

KNOWLEDGE PACK

Devices for Education



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DEVICES FOR EDUCATION

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1818 H Street NW, Washington, DC 20433
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Design : Alejandro Scaff, Sarah Kleinmann



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Introduction

What is a KP ?

Knowledge Packages (KPs) are short, pragmatic guides on individual topics within EdTech, meant to provide sufficient knowledge and understanding so that non-technical stakeholders can make key planning, design, and procurement decisions for education.

They can be used as a starting point for the planning of technology deployment to improve education, especially with education ministries.

About this KP

Devices are a part of a broader EdTech Program Framework and should always be considered an element of the solution that includes adequate software, incentives, policies and training (see [annexes](#) for references).

This KP focuses on:

- **Personal computers:** desktop, laptop, 2-1's, tablet
- **Display:** interactive whiteboards, TV's, video projectors, web-cameras, cameras, smart / interactive screens, Smart Tables
- **Servers:** thin client school servers, school and classroom servers

Additional acknowledgement

We would also like to thank the contribution from several external entities namely Absolute Software, Critical Links, Inforlandia, Intel, Microsoft, JPIK, Mustek and Plan Ceibal who shared their expertise and experience in this topics.

WHO are the main stakeholders ?



KPs are designed with a **human-centered vision**.

This knowledge pack is meant to provide sufficient knowledge and understanding to help decisionmakers make key planning, design, and procurement decisions of technologies for personalized and adaptive learning.

Task Team Leaders (TTL's) & Bank Project Managers
(non-technical)



- Assist MOE leadership in the application of KPs for in-country EdTech programs. Help design Bank-financed projects with practical information to include in project documents.

MOE Leadership
(non-technical)



- Use KP to make key planning, design, and procurement decisions for in-country EdTech programs.

MOE Program Managers
(semi-technical)



- Use KP to make key planning, design, and procurement decisions for in-country EdTech programs.

Donors, NGOs and Other Partners
(non-technical)



- Use KP to align with Bank EdTech programs and establish a common EdTech framework.

RESPONSIBILITY

WHY is this KP designed ?

