USD/year for 1,000 students studying at a US online higher education program.
- **Target 4.3**: This would only be an increase in enrollment of 0.07% but it would still be a direct and measurable improvement in the indicator.
- **Leverage Points for Target 4.3:**
    - **Infrastructure:** The National Autonomous University of Mexico (UNAM) expansion in Mexico cost more than $100 million USD and currently enrolls slightly less than 1,000 students as a comparison of savings.
    - **Qualified Faculty:** The large Nigerian universities have ratios as high as 100 students per faculty, so this project would reduce the need for 10 additional faculty.
    - **Living Expenses:** It would be difficult to calculate savings without additional data collection.
    - **Geographic:** Program could be targeted at peri-urban or rural students without access to existing universities.
- **Leverage Points for Target 4.b**: Donors are currently spending $3.8 billion on scholarships and student costs, so this would represent just a 0.01% increase if the costs of enrollment were provided by scholarships.
- **Relevance for Targets 4.4, 4.5 & 4.7:** By design this intervention could impact these additional targets in a meaningful way. Students could be required to take a programming course or major in STEM (Target 4.4) or take sustainability courses (Target 4.7). A portion (or all) of the scholarships could go towards women (Target 4.5) or other disadvantaged groups (ethnic minorities, rural, poor, etc).
- **Net positive benefits:** While these would need to be recalibrated to Nigeria, based on the previous Dell Online Education Study, an estimated $130 million in yearly socio-economic benefits could accrue for Nigeria (starting in year 5 when students have graduated) and 7,000 tons of CO_2e emissions could be reduced.

6. Strategic Possibilities

How might a business take the SDGs into account when making product, service and solutions decisions? There are 17 goals, 169 targets, 193 countries, hundreds of indicators and thousands of possible ICT solutions.

While not the primary focus of this study, in the course of this research, several opportunities for strategic approaches to impacting the SDGs were identified and are presented here in brief.

6.1. Potential for ICT by Targets

Figure 17 shows a “traffic light diagram” for three evaluation criteria for each target in SDG-4 rated poor (red), reasonable (yellow) and good (green). The basis for these structured qualitative judgements is elaborated more fully in Appendix F.

- **The Indicator & the Data**: This is an assessment of how well progress against this target can be measured with the proposed indicator and the available data sources.
- **Relevancy of ICT**: This is an assessment of how much potential ICT solutions have to make a difference to this target, based on its leverage points. For example, compare the role of ICT for kindergarteners versus college students.
- **Magnitude of ICT Impact**: This is an assessment of the potential magnitude (transformative potential) of impact for ICT solutions in this sector, even if that solution does not exist yet. For example, a computer program which successfully made every student a math prodigy would be transformational in terms of Target 4.1.

Target	Short Name	The Indicator & the Data	Relevancy of ICT	Magnitude of ICT Impact
4.1	Proficiency of Primary and Secondary students	🟡	🟡	🟢
4.2	Early Childhood/ Preprimary Enrollment	🟢	🔴	🔴
4.3	Post- Secondary Education	🟢	🟢	🟢
4.4	ICT Skills	🔴	🟢	🟢
4.5	Equal access for all	🟢	🟡	🟡
4.6	Literacy	🟢	🟡	🔴
4.7	Sustainable Development Knowledge	🔴	🟡	🟡
4.a	School Infrastructure	🟡	🟡	🟡
4.b	Scholarships	🟡	🟡	🟡
4.c	Qualified Teachers	🟢	🟡	🟢

Figure 17: Assessing Target Selection

6.2. Potential for ICT by Country

One of the main disconnects between the SDGs and corporate sustainability reporting is the unit of interest. Businesses measure their globally-distributed impacts (and those of their suppliers), aggregating results and impacts irrespective of location. The SDGs on the other hand are concerned with how well individual countries are doing. So when it comes to measuring progress on the SDGs it matters very much where the activities or impacts of interest are taking place. Reporting corporate sustainability activities by country is an essential step for alignment with the SDGs. A re-orientation towards countries presents much greater opportunities than just improved reporting. With a basic tool, one can quickly identify those countries with the best opportunity for the largest and most immediate impact on the SDGs.

This tool, the ICT Opportunity Index (IOI) was created to identify the best countries for deploying ICT solutions. It is calculated as follows for each indicator:

IOI = internet users / current state of the indicator of interest

Countries with a high score are considered to be the best opportunities because in these countries there is a large number of people who can use the ICT solution relative to the number of people who need such solutions. There will be a lot of other factors that determine the “best” country (supportive government, shared language, local partner, etc.), but the IOI narrows down the list and avoids, for example, deploying an online higher education degree program in a country where few people are online and lots of people are already getting immersive degrees anyway (such as Ukraine).

So after selecting a target, the IOI can be used to select an initial list of target countries. Figure 8 illustrates the results of calculating this index for indicator 4.3.1; additional results for SDG-4 and a more detailed explanation of the approach to calculating the IOI can be found in Appendix H. As shown, most of the best opportunities for online higher education programs to have a big impact on SDG 4.3 are in Africa where, while enrollment is generally very low across the board, there are countries such as Kenya and Nigeria with a significant proportion of the population online.

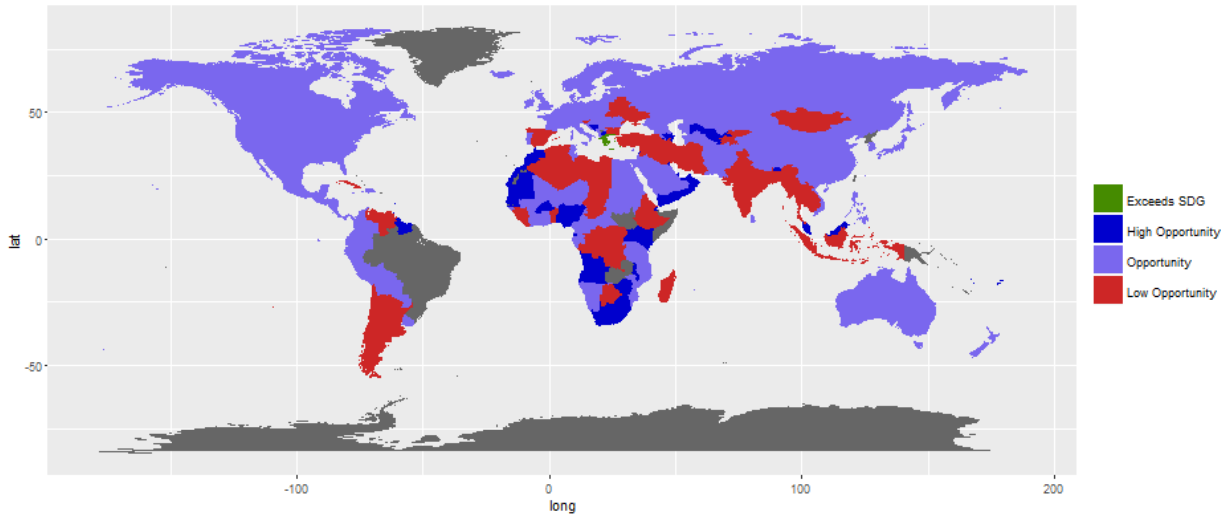

Figure 18: ICT Opportunity Index for Indicator 4.3.1 Gross Tertiary Enrollment (%)

Looking at all of the indicators for SDG-4 (where there is data), a list of the countries which show the greatest potential for ICT to have an impact can be calculated. Table 1 is a list of the top 15 countries along with their HDI level and Internet Access.

Table 1 Top 15 ICT Opportunity Index Countries for SDG-4

Countries	HDI Level	Internet Access
Lebanon	High	74.7%
Malaysia	High	67.5%
Morocco	Medium	56.8%
Nigeria	Low	42.7%
Macedonia	High	68.1%
Azerbaijan	High	61.0%
Antigua and Barbuda	High	64.0%
Trinidad and Tobago	High	65.1%
Oman	High	70.2%
Kenya	Low	43.4%
Saint Vincent	High	56.5%
Dominica	High	62.9%
Mexico	High	44.4%
Palestine	Medium	53.7%
Yemen	Low	22.6%

Takeaways:

- *A strategic approach is essential in order to have solutions with a meaningful and measurable impact on the SDGs.*
- *SDG impact is measured at the country level.*
- *The tools proposed here can assist in strategically selecting targets and countries.*
- *Mapping ICT solutions to the SDGs can help with project design and is essential for measuring impact.*

7. Conclusion

7.1. Key Considerations and Constraints

- **Targets and indicators are not necessarily aligned.** The UN will measure progress on the SDGs with specific indicators (currently still in draft form) that are not necessarily aligned closely to their targets. In all cases the indicators are narrower in scope than their targets.
- **The targets fall on different points of the TOC model**. Solutions that are targeting inputs will be much easier to implement and measure but have the least impact, while targeting outputs and outcomes will be the more impactful but more difficult to implement.
- **The major constraint is lack of good data.** Very few of the proposed SDG indicators have good data and almost none have thresholds. There are also few quality studies on the impact of ICT on relevant education outcomes.
- **Selecting targets and countries will get easier over the next few years.** As the coordinated global effort to achieve the SDGs ramps up, the process will get easier. More data will come online as countries and international agencies release reports.
- **For some SDG targets (and their indicators) a rigorous mapping will likely never be possible.** Some of the targets will never be measured sufficiently, in enough places and over long enough periods of time to meaningfully assess impact. For others, the connection to ICT is just too distant and/or weak. Finally, many possible ICT solutions will lack sufficient evidence about their relevant real-world impacts.
- **The SDGs are interlinked.** There are numerous links between the targets. Several other groups of researchers are currently working on systematically analyzing and mapping the links between all of the SDG targets, and taking advantage of their work will be critical in the future to conduct more holistic mapping.

7.2. Conclusions

Based on what is known today, ASU Global Sustainability Solutions Services can draw the following conclusions:

- **Mapping ICT solutions to the SDGs is possible in many cases.** Some cases are more direct and easier to map than others, but overall the process is currently very difficult.
- **Insufficient data is the primary barrier.** A lack of meaningful data about the specifics of the SDGs and the relevant impacts of ICT solutions are the main barriers to meaningful mapping and measurement.
- **SDG impact is measured at the country level.** To measure progress on the SDGs, solutions and their impacts must be studied on a country by country basis.
- **Evaluation of the leverage points independent from specific solutions is critical.**
- **An unexpected and valuable result of the study was identification of the possibility of using a strategic approach to the SDGs.** This could be essential in order to have projects with meaningful and measurable impact on the SDGs. The tools developed in this study can assist in strategically selecting targets and countries.

7.3. Next Steps

7.3.1. Next steps for practitioners and researchers:

- Fully quantify the impact of one case study against all of the SDGs.
- Map the impact of all corporate activities of one ICT company against a selection (or all) of the SDGs.
- Expand the analysis on the impacts of the ICT sector on SDG-4 from this report to the impacts of the ICT sector on all 17 of the SDGs.

7.3.2. Next steps for the ICT sector:

- Gather and share better ICT data.
- Find evidence of the impact of ICT solutions on specific SDG goals, targets and especially indicators.
- Create sector-wide alliances to establish standards for mapping solutions to the SDGs, collect more reliable data and collaborate on having a greater impact.

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Appendix B: The Private Sector

This is a list of some of the websites which are supporting private sector collaboration to achieve the SDGs:

- SDG Compass: http://sdgcompass.org/
- WBCSD SDG Hub: http://www.wbcsd.org/sdghub.aspx
- Official UN partnerships https://sustainabledevelopment.un.org/partnerships/
- SDG Industry Matrix (does not yet have ICT): https://www.unglobalcompact.org/library/3111
- Global Sourcing Council: http://gscouncil.org/gsc-17-17-sdg-program/
- UN Global Compact: https://www.unglobalcompact.org/

As discussed in the report, the SDG compass has linked the SDGs to existing indicators, principally from Global Reporting Initiative (GRI), which is published on their website. We share the list for SDG 4 here which shows the distinct difference from what we are trying to accomplish with this study.

SDG Target	Business Theme	Type of Indicator	Indicator Source	Indicator Description	Indicator ID & Info
4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes	No indicators have been identified	No indicators have been identified	No indicators have been identified	No indicators have been identified	No indicators have been identified
4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education	Childcare services and benefits	General	UN Global Compact-Oxfam Poverty Footprint	Approximate proportion of young children of working parents who have access to local, affordable and safe childcare service.	PF - 15.2
4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education	Childcare services and benefits	General	UN Global Compact-Oxfam Poverty Footprint	Average investment for childcare provisions or benefits (per working family) by i) the Company system and ii) other employers in the value chain.	PF - 15.7
4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education	Childcare services and benefits	General	The Women's Empowerment Principles: Reporting on Progress (aligned with GRI G4)	What is the business' policy and provision of childcare facilities and how many employees, if any, use this facility?	N/A
4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	Employee training and education	General	GRI G4 Sustainability Reporting Guidelines	Average hours of training per year per employee by gender, and by employee category	G4-LA9
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	Employee training and education	General	UN Global Compact-Oxfam Poverty Footprint	**i)** Approximate proportion of workers (m/w) along the value chain who receive training per year. **ii)** Average number of hours (or days) of	PF - 4.1

				training(s) provided to workers (m/w). **iii)** Provide details on the type(s) of training(s) provided	
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	Employee training and education	General	GRI G4 Sustainability Reporting Guidelines	Average hours of training per year per employee by gender, and by employee category	G4-LA9
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	Employee training and education	Sector-specific	GRI G4 Electric Utilities Sector Disclosures	Programs and processes to ensure the availability of a skilled workforce	former EU14
4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations	Employee training and education	General	GRI G4 Sustainability Reporting Guidelines	Average hours of training per year per employee by gender, and by employee category	G4-LA9
4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy	Media literacy	Sector-specific	GRI G4 Media Sector Disclosures	Actions taken to empower audiences through media literacy skills development and results obtained	M7
4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	Education for sustainable development	General	GRI G4 Sustainability Reporting Guidelines	a. Report the measures taken to develop and enhance the highest governance body's collective knowledge of economic, environmental and social topics.	G4-43
4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including…	Education for sustainable development	Sector-specific	GRI G4 Event Organizers Sector Disclosures	Number, type and impact of sustainability initiatives designed to raise awareness, share knowledge and impact behavior change, and results achieved	EO11
4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	Accessibility of buildings	Sector-specific	GRI G4 Construction and Real Estate Sector Disclosures	Type and number of sustainability certification, rating and labeling schemes for new construction, management, occupation and redevelopment	CRE8
4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries…	No indicators have been identified	No indicators have been identified	No indicators have been identified	No indicators have been identified	No indicators have been identified
4.c By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries…	No indicators have been identified	No indicators have been identified	No indicators have been identified	No indicators have been identified	No indicators have been identified

Appendix C: Discussion of Data about ICT

Reasons for Caution

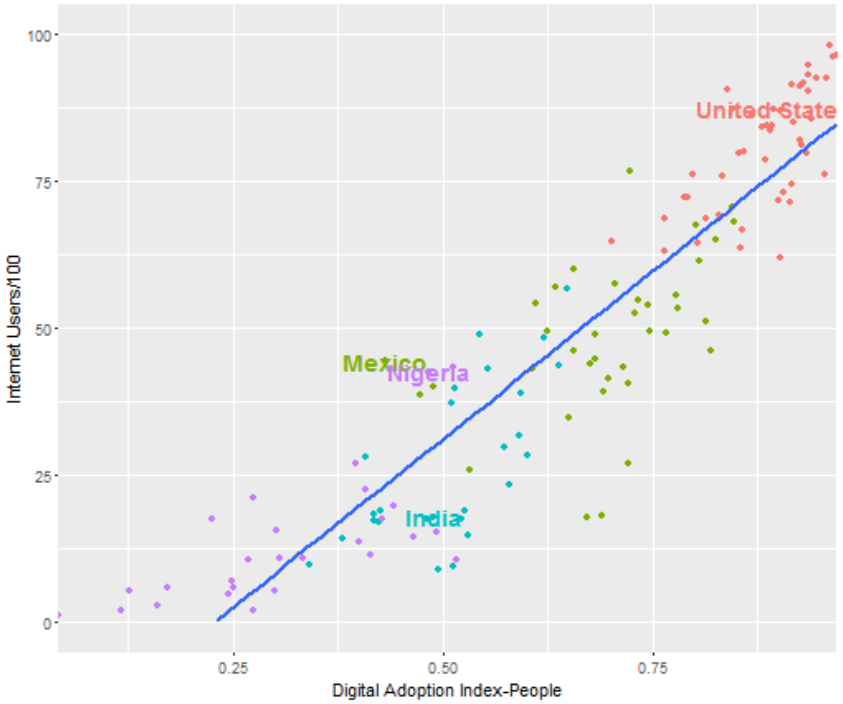
More and better research would do much to help but there are several reasons for caution about claims of ICT solutions for the SDGs:

- **Casual Pathway:** As already mentioned, for all but a handful of the SDGs ICT solutions will be indirect. Few if any causal pathways in development, particularly bridging from the micro (project) to macro (national) scale are widely agreed upon and even fewer are universal. The more distant on the pathway the proposed solution is from the problem the more caution should be taken in assuming an impact.
- **Matthew Effect:** This term was first used to describe the fact that credit for new scientific discoveries went to those who already had a bigger reputation; the rich get richer phenomenon. Those best positioned to take advantage of the introduction of new ICT solutions are typically those with the resources or pre-existing ICT skills, not those who need it most. Trucano (2013) discusses how the building of computer labs probably benefits mostly the leading students as an example of this phenomenon.
- **Diminishing Returns:** Impactful and positive initial results should only be extrapolated with caution. The first adopters of ICT will be those who can benefit most and the benefits for each new adopter will be smaller (the exception being technologies with network effects, such as cellphones). Online higher education for example will start by recruiting those who are most motivated and able to work independently but each new student will probably be less motivated and/or capable. For well-established solutions we have information about the rate of diminishing return but most ICT solutions are too new for us to be sure, e.g. how many people are really able to get a degree fully online?
- **Comparative Cost Effectiveness:** For any specific problem there will most likely be many possible solutions. An ICT based solution may have a positive impact, as did Computer Assisted Learning, based on one study in India; but be less cost effective than in this example, one on one tutoring (Linden, 2008). Given the expense of deploying ICT solutions in many less developed contexts, cost effectiveness is a key concern.
- **History:** Africa, Latin America and Asia are littered with the technological skeletons of well-intentioned “experts” from the developed world. Typically this came about from applying technological solutions that worked in their country to a new place. Not all have failed (e.g. cellphones), but the vast majority have.

As discussed in section 1.2.2 there is very little publicly available country-level data related to ICT. Our best indicator of ICT use in a country appears to be Internet Users

(% of population that have used the internet at least once in the last twelve months). There are other possibilities (broadband access and cellphone subscriptions for example) but the data the results seem too irregular and not directly relevant (e.g. # of cellphone subscribers has to do more with regulatory structure than connectivity). Hopefully a broad effort will be made to bring more data together and into the public domain but there are a couple of other sources which could be used more in the future. This year (2016) in collaboration with Microsoft, the World Bank released the Digital Adoption Index which incorporates various data points to create an index of a country's public, business and government digital adoption, http://www.digitaladoptionindex.org. Unfortunately the data does not yet appear to be shared publicly. Some data is available (though with obvious errors) via the World Bank report. The website could be scrubbed to get the data. Of most interest is the DAI People Index which includes two sub-components, cellphone access and internet access at home. The data comes from the Gallop World Poll asking "home has access to internet" and "home has cellular phone". This data is not available to the public but we were able to extract a rough form from the World Bank report.

The DAI People Index was plotted against the World Bank Internet Users and they are closely correlated though some of the countries do vary significantly--perhaps because of the addition of cellphone ownership.



The Pew Research Center conducts a survey of smartphone use in forty countries which they published this February (Pew Research Center, 2016). In advanced economies 68% of adults own a smartphone versus 37% in developing or emerging economies. See the map below for specific countries.

Smartphones are more common in Europe, U.S., less so in developing countries

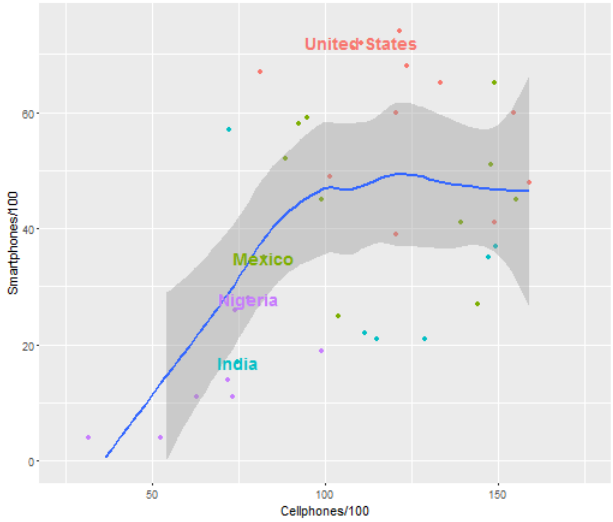
Percent of adults who report owning a smartphone

Note: Percentages based on total sample.

Source: Spring 2015 Global Attitudes survey. Q71 & Q72.

PEW RESEARCH CENTER

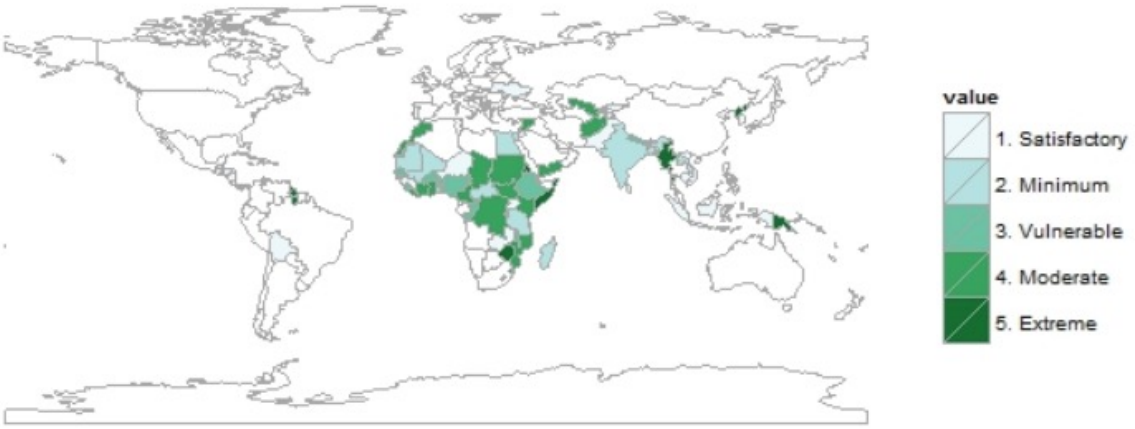
Unfortunately, this dataset is fairly limited in terms of comparative analysis because few countries are included in the survey but it does include many where potential projects might be located. Additionally, Pew asks a lot of other questions which enable one to dive a little deeper for the surveyed countries. This data set was compared to the World Bank's Cellphone Subscription dataset and found a correlation of only 0.44; therefore, cellphone subscriptions should not be considered a proxy for smartphone adoption.



There are likely to be other accessible data. One possibility is to look into Google Trends and research key terms like "online education" to judge in which countries people were showing the most interest in relevant

ICT solutions. In general it is important to emphasize that these data do not necessarily measure factors relevant to this study. For example the #SystemsTransformation report features the fact that 70% of sub-Saharan Africans have cellphones when in fact the data states that there are 70 subscriptions per 100 people which is not the same in regions where it may be common to have multiple subscriptions. Weak data collection and analysis can affect reporting major develop trends (Jerven, 2016). Therefore, it is important to scrutinize both the raw data and the interpretation of that data in relation to the indicators. The map below shows how much bad data there is for poverty, the biggest data point of them all.

Figure 5 – Poverty Data Deprivation in the Developing World (2003-2012)



Appendix D: Part 1 Data on SDG 4

1. Quality of Current Data for SDG 4

There is a significant gap in both the quantity and quality of data in the current provisional indicators released by the UN. The Center for Global Development (CGD) has made an effort at scoping all the indicators http://www.cgdev.org/blog/sdg-indicators-serious-gaps-abound-data-availability and http://www.cgdev.org/blog/what-sdgs-can-we-track-now. The UN also assessed the indicators, ranking them in three tiers. The UN itself found that of their 230+ indicators only 42% have an established methodology and regularly accessible data. The CGD analysis of the indicators found that only a portion of these supposed Tier One indicators have direct, publicly accessible data, leaving only 25% of SDG indicators usable today.

In this study, the independent analysis of the indicators for SDG4: Education was conducted. The table below compares the study's rating of the current data available with the rating of the agency which proposed the indicator and then the rating of the UN Secretariat which reviews all the indicators after submission (and tend to be more pessimistic than the proposing agencies).

Target	Short Name	Review of Current Data	UN Tiers	
			Agency	Secretariat
4.1.1	Proficiency of Primary and Secondary students			
4.2.1	Early Childhood Development Index			
4.2.2	Preprimary Enrollment			
4.3.1	Post- Secondary Education			
4.4.1	ICT Skills			
4.5.1	Equal access for all			
4.6.1	Literacy			
4.7.1	Sustainable Development Knowledge			
4.a.1	School Infrastructure			
4.b.1	Scholarships			
4.c.1	Qualified Teachers			

In general the study's ratings line up with what the UN has determined about the indicators with three exceptions:

1. ICT skills (4.4.1) were rated lower than the UN because the skills they propose are already quite outdated,
2. Scholarships (4.b.1) were rated lower because it only includes official development aid for scholarships and not private or other types of scholarships
3. Qualified teachers (4.c.1) was rated lower because the data is based on national standards which varies enormously (or in the US doesn't exist) and makes comparisons between countries useless.

Quality of data for four example countries

The availability and quality of the data available for each country was assessed based on key measurement data for each of the indicators.

Target	Short Name	USA	Mexico	India	Nigeria
4.1.1	Proficiency of Primary and Secondary students				
4.2.1	Early Childhood Development Index				
4.2.2	Preprimary Enrollment				
4.3.1	Post- Secondary Education				
4.4.1	ICT Skills				
4.5.1	Equal access for all				
4.6.1	Literacy	N/A			
4.7.1	Sustainable Development Knowledge	N/A	N/A	N/A	N/A
4.a.1	School Infrastructure				
4.b.1	Scholarships	N/A	N/A	N/A	N/A
4.c.1	Qualified Teachers				

1.1. In-Depth Analysis of Data for SDG 4

The same analytical process was applied to each of the ten targets of SDG 4:

1. The target and its proposed indicators were summarized and compared with a focus on identifying gaps between them.
2. Publicly available data was found that matched the proposed indicator as closely as possible (if it existed).
3. The match between this data and the proposed indicator was analyzed and the future landscape for indicator data assessed.
4. Finally, the data was analyzed to get a sense of the current global situation, look at trends in the four example countries, explore potential links to ICT and identify outlier countries (both leaders and laggards).

Originally this analysis was going to include an assessment of progress towards proposed thresholds for each indicator but as of now almost none exist for the SDGs and it is unclear whether they will be included in the final indicators (e.g. what percentage of tertiary enrollment is considered successful).

1.2. The Process

1. **Select Target**
2. **Review SDG Indicator**
    a. Highlights
    b. Missing from the indicator
3. **Existing Data**
    a. What is available now for assessing the current state of the indicator?
    b. How close does this match to what the indicator metadata describes?
    c. Is there data for aspects of the target not captured by the indicator?
    d. Is there a goal(s) for 2030 for target and/or indicator(s)?
    e. What can we learn from the available data?

1.3. Notes on the Process

3a: Select indicators for which there is data now.

3b: Judge how close current data matches specific indicator and estimate timeline for exact indicator data existence.

3c: Review metrics for the target outside the indicator(s).

3e: No indicators had thresholds explicitly included in the metadata but some could be inferred to be 100% based on target or indicator wording.

1.4. Approach taken for 3e

- A consistent approach will be used on every target and proposed data set.
- The goal is to provide a consistent overview of the data for each target so that they can be qualitatively compared with each other.

This will include:

- Trends in the four countries of focus

- Current global situation
    - Will use most recent available year (from the last five)
    - Countries grouped by Human Development Index
- Exploration of potential links to ICT
    - Plot correlation with internet and cellphone use
    - Regression of whether these predict the indicator (controlling for HDI)
- Outlier countries (leaders and laggards)
    - Identify countries which are further than one standard deviation from the mean for their HDI group

1.5. ICT Indicators

Introduction to the ICT Indicators

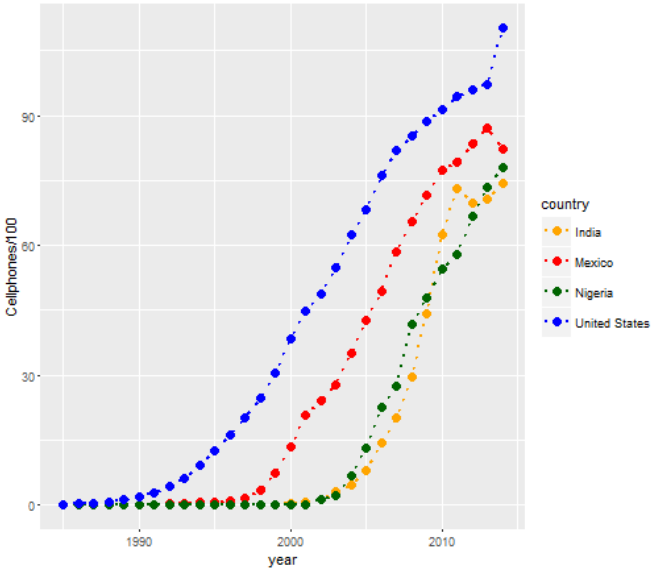
- Mobile cellular subscriptions (per 100 people)

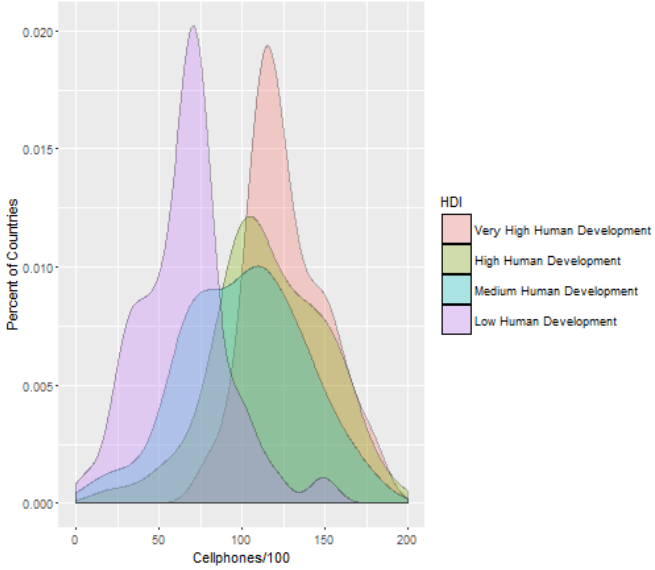
Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provides access to the PSTN (public switched telephone network) using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services. (Official indicator description)

- Internet users (per 100 people)

Internet users are individuals who have used the Internet from any location in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. (Official indicator description)

Mobile cellular subscriptions (per 100 people)



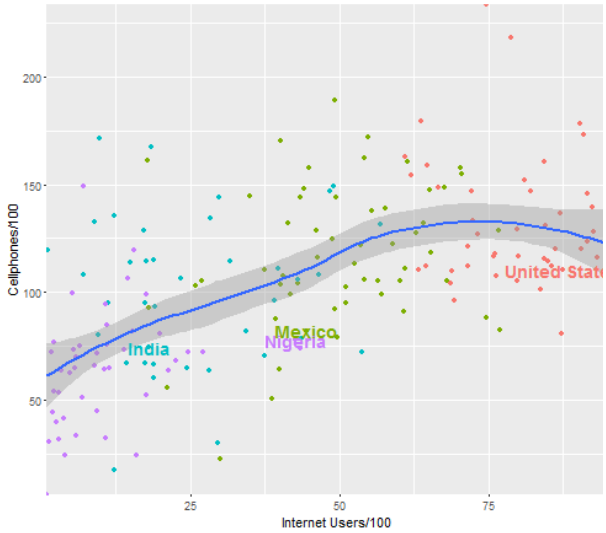


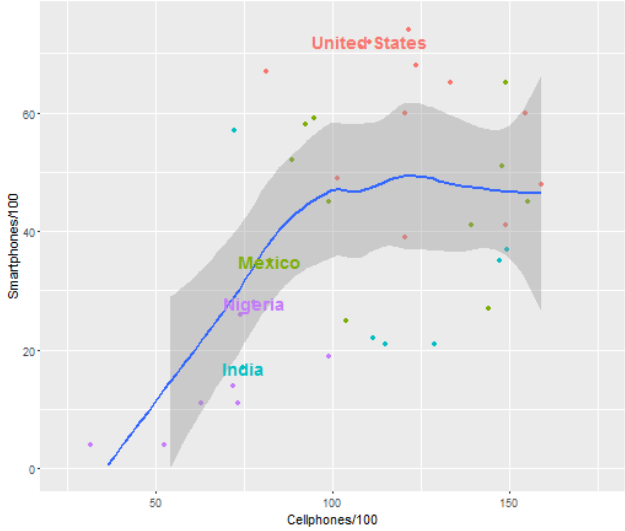
Means by HDI

HDI Level	Cell Mean	Internet Mean
Very High Human Development	131.15	80.84
High Human Development	116.92	50.09
Medium Human Development	100.9	25.52
Low Human Development	65.48	11.1

Internet vs. Cellphones

Correlation = 0.55 (p<0.01)





Cellphone use may be able to be used as a proxy for smartphone penetration

Pew collected data from 40 countries on smartphone use

Correlation = 0.44 (p<0.01)

High Internet Countries

HDI	Country	Internet
Very High Human Development	Andorra	95.9
Very High Human Development	Denmark	95.99
Very High Human Development	Finland	92.38
Very High Human Development	Iceland	98.16
Very High Human Development	Liechtenstein	95.21
Very High Human Development	Luxembourg	94.67
Very High Human Development	Netherlands	93.17
Very High Human Development	Norway	96.3
Very High Human Development	Sweden	92.52
High Human Development	Bahamas, The	76.92
High Human Development	Barbados	76.67
High Human Development	Lebanon	74.7
High Human Development	Malaysia	67.5
High Human Development	Oman	70.22
High Human Development	Russian Federation	70.52
High Human Development	St. Kitts and Nevis	65.4
High Human Development	Macedonia, FYR	68.06
High Human Development	Trinidad and Tobago	65.1
Medium Human Development	Moldova	46.6
Medium Human Development	Morocco	56.8
Medium Human Development	Paraguay	43
Medium Human Development	South Africa	49
Medium Human Development	Uzbekistan	43.55
Medium Human Development	Vietnam	48.31
Medium Human Development	West Bank and Gaza	53.67
Low Human Development	Angola	21.26
Low Human Development	Kenya	43.4
Low Human Development	**Nigeria**	**42.68**
Low Human Development	Sudan	24.64
Low Human Development	Swaziland	27.1
Low Human Development	Yemen, Rep.	22.55

Low Internet Countries

HDI	Country	Cellphones
Very High Human Development	Bahrain	173.27
Very High Human Development	Hong Kong SAR, China	233.62
Very High Human Development	Kuwait	218.43
Very High Human Development	Montenegro	163.03
Very High Human Development	Saudi Arabia	179.56
Very High Human Development	United Arab Emirates	178.06
High Human Development	Kazakhstan	172.19
High Human Development	Libya	161.12
High Human Development	Maldives	189.38
High Human Development	Oman	157.75
High Human Development	Panama	158.05
High Human Development	Russian Federation	155.14
High Human Development	Seychelles	162.19
High Human Development	Suriname	170.57
High Human Development	Uruguay	160.8
Medium Human Development	Botswana	167.3
Medium Human Development	El Salvador	144.01
Medium Human Development	Gabon	171.38
Medium Human Development	South Africa	149.19
Medium Human Development	Vietnam	147.11
Low Human Development	Benin	99.65
Low Human Development	Cote d'Ivoire	106.25
Low Human Development	Gambia, The	119.63
Low Human Development	Mali	149.07
Low Human Development	Mauritania	94.2
Low Human Development	Senegal	98.84

High Cellphone Countries

HDI	Country	Internet
Very High Human Development	Argentina	64.7
Very High Human Development	Brunei Darussalam	68.77
Very High Human Development	Croatia	68.57
Very High Human Development	Cyprus	69.33
Very High Human Development	Greece	63.21
Very High Human Development	Italy	61.96
Very High Human Development	Montenegro	61
Very High Human Development	Poland	66.6
Very High Human Development	Portugal	64.59
Very High Human Development	Saudi Arabia	63.7
High Human Development	Algeria	18.09
High Human Development	Samoa	21.2
High Human Development	Cuba	30
High Human Development	Libya	17.76
High Human Development	Mongolia	27
High Human Development	Sri Lanka	25.8
High Human Development	Thailand	34.89
Medium Human Development	Bangladesh	9.6
Medium Human Development	Cambodia	9
Medium Human Development	Congo, Rep.	7.11
Medium Human Development	Gabon	9.81
Medium Human Development	Timor-Leste	1.14
Low Human Development	Eritrea	0.99

Low Cellphone Countries

HDI	Country	Cellphones
Very High Human Development	Andorra	82.64
Very High Human Development	Canada	81.04
Very High Human Development	Cyprus	96.34
High Human Development	Samoa	55.53
High Human Development	Bahamas, The	82.3
High Human Development	Belize	50.71
High Human Development	Cuba	22.48
High Human Development	Dominican Republic	78.86
High Human Development	**Mexico**	**82.22**
High Human Development	Tonga	64.28
Medium Human Development	Kiribati	17.41
Medium Human Development	Micronesia, Fed. Sts.	30.32
Medium Human Development	Sao Tome and Principe	64.94
Medium Human Development	Syrian Arab Republic	63.86
Medium Human Development	Vanuatu	60.41
Low Human Development	Burundi	30.46
Low Human Development	Central African Republic	24.54
Low Human Development	Djibouti	32.39
Low Human Development	Eritrea	6.39
Low Human Development	Ethiopia	31.59
Low Human Development	Malawi	33.47
Low Human Development	South Sudan	24.5

1.6. Conclusions

- Mexico is behind on cellphone coverage which has been noted in studies which found its prices to be much higher than global averages
- Nigeria is ahead on internet

- Cellphone penetration is very high in low income countries but internet generally is not
- Medium and High HDI have a big spread in internet penetration

2. Target 4.1 - Primary & Secondary Education

2.1. Process

1. Select Target

Target 4.1

By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.

2a. Review SDG Indicator and Metadata

Indicator 4.1.1: Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex

- Divide percentage of children and young people at the end of primary and lower secondary levels of education achieving at least minimum proficiency level in (a) reading and (b) mathematics
- The minimum proficiency level will be measured relative to new common reading and numeracy scales currently in development

2b. Missing from the Indicator

- The indicator shows how well those who make it all the way to the end of primary and secondary are doing but does not say if all are making it to that stage
- Does not assess whether education is free (especially private costs like uniforms, transport etc.) or equitable (e.g. 80% may be proficient but what if only 20% of indigenous students are?)

3a. What is available now for assessing the current state of the indicator?

- UNESCO collects most education data but currently the most commonly used international assessment test is organized through the OECD (Organization for Economic Cooperation and Development).
- Various international assessments (e.g., PIRLS, PISA, TIMSS), regional learning assessments (e.g., LLECE, SACMEQ, PASEC), national and citizen-led learning assessments exist and will need to be harmonized

Proposed existing data sources:

- Gross graduation ratio from primary education, both sexes (%)
- Gross graduation ratio from lower secondary education, both sexes (%)

Number of graduates regardless of age in a given level or programme, expressed as a percentage of the population at the theoretical graduation age for that level or programme.

3b. How closely does this match to what the indicator metadata describes?

- Judgment: Presumably every education system requires students to meet some proficiency standard in order to graduate. This data will give us a fair sense about how far we are from the whole population making it to nationally accepted levels of proficiency.
- Missing elements:
    - The level of proficiency required to graduate in each country is not the same
    - Does not assess progress of grades 2/3 as called for by the indicator
    - Does not specifically assess reading and math progress separately
    - Timeline: 3-5 years

3c. Is there data for aspects of the target not captured by the indicator?

- % of population which is currently reaching the end of primary and the end of secondary is available (and what we will be using)
- Unknown if there is a way to measure the costs of primary/secondary education or how equitable it is

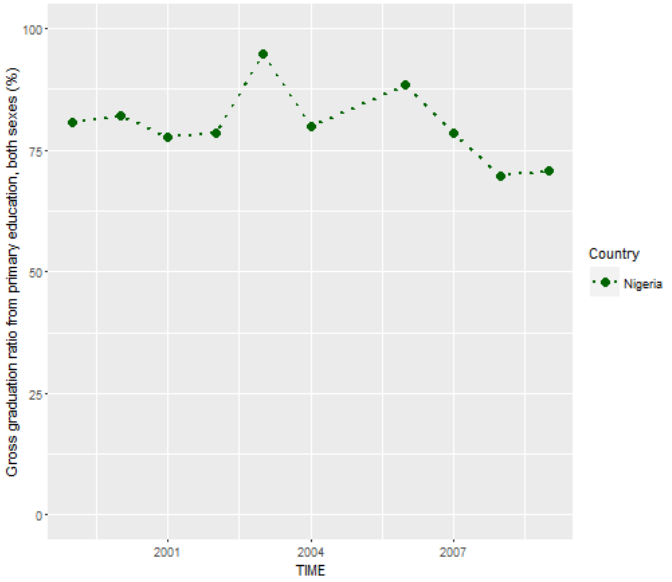
3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

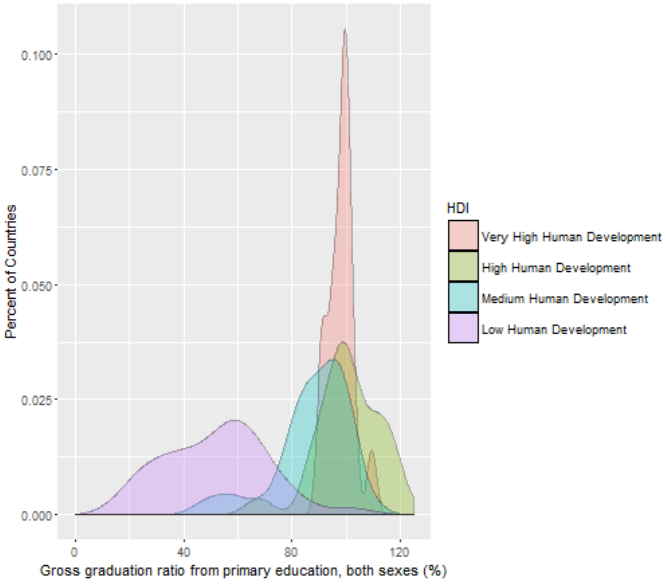
- The goal is that EVERYONE achieve proficiency—i.e. 100%

3e. What can we learn from the available data?

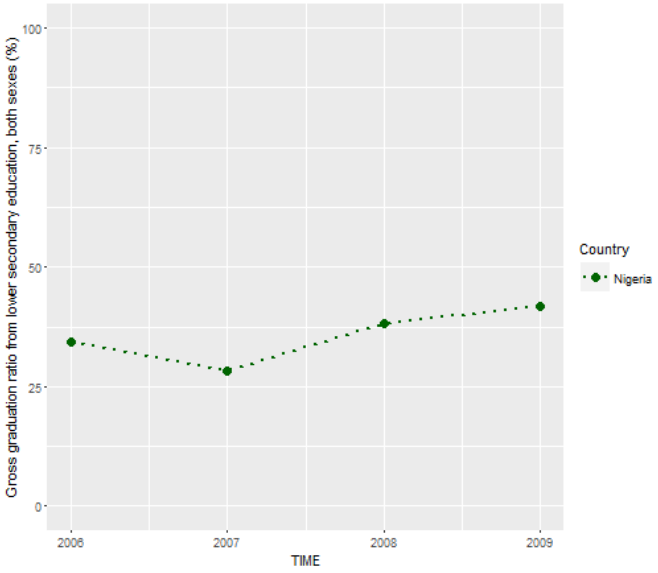
- Gross graduation ratio from primary education, both sexes (%)
- Gross graduation ratio from lower secondary education, both sexes (%)
- Countries: USA, Mexico, India, Nigeria
- ICT data: Internet users and cellphone subscriptions

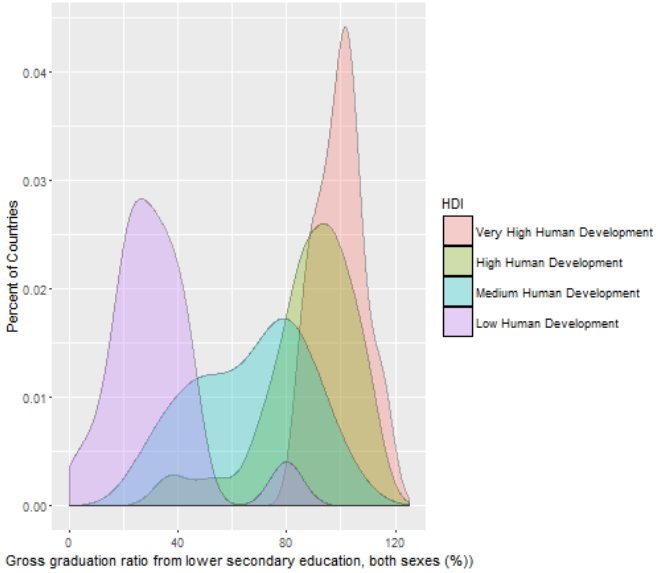
Gross graduation ratio from primary education, both sexes (%)





Gross graduation ratio from lower secondary education, both sexes (%)

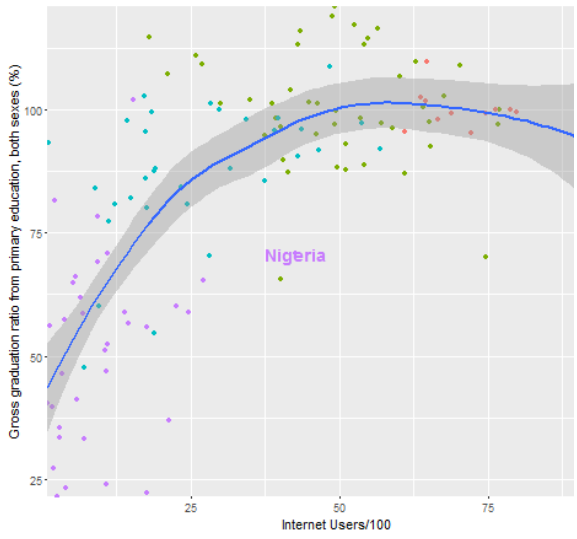


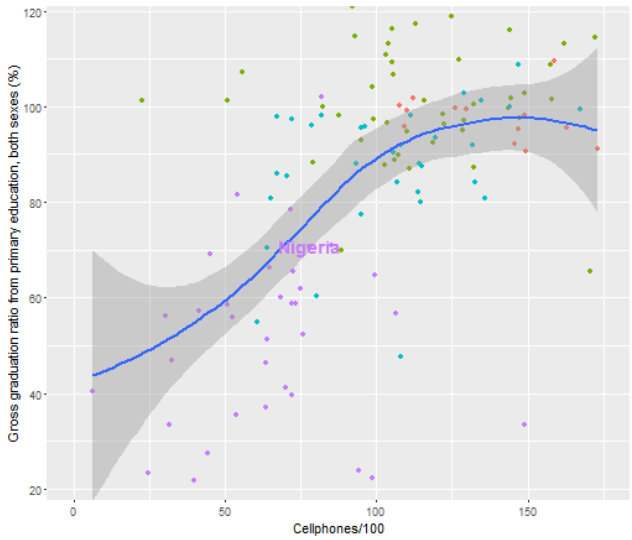


Means by HDI

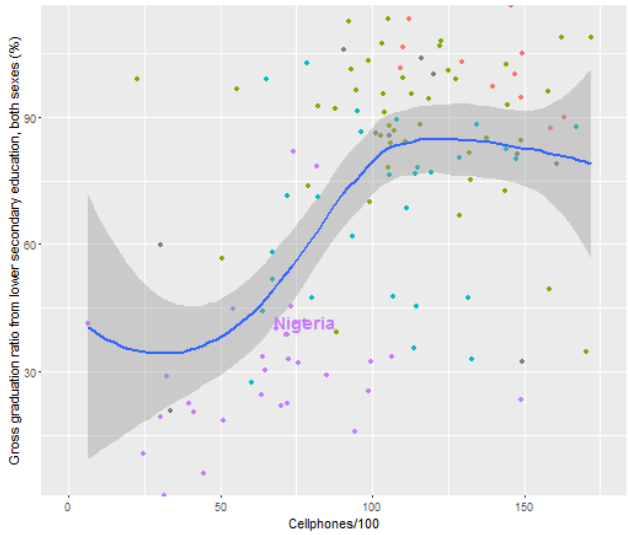
HDI Level	Primary Graduation Mean	Secondary Graduation Mean
Very High Human Development	98.14	99.71
High Human Development	100.65	88.24
Medium Human Development	87.72	66.52
Low Human Development	52.03	31.28

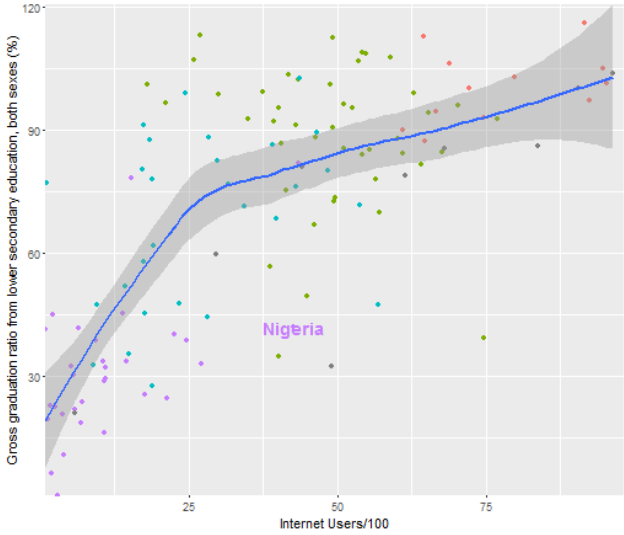
Primary Graduation vs. ICT





Secondary Graduation vs. ICT





Regression Results

	Primary Graduation	Secondary Graduation
	(1)	(2)
High HDI	7.450 (4.963)	-5.271 (6.911)
Medium HDI	-2.533 (6.663)	-20.365** (8.958)
Low HDI	-34.112*** (8.157)	-52.754*** (10.771)
Internet	0.114 (0.098)	0.231* (0.131)
Cellphones	0.051 (0.041)	0.013 (0.056)
Constant	81.652*** (9.703)	80.792*** (12.868)

Observations	127	115
R^2	0.689	0.680
Adjusted R^2	0.676	0.665
Residual Std. Error	13.864 (df = 121)	17.717 (df = 109)
F Statistic	53.534*** (df = 5; 121)	46.298*** (df = 5; 109)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Primary Outliers

High

HDI	Country	Graduation
Very High Human Development	Argentina	109.61
High Human Development	Algeria	114.63
High Human Development	China	120.91
High Human Development	Colombia	117.18
High Human Development	Ecuador	113.11
High Human Development	Georgia	118.94
High Human Development	Kazakhstan	114.31
High Human Development	Seychelles	113.16
High Human Development	St. Vincent and the Grenadines	116.35
High Human Development	Ukraine	115.91
Medium Human Development	Indonesia	102.73
Medium Human Development	Vietnam	108.68
Low Human Development	Burkina Faso	78.43
Low Human Development	Lesotho	70.93
Low Human Development	Myanmar	81.44
Low Human Development	Nepal	101.93

Low

HDI	Country	Graduation
Very High Human Development	Bahrain	91.17
Very High Human Development	Luxembourg	90.63
Very High Human Development	Qatar	92.25
High Human Development	Azerbaijan	87.1
High Human Development	Dominican Republic	88.4
High Human Development	Lebanon	70.02
High Human Development	Mauritius	87.36
High Human Development	Romania	88.73
High Human Development	St. Lucia	87.78
High Human Development	Suriname	65.54
Medium Human Development	Bangladesh	60.23
Medium Human Development	Congo, Rep.	47.61
Medium Human Development	Syrian Arab Republic	70.34
Medium Human Development	Vanuatu	54.77
Low Human Development	Central African Republic	23.27
Low Human Development	Chad	21.65
Low Human Development	Mauritania	23.92
Low Human Development	Niger	27.38
Low Human Development	Senegal	22.33

Secondary Outliers

High

HDI	Country	Graduation
Very High Human Development	Portugal	112.86
Very High Human Development	Qatar	116.15
High Human Development	Belarus	107.66
High Human Development	China	112.43
High Human Development	Kazakhstan	108.54
High Human Development	Mongolia	113
High Human Development	Serbia	106.68
High Human Development	Seychelles	108.71
High Human Development	Sri Lanka	107.1
Medium Human Development	Botswana	87.45
Medium Human Development	**Kyrgyz Republic**	88.02
Medium Human Development	Moldova	89.35
Medium Human Development	Sao Tome and Principe	98.95
Medium Human Development	Tajikistan	91.19
Medium Human Development	Uzbekistan	102.59
Low Human Development	**Kenya**	**81.72**
Low Human Development	Nepal	78.36

Low

HDI	Country	Graduation
Very High Human Development	Argentina	87.25
Very High Human Development	France	86.06
Very High Human Development	Montenegro	89.85
High Human Development	Belize	56.57
High Human Development	Lebanon	39.33
High Human Development	Panama	49.36
High Human Development	Suriname	34.73
High Human Development	Tunisia	66.92
High Human Development	Venezuela, RB	69.83
Medium Human Development	Cambodia	32.86
Medium Human Development	Namibia	35.53
Medium Human Development	Nicaragua	45.36
Medium Human Development	South Africa	32.53
Medium Human Development	Syrian Arab Republic	44.37
Medium Human Development	Vanuatu	27.51
Low Human Development	Central African Republic	10.85
Low Human Development	**Ethiopia**	**1.1**
Low Human Development	Niger	6.29

2.2. Conclusions

- Indicator marks a shift from attendance to a focus on what the students are gaining. It will be difficult to measure that. It is much easier to count bodies in a seat than to assess proficiency on a universal scale.
- There is still significant progress that needs to be made on graduation rates, particularly in low HDI countries, regardless of proficiency
- Internet access and graduation rates do appear to be linked
    - Going from 0 to 25% internet also means big increases in graduation rates after which it flattens out
    - Internet access is a significant predictor of secondary graduation rates in a country
- Our four focus countries
    - Only have data from Nigeria
    - Nigeria has not raised the graduation rate in the last 15 years, presumably at least partly because of an increasing youth population—this is a major concern
- Outliers of interest
    - Kyrgz Republic stands out in secondary
    - Massive difference between neighbors, Ethiopia and Kenya, on secondary education
    - Conflict is probably a driver of Lebanon and Syria's low outcomes

2.3. Traffic Light Analysis of Indicator 4.1

Indicator <-> Target	• The indicator is an ambitious to create a universal metric for proficiency at various educational levels • Does not touch many of the elements of the target
Current Data	• Graduation rates give a good approximation of how well countries are doing in getting their youth educated • Does not truly assess proficiency nor free/equitable
Future Data	• Agreeing on a universal standard of proficiency is going to be a serious challenge • This type of testing has only really been deployed in more developed countries; much more challenging in other places

3. Target 4.2 - Access to Early Childhood Development, Care & Pre-primary Education

3.1. Process

1. Select Target

Target 4.2

By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education.

3.2. Indicator 4.2.1

2. Review SDG Indicator and Metadata

Indicator 4.2.1: Proportion of children under 5 years of age who are developmentally on track in health, learning and psychosocial well-being, by sex

- Divide population of children to isolate those under 5 years of age
- Data is available by age, sex, place of residence, wealth quintiles and other background characteristics. When used in conjunction with a module on child disability, data can also be disaggregated by disability statistics.
- Disaggregate by sex

3a. What is available now for assessing the current state of the indicator?

- UNICEF has estimates for the percentage of children under the age of five who are developmentally on track in health, learning and psychosocial well-being by country and some regional groupings
- Proposed existing data sources:
    - UNICEF – Early Childhood Development Index (ECDI)

The ECDI score is calculated as the percentage of children aged 36 to 59 months who are developmentally on track in at least three of four domains of development—Literacy-numeracy, Physical, Social-emotional and Learning. The index is best interpreted within the context of other variables related to support for early childhood development in the home and community. (Official indicator description)

- Domain Definitions:
    - Literacy-numeracy: Children are identified as being developmentally on track if they can do at least two of the following: identify/name at least 10 letters of the alphabet; read at least four simple, popular words; and/or know the name and recognize the symbols of all numbers from 1 to 10.
    - Physical: If the child can pick up a small object with two fingers, like a stick or rock from the ground, and/or the mother/primary caregiver does not indicate that the child is sometimes too sick to play, then the child is regarded as being developmentally on track in the physical domain.
    - Social-emotional: The child is considered developmentally on track if two of the following are true: The child gets along well with other children; the

child does not kick, bite or hit other children; and the child does not get distracted easily.
    - Learning: If the child follows simple directions on how to do something correctly and/or when given something
    - Availability: Although the individual elements are mostly accessible, the index does not appear to be available in a raw data type of format. This will surely be remedied as it is integrated into the SDG reporting.

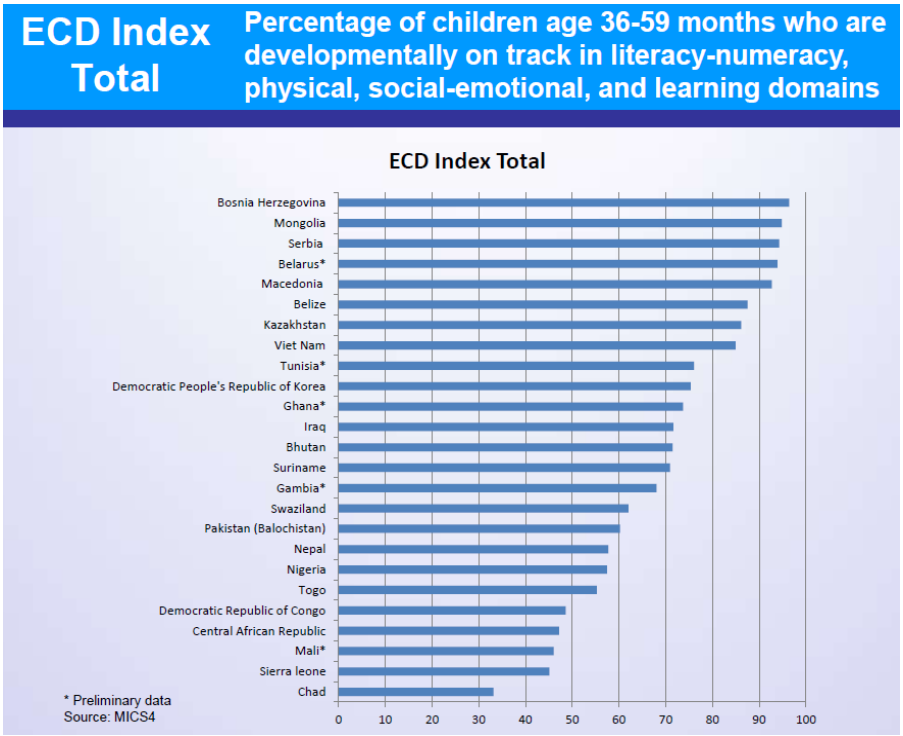
3b. How closely does this match to what the indicator metadata describes?

- Judgment: Although measuring early childhood development is an imprecise science, the ECDI seems to be a close match.
- Missing elements:
    - Need to ensure proposed measures are relevant to all children, in all parts of the world. What is "normal" varies across cultures and parenting strategies and may differ among countries, and also among cultural, ethnic or religious groups within the same country.
    - Need to ensure the index measures the skills and competencies most important for early school participation and learning.
    - Not clear how measuring the elements in ECDI translate to being ready for primary education as described in the target.
    - Currently, this data comes from a certain survey (MICs), which is not taken in all countries.
    - Timeline: 1-3 years (i.e., by 2018)

3c. Is there data for aspects of the target not captured by the indicator?

- Indicator measures percentage of children who are developmentally "on track" in health, learning and psychosocial well-being by sex
- Aspects of target not captured:
    - Access to ECD care and pre-primary education
    - Quality of care and education
    - Availability of pre-primary education
    - Readiness for primary education as a result
- Other data options
    - Access
        - Home environment – Inadequate care (UNICEF)
        - Home environment – Support for learning (UNICEF)
    - Quality
        - Trained teachers in pre-primary education
        - Pupil-teacher ratio, pre-primary
    - Availability

    - Attendance in early childhood education (UNICEF)
    - School enrollment, pre-primary (% gross)
    - Home environment – Learning materials at home (UNICEF)
- How is readiness for primary education determined?
- Data available for primary, secondary and tertiary education not reported for pre-primary
    - Children out of school
    - Current education expenditure as a percentage of total expenditures in public institutions
    - Net school enrollment



http://www.unicef.org/earlychildhood/files/Website_data_presentation_Global_-_11_July_2013.pdf

3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

- No quantitatively defined goals for Target nor Indicator

3e. What can we learn from the available data?

3.3. Indicator 4.2.2

2. Review SDG Indicator and Metadata

Indicator 4.2.2: Participation rate in organized learning (one year before the official primary entry age), by sex

- No metadata received on the current indicator formulation

3a. What is available now for assessing the current state of the indicator?

- UNESCO collects education related data including on preprimary enrollment.
- School enrollment, preprimary (% gross)

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.

Preprimary education refers to programs at the initial stage of organized instruction, designed primarily to introduce very young children to a school-type environment and to provide a bridge between home and school. (Official indicator description)

3b. How close does this match to what the indicator metadata describes?

- Judgment: We cannot make a judgment without the metadata, but the current data would appear to be close to what the indicator calls for.
- Missing elements:
    - Indicator specifies only the year before primary as opposed to the whole age group.
    - Timeline:

3c. Is there data for aspects of the target not captured by the indicator?

Unknown

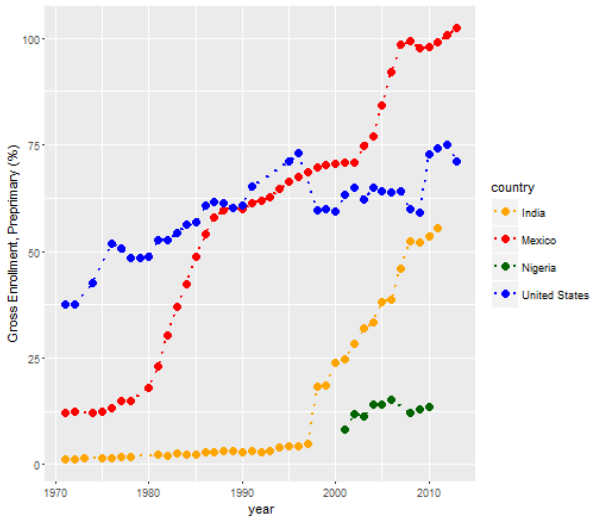
3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

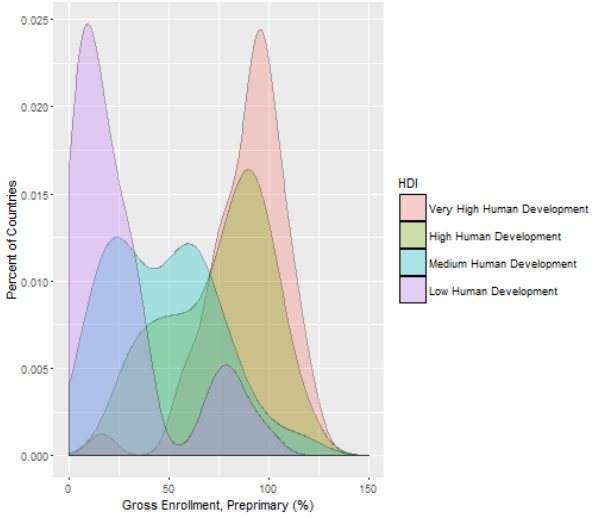
- No quantitatively defined goals for Target nor Indicator

3e. What can we learn from the available data?

- Gross Enrollment, Preprimary (%)
- Countries: USA, Mexico, India, Nigeria
- ICT data:
    - Internet users
    - Cellphone subscriptions

School enrollment, preprimary (% gross)



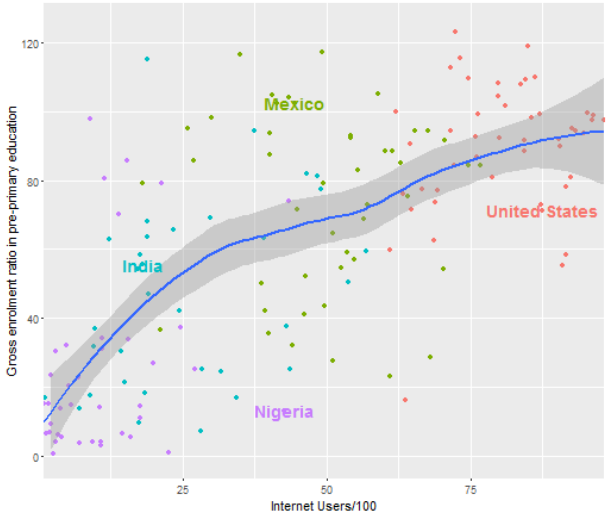


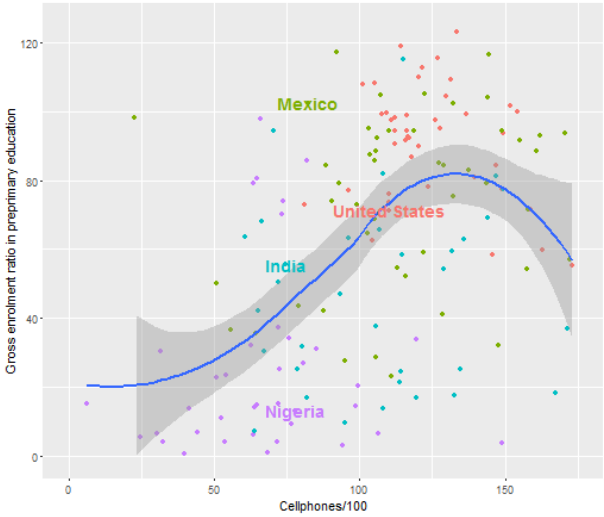
Means by HDI

HDI Level	Preprimary Enrollment Mean
Very High Human Development	89.53

High Human Development	77.04
Medium Human Development	46.84
Low Human Development	25.36

Preprimary Enrollment vs. ICT





Regression Results

	Preprimary
High HDI	-1.770 (7.314)
Medium HDI	-23.897** (10.632)
Low HDI	-39.845*** (12.826)
Internet	0.337** (0.165)
Cellphones	0.017 (0.067)
Constant	60.114*** (15.318)
Observations	166
R^2	0.507
Adjusted R^2	0.492
Residual Std. Error	25.752 (df = 160)
F Statistic	32.944*** (df = 5; 160)
Note:	*p<0.1; **p<0.05; ***p<0.01

Preprimary Outliers

High

HDI	Country	Preprimary
Very High Human Development	Australia	109.23
Very High Human Development	Belgium	118.81
Very High Human Development	Chile	122.9
Very High Human Development	Germany	109.71
Very High Human Development	Hong Kong SAR, China	109.41
Very High Human Development	Israel	112.68
Very High Human Development	Malta	115.41
High Human Development	China	117.15
High Human Development	Ecuador	187.19
High Human Development	Thailand	116.5
Medium Human Development	Ghana	115.1
Medium Human Development	Guyana	94.34
Medium Human Development	Moldova	82.06
Medium Human Development	South Africa	77.37
Medium Human Development	Vietnam	81.35
Low Human Development	Angola	79.25
Low Human Development	Haiti	80.64
Low Human Development	Kenya	73.8
Low Human Development	Nepal	85.76
Low Human Development	Pakistan	70.24
Low Human Development	Solomon Islands	97.9

Low

HDI	Country	Preprimary
Very High Human Development	Bahrain	55.23
Very High Human Development	Croatia	62.67
Very High Human Development	Montenegro	59.66
Very High Human Development	Qatar	58.49
Very High Human Development	Saudi Arabia	16.33
High Human Development	Samoa	36.87
High Human Development	Azerbaijan	23.11
High Human Development	Dominican Republic	43.6
High Human Development	Iran, Islamic Rep.	42.4
High Human Development	Jordan	32.23
High Human Development	Macedonia, FYR	28.66
High Human Development	Tonga	35.53
High Human Development	Tunisia	41.25
High Human Development	Turkey	27.58
Medium Human Development	Bhutan	17.05
Medium Human Development	Botswana	18.33
Medium Human Development	Cambodia	17.6
Medium Human Development	Congo, Rep.	13.91
Medium Human Development	Syrian Arab Republic	7.22
Medium Human Development	Tajikistan	9.92
Medium Human Development	Timor-Leste	17.02

3.4. Conclusions

- Indicator 4.2.1 represents the end product of a long process in assessing early childhood development
    - The data appears to be mostly there, but not available in a functionally accessible form for independent analysis
    - Currently only a limited subset of countries are participating, expected to expand with enactment of SDGs
- Indicator 4.2.2 is fairly straightforward in looking at enrollment—the only challenge is looking at only one year rather than an age range
- Low and medium HDI countries have quite low rates of pre-primary education enrollment
- 100% is unlikely, given that many parents choose to keep kids at home in developed countries until primary.
- Internet access is a significant predictor of pre-primary enrollment (have no hypothesis as to why).
- Consider that the very high enrollment of some countries (e.g. Mexico) is because Kindergarten and earlier may be offered free in those countries (or could represent measurement oddities). Germany for example heavily subsidizes daycare beginning at one year old.

3.5. Traffic Light Analysis of Indicator 4.2.1

Indicator <-> Target	• With two indicators this target's aspects are better captured than with others. • The ECD index is a well developed and useful tool
Current Data	• This indicator appears to be on the verge of being fully measurable for a subset of countries • Currently one either has to look at reports or the actually country level surveys (no accessible database for ECD index)
Future Data	• The approach to measuring this indicator is well established and the main challenge remaining is to roll it out in more countries and share the results in a public database.

3.6. Traffic Light Analysis of Indicator 4.2.2

Indicator <-> Target	• This along with the other indicator well captures the target
Current Data	• Data on enrollment is widely available and very close to the specifics of the indicator
Future Data	• Although the metadata is not yet available it would seem that aligning data collection with the specifics of the indicator will be straightforward.

4. Target 4.3 - Post-Secondary Education

4.1. Process

1. Select Target

Target 4.3

By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.

2a. Review SDG Indicator and Metadata

Indicator 4.3.1: Participation rate of youth and adults in formal and non-formal education and training in the last 12 months, by sex

- Divide population into age ranges (e.g. 15-24 years, 25-64 years etc.)

- Disaggregate by type of program
- Disaggregate by sex

2b. Missing from the Indicator

The indicator does not measure:

- *Affordable* (not just public costs but private costs as well)
- *Quality*
- *Equal Access*

3a. What is available now for assessing the current state of the indicator?

- UNESCO currently collects and publishes education data
- Proposed existing data sources:
    - School enrollment, tertiary (% gross)

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level.

3b. How closely does this match to what the indicator metadata describes?

- Judgment: It is close enough to give a fair judgment of the current state and broad trends.
- Missing elements
    - All types of post-secondary education (particularly non-formal) are not tracked sufficiently
    - Lack of consistent definitions of adult education across countries
    - Enrollment by age group is not tracked
    - Timeline: 1-3 years

3c. Is there data for aspects of the target not captured by the indicator?

- There is a possibility to capture as well:
    - Equal Access
    - Affordability
- No currently accepted measures:
    - Quality
- Murakami and Blom (2008) describe an affordability and an accessibility index
- Affordability Index: Out-of-pocket costs/GDP per capita
    - Education (tuition etc.)-mixed availability of data
    - Living costs-very crude estimates
    - Grants/Tax breaks- fair data
    - Loans-okay data
- Accessibility:
    - Participation rate-% of college age population in university
    - Attainment rate-population by age 34 that has attained a degree

- Educational Equity Index-% of tertiary students whose fathers have a degree/% of males between 45-64 who have a degree
- Gender Parity Index-female to male enrollment ratio

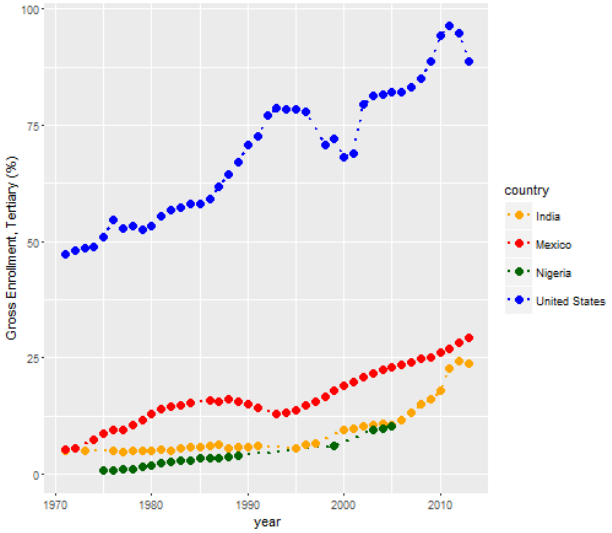
3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

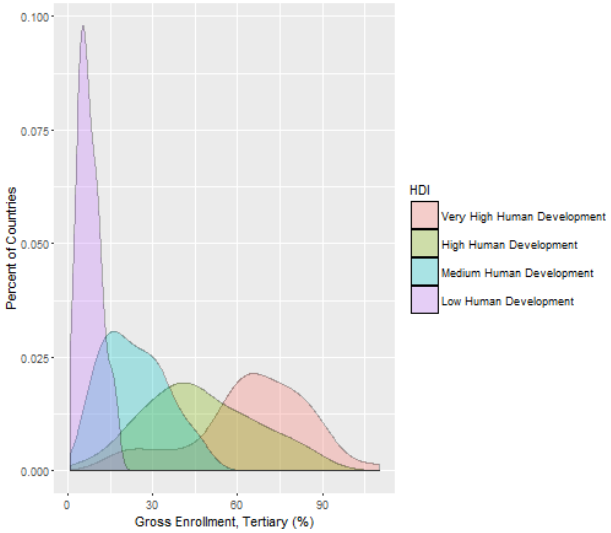
- There are no quantitatively defined goals for the target or the indicator.

3e. What can we learn from the available data?

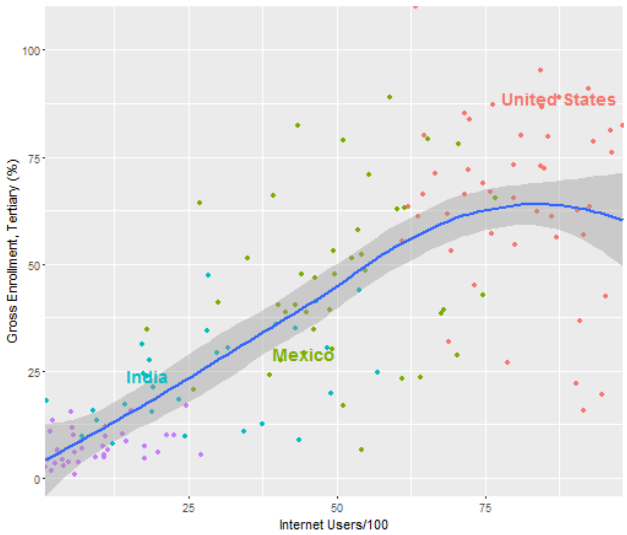
- Gross Enrollment, Tertiary (%)
- Countries: USA, Mexico, India, Nigeria
- ICT data:
  - Internet users
  - Cellphone subscriptions

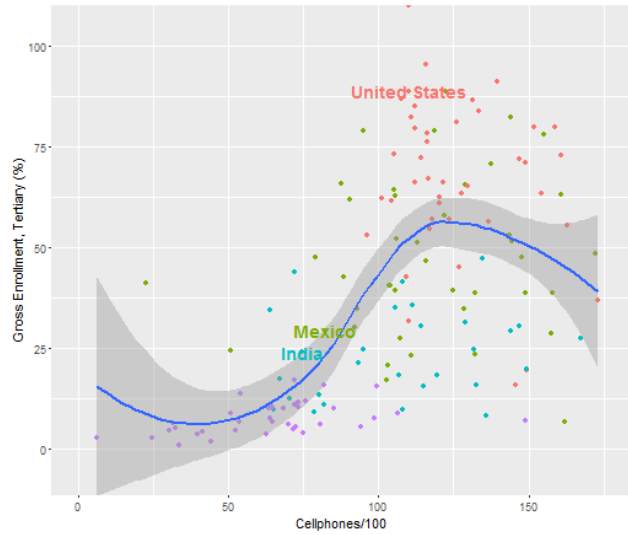
Gross Enrollment, Tertiary (%)





Gross Enrollment, Tertiary (%) vs. ICT





Means by HDI

HDI Level	Enrollment Mean
Very High Human Development	64.99
High Human Development	47.05
Medium Human Development	23.53
Low Human Development	7.48

Regression Analysis

	Enrollment
High HDI	-13.861*** (4.815)
Medium HDI	-33.616*** (7.039)
Low HDI	-47.751*** (8.910)
Internet	0.161 (0.113)
Cellphones	-0.024 (0.046)
Constant	55.233*** (10.464)
Observations	151
R^2	0.670
Adjusted R^2	0.659
Residual Std. Error	16.107 (df = 145)
F Statistic	58.984*** (df = 5; 145)
Note:	*p<0.1; **p<0.05; ***p<0.01

High Enrollment Countries

HDI	Country	Enrollme
Very High Human Development	Australia	86.55
Very High Human Development	Finland	91.07
Very High Human Development	Greece	110.16
Very High Human Development	Korea, Rep.	95.35
Very High Human Development	Spain	87.07
Very High Human Development	United States	88.81
High Human Development	Belarus	88.86
High Human Development	Bulgaria	70.79
High Human Development	Russian Federation	78
High Human Development	St. Kitts and Nevis	79.1
High Human Development	Turkey	78.98
High Human Development	Ukraine	82.31
Medium Human Development	Kyrgyz Republic	47.33
Medium Human Development	Moldova	41.28
Medium Human Development	Paraguay	35.08
Medium Human Development	Philippines	35.75
Medium Human Development	West Bank and Gaza	44.01
Low Human Development	Benin	15.36
Low Human Development	Cameroon	11.93
Low Human Development	Liberia	11.64
Low Human Development	Myanmar	13.53
Low Human Development	Nepal	15.83
Low Human Development	Sudan	16.92

Low Enrollment Countries

HDI	Country	Enrollment
Very High Human Development	Bahrain	36.84
Very High Human Development	Brunei Darussalam	31.73
Very High Human Development	Kuwait	27.03
Very High Human Development	Liechtenstein	42.5
Very High Human Development	Luxembourg	19.41
Very High Human Development	Qatar	15.83
Very High Human Development	United Arab Emirates	22.04
High Human Development	Antigua and Barbuda	23.49
High Human Development	Azerbaijan	23.16
High Human Development	Belize	24.18
High Human Development	Jamaica	27.44
High Human Development	Seychelles	6.47
High Human Development	Sri Lanka	20.71
High Human Development	St. Lucia	16.86
Medium Human Development	Bhutan	10.93
Medium Human Development	Congo, Rep.	9.72
Medium Human Development	Sao Tome and Principe	9.75
Medium Human Development	Turkmenistan	7.98
Medium Human Development	Uzbekistan	8.9
Low Human Development	Central African Republic	2.77
Low Human Development	Eritrea	2.57
Low Human Development	Malawi	0.8
Low Human Development	Niger	1.71

4.2. Conclusions

- Data about post-secondary enrollment is also available in more disaggregated forms than is presented here
- HDI and Tertiary Enrollment are closely linked
    - Low HDI countries are uniformly behind
    - More overlap between other groups
- Focus Countries
    - Nigeria does not have much tertiary data
    - US leads in enrollment
    - Trajectories on enrollment in India and Mexico are good but too slow
- Leaders and Laggards
    - Geographic (e.g. islands), culture (e.g. Islam) and conflict are clearly factors
    - Interesting questions
        - What have Paraguay and Turkey done right?
        - Why is Kyrgyz Republic doing well but its neighbors of Uzbekistan and Tajikistan not?

4.3. Traffic Light Analysis of Indicator 4.3

Indicator <-> Target	• The target calls for affordability, accessibility and quality which the indicator does not touch • These are actually more measurable than many of the other target elements left out of indicators
Current Data	• The current data is available for a large number of countries • Data can be disaggregated somewhat (though not quite to the extent called for in the indicator)
Future Data	• One of the main differences will be aligning it to track by enrollment by age group, not just dividing total enrollees by the country's age cohort. • Also further disaggregation is going to be needed, including the defining of types of adult education

5. Target 4.4 - ICT Skills

5.1. Process

1. Select Target

Target 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.

2a. Review SDG Indicator and Metadata

Indicator 4.4.1: Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill

- The percentage of youth (aged 15-24 years) and adults (aged 15 years and above) that have undertaken certain computer-related activities in a given time period (e.g. last three months)
- List of activities which would be considered is included in the metadata

2b. Missing from the Indicator

- In terms of ICT skills, this list is already quite dated and would struggle to stay relevant regardless. Also it does not get at the level of competence in any of these skills.
- More significantly, Target 4.4 calls for increasing all relevant skills, of which ICT can only be considered one of many. The target specifically mentions vocational skills, which are quite distinct from the more white collar ICT skills.

3a. What is available now for assessing the current state of the indicator?

- Proposes to use household surveys which collect data on the use of selected ICT skills.
- Proposed existing data sources:

Eurostat: Has collected the data called for in this indicator, but this provides only a limited snapshot of the global state. This is not useful for measuring trends globally, but gives an idea of what the indicator will look like.

3b. How closely does this match to what the indicator metadata describes?

- Judgment: This matches many of the specific skills that the indicator calls for
- Missing elements:
    - Participation from most of the globe
    - Timeline: Unclear what timeline other countries and multinational statistical organizations have for globalizing this measurement

3c. Is there data for aspects of the target not captured by the indicator?

Unknown

3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

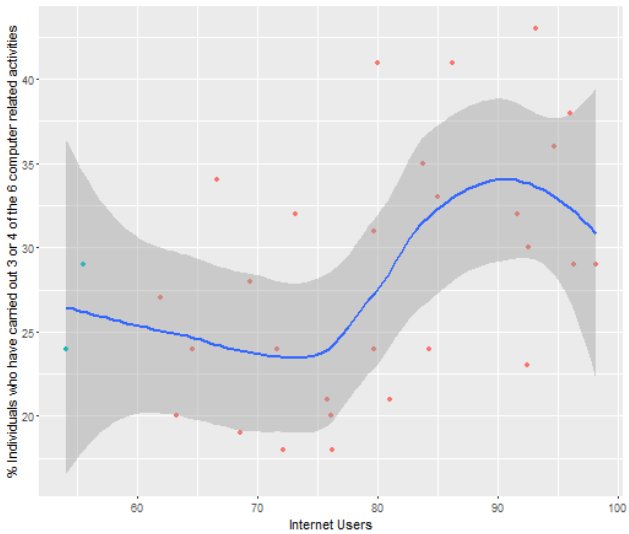
No

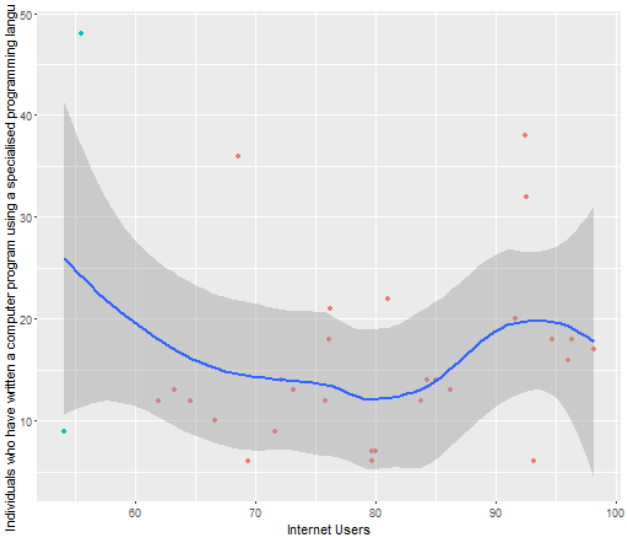
3e. What can we learn from the available data?

- European Union Wide Averages for 16-29 year olds (2011)

Indicator	Percentage
Individuals who have copied or moved a file or folder	87
Individuals who have used copy or cut and paste tools to duplicate or move information on screen	86
Individuals who have used basic arithmetic formulae to add, subtract, multiply or divide figures in a spreadsheet	65
Individuals who have compressed files	58
Individuals who have written a computer program using a specialised programming language	19
Individuals who have connected and installed new devices, e.g. a printer or a modem	65
Individuals who have carried out 3 or 4 of the 6 computer related activities	34
Individuals who judge their current computer or Internet skills to be sufficient if they were to look for a job or change job within a year	66
Individuals who judge their current computer or Internet skills to be sufficient to communicate with relatives, friends, colleagues over the Internet	90
Individuals who judge their current computer or Internet skills to be sufficient to protect their personal data	69
Individuals who judge their current computer or Internet skills to be sufficient to protect their private computer from virus or other computer infection	68

Internet Users vs. ICT Skills





5.2. Conclusions

- The target calls for a wide range of skills but the indicator narrows it down to only ICT.
- The ICT skills called for are very narrow and mostly outdated
- Only the EU has collected data on this indicator and that is somewhat old

5.3. Traffic Light Analysis of Indicator 4.4

Indicator <-> Target	• While ICT skills are obviously highly relevant for this particular project they do not represent all the skills adults should have • The indicator does a poor job of even measuring ICT skills
Current Data	• Only available for the EU, does not include all parts of the indicator and does not appear to be collected regularly
Future Data	• Given that the proposed metrics are already dated before their collection has begun it seems a serious challenge to create an approach which assesses relevant ICT skills for today

6. Target 4.5 - Parity in Education and Equal Access to All Levels of Education and Vocational Training

6.1. Process

1. Select Target

Target 4.5

By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.

2a. Review SDG Indicator and Metadata

Indicator 4.5.1: Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data becomes available) for all education indicators on this list that can be disaggregated.

2b. Missing from the Indicator

The indicator does not measure:

- Children in vulnerable situations which is mentioned in the target
- Does not define equal access

3a. What is available now for assessing the current state of the indicator?

- The GPI (Gender Parity Index) is available for most of the data sources that were selected to represent the indicators and little of the other disparities of interest, so we'll focus on that
- Proposed existing data sources:
    - 4.1: GPI-Graduation from Primary and Lower Secondary (UNESCO)
    - 4.2: GPI-Enrollment Preprimary

    - 4.3: GPI-Enrollment Tertiary
    - 4.4: GPI(calculate)-ICT Skills Eurostat (check online)
    - 4.6: GPI(calculate)-Literacy youth and adult
    - 4.c: GPI(calculate)-Trained teachers at various levels

3b. How closely does this match to what the indicator metadata describes?

- Judgment: While the gender parity data is widely available, the other elements called for in the indicator are less so. Ultimately this indicator depends on the quality of measurement done for the other education targets
- Missing elements:
    - Limited urban/rural and wealth group data
    - No disability data
    - Timeline: none given

3c. Is there data for aspects of the target not captured by the indicator?

No

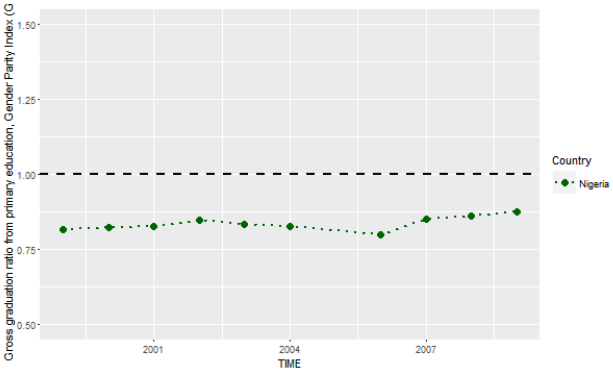
3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

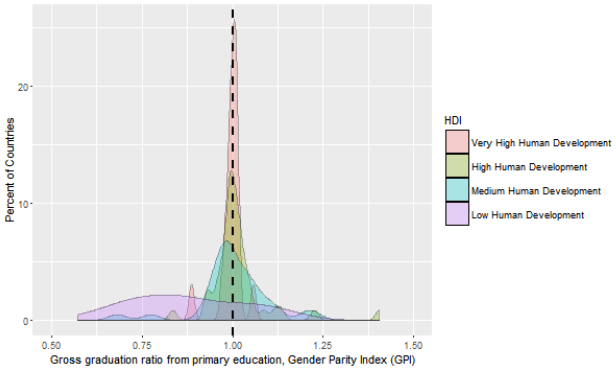
- Elimination of gender disparity is interpreted as raising the GPI to at least 1 on all education levels. Equal access is not yet clearly defined.

3e. What can we learn from the available data?

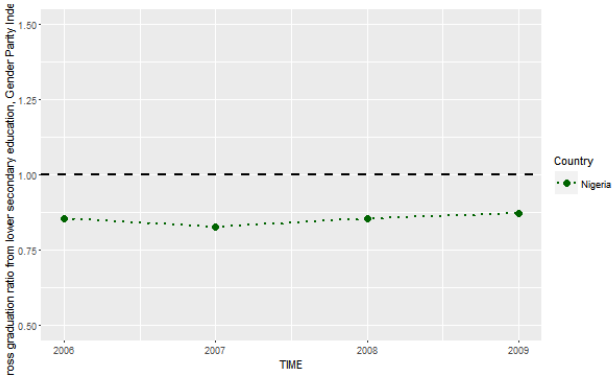
- 4.1: GPI-Graduation from Primary and Lower Secondary (UNESCO)
- 4.2: GPI-Enrollment Preprimary
- 4.3: GPI-Enrollment Tertiary
- 4.4: GPI(calculate)-ICT Skills Eurostat
- 4.6: GPI(calculate)-Literacy youth and adult
- 4.c: GPI(calculate)-Trained teachers at various levels
- Countries: USA, Mexico, India, Nigeria
- ICT data:
    - Internet users
    - Cellphone subscriptions

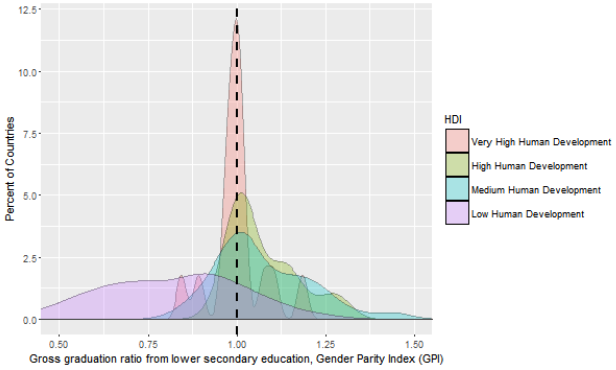
Gross graduation ratio from primary education, Gender Parity Index (GPI)





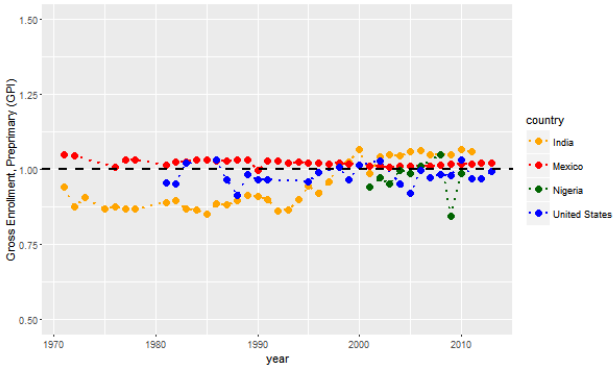
Gross graduation ratio from lower secondary education, Gender Parity Index





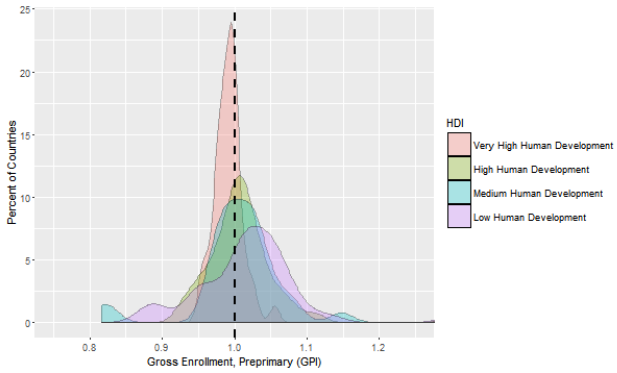
(GPI)

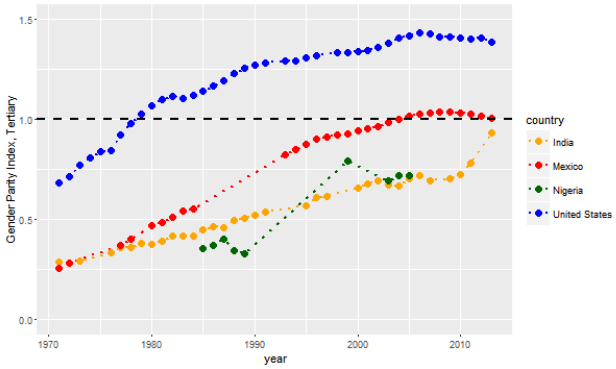
School enrollment, preprimary (GPI calculated)

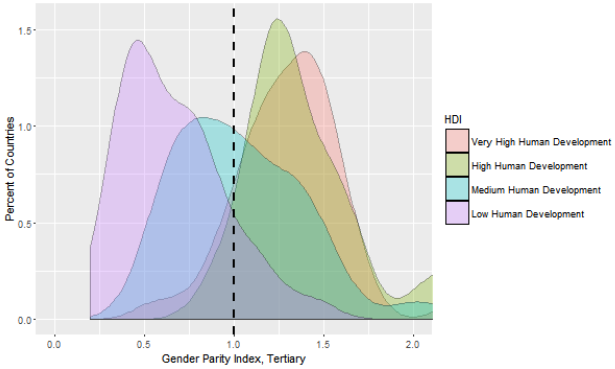


Gross Tertiary Enrollment, Gender Parity

Index (GPI)



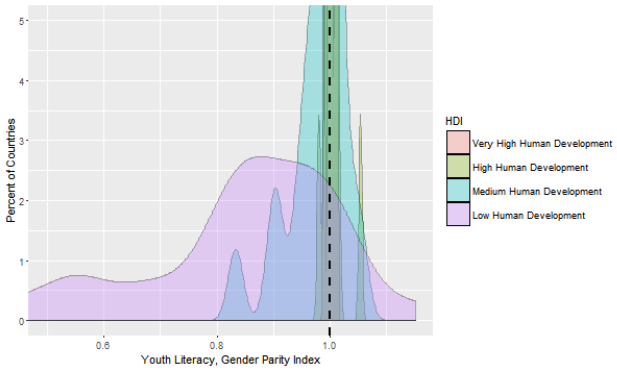




Eurostat ICT Skills Indicators (GPI)

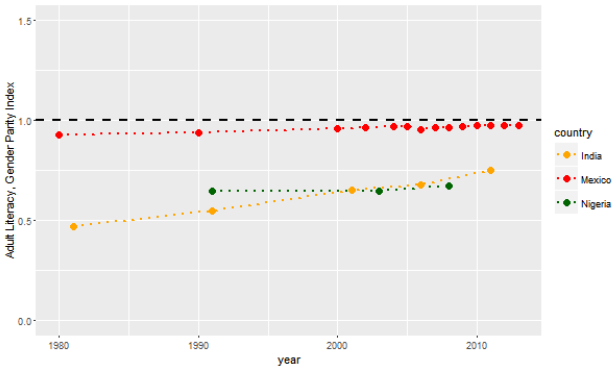
Indicator	Percentage	GPI
Individuals who have copied or moved a file or folder	90	1.01
Individuals who have used copy or cut and paste tools to duplicate or move information on screen	89	1.02
Individuals who have used basic arithmetic formulae to add, subtract, multiply or divide figures in a spreadsheet	65	1
Individuals who have compressed files	50	0.78
Individuals who have written a computer program using a specialised programming language	9	0.45
Individuals who have connected and installed new devices, e.g. a printer or a modem	57	0.79
Individuals who have carried out 3 or 4 of the 6 computer related activities	38	1.58
Individuals who judge their current computer or Internet skills to be sufficient if they were to look for a job or change job within a year	67	1.02
Individuals who judge their current computer or Internet skills to be sufficient to communicate with relatives, friends, colleagues over the Internet	94	1.01
Individuals who judge their current computer or Internet skills to be sufficient to protect their personal data	65	0.89
Individuals who judge their current computer or Internet skills to be sufficient to protect their private computer from virus or other computer infection	61	0.81

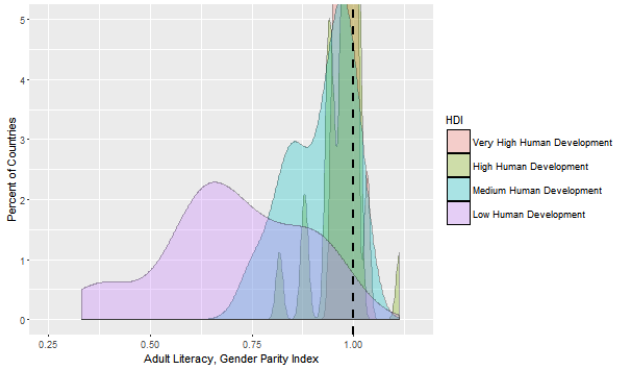
Youth Literacy, Gender Parity Index



Ad

Adult Literacy, Gender Parity Index (GPI)

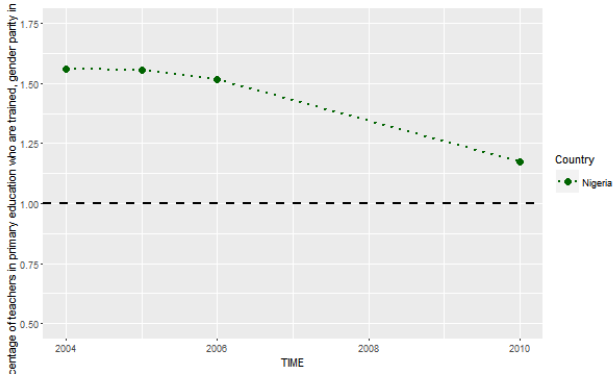


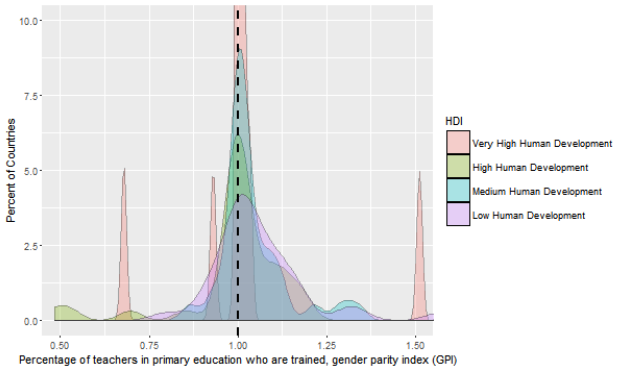


Teachers Preprimary GPI

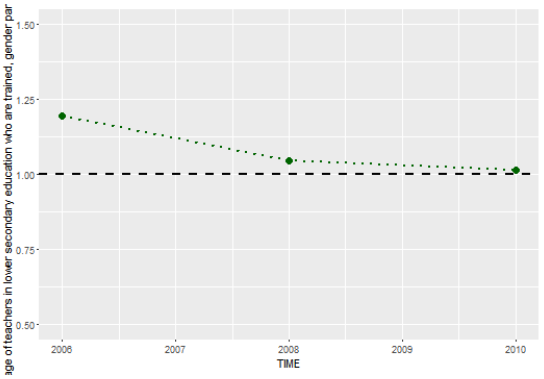
No data from selected countries

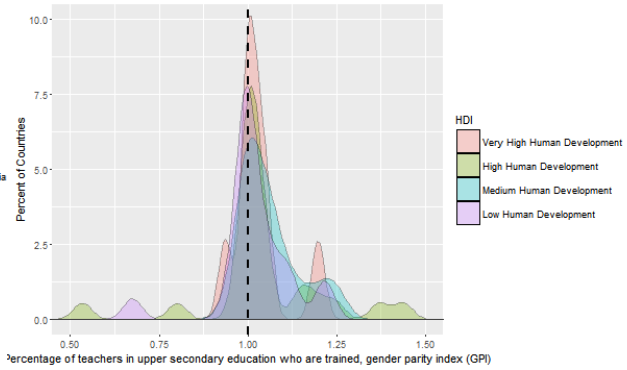
Teachers Training Primary GPI



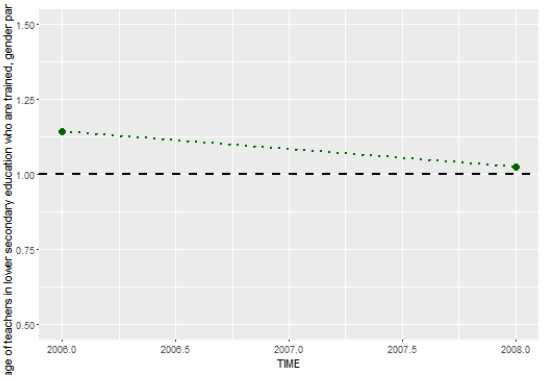


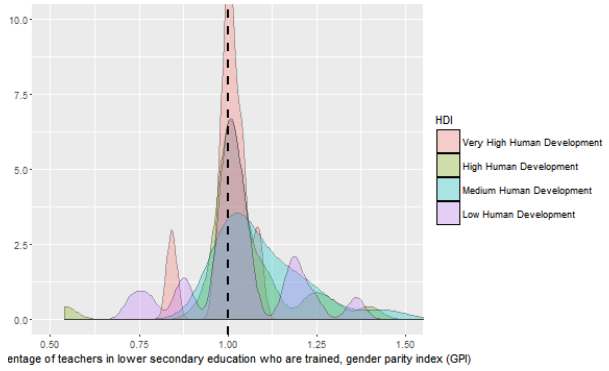
Teacher Training Lower Secondary GPI





Teacher Training Upper Secondary GPI

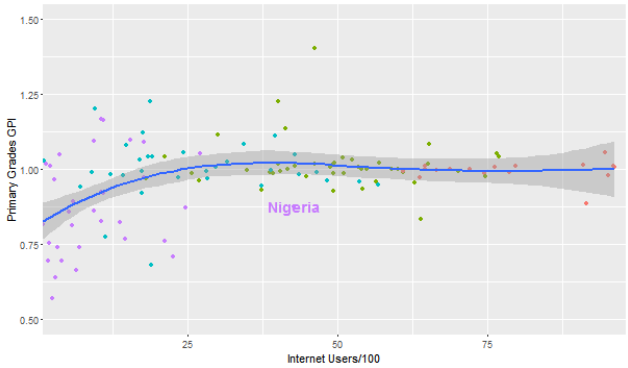


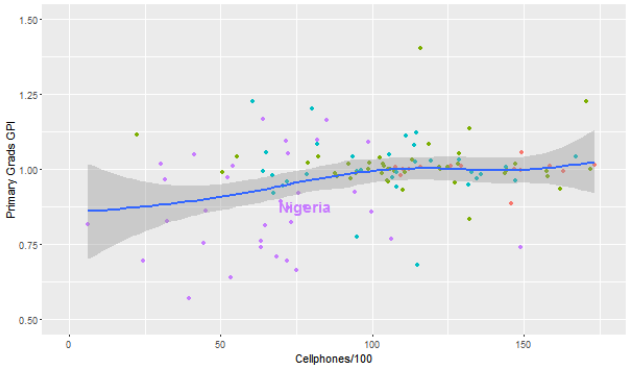


Means by HDI

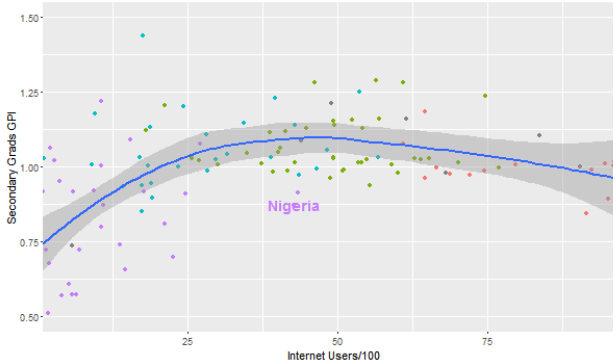
HDI Level	Primary Grads	Secondary Grades	Preprimary Enrollment	Tertiary Enrollment	Youth Literacy	Adult Literacy	Preprimary Teachers	Primary Teachers	Lower Secondary Teachers	Upper Secondary Teachers
Very High Human Development	1	1	1	1.44	1	0.99	0.8	1.02	1	1.03
High Human Development	1.02	1.09	1.01	1.41	1	0.98	2.92	1.09	1.07	1.1
Medium Human Development	1	1.07	1	1.04	0.98	0.92	1.56	1.04	1.15	1.06
Low Human Development	0.88	0.82	1.03	0.66	0.85	0.7	1.16	1.09	1.03	1.02

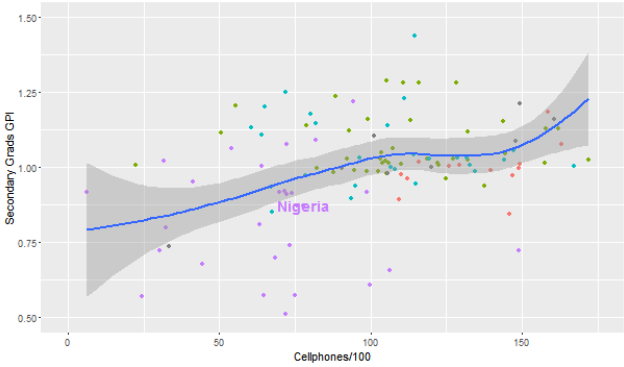
Primary Grads GPI vs. ICT



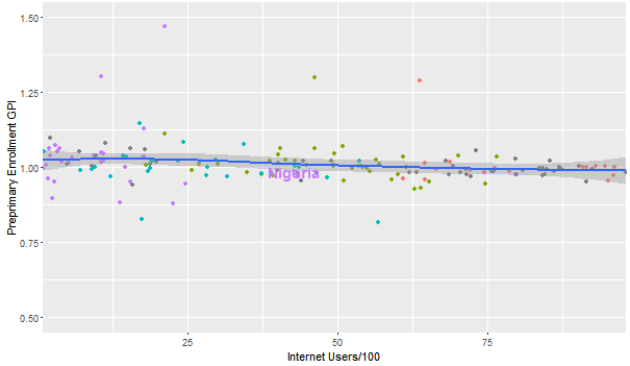


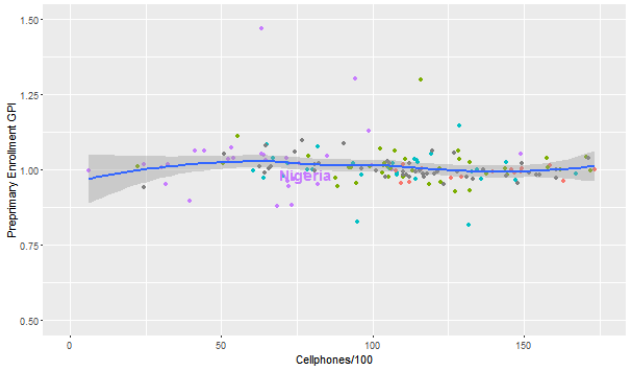
Secondary Grads GPI vs. ICT



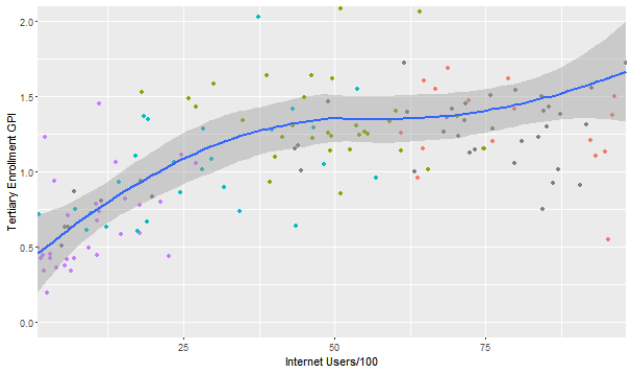


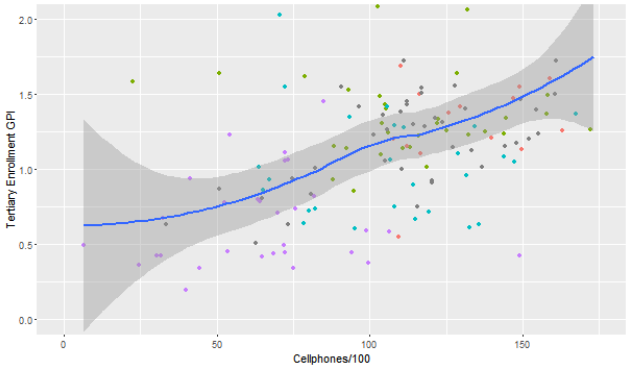
Preprimary Enrollment vs. ICT



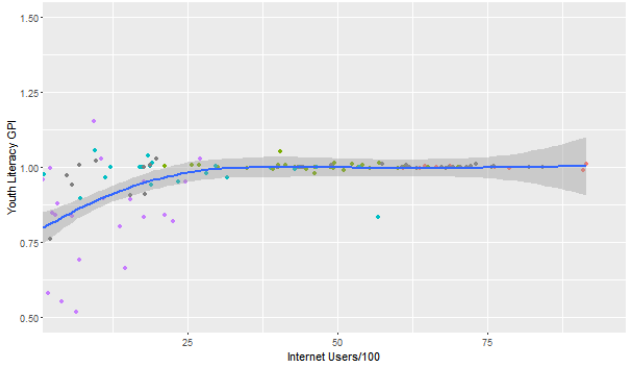


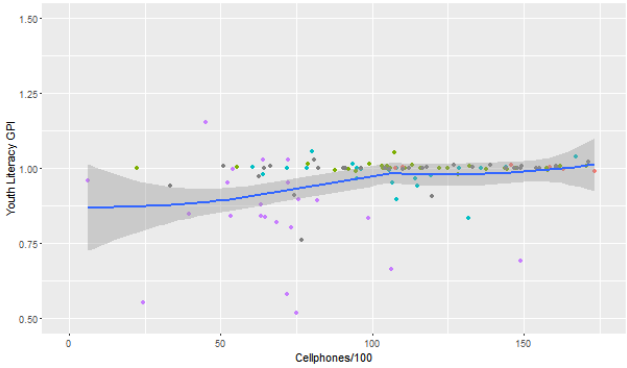
Tertiary Enrollment GPI vs. ICT



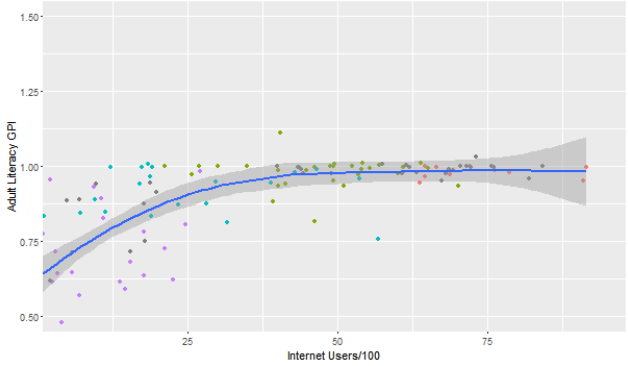


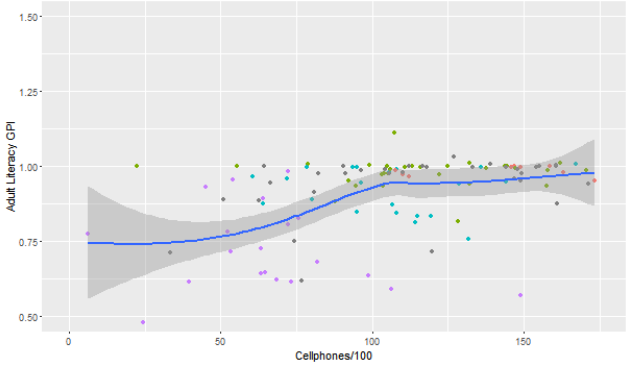
Youth Literacy GPI vs. ICT



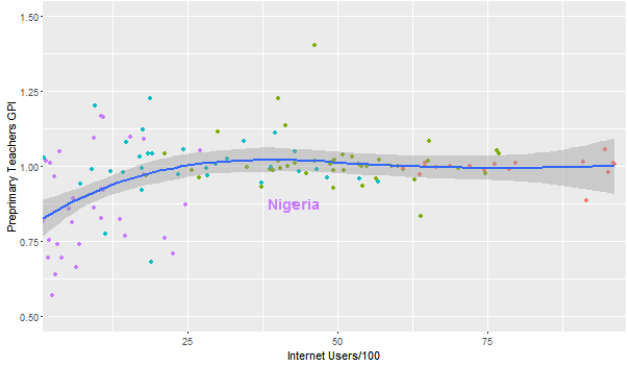


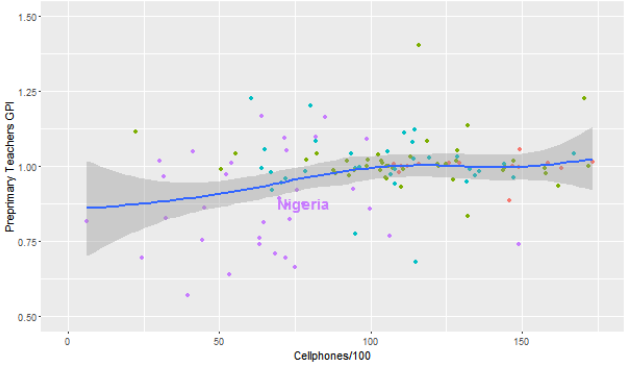
Adult Literacy GPI vs. ICT



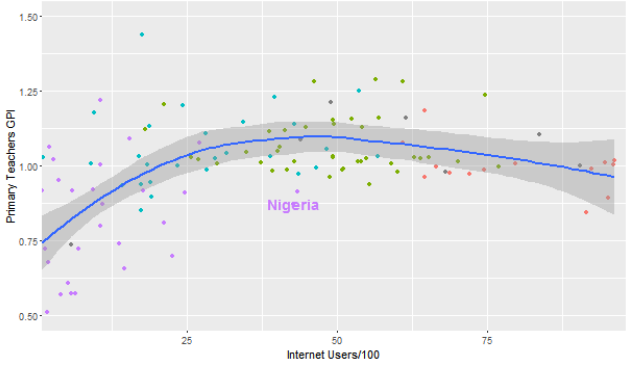


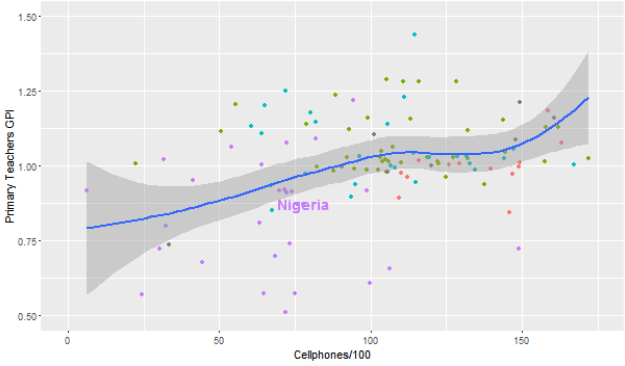
Preprimary Teachers GPI vs. ICT



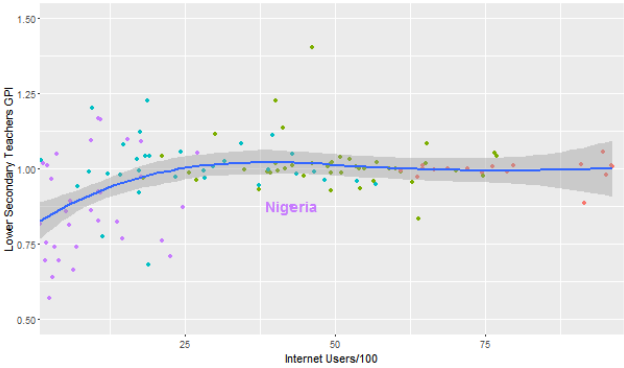


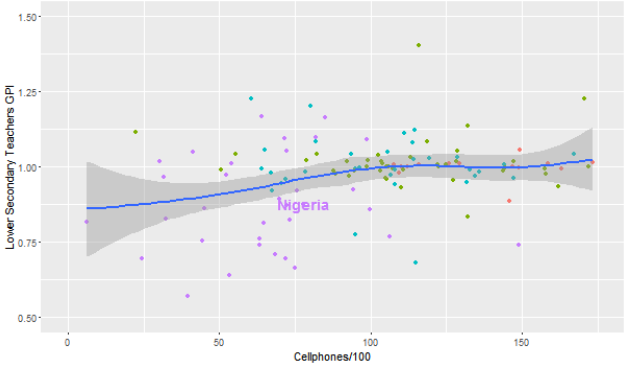
Primary Teacher GPI vs. ICT



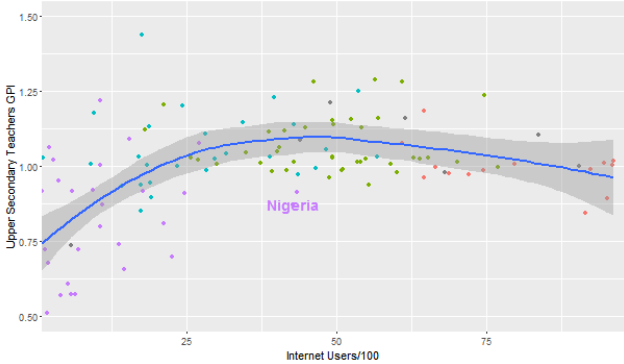


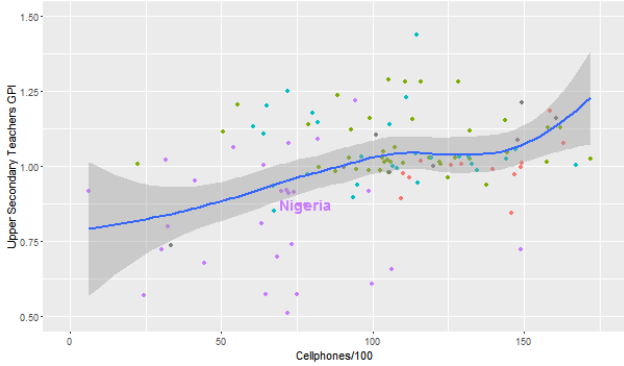
Lower Secondary Teachers vs. ICT





Upper Secondary Teachers GPI vs. ICT





Regression Results

	Primary Grads	Secondary Grades	Preprimary Enrollment	Tertiary Enrollment	Youth Literacy	Adult Literacy	Preprimary Teachers	Primary Teachers	Lower Secondary Teachers	Upper Secondary Teachers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High HDI	0.021 (0.040)	0.127** (0.060)	-0.019 (0.029)	0.126 (0.223)	0.010 (0.043)	0.022 (0.045)	0.021 (0.040)	0.127** (0.060)	0.021 (0.040)	0.127** (0.060)
Medium HDI	0.011 (0.053)	0.108 (0.079)	-0.055 (0.038)	-0.085 (0.301)	0.002 (0.057)	-0.013 (0.060)	0.011 (0.053)	0.108 (0.079)	0.011 (0.053)	0.108 (0.079)
Low HDI	-0.118* (0.065)	-0.111 (0.095)	-0.033 (0.047)	-0.278 (0.382)	-0.156** (0.070)	-0.247*** (0.074)	-0.118* (0.065)	-0.111 (0.095)	-0.118* (0.065)	-0.111 (0.095)
Internet	0.0002 (0.001)	0.001 (0.001)	-0.001* (0.001)	0.009** (0.005)	0.001 (0.001)	0.001 (0.001)	0.0002 (0.001)	0.001 (0.001)	0.0002 (0.001)	0.001 (0.001)
Cellphones	-0.0001 (0.0003)	0.0004 (0.0005)	0.0002 (0.0002)	0.001 (0.002)	-0.0004 (0.0004)	-0.0004 (0.0004)	-0.0001 (0.0003)	0.0004 (0.0005)	-0.0001 (0.0003)	0.0004 (0.0005)
Constant	0.999*** (0.078)	0.899*** (0.114)	1.066*** (0.057)	0.797* (0.455)	1.000*** (0.084)	0.937*** (0.089)	0.999*** (0.078)	0.899*** (0.114)	0.999*** (0.078)	0.899*** (0.114)
Observations	125	112	118	109	84	85	125	112	125	112
R^2	0.228	0.363	0.054	0.317	0.402	0.618	0.228	0.363	0.228	0.363
Adjusted R^2	0.195	0.332	0.011	0.284	0.364	0.594	0.195	0.332	0.195	0.332
Residual Std. Error	0.110 (df = 119)	0.155 (df = 106)	0.079 (df = 112)	0.583 (df = 103)	0.098 (df = 78)	0.105 (df = 79)	0.110 (df = 119)	0.155 (df = 106)	0.110 (df = 119)	0.155 (df = 106)
F Statistic	7.018*** (df = 5; 119)	12.056*** (df = 5; 106)	1.267 (df = 5; 112)	9.574*** (df = 5; 103)	10.487*** (df = 5; 78)	25.562*** (df = 5; 79)	7.018*** (df = 5; 119)	12.056*** (df = 5; 106)	7.018*** (df = 5; 119)	12.056*** (df = 5; 106)

Note: *p<0.1; **p<0.05; ***p<0.01

6.2. Conclusions

- The gender, rural/urban and wealth distributional aspects should be fairly straightforward to capture down the road if data for the other education indicators is properly captured.
- Gender parity is good for all levels in pre-primary but grows worse for low HDI at each level up and is concerning for medium HDI countries only at the tertiary level.
- For literacy parity is low in Low HDI countries and still below 1 on average in medium HDI countries
- Gender parity is quite universal in Europe except for programming, a great opportunity for impact
- Again the relationship between the internet and the indicators from 0-25% internet penetration
- Tertiary GPI is significantly related to internet access. Could represent a third variable, like cultural openness.
- There was little data for the focus countries and we did not calculate the outlier countries

6.3. Traffic Light Analysis of Indicator 4.5

Indicator <-> Target	• The indicator captures virtually all the elements of the target.
Current Data	• There is good information available about gender • Little to no data about the other aspects
Future Data	• It can be expected that as the other indicators' data is brought up to standard they will include the ability to disaggregate by gender, rural/urban, and wealth • The probability that the data will be disaggregated by disability, or indigenous status is lower where conflict status may be possible to pull from other sources

7. Target 4.6 - Literacy

7.1. Process

1. Select Target

Target 4.6

By 2030, ensure that all youth and a substantial proportion of adults, both men and women, can achieve literacy and numeracy.

2a. Review SDG Indicator and Metadata

Indicator 4.6.1: Percentage of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex

- The percentage of youth (age 15-24 years) and of adults (age 15 years and above) who achieve or exceed a given level of proficiency in (a) literacy and (b) numeracy
- The indicator will be disaggregated by sex and other relevant characteristics enabling a more thorough analysis of the disparities between the sexes

2b. Missing from the Indicator

- The indicator is exactly what the target calls for

3a. What is available now for assessing the current state of the indicator?

- Skills' assessment surveys of the adult population (source UNESCO)
- Proposed existing data sources:
    - Literacy rate, youth total (% of people ages 15-24)

Youth literacy rate is the percentage of people ages 15-24 who can both read and write with understanding a short simple statement about their everyday life.

- Literacy rate, adult total (% of people ages 15 and above)

Adult literacy rate is the percentage of people ages 15 and above who can both read and write with understanding a short simple statement about their everyday life.

- OECD Skills Outlook 2013: has the literacy and numeracy scores of the style called for in the indicator for 20 countries

3b. How closely does this match to what the indicator metadata describes?

- Judgment: Good only for worst case countries. Most countries have achieved effectively universal literacy at the low bar set by the existing data collection approach.
- Missing elements:
    - Based on the OECD's PIAAC (Program for the International Assessment of Adult Competencies), they want to use a one hour cognitive assessment
    - Includes literacy, numeracy and problem solving in technical environments
- Timeline: 3-5 years

3c. Is there data for aspects of the target not captured by the indicator?

- N/A

3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

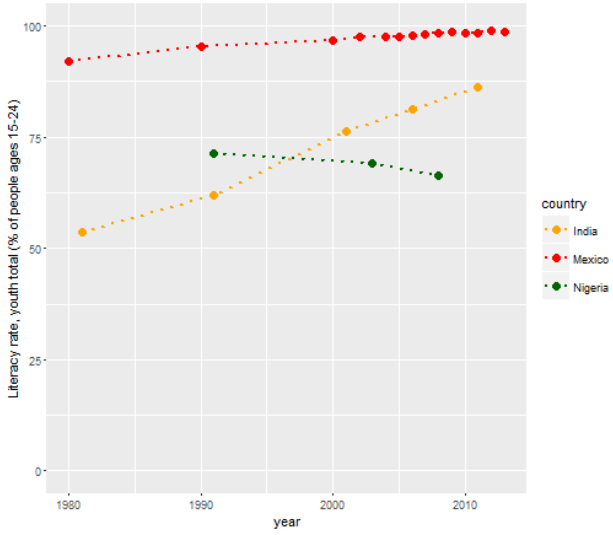
- Yes: 100% youth literacy and numeracy.
- No goal stated for adults

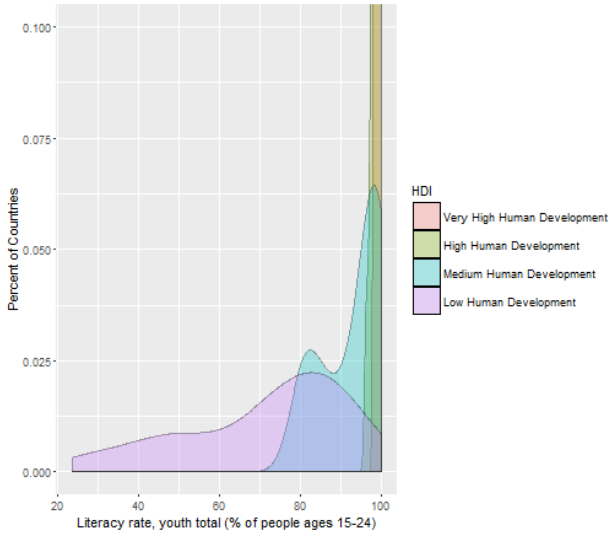
3e. What can we learn from the available data?

- Literacy rate, youth total (% of people ages 15-24)
- Literacy rate, adult total (% of people ages 15 and above)
- Countries: USA, Mexico, India, Nigeria

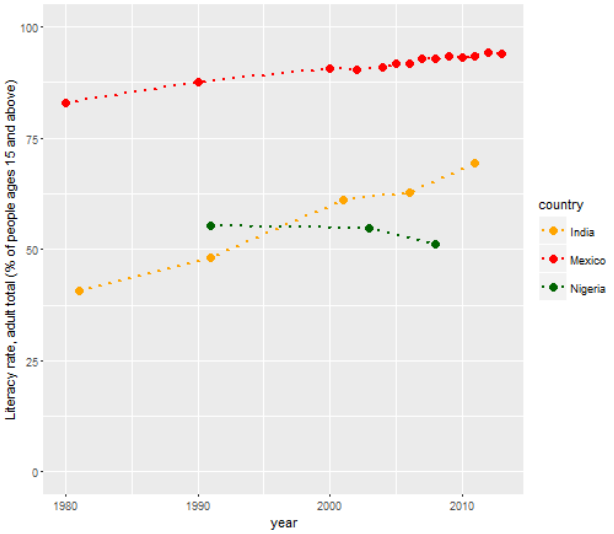
- ICT data:
    - Internet users
    - Cellphone subscriptions
- Qualitative look at OECD data on adult skills

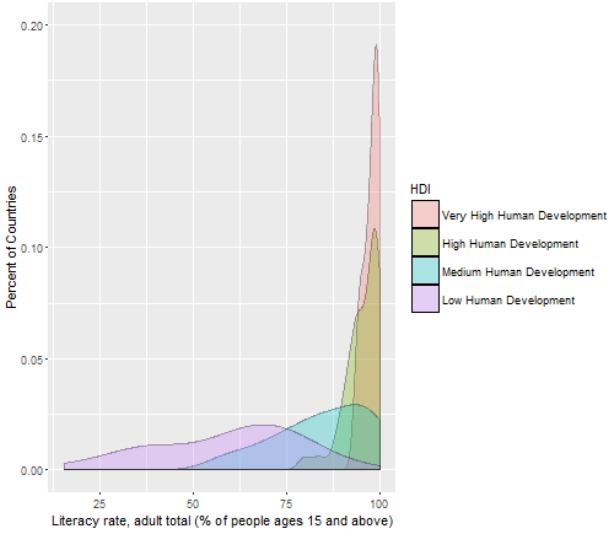
Literacy rate, youth total (% of people ages 15-24)





Literacy rate, adult total (% of people ages 15 and above)



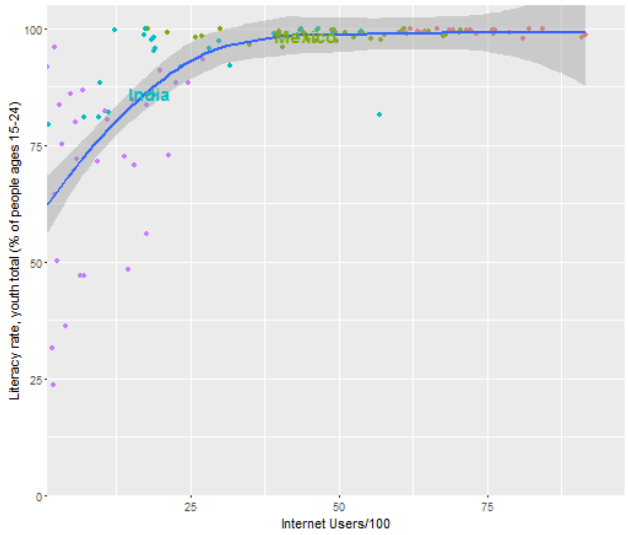


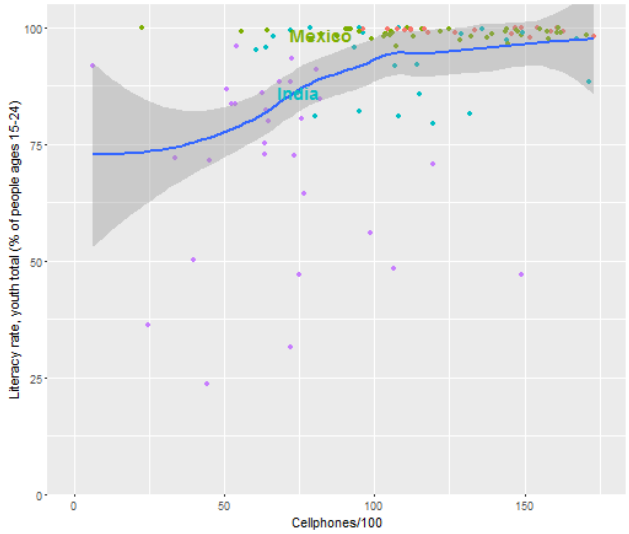
Means by HDI

HDI Level	Youth Literacy Mean	Adult Literacy Mean
Very High Human Development	99.37	97.56
High Human Development	98.78	95.3
Medium Human Development	92.93	84.58

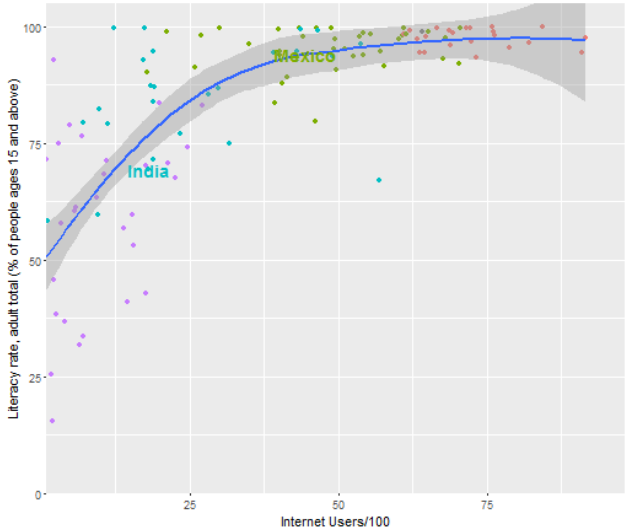
Low Human Development	70.9	58.86

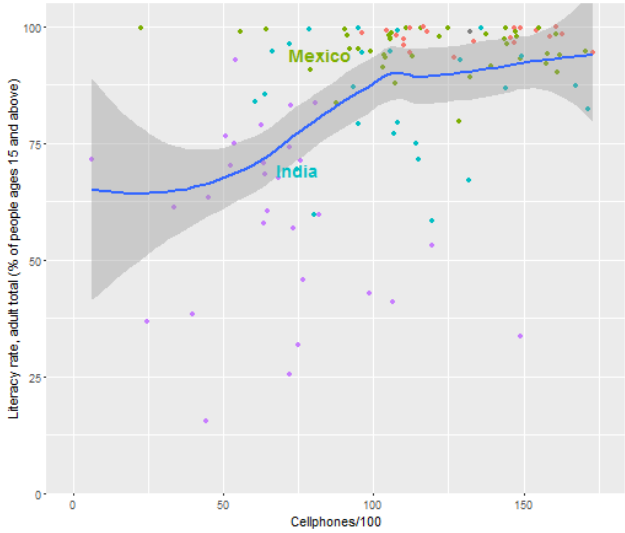
Youth Literacy vs. ICT





Adult Literacy vs. ICT





Regression Results

	Youth Literacy	Adult Literacy
High HDI	3.577 (3.400)	2.851 (3.697)
Medium HDI	1.878 (4.910)	-2.331 (5.319)
Low HDI	-18.650*** (6.038)	-26.336*** (6.537)
Internet	0.203** (0.084)	0.266*** (0.091)
Cellphones	-0.040 (0.032)	-0.059* (0.035)
Constant	90.163*** (7.158)	86.419*** (7.749)

Observations	117	116
R^2	0.581	0.673
Adjusted R^2	0.562	0.659
Residual Std. Error	10.362 (df = 111)	11.217 (df = 110)
F Statistic	30.748^{***} (df = 5; 111)	45.360^{***} (df = 5; 110)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Outlier Countries for Youth Literacy

High

HDI	Country	YouthLit
Very High Human Development	Estonia	99.95
Very High Human Development	Poland	100
High Human Development	Armenia	99.85
High Human Development	Azerbaijan	99.96
High Human Development	Cuba	99.87
High Human Development	Georgia	99.8
High Human Development	Libya	99.93
High Human Development	Palau	99.81
High Human Development	Russian Federation	99.71
High Human Development	Ukraine	99.77
Low Human Development	Eritrea	91.78
Low Human Development	Myanmar	96.13
Low Human Development	Swaziland	93.5

Low

HDI	Country	YouthLit
Very High Human Development	Austria	98.01
Very High Human Development	Bahrain	98.16
Very High Human Development	Qatar	98.71
High Human Development	Dominican Republic	97.47
High Human Development	Jamaica	96.1
High Human Development	Panama	97.64
High Human Development	Thailand	96.6
High Human Development	Tunisia	97.3
High Human Development	Venezuela, RB	97.56
Medium Human Development	Bangladesh	81.08
Medium Human Development	Congo, Rep.	80.91
Medium Human Development	Iraq	81.95
Medium Human Development	Morocco	81.51
Medium Human Development	Timor-Leste	79.53
Low Human Development	Afghanistan	46.99
Low Human Development	Central African Republic	36.36
Low Human Development	Chad	50.17
Low Human Development	Cote d'Ivoire	48.31
Low Human Development	Guinea	31.41
Low Human Development	Mali	47.14
Low Human Development	Niger	23.52

Outlier Countries for Adult Literacy

High

HDI	Country	AdultLit
Very High Human Development	Estonia	99.86
Very High Human Development	Latvia	99.9
Very High Human Development	Lithuania	99.82
Very High Human Development	Poland	99.76
Very High Human Development	Slovenia	99.71
Medium Human Development	Moldova	99.17
Medium Human Development	Tajikistan	99.75
Medium Human Development	Turkmenistan	99.65
Medium Human Development	Uzbekistan	99.52
Low Human Development	Myanmar	92.79
Low Human Development	Swaziland	83.1
Low Human Development	Tanzania	78.98
Low Human Development	Zimbabwe	83.58

Low

HDI	Country	Adult Lit
Very High Human Development	Bahrain	94.56
Very High Human Development	Malta	93.31
Very High Human Development	Portugal	94.48
Very High Human Development	Saudi Arabia	94.43
High Human Development	Iran, Islamic Rep.	83.63
High Human Development	Jamaica	87.9
High Human Development	Libya	90.26
High Human Development	Mauritius	89.25
High Human Development	Tunisia	79.65
Medium Human Development	Bangladesh	59.72
Medium Human Development	Ghana	71.5
Medium Human Development	India	69.3
Medium Human Development	Morocco	67.08
Medium Human Development	Timor-Leste	58.31
Low Human Development	Afghanistan	31.74
Low Human Development	Central African Republic	36.75
Low Human Development	Chad	38.23
Low Human Development	Guinea	25.31
Low Human Development	Mali	33.56
Low Human Development	Niger	15.46

7.2. Conclusions

- This indicator exactly matches the target.
- It is unclear what the difference is between the current assessment of Literacy and the new one this indicator calls for. Numeracy on the other hand does not yet appear to be measured.
- India and Mexico have been making steady improvements, while it appears that Nigeria has been getting worse.
- Almost 1/3 of youth in Low HDI countries are still illiterate
- Internet and literacy have a significant relationship, though perhaps it is increased literacy that drives internet access, not vice versa

7.3. Traffic Light Analysis of Indicator 4.6

Indicator <-> Target	• The indicator measures exactly what is called for in the target
Current Data	• Literacy data is widely available though the standard is going to be raised • Numeracy data is currently not available
Future Data	• Seems that fairly straightforward enhancements to current data collections will yield what this indicator calls for

8. Target 4.7 - Knowledge and Skills Needed to Promote Sustainable Development

8.1. Process

1. Select Target

Target 4.7

By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, thorough education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

2a. Review SDG Indicator and Metadata

Indicator 4.7.1: Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are

mainstreamed at all levels in: (a) national education policies, (b) curricula, (c) teacher education and (d) student assessment

- No metadata

2b. Missing from the Indicator

The indicator does not directly measure how "*all learners acquire the knowledge and skills needed to promote sustainable development"* rather, it does so indirectly, and especially in this area the causal links in education are not well proven.

3a. What is available now for assessing the current state of the indicator?

- There does not appear to be any current source of data which can be used to assess the indicator nor the target in any kind of rigorous way. Case studies and examples abound but this target will require agreement about what these types of education look like and what is required for it to count as being "mainstreamed" (e.g. one question on student assessments or a whole section?).

3b. How close does this match to what the indicator metadata describes?

N/A

3c. Is there data for aspects of the target not captured by the indicator?

N/A

3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

N/A

3e. What can we learn from the available data?

N/A

8.2. Conclusions

- This target is very closely aligned with much work being done at Arizona State University (ASU)
- Unfortunately, this looks like one of the targets that was included because everyone agreed this element needed to be captured but there was no thought yet as to how it might be measured.
- There are small scale and a case study attempts to measure this, but nothing that we found on a national level, let alone international level, which meets what this indicator is looking for.

8.3. Traffic Light Analysis of Indicator 4.7

Indicator <-> Target	• The indicator captures some of the key elements of the target though not all of it • Indicator focuses more on the inputs/outputs then the impacts/outcomes that the target does
Current Data	• There is none
Future Data	• With no meta data to show the direction there is currently no reason to expect that sufficient data will become available to assess progress on this indicator.

9. Mapping of Target 4.a - Education Facilities

9.1. Process

1. Select Target

Target 4.a

Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.

2a. Review SDG Indicator and Metadata

Indicator 4.a.1: Proportion of schools with access to: (a) electricity; (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; (g) basic handwashing facilities (as per the WASH indicator definitions)

- Percentage of schools by level of education (primary, lower secondary and upper secondary)
- Internet that is available for enhancing teaching and learning
- Functional drinking water source on or near the premises and water points accessible to all users during school hours
- Schools with access to the given facility and service
- Toilet and handwashing facilities by gender

2b. Missing from the Indicator

- While the indicator addresses important infrastructure concerns it does not directly get at many elements of the target itself including:
    - Gender sensitive (it calls for sex-specific bathrooms which could create problems for transgender individuals)
    - Safe, non-violent and inclusive don't appear to be addressed at all

- The indicator also does not say whether all schools should meet these standards or not.

3a. What is available now for assessing the current state of the indicator?

- The World Bank currently collects data on access to electricity, improved water sources, and improved sanitation facilities among households

This is not available for schools, just households

- Data from UNESCO on proportion of computers connected to the Internet for Primary and Secondary

Limited set of countries with data

- Data from UNESCO on proportion of all computers available for pedagogical use for Primary and Secondary

Limited set of countries with data

3b. How closely does this match to what the indicator metadata describes?

- Judgment: Data is close enough to obtain broad country-wide trends for electricity, water, and sanitation. However, it was not adequate enough to see a trend in the Internet, computers, infrastructure and materials for students with disabilities and basic handwashing facilities at schools themselves.
- Missing elements:
    - School specific (data is country-wide)
    - Data based on level of education
    - Administrative data from schools and other providers of education or training was not found
    - Data on gender or disabilities
    - Timeline: 2-4 years

3c. Is there data for aspects of the target not captured by the indicator?

None found

3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

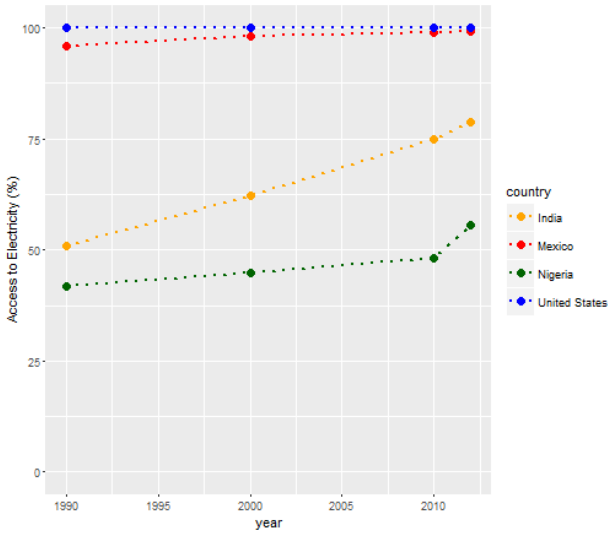
- Goal for indicator 4.a.1 (d) is to develop approach to assess school conditions for people with disabilities by 2020
- Goal for indicator 4.a.1 (g) Apply WASH definitions fully and extend coverage to more countries by 2018
- Although not specified, the goal for this indicator is most likely that all schools should have this infrastructure

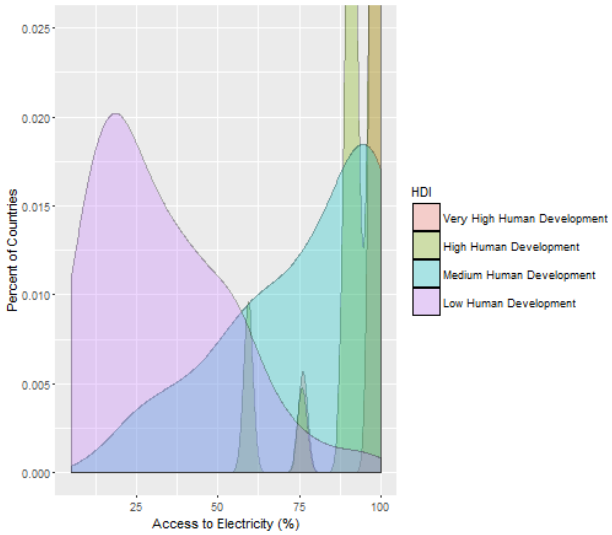
3e. What can we learn from the available data?

- Households with access to electricity (%)
- Proportion of computers connected to the internet (%)
- Proportion of computers available for pedagogical use (%)
- Improved water source, (% of population with access)
- Improved sanitation facilities, (% of population with access)
- Countries: USA, Mexico, India, Nigeria

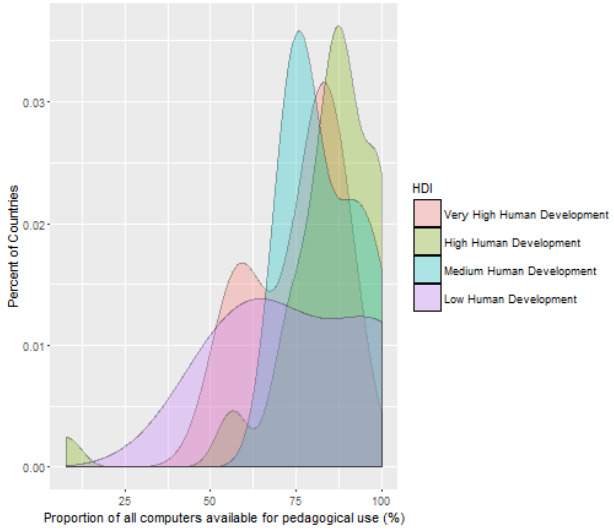
- ICT data:
    - Internet users
    - Cellphone subscriptions

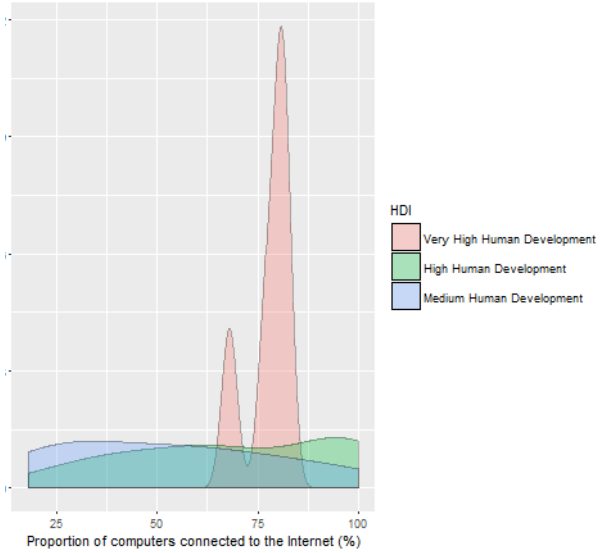
4.a.1(a) Access to Electricity (%)





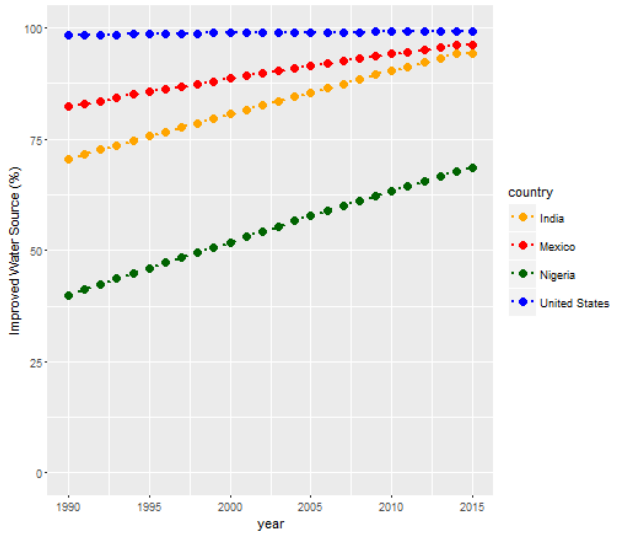
4.a.1 (b) Proportion of computers connected to the Internet (%)

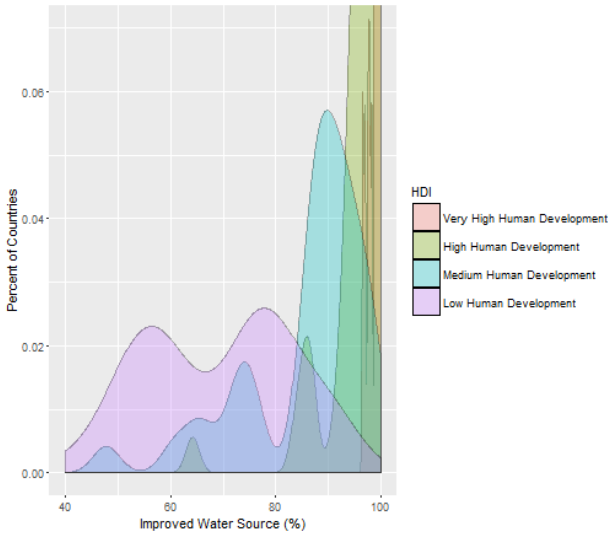




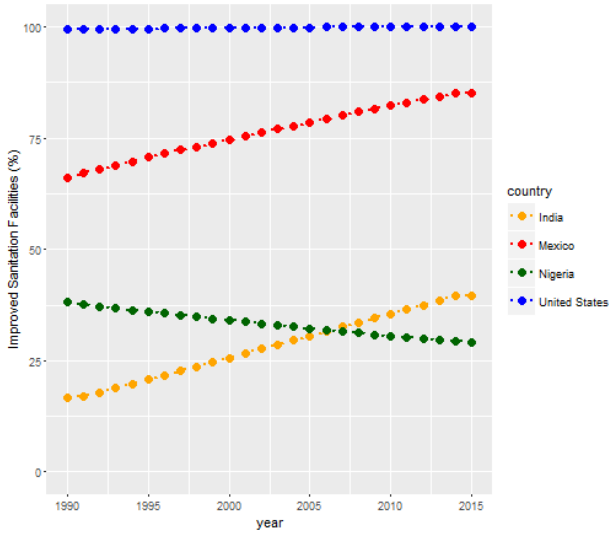
4.a.1 (c) Proportion of all Computers Available for Pedagogical Use (%)

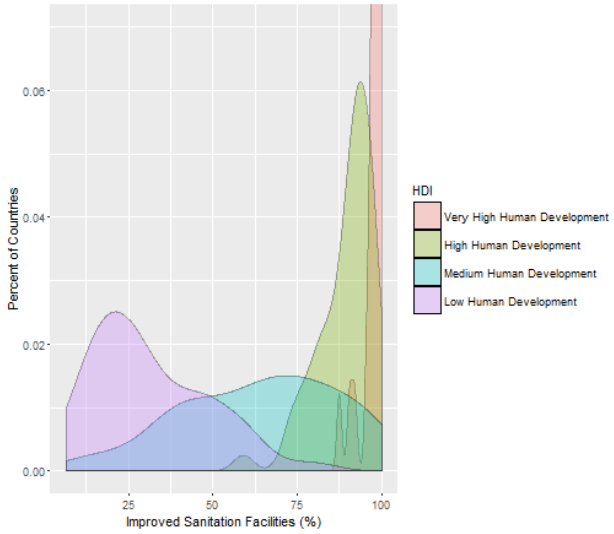
4.a.1 (e) Improved water source, (% of population with access)





4.a.1 (f) Improved sanitation facilities, (% of population with access)

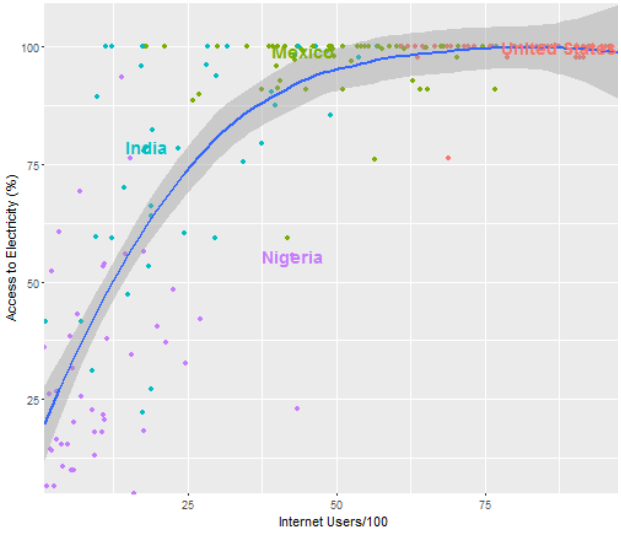


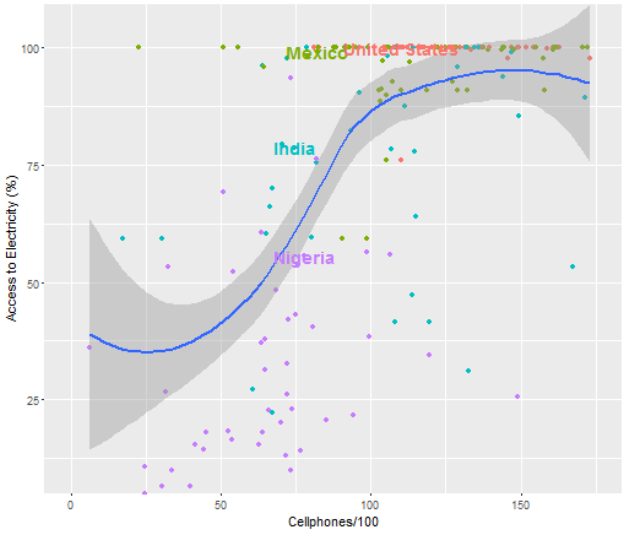


Means by HDI

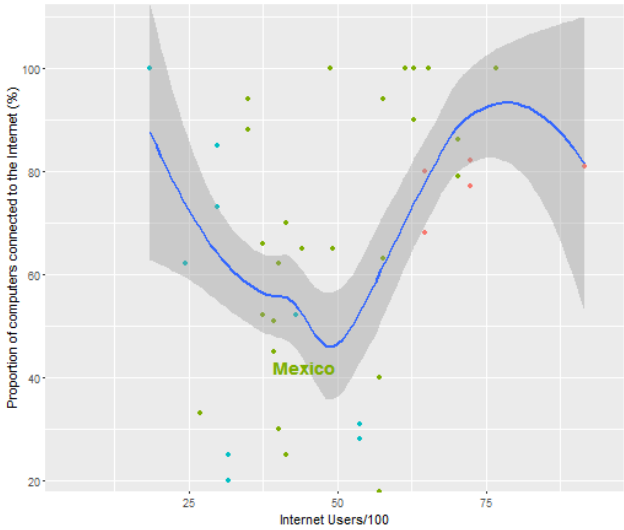
HDI Level	Electricity Mean	Internet Mean	Computer Mean	Water Mean	Sanitation Mean
Very High Human Development	99.27	77.6	75	99.58	98.33
High Human Development	96.03	68.83	84.16	95.46	89.42
Medium Human Development	76.54	52.8	82.93	85.9	64.12
Low Human Development	32.43		76.8	69.23	31.47

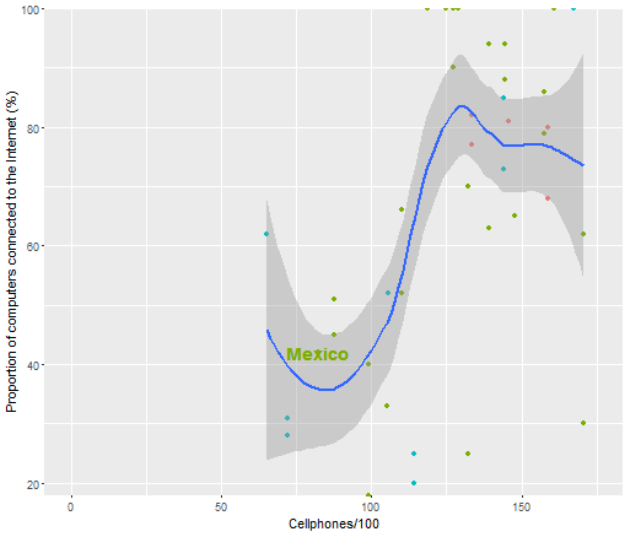
Access to Electricity vs. ICT (%)



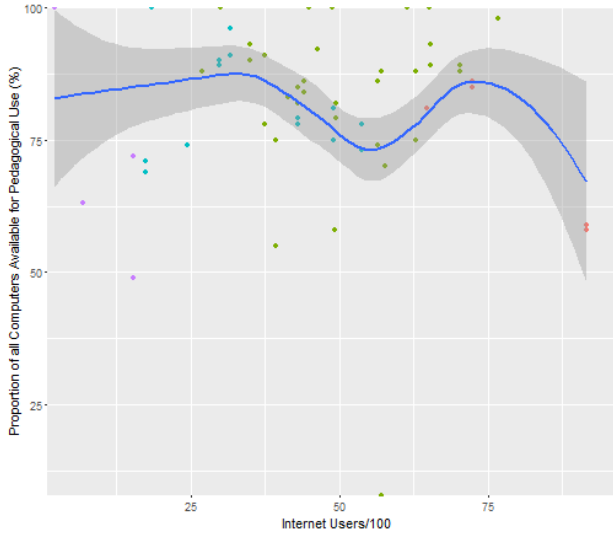


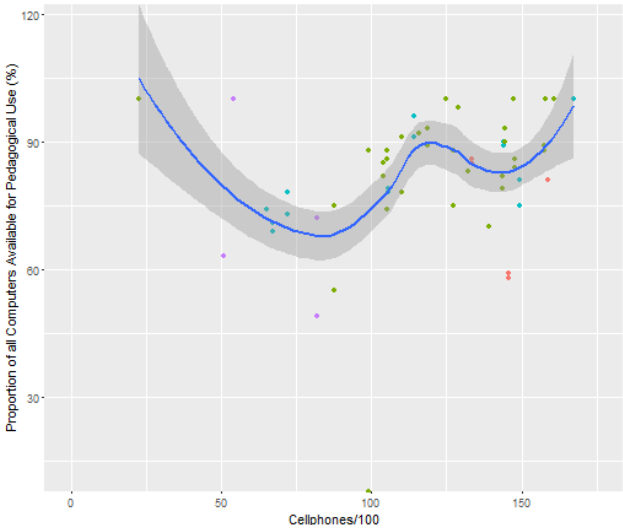
Internet in Schools vs. ICT



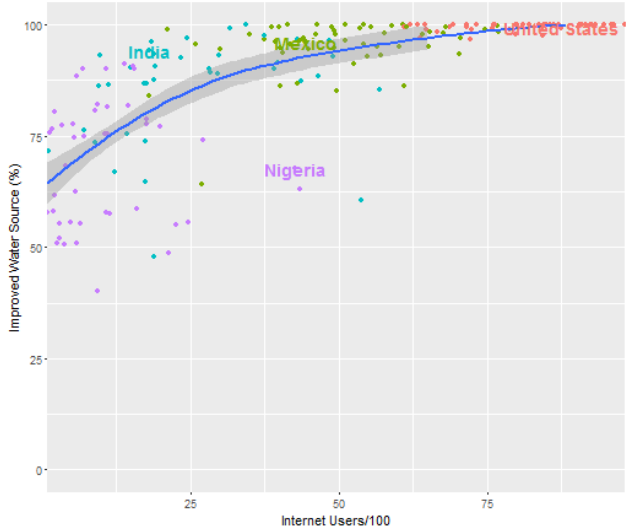


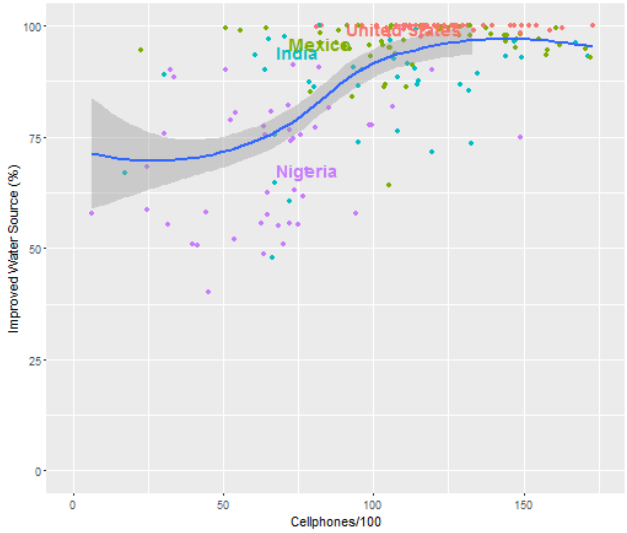
Computers in Schools vs. ICT



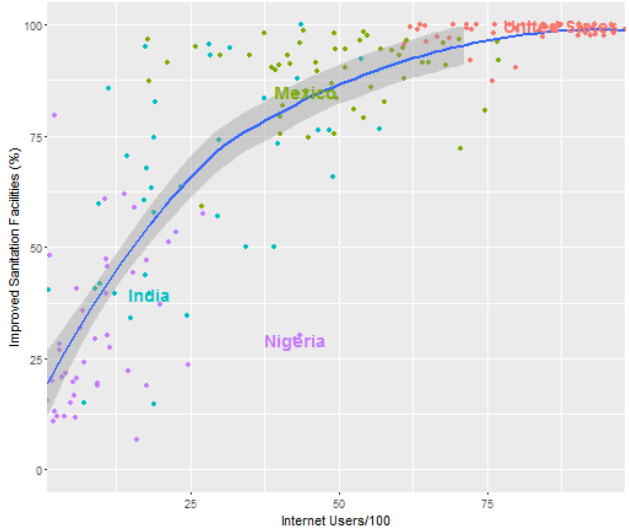


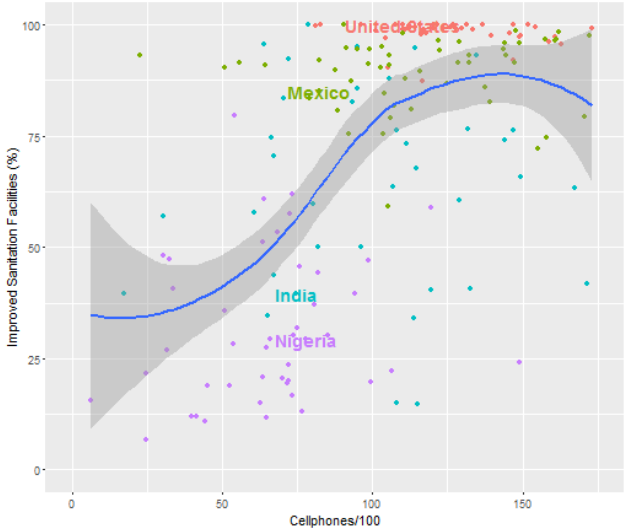
Improved Water Source vs. ICT (%)





Improved Sanitation Facilities vs. ICT





Regression Analysis

	Electricity	Internet	Computers	Water	Sanitation
High HDI	6.756** (3.118)	13.641 (8.336)	3.547 (6.032)	-1.377 (2.019)	1.994 (3.133)
Medium HDI	-2.117 (4.487)	11.986 (11.069)	3.078 (7.634)	-8.936*** (2.875)	-12.557*** (4.355)
Low HDI	-40.327*** (5.758)		-2.433 (12.271)	-21.473*** (3.686)	-42.615*** (5.589)
Internet	0.301*** (0.070)	0.575*** (0.182)	-0.159 (0.127)	0.045 (0.046)	0.324*** (0.069)
Cellphones	0.066** (0.029)	0.490*** (0.091)	0.115** (0.056)	0.075*** (0.019)	0.009 (0.029)
Constant	66.480*** (6.771)	-35.884* (20.815)	73.152*** (12.478)	85.981*** (4.327)	71.235*** (6.572)
Observations	250	81	98	241	235

R^2	0.756	0.393	0.066	0.609	0.769
Adjusted R^2	0.751	0.361	0.015	0.601	0.764
Residual Std. Error	14.039 (df = 244)	20.632 (df = 76)	15.600 (df = 92)	8.821 (df = 235)	13.340 (df = 229)
F Statistic	150.927^{***} (df = 5; 244)	12.309^{***} (df = 4; 76)	1.304 (df = 5; 92)	73.313^{***} (df = 5; 235)	152.384^{***} (df = 5; 229)

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

High Electricity

HDI	Country	Electricity
Medium Human Development	Egypt, Arab Rep.	100
Medium Human Development	Iraq	100
Medium Human Development	Kyrgyz Republic	100
Medium Human Development	Moldova	100
Medium Human Development	Morocco	100
Medium Human Development	Tajikistan	100
Medium Human Development	Turkmenistan	100
Medium Human Development	Uzbekistan	100
Low Human Development	Cameroon	53.7
Low Human Development	Comoros	69.3
Low Human Development	Cote d'Ivoire	55.8
Low Human Development	Djibouti	53.26
Low Human Development	Guinea-Bissau	60.61
Low Human Development	Nepal	76.3
Low Human Development	Nigeria	55.6
Low Human Development	Pakistan	93.6
Low Human Development	Senegal	56.5

Low Electricity

HDI	Country	Electricity
Very High Human Development	Brunei Darussalam	76.16
High Human Development	Fiji	59.33
High Human Development	Palau	59.33
High Human Development	St. Vincent and the Grenadines	75.91
Medium Human Development	Cambodia	31.1
Medium Human Development	Congo, Rep.	41.6
Medium Human Development	Namibia	47.26
Medium Human Development	Timor-Leste	41.56
Medium Human Development	Vanuatu	27.08
Medium Human Development	Zambia	22.06
Low Human Development	Burundi	6.5
Low Human Development	Central African Republic	10.8
Low Human Development	Chad	6.4
Low Human Development	Liberia	9.8
Low Human Development	Malawi	9.8
Low Human Development	South Sudan	5.06

High Improved Water

HDI	Country	Water
Medium Human Development	Bhutan	100
Medium Human Development	Egypt, Arab Rep.	99.2
Low Human Development	Comoros	90.1
Low Human Development	Djibouti	90
Low Human Development	Gambia, The	90.2
Low Human Development	Malawi	88.4
Low Human Development	Nepal	90.7
Low Human Development	Pakistan	91.3

Low Improved Water

HDI	Country	Water
Very High Human Development	Ireland	97.9
Very High Human Development	Korea, Rep.	97.6
Very High Human Development	Lithuania	96.6
Very High Human Development	Poland	98.3
Very High Human Development	Saudi Arabia	97
High Human Development	Algeria	84
High Human Development	Azerbaijan	86.2
High Human Development	Dominican Republic	85
High Human Development	Ecuador	86.9
High Human Development	Mongolia	64.2
High Human Development	Peru	86.3
Medium Human Development	Cambodia	73.4
Medium Human Development	Equatorial Guinea	47.8
Medium Human Development	Kiribati	66.8
Medium Human Development	Tajikistan	73.7
Medium Human Development	Timor-Leste	71.7
Medium Human Development	West Bank and Gaza	60.6
Medium Human Development	Zambia	64.6
Low Human Development	Afghanistan	55.2
Low Human Development	Angola	48.6
Low Human Development	Chad	50.8
Low Human Development	Congo, Dem. Rep.	52.1
Low Human Development	Madagascar	50.6
Low Human Development	Mozambique	50.9
Low Human Development	Papua New Guinea	40
Low Human Development	Yemen, Rep.	54.9

High Sanitation

HDI	Country	Sanitation
High Human Development	Grenada	98
High Human Development	Jordan	98.6
High Human Development	Maldives	98
High Human Development	Palau	100
High Human Development	Seychelles	98.4
Medium Human Development	Egypt, Arab Rep.	94.7
Medium Human Development	Kyrgyz Republic	93.2
Medium Human Development	Paraguay	87.8
Medium Human Development	Syrian Arab Republic	95.7
Medium Human Development	Tajikistan	95
Medium Human Development	Uzbekistan	100
Medium Human Development	West Bank and Gaza	92.3
Low Human Development	Angola	51.1
Low Human Development	Gambia, The	58.8
Low Human Development	Myanmar	79.5
Low Human Development	Pakistan	61.8
Low Human Development	Rwanda	60.8
Low Human Development	Swaziland	57.5
Low Human Development	Yemen, Rep.	53.3

Low Sanitation

HDI	Country	Sanitation
Very High Human Development	Ireland	90.5
Very High Human Development	Latvia	87.4
Very High Human Development	Lithuania	92
Very High Human Development	Montenegro	95.6
High Human Development	China	75.4
High Human Development	Colombia	81.1
High Human Development	Lebanon	80.7
High Human Development	Mongolia	59.1
High Human Development	Panama	74.5
High Human Development	Peru	75.4
High Human Development	Romania	79
High Human Development	Russian Federation	72.2
High Human Development	Suriname	79.2
Medium Human Development	Cambodia	40.8
Medium Human Development	Congo, Rep.	14.9
Medium Human Development	Ghana	14.8
Medium Human Development	India	39.5
Medium Human Development	Kiribati	39.7
Medium Human Development	Namibia	34
Medium Human Development	Sao Tome and Principe	34.6
Medium Human Development	Timor-Leste	40.4
Low Human Development	Chad	12
Low Human Development	Madagascar	11.9
Low Human Development	Niger	10.8
Low Human Development	Sierra Leone	13.1
Low Human Development	South Sudan	6.7
Low Human Development	Togo	11.6

9.2. Conclusions

- There does not appear to be (virtually) any data on school infrastructure currently available, the best we can do is proxies
- Some very limited information about Internet and computers, but it does not effectively get at the indicator
- It's predictable, but comforting, that country-wide Internet access is significant in predicting % of computers in schools with Internet and electricity use.

9.3. Traffic Light Analysis of Indicator 4.a

Indicator <-> Target	• The indicator gets at some very important elements of infrastructure which are sorely lacking in all too many schools • But it does not actually address many of the elements of the indicator
Current Data	• There is essentially no data for this indicator and the proxies we use here are extremely crude
Future Data	• Given that there are only a limited number of schools in each country it should be feasible to survey them and capture this data about infrastructure without too much trouble as I think the average school principal could answer these questions in a few minutes. • But given that they are starting from scratch on this indicator, the task is more significant

10. Target 4.b - Expand Scholarship Availability

10.1. Process

1. Select Target

Target 4.b

By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrollment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries.

2a. Review SDG Indicator and Metadata

Indicator 4.b.1: Volume of official development assistance flows for scholarships by sector and type of study

- Total net official development assistance (ODA) for scholarships and student costs in donor countries
- Financial aid awards for students and contributions to trainees (E01)
- Indirect costs of tuition in donor countries (E02)
- Scholarships by sector and type of study
- US dollars at average annual exchange rate
- Disaggregated by provider and recipient country
- Data for high-income countries is readily available and improving for middle-income

2b. Missing from the Indicator

The indicator does not address:

- *Depth of scholarship beneficiaries.*
- *Target focus for specific locations and programmes*

- *Any scholarships which come from outside of the ODA (universities, companies, NGOs or even individuals)*

3a. What is available now for assessing the current state of the indicator?

- Proposed Indicator:
    - OECD reports on flows from most donor countries: “I.A.5 Scholarships and student costs in donor countries”

3b. How closely does this match to what the indicator metadata describes?

- Judgment: The ODA flow for scholarships extremely limits the original Target 4.b. By not tracking scholarships provided by universities, colleges, foundations, NGOs and other sources, the understanding of the actual number of scholarships available to developing countries is skewed.
- Missing elements:
    - Detailed, internationally comparable data on scholarships for developing country nationals provided by universities, colleges, foundations, NGOs and other sources
    - Breakdown by sex of beneficiaries is not available
    - Low-income countries lack data
    - Definition of “substantially” in Target 4.b
    - Timeline: 2020 goal

3c. Is there data for aspects of the target not captured by the indicator?

Not found

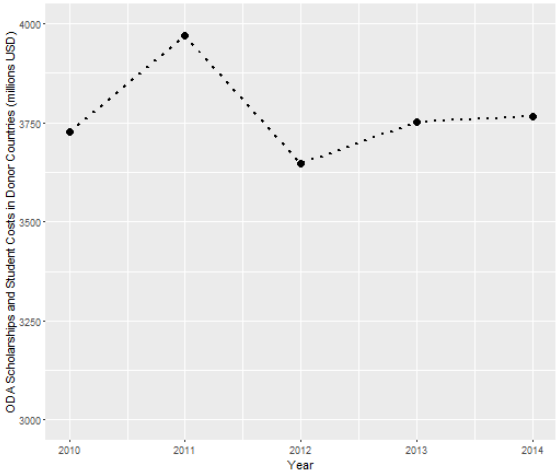
3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

- No, does not define what “substantially expand” means

3e. What can we learn from the available data?

- OECD Data “I.A.5 Scholarships and student costs in donor countries”
    - All Donors
    - Amount by country

I.A.5 Scholarships and student costs in donor countries (All Donors)



"I.A.5 Scholarships and student costs in donor countries" (by country)

Donor	Year	Millions of USD
Germany	2014	1057.58
France	2014	1051.24
Australia	2014	308.95
Turkey	2014	226.33
Japan	2014	201.37
Canada	2014	182.1
Austria	2014	115.65
Belgium	2014	96.38
Romania	2014	78.54
Korea	2014	66.69
Sweden	2014	53.71
Netherlands	2014	46.31
New Zealand	2014	42.37
United Kingdom	2014	30.25
Poland	2014	29.16
Portugal	2014	26.68
Greece	2014	13.17
Spain	2014	10.21
Denmark	2014	8.01
Hungary	2014	7.37
Switzerland	2014	7.01
Slovenia	2014	5.3
Czech Republic	2014	5.15
Italy	2014	5.05
Norway	2014	4.73
Ireland	2014	3.54
Slovak Republic	2014	2.21
United Arab Emirates	2012	1
Luxembourg	2014	0.67
Estonia	2014	0.6
Lithuania	2014	0.3
Malta	2014	0.26
Finland	2013	0.11

10.2. Conclusions

- The indicator substantially narrows the scope of this target, but limiting the measurement of it to official development flows. This unfortunately makes it impossible for a private entity to improve the indicator, even if directly addressing the target.
- OECD countries report data about this indicator, though not quite all of what the indicator metadata calls for

10.3. Traffic Light Analysis of Indicator 4.b

Indicator <-> Target	• The indicator measures one potential source of funds to support the target but misses measuring more creative (and bigger potential) options
Current Data	• There is data on aid going to scholarships by source country • Not yet disaggregated in the ways called for by the indicator
Future Data	• Since aid is reported and tracked by government agencies it should be fairly straightforward for the mostly wealth countries to meet this new reporting standard in the near future.

11. Target 4.c - Increase Supply of Qualified Teachers

11.1. Process

1. Select Target

Target 4.c

By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States.

2. Review SDG Indicator and Metadata

Indicator 4.c.1: Percentage of teachers in: (a) pre-primary; (b) primary; (c) lower secondary; and (d) upper secondary education who have received at least the minimum organized teacher training (i.e. pedagogical training) pre-service or in-service required for teaching at the relevant level in a given country

- Calculated separately for public and private institutions
- Measures the share of the teaching workforce which is pedagogically well-trained
- Disaggregated by sex

2b. Missing from the Indicator

Indicator does not define:

- *Substantially increase*

Or address:

- *Target focus for specific locations*

Which are both called for in the target.

3a. What is available now for assessing the current state of the indicator?

- Proposed Indicator:
    - The World Bank currently collects data on trained teachers in pre-primary, primary, lower and upper secondary (% of total teachers)

Trained teachers in primary education are the percentage of primary school teachers who have received the minimum organized teacher training (pre-service or in-service) required for teaching in a given country.

3b. How closely does this match to what the indicator metadata describes?

- Judgment: Is close enough to give a fair judgment of the current state and broad trends
- Missing elements:
    - This indicator does not take into account differences in teachers' experiences and status, teaching methods, teaching materials and classroom conditions - all factors that affect the quality of teaching and learning. Some teachers without formal training may have acquired equivalent pedagogical skills through professional experience. In addition, national standards regarding teacher qualifications and pedagogical skills may vary.
    - Timeline: 2030 goal

3c. Is there data for aspects of the target not captured by the indicator?

- None found

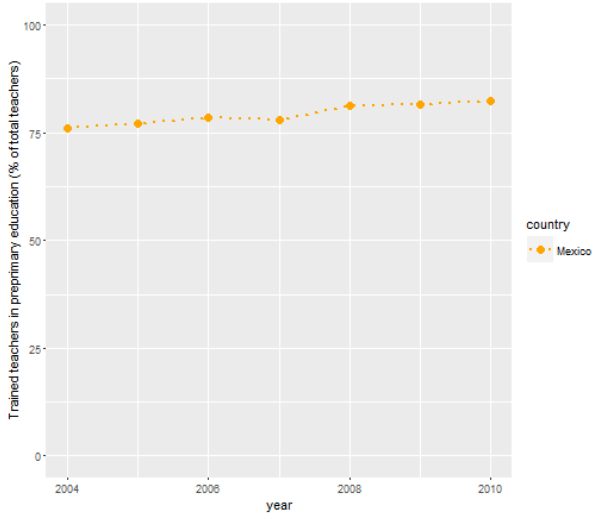
3d. Is there a goal(s) for 2030 for target and/or indicator(s)?

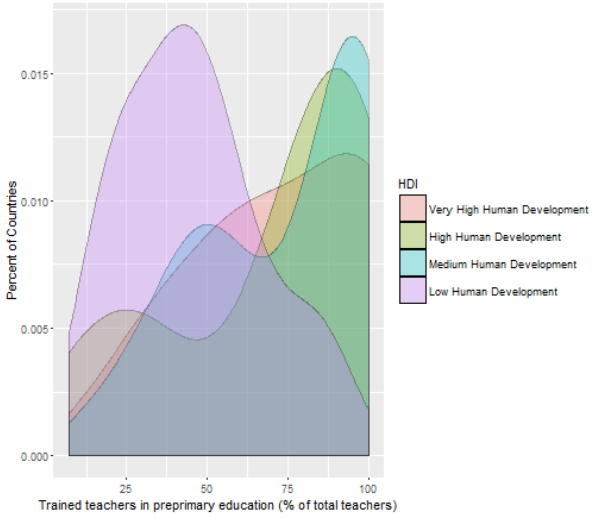
- Substantially is not defined, so no.

3e. What can we learn from the available data?

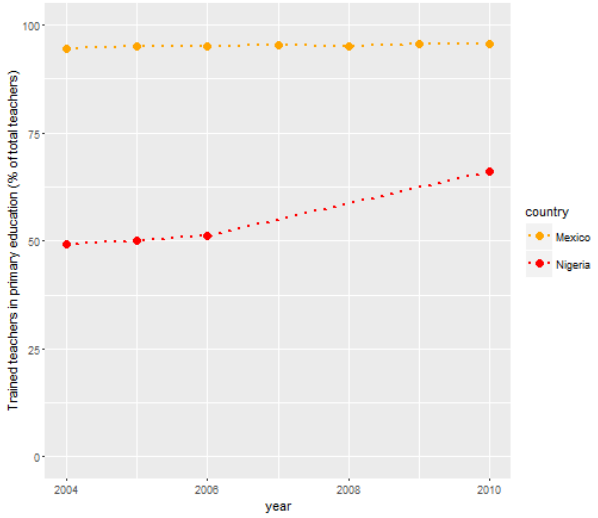
- Trained Teachers in:
    - Pre-primary
    - Primary
    - Lower Secondary
    - Upper Secondary
    - Countries: USA, Mexico, India, Nigeria
- ICT data:
    - Internet users
    - Cellphone subscriptions

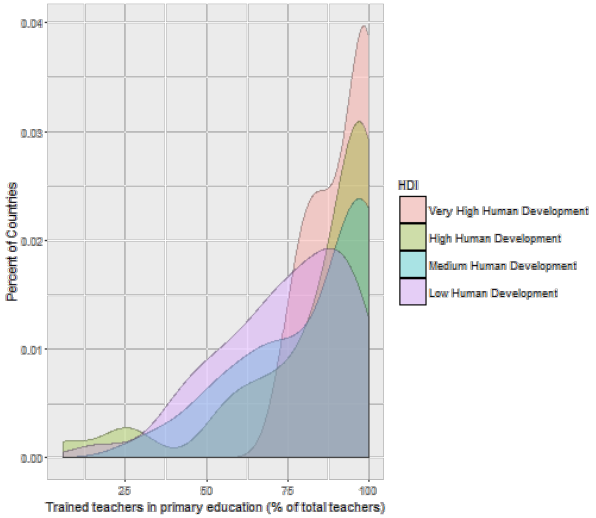
Trained teachers in preprimary education (% of total teachers)



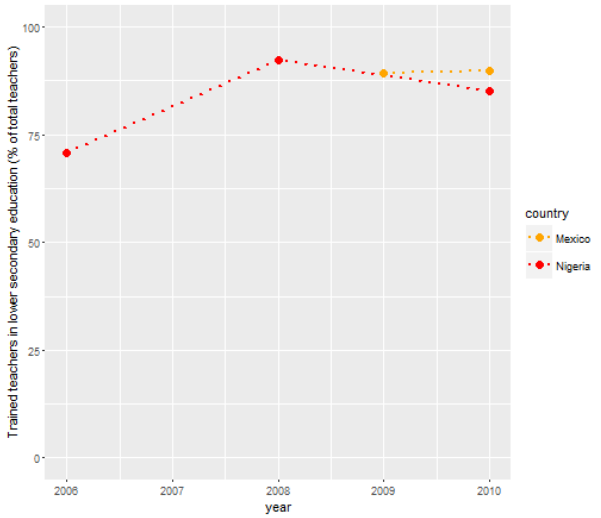


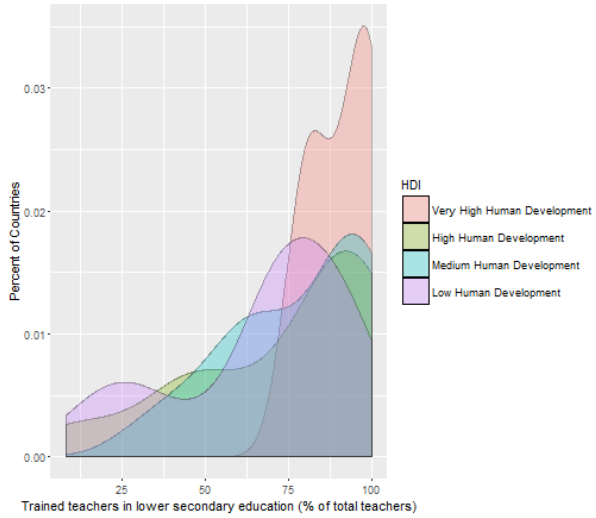
Trained teachers in primary education (% of total teachers)



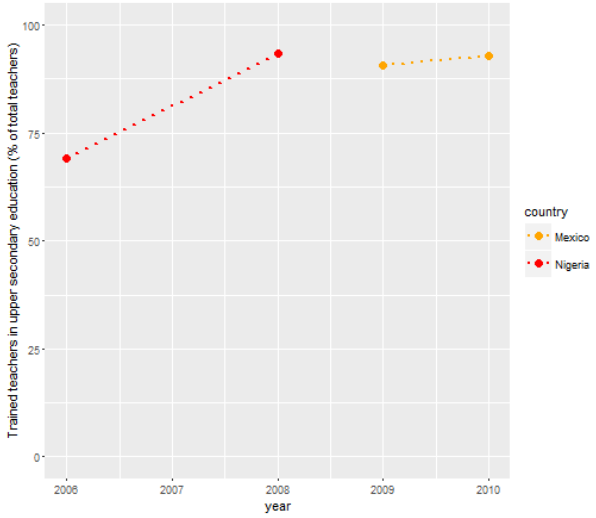


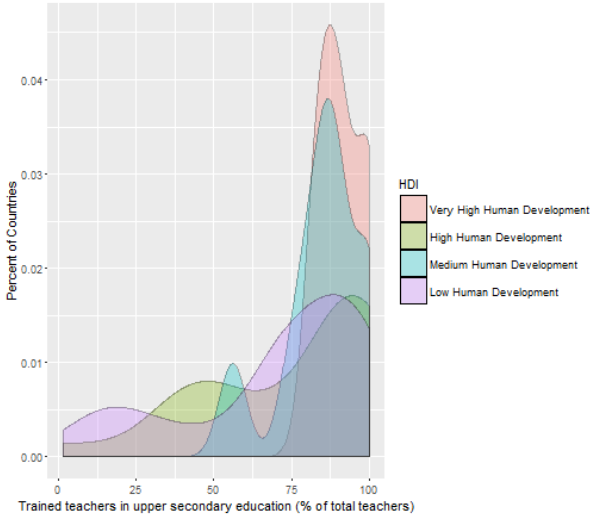
Trained teachers in lower secondary education (% of total teachers)





Trained teachers in upper secondary education (% of total teachers)

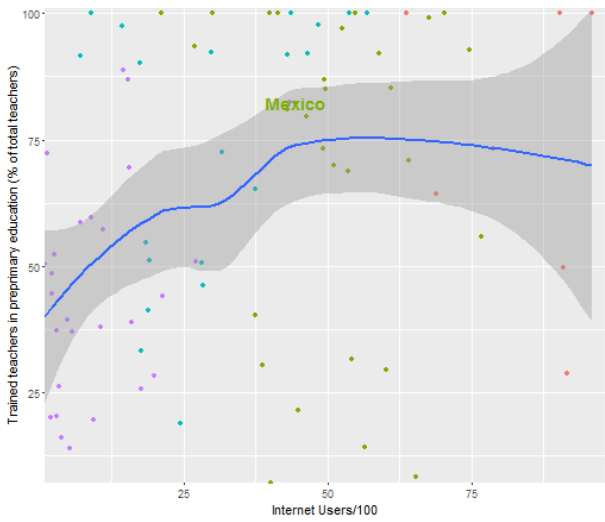


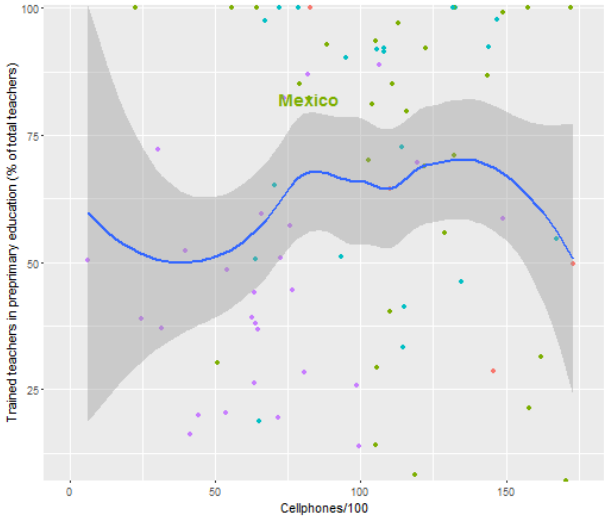


Means by HDI

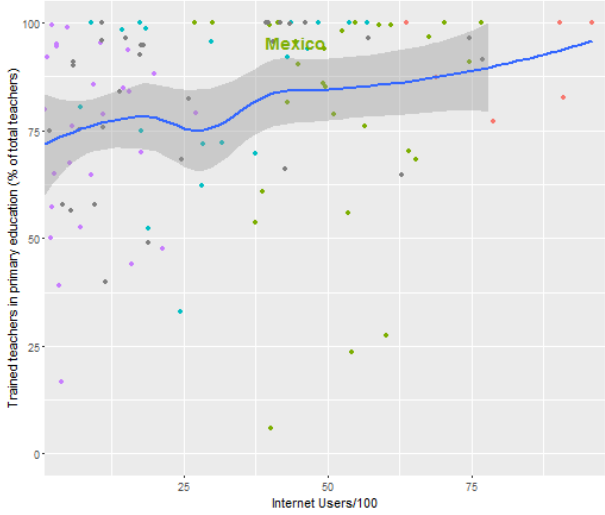
HDI Level	Preprimary Mean	Primary Mean	Lower Secondary Mean	Upper Secondary
Very High Human Development	73.71	91.97	91.17	91.37
High Human Development	69.86	83.24	73.48	75.03
Medium Human Development	74.34	82.94	78.49	84.97
Low Human Development	45.39	74.24	67.08	70.46

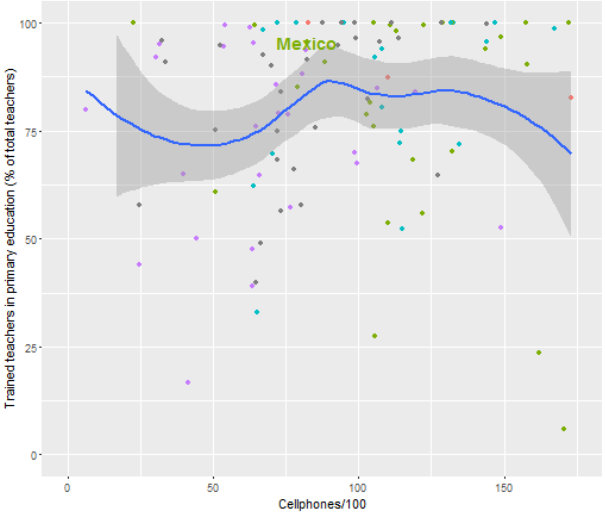
Pre-primary vs. ICT



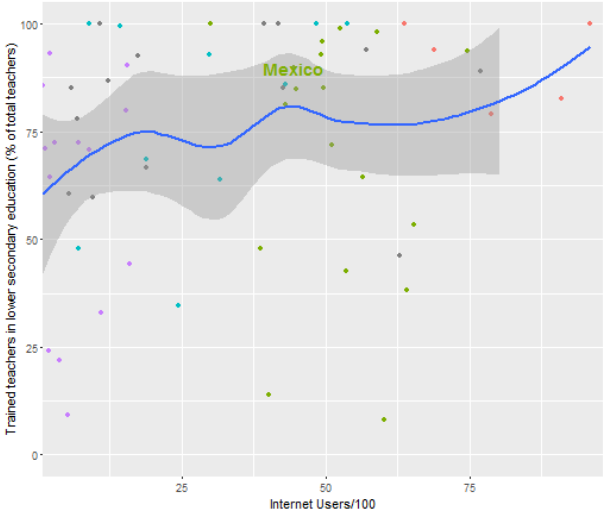


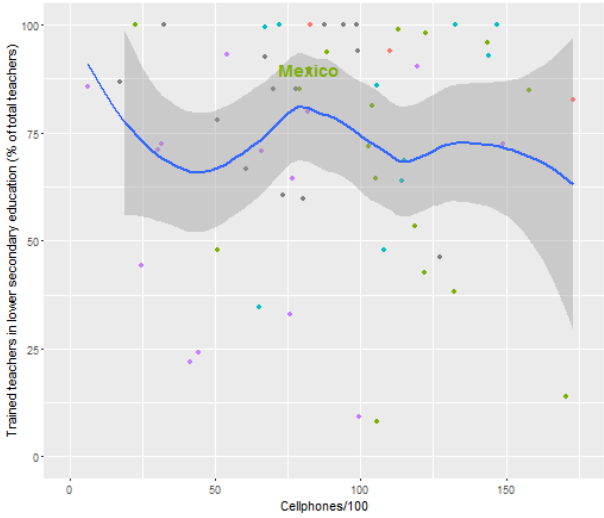
Primary vs. ICT



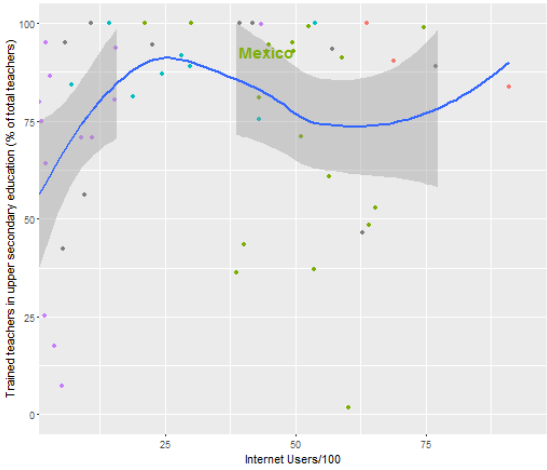


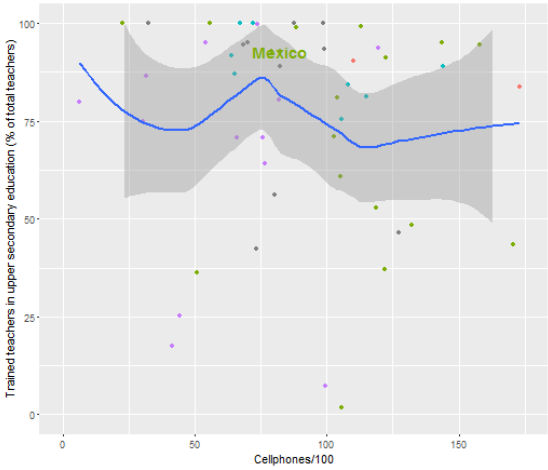
Lower Secondary vs. ICT





Upper Secondary vs. ICT





Regression Analysis

	Preprimary Mean	Primary Mean	Lower Secondary Mean	Upper Secondary
High HDI	3.778 (13.900)	-5.448 (12.061)	-18.962 (17.442)	-23.099 (19.065)
Medium HDI	13.928 (17.548)	3.444 (15.380)	-6.870 (24.139)	-5.930 (24.210)
Low HDI	-10.995 (21.271)	-3.555 (19.118)	-25.453 (30.784)	-29.922 (28.323)
Internet	0.285 (0.245)	0.238 (0.220)	0.128 (0.366)	0.091 (0.349)
Cellphones	-0.038 (0.089)	-0.029 (0.074)	-0.035 (0.104)	-0.120 (0.133)
Constant	56.034** (24.323)	76.435*** (21.681)	86.369** (34.032)	103.139*** (31.875)
Observations	84	79	47	42
R^2	0.197	0.073	0.136	0.132
Adjusted R^2	0.145	0.010	0.030	0.011
Residual Std. Error	27.243 (df = 78)	22.399 (df = 73)	27.150 (df = 41)	26.823 (df = 36)
F Statistic	3.823*** (df = 5; 78)	1.154 (df = 5; 73)	1.288 (df = 5; 41)	1.094 (df = 5; 36)
Note:	*p<0.1; **p<0.05; ***p<0.01			

Preprimary High and Low

High

HDI	Country	Preprimary
Low Human Development	Burundi	72.2
Low Human Development	Cote d'Ivoire	88.8
Low Human Development	Gambia, The	69.53
Low Human Development	Kenya	82.32
Low Human Development	Nepal	86.87

LOW

HDI	Country	Preprimary
Very High Human Development	Qatar	28.7
High Human Development	Albania	29.36
High Human Development	Belize	30.31
High Human Development	Panama	21.46
High Human Development	Seychelles	31.53
High Human Development	St. Vincent and the Grenadines	14.07
High Human Development	St. Kitts and Nevis	8.28
High Human Development	Suriname	7.17
Medium Human Development	Ghana	41.16
Medium Human Development	Kyrgyz Republic	46.16
Medium Human Development	Nicaragua	33.29
Medium Human Development	Sao Tome and Principe	18.84
Low Human Development	Benin	13.82
Low Human Development	Burkina Faso	19.59
Low Human Development	Congo, Dem. Rep.	20.33
Low Human Development	Madagascar	16.1
Low Human Development	Niger	19.95

Primary High and Low

High

HDI	Country	Primary
Low Human Development	Congo, Dem. Rep.	94.62
Low Human Development	Djibouti	96
Low Human Development	Ethiopia	95
Low Human Development	Mauritania	100
Low Human Development	Myanmar	99.55
Low Human Development	Rwanda	95.2
Low Human Development	Tanzania	98.99
Low Human Development	Uganda	94.77

Low

HDI	Country	Primary
Very High Human Development	Kuwait	77.16
High Human Development	Albania	27.53
High Human Development	Grenada	53.71
High Human Development	Serbia	55.73
High Human Development	Seychelles	23.65
High Human Development	Suriname	5.86
Medium Human Development	Bangladesh	57.73
Medium Human Development	Equatorial Guinea	48.83
Medium Human Development	Ghana	52.4
Medium Human Development	Sao Tome and Principe	33.02
Medium Human Development	Syrian Arab Republic	62.12
Low Human Development	Angola	47.49
Low Human Development	Guinea-Bissau	38.93
Low Human Development	Haiti	39.94
Low Human Development	Madagascar	16.66
Low Human Development	Mali	52.42
Low Human Development	Niger	50.08
Low Human Development	South Sudan	44.03

Lower Secondary High and Low

High

HDI	Country	Lower Sec
Low Human Development	Djibouti	100
Low Human Development	Mauritania	100

Low

HDI	Country	Lower Sec
Very High Human Development	Kuwait	79.14
High Human Development	Albania	8.18
High Human Development	Antigua and Barbuda	38.21
High Human Development	Serbia	42.51
High Human Development	Suriname	13.86
Medium Human Development	Congo, Rep.	47.9
Medium Human Development	Sao Tome and Principe	34.48
Low Human Development	Benin	9.34
Low Human Development	Cameroon	33.01
Low Human Development	Madagascar	21.93
Low Human Development	Niger	24.15

Upper Secondary High and Low

HDI	Country	Upper Sec
Very High Human Development	Saudi Arabia	100
Medium Human Development	Lao PDR	99.95
Medium Human Development	West Bank and Gaza	100

HDI	Country	Upper Sec
High Human Development	Albania	1.66
High Human Development	Belize	36.19
High Human Development	Dominica	46.48
High Human Development	Serbia	37.18
High Human Development	Suriname	43.49
Medium Human Development	Bangladesh	56.19
Low Human Development	Benin	7.42
Low Human Development	Madagascar	17.39
Low Human Development	Niger	25.2

11.2. Conclusions

- Percentage of teachers who are trained is already reported to international agencies, though many countries (including the USA) are not reporting any data.
- The variance between national standards makes comparing countries a fraught exercise and probably not very useful.
- This is the only indicator where none of the data had any correlation with Internet or cellphone access

11.3. Traffic Light Analysis of Indicator 4.b

Indicator <-> Target

- The indicator captures the intended result of the target if not all the means mentioned (ie “international cooperation)

Current Data

- There is data for many countries on teacher training
- It is disaggregated in all the desired ways
- Hard to impossible to compare

Future Data

- The number of countries reporting this indicator will likely increase as will the ability to disaggregate the data
- Still will be difficult to compare countries but the indicator does not actually call for us to be able to do that

Appendix E: Leverage Points

Indicator 4.1.1. *Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex*

- **Infrastructure**: Rapidly growing youth populations and a need to enroll far higher proportions of youth calls for significant infrastructure.
    - **More schools**: In countries lagging far behind they simply need more schools. For example building schools was extremely effective in Afghanistan.
    - **Materials**: So far studies have not found meaningful improvements when things like books or backpacks are distributed but there may be other more fruitful approaches in this area.
    - **4.a** outlines the minimum infrastructure which the UN has agreed is necessary for all schools to have by 2030
- **Teachers**: Some recent studies have found that the most important factor in student success is the quality of the teachers
    - **Absenteeism**: Studies have found that teachers miss between 10-30% of school days in much of the developing world.
    - **4.c**: Qualified teachers (based on national standards)
- **Student Assessments**: Incorporating and measuring 21st century skills in reading and mathematics assessments, for example, could shift what is tested, how it is tested, and how student achievement is defined, potentially leading to the development of large-scale performance assessments that can capture a broader range of student primary learning and preparation.
- **Curriculum**: Many school systems need radically upgraded curricula to meet proficiency standards.
    - **Localization**: There is an extreme lack of materials in local languages which hampers the learning of children working in their non-native tongues
    - **Pedagogy:** Teacher directed, rote learning is still dominant in much of the world, an approach shown to be far less effective than other methods
    - **Streaming:** This can be done by sorting students or through computer assisted learning, but some evidence that learning improves when students are able to learn at their level (and not the average of their peers).
- **Inequitable access**: Beyond being part SDG 4.5, inequitable access will be a barrier to raising participation rates because it means a portion of the population is not involved.
    - **Socio-economic**: Poor families may not be able to afford to keep their kids in school through completion, or they may have to miss too many days for farm labor. In addition certain indigenous and other social groups have been marginalized out of the system in many places.
    - **Geographic**: In rural areas students may face a long walk or difficult transportation situation, particularly for secondary school.
    - **See 4.5**

Indicator 4.2.1 *Proportion of children under five years of age who are developmentally on track in health, learning and psychosocial well-being, by sex*

Indicator 4.2.2 *Participation rate in organized learning (one year before the official primary entry age), by sex*

- **Infrastructure:** Adequate pre-primary availability to meet the requirements
    - **4.c** Sufficient numbers of trained teachers
    - **4.a** Adequate facilities
    - **Government Support:** Whether subsidized by the government or provided as part of public schools, this makes an enormous difference
- **Home Learning Materials:** The existence and use of books and other learning materials and activities at home makes a big difference in early childhood development (could potentially be digital)
- **Health and Nutrition:** There is increasing evidence that poor nutrition sets children back in terms of brain development, from which they can never recover
- **Safety from Violence**
- **Inequitable access**: Beyond being part SDG 4.5, inequitable access already shows up in the limited data as an issue, with a yawning gap in outcomes between the rich and poor.

Indicator 4.3.1 *Participation rate of youth and adults in formal and non-formal education and training in the last 12 months, by sex*

- **Public Costs**: This refers to costs borne by the higher education system and government. For low income countries it costs an average of 100% of GDP/capita to educate one student.
    - **Infrastructure**: Many of these countries have large and rapidly growing youth populations and a sudden influx of secondary graduates from improved K-12 systems. This is creating a demand which far outstrips the limited infrastructure which exists.
    - **ICT costs**: While costs are generally lower in less developed countries, ICT costs are the same or higher than in developed countries. This means that as a proportion of university budgets, ICT capital expenditures and maintenance is quite large and is often sacrificed.
    - **Qualified Faculty:** To meet demand and this target countries need to vastly grow their enrollments which does not just mean infrastructure but also qualified faculty to teach the classes. Many of these countries have too few PhD trained citizens and of those it can be difficult to convince them to live where new universities are being built (often in the middle of nowhere or less developed regions of the country).
- **Private Costs**: Even though many countries make higher education free or virtually so, families and students still have to bear significant costs to send their child to school. A reliance on private universities to expand enrollment is a much more serious barrier.
    - **Living Expenses**: In many developing countries young people live with family until marriage (and sometimes after). The cost difference between living at home and on one's own is very large. In addition new universities are often built on cheap land on the periphery of cities leading to significant transportation costs.
    - **Lack of scholarships/loans**: Most low income countries have no system for students to get loans and especially when university is heavily subsidized, few scholarships available. The advantage of these systems is they could be used to

target low income families instead of free tuition being captured mostly by middle and upper income students. Also **4.b**

- **Inequitable access**: Beyond being part of SDG 4.5, inequitable access will be a barrier to raising participation rates because it means a portion of the population is not involved.
    - **Socio-economic**: Middle and upper income students are overrepresented in higher education the world over. In addition certain indigenous and other social groups have been marginalized out of the system in many places.
    - **Geographic**: Typically national universities are located in the capitals of countries, leaving other parts of the country with much lower quality (or no) higher education institutions. This is a significant barrier for students from these regions.
    - **See 4.5**

Indicator 4.4.1 *Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill*

- **Infrastructure**: Computers, internet access and mobile networks are all prerequisites for the development of ICT skills
    - **4.a.** Call for computers and internet in schools
    - **9.c.** Universal and affordable internet access
- **Schools:** Even with infrastructure, students are not necessarily gaining the necessary ICT skills during their schooling years.
    - **Curriculum:** ICT skills need to be integrated fully into the curriculum
    - **4.c/Qualified Teachers:** This does not only apply in less developed regions where teachers may never have used a computer before but also in developed regions where teachers don't feel comfortable in ICT where their students may actually know more than them.
- **Adult Learning:** To boost ICT skills it will be necessary to reach adults who have finished their education yet whose ICT skills are not adequate. This will be an ongoing challenge as particular skills an individual needs will evolve and change over one's lifetime.
- **Inequitable access**: Beyond being part SDG 4.5, inequitable access to ICT is holding back the skill levels of large portions of the population
    - **Socio-economic**: Poor families cannot afford the ICT equipment at home where so much ICT skill development really happens.
    - **Unconnected Adults**: Billions of adults around the world have never used a computer or connected to the internet.
    - **See 4.5**

Indicator 4.5.1: *Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated*

- **Socio-cultural constraints**: Whether explicit or implicit, internal to households or an aspect of the broader society, socio-cultural constraints are the biggest reason that in many places around the world women and girls are less educated than their male counterparts.

    - **Cultural**: A range of barriers including child marriage, early motherhood, traditional seclusion practices, sexual violence and more severely limit the education of women.
    - **Domestic**: In most of the world women are expected to bear a disproportionate share of the household labor and young girls begin contributing early, limiting their ability to continue in school.
- **Educational policies:** Include but are not limited to the following:
    - **Female Teachers:** Beyond serving as role models, female teachers can also make classrooms safer and more inviting places for young girls.
    - **Costs:** Whether formal fees or other costs like books and uniforms, poor families will typically choose to cover the male children's' expenses before those of their sisters.
- **Infrastructure:** Include but are not limited to the following:
    - **Bathrooms:** Shared (or no) bathrooms can be a serious problem for secondary girls, particularly in more traditional societies.
    - **Distance:** Rural girls in particular may live long walks from school which (beyond being dangerous) cut into the time girls have to do school work as well as their expected household chores.
- **Returns on education**: In countries where women are excluded from jobs or expected to stay home once married, the financial return on investing in education is much lower for women compared to men. This creates a disincentive for women (and their families) to invest in education for them.

Indicator 4.6.1 *Percentage of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex*

- **Improved Measurement:** Even developed countries have not done a good job at assessing how much of their adult population struggles with literacy and numeracy even if they pass a minimum bar.
- **Identifying and Inducing Participation:** Given the data it can be a challenge to identify those adults who would most benefit from literacy programs and to induce them to participate in them.
- **Effective Content and Practices:** There is a need to continue to improve the content and implementation of literacy programs as assessed by their effectiveness
- **Inequitable access**: Beyond being part of SDG 4.5, inequitable access is already a problem as more women than men suffer from illiteracy.
    - **Socio-economic**: Poor families are far more likely to have illiterate members and be least able to afford for them to study.
    - **Geographic**: In rural areas adults may not have access to any continuing education.
    - **See 4.5**
- **Literate Environment:** Maintaining and improving literacy happens best in local environments with rich literacy and numeracy opportunities. This is a particularly key opportunity for ICT.
    - **Mobile phones:** Many low literate people have cellphones and text messaging and other approaches have been shown to be successful in maintaining and improving literacy and numeracy

- **Radio/TV:** With their wide and deep penetration radio and TV offer excellent gateways for promoting sustainable literacy.

Indicator 4.7.1 *Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies, (b) curricula, (c) teacher education and (d) student assessment*

- **Interdisciplinarity**: One of the principal barriers to integrating Sustainability and citizenship curriculum into schools is that it does not live within any of the traditional silos. Sustainability should properly be part of all the disciplines. Rather than just work with one of the silos, one has to work to integrate it everywhere, a much bigger task.
- **Agreement:** There is a wide-ranging debate about citizenship and Sustainability education. In a positive sense this has created a diversity of approaches but this diversity has created a barrier to it being mainstreamed in a more permanent fashion. The challenge of reaching an international agreement on this is clear when compared to agreement on what proficiency in math and reading means in 4.1.
- **Research:** Most of the research in this area consists of case study descriptions. Too little work has been done to rigorously analyze curriculum and programs to identify the most successful which could then be scaled up (as this indicator calls for). Additionally we have little follow-up in terms of what kind of impact these programs are having on students' lives down the road.
- **Employability:** While surveys and other work have found that employers say they want knowledge and skills regarding sustainability, actual hiring practices don't appear to be prioritizing this. Therefore for students and educational systems there is little incentive to go beyond paying lip service to sustainability education. Part of this may be driven by a lack of accepted sustainability standards by employers.

Indicator 4.a.1 *Proportion of schools with access to: (a) electricity; (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water;(f) single-sex basic sanitation facilities; (g) basic handwashing facilities, as per the WASH (water, sanitation and hygiene) indicator definitions.*

<u>Computers/Internet</u>

- **Infrastructure**: Personnel, building, and equipment infrastructure is essential for operating computers and providing Internet access.
    - **Reliable Electricity:** Battery back-up is critical when electricity is not reliable.
    - **Secure Facility:** Ability to lock equipment into a secure room is essential to reducing theft and misuse.
    - **Capacity Building for ICT Integration:** Computers were left for individual schools to figure out what to do with the computers
- **ICT costs**:
    - **Necessity cost**: While costs are generally lower in less developed countries, ICT costs are the same or higher than in developed countries. This means that as a proportion of a family or school's budget, ICT capital expenditures and maintenance is quite large and is often sacrificed. Empirical studies show that

people consider ICT expenditure of US$120 per year as a basic necessity. ICT costs must be weighed to other needs, like food or medicine.
    - **Supplemental expenses:** ICT costs will also add additional expenses in the budget with the need of fans, added security, and ongoing-training.
    - **Computer lab vs individual classroom computers:** Little has been reported, but some research shows computer labs are more cost effective.
- **Trade Environment**: Many less developed countries have to import 100% of their ICT equipment, tariffs, costs of shipping and customs, which can dramatically increase cost and difficult of setting up infrastructure.
- **Geographic:** Rural schools, already disadvantaged, are going to have particular difficulty with installing computers and connecting to the internet

Adapted Infrastructure and Materials for Students with Disabilities

- **Modified computers and software**: Providing the disabled community with more equitable opportunities in school and the workplace.

Electricity/ Improved Sanitation and Water Source

- **Local Infrastructure:** Many schools are in places with no electrical grid or the existing grid may be very unreliable or too expensive for the school to use for much beyond lights. Same applies for water and sanitation infrastructure
- **Solar Energy**: Or other localized electricity solutions may enable schools to jump ahead of local grid development.

Indicator 4.b.1 *Volume of official development assistance flows for scholarships by sector and type of study*

- **Proportion of ODA:** Scholarships currently form only a tiny portion of ODA and even small increases relative to the overall budget would mean a huge increase in the number of scholarships.
- **Accountability:** Donor nations have not been held to the quality or quantity of support.

Note: While the indicator only measures ODA, there would seem to be a lot of other sources for scholarships

- **Private Scholarships:**
    - **Donors:** Currently existing scholarship programs could be re-oriented to support students from developing countries.
    - **Universities:** Universities often target international students as a source of revenue but could also develop special scholarships for the less wealthy (means based scholarships)
    - **Online:** Online universities in the developed world could be a key way to increase opportunities of study for students in developing countries without incurring the cost and difficult of them leaving their home country.
- **Inequitable access**: Crudely measuring the number of students who leave developing countries for university would not be sufficient as wealthy youth in these countries are already going abroad for university. This goal needs to be focused on reaching the less well-off.

Indicator 4.c.1 *Percentage of teachers in: (a) pre-primary; (b) primary; (c) lower secondary; and (d) upper secondary education who have received at least the minimum*

organized teacher training (i.e. pedagogical training) pre-service or in-service required for teaching at the relevant level in a given country

- **Standards for Teacher Training**: This indicator focuses on meeting national standards which points to the need for the development of rigorous national standards that actually ensure effective teaching.
- **Pre-service:** Obtaining a teaching degree, generally via a post-secondary education.
- **In-service:** Many education systems require that teacher participate in professional development during their careers. There is vast room to improve this even in countries like the USA where much investment in time and money seems to be wasted.
- **Evidence Based Teaching Standards:** While much evidence is beginning to emerge on what makes great teachers, their training both pre- and in-service does not reflect these best practices for the vast majority of teachers.

Appendix F: Case Studies

1. ASU Online http://asuonline.asu.edu/

ASU Online is a rapidly growing part of Arizona State University which seeks to enroll 100,000 students by 2030. ASU Online was recently ranked by US News as the 11th best online bachelor's degree program in America (http://asuonline.asu.edu/about-us/newsroom/us-news-ranks-asu-top-15-online-bachelors-programs). Anyone in the world can enroll for a degree from ASU Online but outside of the US they warn that: "Several countries will not formally recognize foreign online degrees." The cost of a degree would vary based on your major, pace of study and transfer credits but we estimate it would be ~$50,000.

Mappings to SDG 4:

- **Measure 4.3**: ASU Online contributes directly to increasing enrollment rates for each student it enrolls from a low-enrollment country.
- **Leverage Points 4.3**:
    - **Infrastructure**: Low enrollment countries would not have to build any additional infrastructure to increase enrollment via online education
    - **Qualified faculty**: High quality faculty will not have to be convinced to move out to isolated new campuses
    - **Living Expenses**: Students will be able to live at home and support their household with local work or domestic labor.
    - **Geographic**: Students who live outside of the main cities will have equal access to ASU Online (as long as they have the internet)
- **Leverage Points 4.b**: Although technically not included in the indicator (which only measures ODA flows), ASU or another entity could offer scholarships to students from the countries and degrees called for in Target 4b. Online scholarships would be much cheaper than paying students to travel and live abroad.
- **Relevance to 4.5**: In cultures where the movement of females in public is restricted, ASU Online could be a vehicle for reaching them with post-secondary education.
- **Relevance to 4.7**: As a global leader in sustainability education, ASU Online would offer students not just a degree in sustainability but also the integration of sustainability into many of their other course offerings.

2. Unete http://www.unete.org/

Unete is a Mexican non-profit which seeks to improve the quality of education in Mexico, principally through a focus on equipping schools with computer labs along with the training, support and materials for them to operate effectively. They have received support from this from various entities including Dell who has supported projects through Unete in more than 300 schools around the country. In total they have installed

labs in nearly 8,000 schools reaching 12% of Mexico's primary and secondary public school students. They have also done impact analysis of their program on student achievement.

Mappings to SDG 4:

- **Measure 4.a:** Unete's work directly contributes to two of the measures for target 4.a, schools with computer and internet access. Through their work they have reached 4% of schools in the country (though a higher percentage of students—most likely because there are a lot of very small, rural schools in Mexico). They estimate that of the ~145,000 schools in Mexico, another 50,000 are still lacking functional computers of any kind.
- **Measure 4.1**: One could fairly easily measure both the changes in graduation and the changes on test scores of students with a Unete computer lab, thus measuring directly the difference on target 4.1 which this solution is making.
- **Leverage Points 4.1**: An impact analysis found significant impact on math scores and a bigger impact in primary and more marginalized schools. Other studies have found very mixed results in terms of student improvement after introducing computer learning, enrollment and other metrics. One study found computers to have a positive impact but still found it less cost effective than tutoring and other approaches.
    - **Measure 4.a**: Computer labs are seen as a key input to successful primary and secondary educations
    - **Curriculum**: Unete directly offers new curriculum materials and the combination of computers and internet enables access to an endless amount as well as the streaming of students by need and ability.
    - **Teachers**: A University of Milan study showed that the biggest benefits to student performance from having computers in schools comes through the teachers' use of them to support their teaching.
- **Measure 4.4:** Impact study on 131 schools found a difference in digital skills between students at schools with Unete computer labs and those that didn't have them.
- **Leverage Points 4.4:**
    - **Measure 4.a**
    - **Teacher Skills:** Unete study found increased digital skills among teachers.

3. Close the Gap http://close-the-gap.org/

"Close the Gap is an international non-profit organization that aims to bridge the digital divide by offering high-quality, pre-owned computers donated by large and medium-sized corporations or public organizations to educational, medical, entrepreneurial and social projects in developing and emerging countries." Dell has been collaborating with Close the Gap to donate over 13,000 decommissioned desktops from Rabobank (http://en.community.dell.com/dell-

blogs/direct2dell/b/direct2dell/archive/2015/11/05/discarded-corporate-technologies-are-given-a-new-life-in-africa). This is enough to equip more than 400 computer labs. Other non-profits such as World Computer Exchange (WCE) (http://www.worldcomputerexchange.org/) are similarly trying to give old computers new life.

Mappings to SDG 4:

- **Measure 4.a:** Close the Gap and WCE work with local partners to find homes for computers and so the end use varies widely from project to project. To assess the impact on target 4.a it would be necessary to capture how many of the computers donated from a certain project ended up in how many different schools (and where).
- **Leverage points 4.1 & 4.4:** The installation of computers in schools (4.a) is seen as a key leverage point for achieving targets 4.1 and 4.4.

4. Dell Professional Learning Services for K-12 https://www.dell.com/en-us/work/learn/professional-learning

"Dell Professional Learning Services works with districts to develop customized outcome-based learning programs, incorporating one-on-one instruction, coaching and modeling, and sharing sessions for teachers and district leaders. We align our services to your state's standards, including Common Core or other next generation standards, as well as the International Society for Technology in Education (ISTE) Standards for students, teachers, administrators and coaches. Using proven industry standards as a foundation, Dell consultants draw from three categories of professional learning activities — experiences, training and professional development — to help you create a program that includes a mix of ongoing activities working together to positively impact teaching practices and student learning."

Mappings to SDG 4:

- **Leverage Points 4.c:** Target 4c calls for teachers to meet national standards of per-service and in-service training. This service (and most other similarly ICT-based teacher training initiatives) are focused on in-service training.
- **Leverage Points 4.4 Teachers**: One of the key determinants to students acquiring ICT skills is the capability and preparedness of their teachers.
- **Leverage Points 4.1 Teachers (4.c)**

5. mTaleem SMS Based Literacy Program

http://www.unesco.org.pk/education/mlp.html

UNESCO and the Mobilink Foundation (http://www.mobilinkfoundation.org/education.php) partnered to deploy a mobile phone based literacy program in Pakistan. Thousands of women have participated so far. After taking an in-person literacy class, the women are given a mobile phone and receive

regular text messages on fun and interesting topics which require the participant to respond. These have been built as lessons which together form a post-class curriculum.
Mappings to SDG 4:

- **Leverage Points 4.6:** This project conducts literacy training but some (to many) of the participants may not ultimately achieve long term literacy (the measure)
    - **Mobile Phones:** These devices are ubiquitous among youths and adults even those who are illiterate.
    - **Identifying and Inducing Participants:** Having a mobile phone increased the feeling of security among female participants, showing how participation in these programs could be incentivized with mobile devices. This project also went out to rural villages to run classes in order to reach those in need.
    - **Effective Content and Practices:** The Mobilink Foundation teamed up with UNESCO to create the highest quality literacy content and assure that it was locally appropriate (including that it was in Urdu).
    - **Inequitable Access:** see 4.5
- **Leverage Points 4.5**: The targeting of rural women was purposeful to bridge the inequitable distribution of illiteracy in the country (Pakistan has one of the worst gender imbalances for literacy in the world).

6. Made with Code https://www.madewithcode.com/

This Google-led initiative seeks to get young women excited about learning to code with the explicit goal of closing the gender gap in the tech industry. They seek to inspire girls to see how coding can help them pursue their passions (of any kind). They have launched a website with resources and coding projects as well as connecting youths to communities and mentors online. They are also directly supporting a variety of nonprofit grantees including: *Black Girls Code, Code.Org, NCWIT Aspirations In Computing, Technovation Challenge, Donorschoose.org* and *Girls Who Code*.
Mappings to SDG 4:

- **Leverage Points 4.4:** This project is creating and distributing curriculum but mostly it is seeking to increase the overall ICT skill level by closing the gender gap.
- **Leverage Points 4.5:**
    - **Cultural:** Even in egalitarian countries there is a cultural bias towards male programmers as can be easily seen the way they are represented in film.
    - **Female Teachers/Models:** One of the key goals of the project is to connect girls with female programmer role models.
- **Relevance to 4.3:** One of the main objectives of this project is to increase the number of women enrolling in computer science degree programs in university.

Appendix G: Traffic Light Analysis

As discussed in section 3.1 we developed a traffic light diagram to assist with decision-making on which targets to focus on.

Target	Short Name	The Indicator & the Data	Relevancy of ICT	Magnitude of ICT Impact
4.1	Proficiency of Primary and Secondary students			
4.2	Early Childhood/ Preprimary Enrollment			
4.3	Post- Secondary Education			
4.4	ICT Skills			
4.5	Equal access for all			
4.6	Literacy			
4.7	Sustainable Development Knowledge			
4.a	School Infrastructure			
4.b	Scholarships			
4.c	Qualified Teachers			

A structured judgement was made for each of the criteria for each of the indicators. For the Indicator and the data three criteria were averaged to get the first column. A diagram of those judgements can be found in section 2.1.2 and justifications for each of the judgements for each of the indicators can be found in Appendix D at the end of the analysis for each indicator. The following two charts provide justifications for the rankings on Relevancy and Magnitude columns.

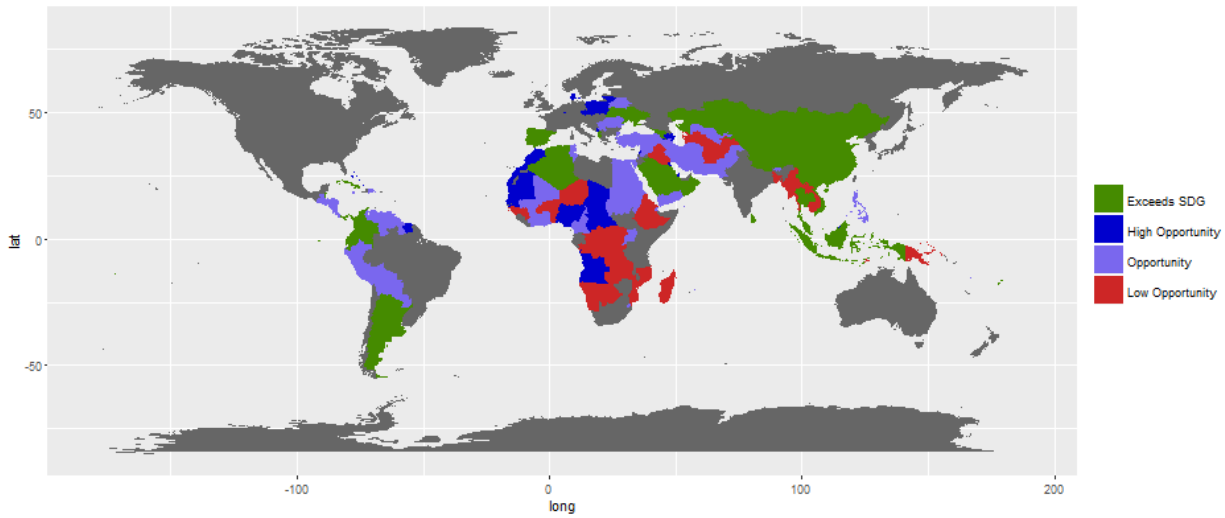
Target	Short Name	Relevancy of ICT	Justification
4.1.1	Proficiency of Primary and Secondary students		Although student performance has been a key justification for the integration of ICT into schools the world over, the evidence of it improving student performance is mixed at best, especially when compared on a cost effectiveness basis. This is not to say that ICT skills and competence are not valuable but so far improvement in other subject areas is not enough to alone justify these programs. One study did show that ICT is most effective when it supports the teacher through access to resources and in class presentations and activities (but was not when the students use the ICT themselves).
4.2.1	Early Childhood Development Index		Early childhood does not appear to be a good target for ICT solutions, in fact it is often not recommended that young children have too much screen time. Unsurprisingly there were not many solutions available in this space..
4.2.2	Preprimary Enrollment		
4.3.1	Post-Secondary Education		ICT looks to be the future of post-secondary education. Fully online education is going to make up an increasing portion of students and even immersive students will be using ICT to do homework, take some classes online or for other services.
4.4.1	ICT Skills		Clearly no progress can be made on this indicator without ICT.
4.5.1	Equal access for all		ICT has the potential to help integrate disadvantaged populations from women to the rural poor in education but ICT is generally more accessible to advantaged populations so without explicit efforts ICT will likely only exacerbate inequalities.
4.6.1	Literacy		Mobile phones provide a possibility for ICT to improve literacy, but only if they are one part of a much bigger non-ICT related project.
4.7.1	Sustainable Development Knowledge		In order to mainstream sustainable development education rapidly, it will be necessary to share resources globally, which ICT could enable. ICT is likely to be as effective in this area as other subjects (see 4.1.1)
4.a.1	School Infrastructure		Two parts of this indicator, computers and internet, are directly ICT but the rest of the parts have little to do with ICT.
4.b.1	Scholarships		Online degrees would seem to present an obvious opportunity to greatly increase the impact of scholarship money but it is not (yet) explicitly included as part of this indicator.
4.c.1	Qualified Teachers		Computer based in-service training has potential to increase qualified teachers but the record so far is not significant.

Target	Short Name	Magnitude of ICT Impact	Justification
4.1.1	Proficiency of Primary and Secondary students		While so far ICT has not produced consistent gains among K-12 students, continued experimentation and evaluation may be pointing the way to approaches such as Computer-Assisted-Learning that could easily be rolled out and create widespread gains across an entire education system.
4.2.1	Early Childhood Development Index		There appears to be little possibility for large scale impact with early childhood.
4.2.2	Preprimary Enrollment		
4.3.1	Post-Secondary Education		The most significant problem post-secondary education faces, is massification—the hundreds of millions of secondary graduates who want to further education but currently have no place to go. It is probably physically impossible to meet this challenge without the extensive use of ICT.
4.4.1	ICT Skills		Clearly no progress can be made on this indicator without ICT.
4.5.1	Equal access for all		ICT has the potential to help integrate disadvantaged populations from women to the rural poor in education but ICT is generally more accessible to advantaged populations so without explicit efforts ICT will likely only exacerbate inequalities.
4.6.1	Literacy		So far there is no evidence that ICT-based programs can have large impacts on reducing illiteracy.
4.7.1	Sustainable Development Knowledge		In order to mainstream sustainable development education rapidly, it will be necessary to share resources globally, which ICT could enable. ICT is likely to be as effective in this area as other subjects (see 4.1.1)
4.a.1	School Infrastructure		Two parts of this indicator, computers and internet, are directly ICT but the rest of the parts have little to do with ICT.
4.b.1	Scholarships		Online degrees would seem to present an obvious opportunity to greatly increase the impact of scholarship money but it is not (yet) explicitly included as part of this indicator.
4.c.1	Qualified Teachers		Currently teacher education has a poor reputation the world over. If one could develop an effective ICT-based model for pre-service or in-service training, the ability to cheaply replicate it at scale would be enormously impactful.

Appendix H: ICT Opportunity Index

The indicators are rescaled to range from $1/n_d$ to 1 where n_d is the number of countries with data for that particular indicator. The ICT Opportunity Index is than created by taking the Rescaled Internet Access Indicator and dividing it by the Rescaled Indicator of interest. The higher the number that results the more people are accessing the internet in that country compared to the indicator of interest (relative to the rest of the world). In order to make the ICT Opportunity Index results were divided into three groups, High Opportunity=Top 25%, Opportunity=Middle 50%, and Low Opportunity=Bottom 25%.

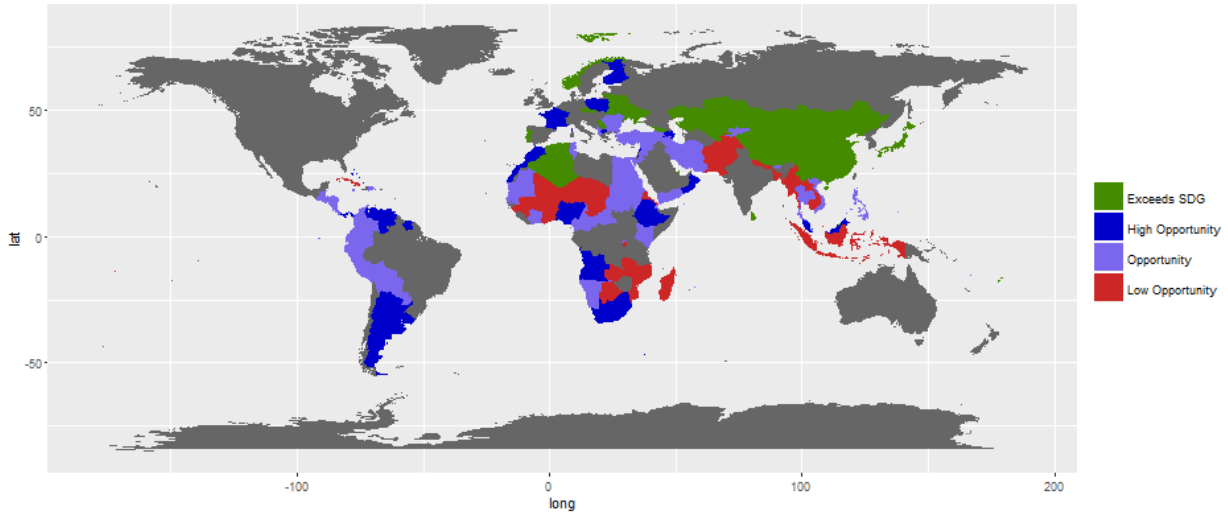
Indicator 4.1.1 Primary Graduation (%)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Primary Graduation (%)	Internet Access (%)
Senegal	Low Human Development	12.01877	22.33341	17.7
Mauritania	Low Human Development	3.435345	23.91544	10.7
Chad	Low Human Development	2.662946	21.64667	2.5
Lebanon	High Human Development	1.54664	70.01833	74.7
Central African Republic	Low Human Development	1.519105	23.26667	4.03
Luxembourg	Very High Human Development	1.382776	90.63339	94.67
Bahrain	Very High Human Development	1.318719	91.17227	90.99998
Angola	Low Human Development	1.318354	37.01685	21.26
Qatar	Very High Human Development	1.305913	92.24603	91.49
Liechtenstein	Very High Human Development	1.294241	95.83333	95.21
Denmark	Very High Human Development	1.239699	99.77603	95.99
Czech Republic	Very High Human Development	1.032283	99.48038	79.71
Barbados	High Human Development	1.02457	97.03357	76.67
Kuwait	Very High Human Development	1.012798	99.97155	78.7
Bahamas	High Human Development	0.9898343	99.96514	76.92
Lithuania	Very High Human Development	0.9870813	95.21604	72.13
Hong Kong	Very High Human Development	0.9671069	99.32491	74.56
Azerbaijan	High Human Development	0.9359858	87.09692	61

Saint Kitts and Nevis	High Human Development	0.9285672	92.47881	65.4
Suriname	High Human Development	0.908051	65.54054	40.08
Brunei Darussalam	Very High Human Development	0.8932741	99.17187	68.77
Poland	Very High Human Development	0.8775658	98.04117	66.6
Nigeria	Low Human Development	0.8658278	70.79452	42.68
Trinidad and Tobago	High Human Development	0.8627341	97.58736	65.1
Montenegro	Very High Human Development	0.8311293	95.45283	61
Morocco	Medium Human Development	0.8118086	91.9296	56.8

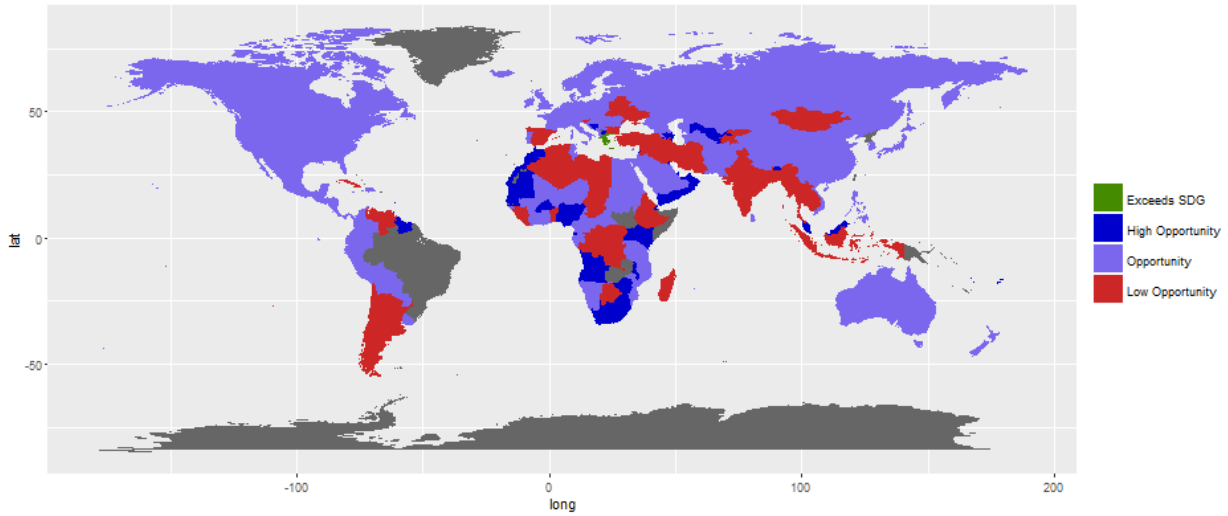
Indicator 4.1.1 Secondary Graduation (%)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Secondary Graduation (%)	Internet Access (%)
Ethiopia	Low Human Development	3.137243	1.10278	2.9
Lebanon	High Human Development	2.251117	39.32621	74.7
South Africa	Medium Human Development	1.780936	32.53068	49
Morocco	Medium Human Development	1.415339	47.42844	56.8
Suriname	High Human Development	1.361012	34.73153	40.08
Nigeria	Low Human Development	1.20048	41.92243	42.68
France	Very High Human Development	1.151157	86.06122	83.75
Finland	Very High Human Development	1.126774	97.01123	92.38
Panama	High Human Development	1.072944	49.36209	44.92
Angola	Low Human Development	1.011662	24.57946	21.26
Bahamas	High Human Development	0.982338	92.5666	76.92
Swaziland	Low Human Development	0.965852	32.91403	27.1
Venezuela, Bolivarian Republic of	High Human Development	0.9635476	69.82771	57
Hong Kong	Very High Human Development	0.9477384	92.98342	74.56
Malaysia	High Human Development	0.9442475	84.45114	67.5
Macedonia, the former Yugoslav Republic of	High Human Development	0.9411481	85.43497	68.06
Antigua and Barbuda	High Human Development	0.9283837	81.41593	64
Uruguay	High Human Development	0.9195806	78.9148	61.46
Palestine, State of	Medium Human Development	0.885038	71.53946	53.67

Argentina	Very High Human Development	0.8757616	87.24584	64.7
Oman	High Human Development	0.8635451	96.06541	70.22
Azerbaijan	High Human Development	0.8554605	84.1778	61
Saint Vincent and the Grenadines	High Human Development	0.8538367	78.05362	56.48
Poland	Very High Human Development	0.833508	94.3653	66.6

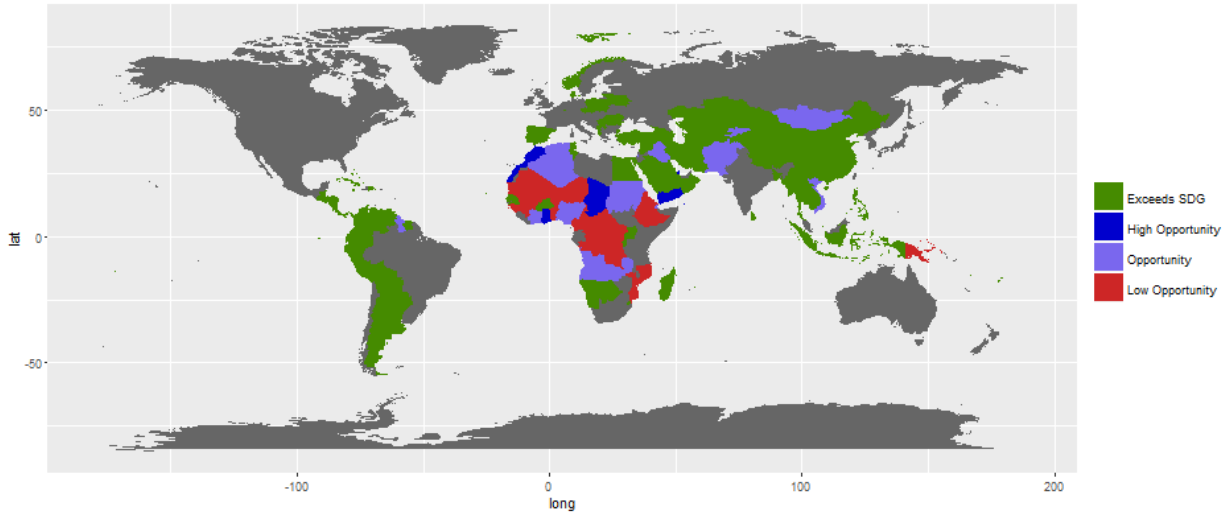
Indicator 4.3.1 Tertiary Enrollment (%)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Tertiary Enrollment (%)	Internet Access (%)
Kenya	Low Human Development	12.46596	4.04682	43.4
Seychelles	High Human Development	9.613301	6.4694	54.26
Malawi	Low Human Development	9.605898	0.79773	5.83
Tonga	High Human Development	7.202991	6.3486	40
Equatorial Guinea	Medium Human Development	6.755165	3.23475	18.86
Qatar	Very High Human Development	6.543384	15.83137	91.49
Trinidad and Tobago	High Human Development	6.176443	11.95117	65.1
Swaziland	Low Human Development	5.811572	5.32888	27.1
Uzbekistan	Medium Human Development	5.555766	8.90016	43.55
Luxembourg	Very High Human Development	5.513196	19.40741	94.67
Nigeria	Low Human Development	4.643129	10.40532	42.68
United Arab Emirates	Very High Human Development	4.629948	22.03907	90.4
Vanuatu	Medium Human Development	4.511442	4.7444	18.8
Uganda	Low Human Development	4.499918	4.48339	17.71
Maldives	High Human Development	4.369453	12.74713	49.28
Zimbabwe	Low Human Development	3.834776	5.87175	19.89
Suriname	High Human Development	3.573062	12.65156	40.08
Bhutan	Medium Human Development	3.548264	10.92693	34.37
St. Lucia	High Human Development	3.40872	16.86029	51
Guyana	Medium Human Development	3.373007	12.48062	37.35
Kuwait	Very High Human Development	3.279605	27.02705	78.7
Samoa	High Human Development	3.157363	7.56238	21.2
Bosnia and Herzegovina	High Human Development	3.096262	22.10831	60.8
Antigua and Barbuda	High Human Development	3.067807	23.48624	64

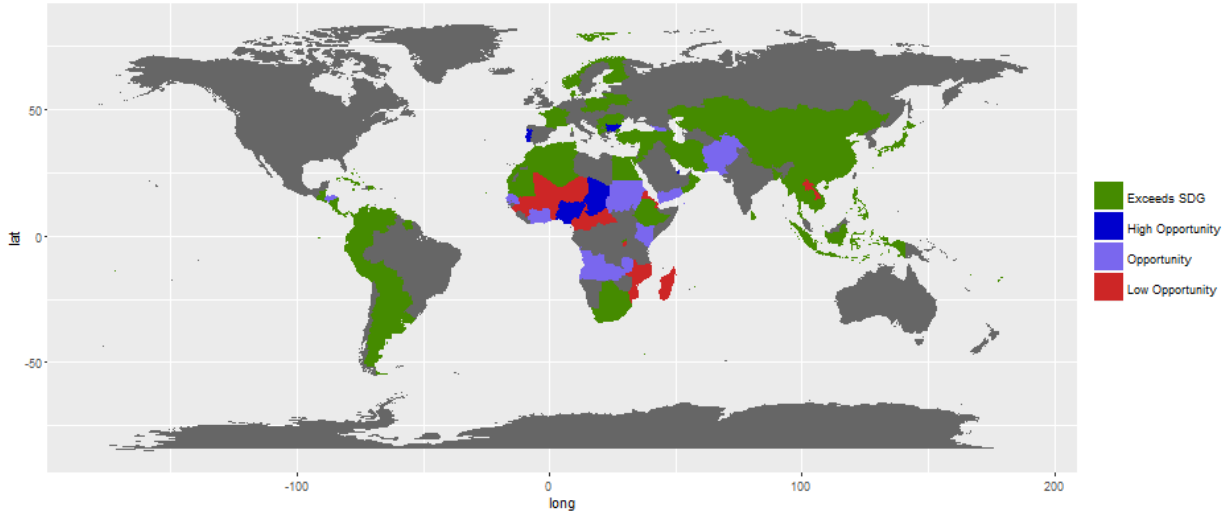
Azerbaijan	High Human Development	2.964456	23.15973	61
Fiji	High Human Development	2.914399	16.1371	41.8
Sao Tome and Principe	Medium Human Development	2.812704	9.75327	24.41
South Africa	Medium Human Development	2.803144	19.66282	49
Bahrain	Very High Human Development	2.779823	36.83768	90.99998
Oman	High Human Development	2.764757	28.57509	70.22
Senegal	Low Human Development	2.687195	7.38946	17.7
Morocco	Medium Human Development	2.599117	24.57194	56.8
Yemen, Rep.	Low Human Development	2.535638	9.9746	22.55
Liechtenstein	Very High Human Development	2.52016	42.49668	95.21
Brunei Darussalam	Very High Human Development	2.437015	31.72534	68.77
Angola	Low Human Development	2.400003	9.92357	21.26
Djibouti	Low Human Development	2.394608	4.98506	10.71
Micronesia, Fed. Sts.	Medium Human Development	2.354888	14.12186	29.65
Burkina Faso	Low Human Development	2.183152	4.77591	9.4
Mauritania	Low Human Development	2.175401	5.46516	10.7
Malaysia	High Human Development	1.967303	38.53282	67.5
Lebanon	High Human Development	1.961792	42.77283	74.7
Macedonia, FYR	High Human Development	1.942327	39.35075	68.06

Indicator 4.5.1 Primary Graduation, Gender Parity Index (GPI)



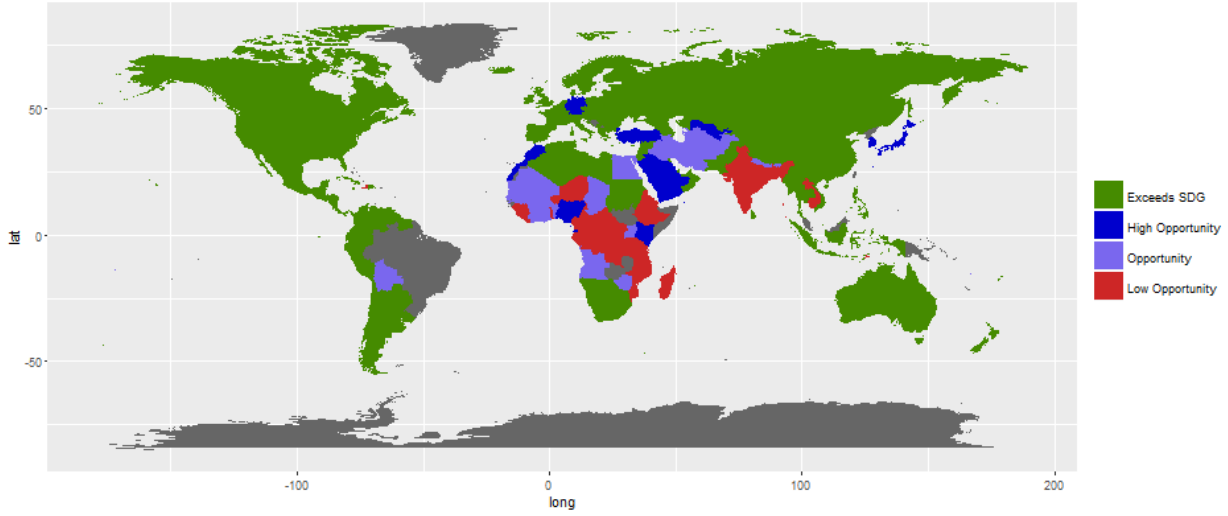
High Opportunity Countries	HDI Level	ICT Opportunity Index	Primary Graduation GPI	Internet Access (%)
Chad	Low Human Development	2.621338	0.57142	2.5
Qatar	Very High Human Development	2.429729	0.88707	91.49
Antigua and Barbuda	High Human Development	2.022675	0.835	64
Dominica	High Human Development	1.371468	0.95617	62.86
Ghana	Medium Human Development	1.355357	0.68176	18.9
Yemen	Low Human Development	1.320784	0.7086	22.55
Morocco	Medium Human Development	1.258877	0.94976	56.8
Seychelles	High Human Development	1.251017	0.93471	54.26
Saint Vincent and the Grenadines	High Human Development	1.217387	0.96062	56.48

Indicator 4.5.1 Secondary Graduation, Gender Parity Index (GPI)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Secondary Graduation GPI	Internet Access (%)
Qatar	Very High Human Development	2.936592	0.84424	91.49
Chad	Low Human Development	2.517317	0.38826	2.5
Antigua and Barbuda	High Human Development	1.481408	1.02384	64
Dominica	High Human Development	1.444834	1.02832	62.86
Morocco	Medium Human Development	1.297598	1.03179	56.8
Nigeria	Low Human Development	1.282123	0.87336	42.68

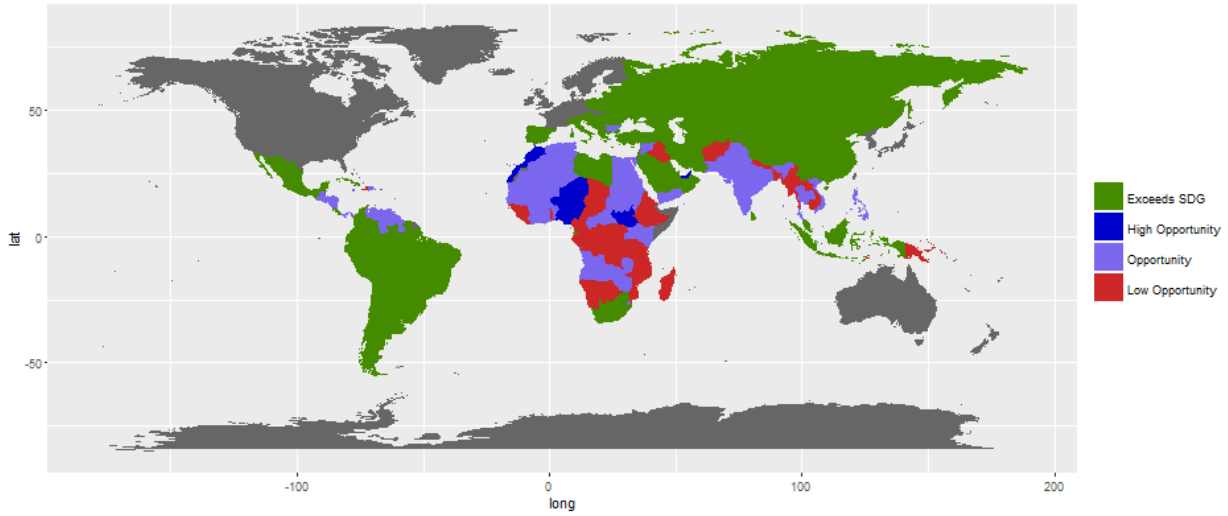
Indicator 4.5.1 Tertiary Enrollment, Gender Parity Index (GPI)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Tertiary Enrollment (GPI)	Internet Access (%)
Liechtenstein	Very High Human Development	15.2387	0.55308	95.21
Korea, Rep.	Very High Human Development	8.920203	0.75367	84.33

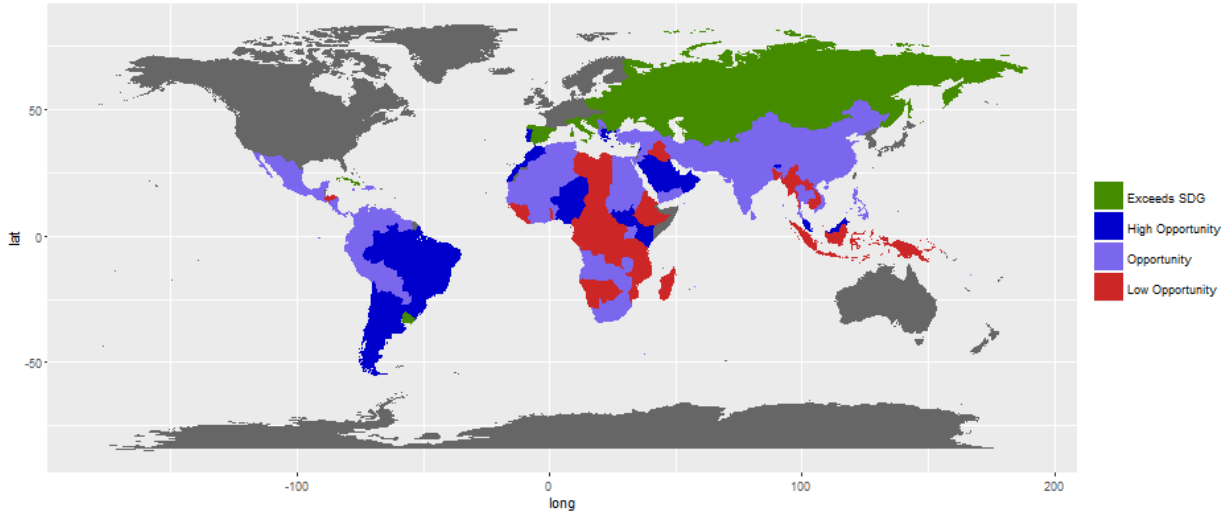
Japan	Very High Human Development	7.551935	0.91311	90.58
Germany	Very High Human Development	7.093902	0.92266	86.19
Uzbekistan	Medium Human Development	5.642213	0.64244	43.55
Kenya	Low Human Development	4.994953	0.70288	43.4
Saudi Arabia	Very High Human Development	4.988458	0.95994	63.7
Yemen, Rep.	Low Human Development	4.959547	0.44191	22.55
Nigeria	Low Human Development	4.778885	0.71787	42.68
Turkey	High Human Development	4.569828	0.85857	51.04
Morocco	Medium Human Development	4.433119	0.96192	56.8
Equatorial Guinea	Medium Human Development	4.053911	0.44723	18.86

Indicator 4.6.1 Youth Literacy (%)



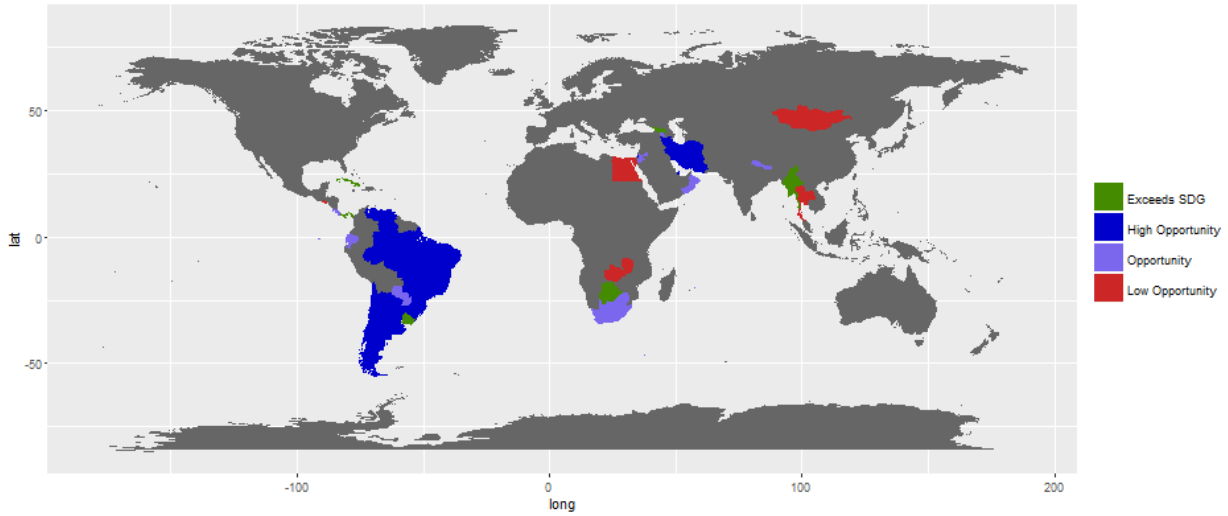
High Opportunity Countries	HDI Level	ICT Opportunity Index	Youth Literacy (%)	Internet Access (%)
Niger	Low Human Development	2.245804	23.52378	1.95
United Arab Emirates	Very High Human Development	0.9844102	95.00645	90.4
South Sudan	Low Human Development	0.8878987	36.70227	15.9
Nigeria	Low Human Development	0.7669385	66.38354	42.68
Morocco	Medium Human Development	0.758864	81.51007	56.8

Indicator 4.6.1 Adult Literacy (%)



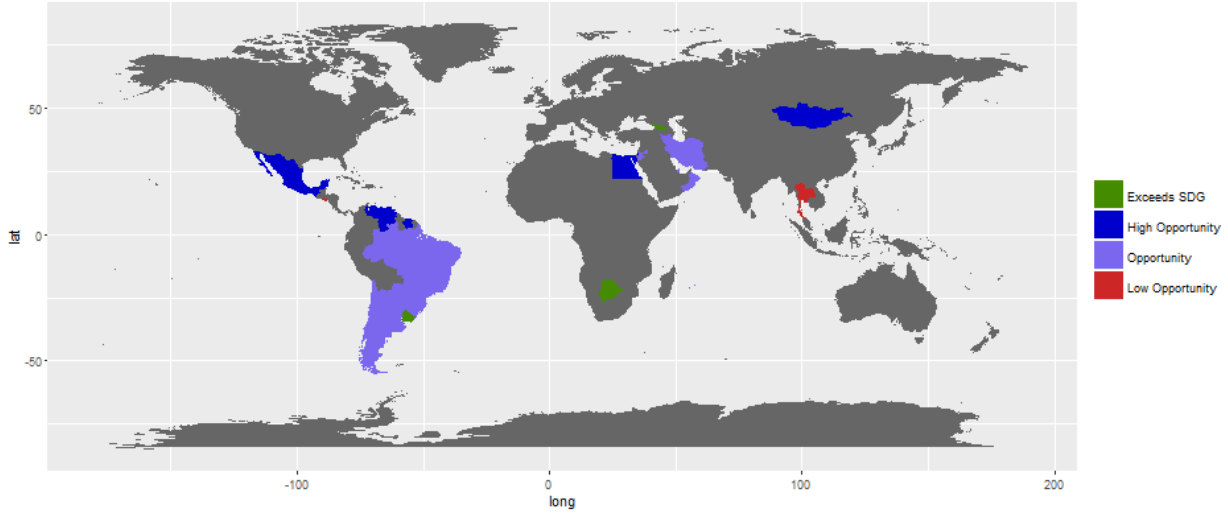
High Opportunity Countries	HDI Level	ICT Opportunity Index	Adult Literacy (%)	Internet Access (%)
Niger	Low Human Development	2.245804	15.4567	1.95
South Sudan	Low Human Development	1.123907	26.83128	15.9
United Arab Emirates	Very High Human Development	1.041372	90.03384	90.4
Nigeria	Low Human Development	1.01488	51.07766	42.68
Bahrain	Very High Human Development	0.9888087	94.55679	90.99998
Qatar	Very High Human Development	0.9558901	97.74669	91.49
Morocco	Medium Human Development	0.9390742	67.08416	56.8
Singapore	Very High Human Development	0.8688803	96.54015	82
Lebanon	High Human Development	0.8644211	89.61244	74.7
Kuwait	Very High Human Development	0.8435713	95.58582	78.7
Malta	Very High Human Development	0.8067176	93.30736	73.17
Oman	High Human Development	0.7872971	91.9812	70.22
Bhutan	Medium Human Development	0.7777642	52.81469	34.37
Chile	Very High Human Development	0.7645167	96.70301	72.35
Malaysia	High Human Development	0.7456038	93.11788	67.5
Brunei Darussalam	Very High Human Development	0.7319647	96.08556	68.77
Macedonia, the former Yugoslav Republic of	High Human Development	0.7107962	97.63467	68.06
Portugal	Very High Human Development	0.7010565	94.47705	64.59
Saudi Arabia	Very High Human Development	0.6917667	94.42635	63.7
Argentina	Very High Human Development	0.6727062	97.97376	64.7
Greece	Very High Human Development	0.6610811	97.47356	63.21
Kenya	Low Human Development	0.6523037	72.15703	43.4
Brazil	High Human Development	0.6490384	91.48424	57.6

Indicator 4.a.1 Computers for Pedagogical Purposes (%)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Computers (%)	Internet Access (%)
Venezuela, Bolivarian Republic of	High Human Development	20.8324	48	57
Qatar	Very High Human Development	4.157779	58.5	91.49
Maldives	High Human Development	2.326748	58	49.28
Brazil	High Human Development	1.331851	70	57.6
Iran, Islamic Republic of	High Human Development	1.15158	65	39.35
Argentina	Very High Human Development	1.019746	81	64.7
Chile	Very High Human Development	1.009472	85.5	72.35
Palestine, State of	Medium Human Development	1.004903	75.5	53.67
Dominica	High Human Development	0.9763781	81.5	62.86

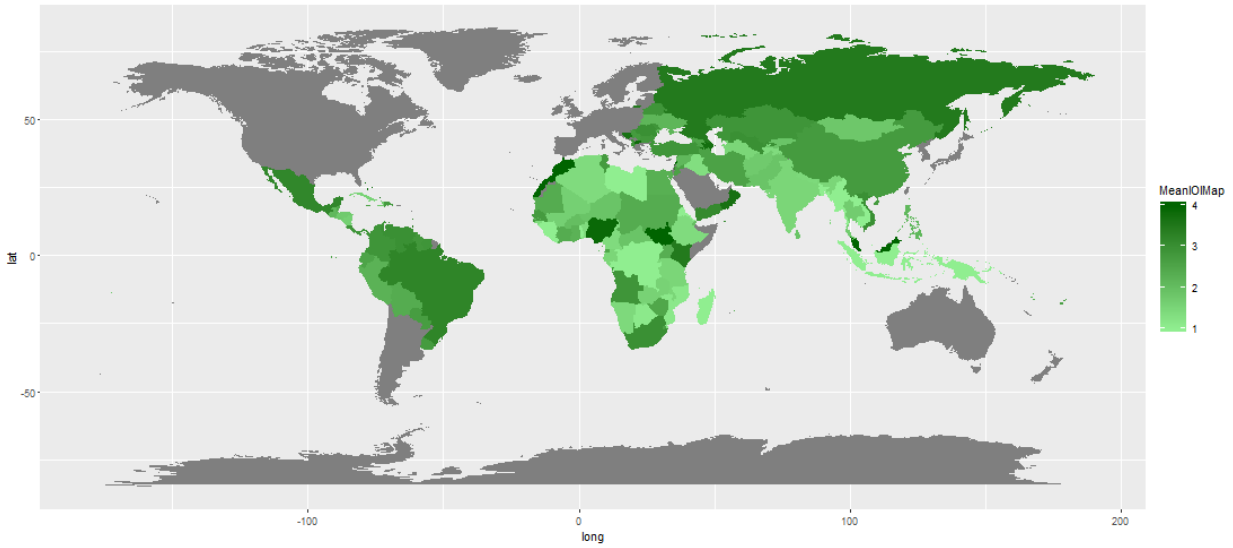
Indicator 4.a.1 Computers with Internet (%)



High Opportunity Countries	HDI Level	ICT Opportunity Index	Internet (%)	Internet Access (%)
Venezuela, Bolivarian Republic of	High Human Development	4.858481	29	57
Palestine, State of	Medium Human Development	4.345945	29.5	53.67
Egypt	Medium Human Development	8.312241	22.5	31.7
Mongolia	High Human Development	1.609578	33	27
Mexico	High Human Development	1.603437	42	44.39
Suriname	High Human Development	1.228638	46	40.08

Countries with the greatest potential for ICT impact on SDG 4 overall according to the IOI

By combining the IOI ratings for each indicator, a list of the countries with the overall greatest potential for ICT impact on SDG 4 could be calculated. The following procedure was followed to calculate this. 1) For each indicator, countries have been grouped by quarters. When the mean of all those groupings was taken across all 10 of the indicators it was possible to calculate the IOI for. A score of 4 would mean that the country was a high opportunity for every IOI that was calculated for it. 2) Very high development countries were dropped from the list as well as countries which had an IOI for fewer than 50% of the indicators. The map shows the countries of greatest potential in darkest green and the table lists the top 25.



Countries	HDI Level	Internet Access (%)
Lebanon	High Human Development	74.7
Malaysia	High Human Development	67.5
Morocco	Medium Human Development	56.8
Nigeria	Low Human Development	42.68
Macedonia	High Human Development	68.06
Azerbaijan	High Human Development	61
Antigua and Barbuda	High Human Development	64

Trinidad and Tobago	High Human Development	65.1
Oman	High Human Development	70.22
Kenya	Low Human Development	43.4
Saint Vincent and the Grenadines	High Human Development	56.48
Dominica	High Human Development	62.86
Mexico	High Human Development	44.39
Palestine	Medium Human Development	53.67
Yemen	Low Human Development	22.55
Maldives	High Human Development	49.28
Albania	High Human Development	60.1
Barbados	High Human Development	76.67
Romania	High Human Development	54.08
Seychelles	High Human Development	54.26
South Africa	Medium Human Development	49
Saint Lucia	High Human Development	51
Uzbekistan	Medium Human Development	43.55
Venezuela	High Human Development	57
Viet Nam	Medium Human Development	48.31