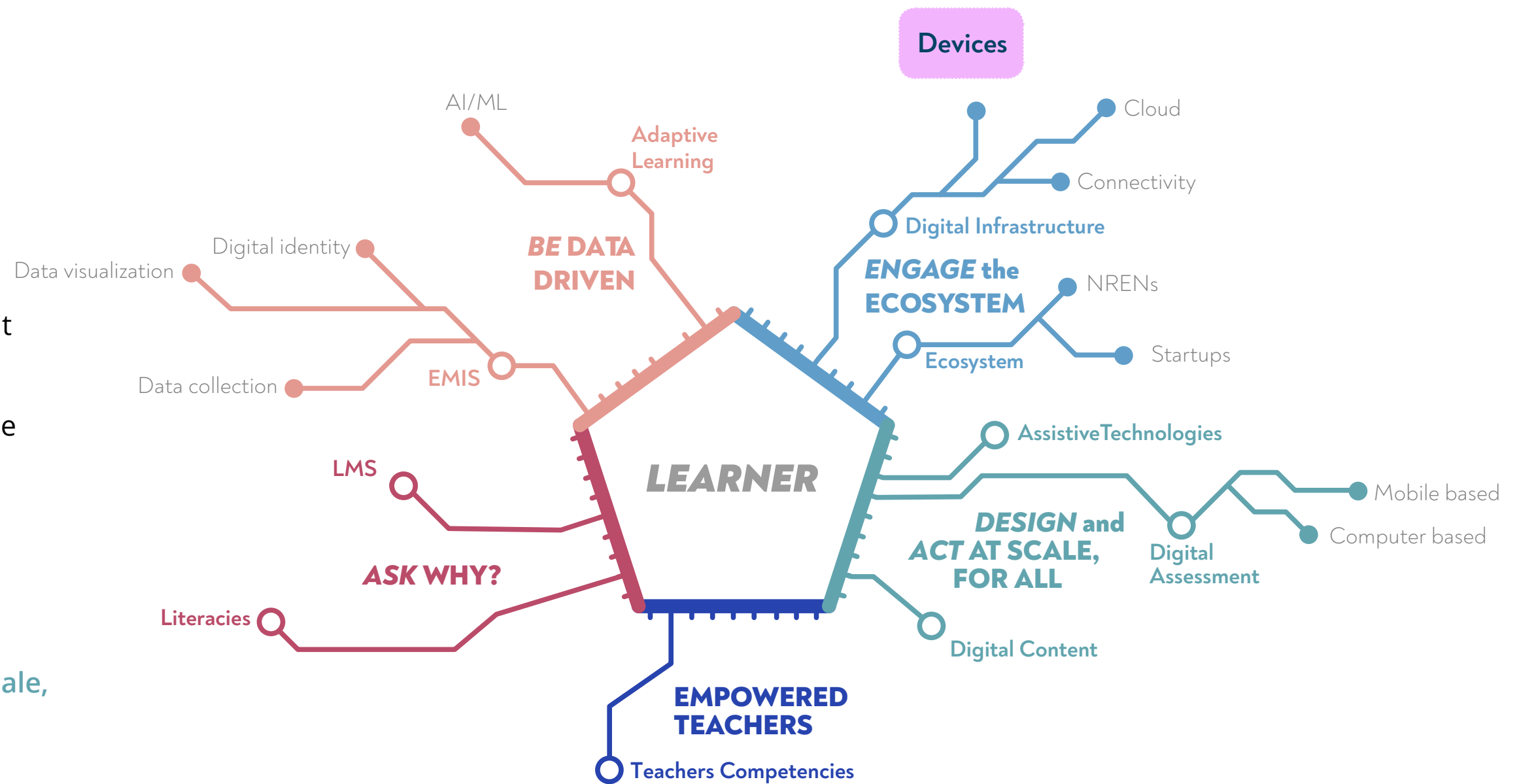
PROBLEM STATEMENT

Edtech should respond to a vision and goals for education. For example: **increase access to education, improve quality, ensure equity and be relevant.**

Providing devices should always be considered an element of the solution to improve learning and not a goal on its own, as it has been demonstrated that solely distributing devices without adequate software, incentives, policies and training to enable a pre-defined use case can be detrimental to learning.

Devices are part of a much bigger network of EdTech interventions guided by 5 principles:

- 1) A clear purpose and focus on educational objectives – **Ask Why**
- 2) Reaching all learners – **Design and Act at Scale, for All**
- 3) **Empowering teachers**
- 4) **Engaging an ecosystem of partners**
- 5) Using data rigorously and routinely to learn what strategies, policies and programs are effective to maximize student learning – **Be Data Driven**



WHY is this KP designed ?

USE CASE SCENARIOS

The question: what are the vision and the goals for your country education system? should always be preliminary to the question: what is the role of devices in materializing the vision?

Therefore, here are examples of use cases in terms of devices, that are connected to predefined goals and objectives:

Goal	Objectives	Use Case Scenarios
Increase Access	<ul style="list-style-type: none"> -Enroll out-of-school youth and promote attendance -Ensure continuity of Learning/ Remote Learning -Build a flexible and resilient education system -Drive completion of assessments & graduation rates 	<ul style="list-style-type: none"> -Teachers can i) create/ curate and deliver content, ii) assess student learning, iii) access professional development & support (coaching, mentoring) -Students can i) access learning content, ii) seek support from teachers, iii) communicate and collaborate with peers, iv) participate in regular assessments -Administrators can i) track student enrollment, attendance & performance, ii) communicate with students, teachers & parents
Improve Quality	<ul style="list-style-type: none"> -Manage class sizes -Increase student engagement -Increase % of Basic literacy to reduce learning poverty -Develop teacher skills and competencies -Increase Internet access and bandwidth -Safety, security and privacy 	<ul style="list-style-type: none"> -Teachers can i) have access to and use guided/ scripted lesson plans, ii) determine the right level of students, iii) conduct regular assessments, iv) create additional learning aids/ content, v) track student achievement, vi) communicate with parents -Students can i) access additional practice & learning resources at school & at home, ii) access support and instruction that is adapted and personalized to the child's level

WHY is this KP designed ?

USE CASE SCENARIOS

Rest of the previous table :

Goal	Objectives	Use Case Scenarios
<p>Ensure Equity</p>	<ul style="list-style-type: none"> -Support learning in rural/ poor communities -Inclusion (children with learning disabilities) -Increase girls' attendance and completion of school -Reduce the digital Divide – access to learning technologies 	<ul style="list-style-type: none"> -Teachers can support learning in the classroom and remotely even in remote areas -i) Students in low income and poor infrastructure conditions have access to learning technologies, ii) Technology is designed and implemented to support students with learning disabilities, iii) Girls are given access and encouraged to use technology to learn even when unable to attend school. -Administrators can i) use data to improve decision making, ii) improve distribution and usage of technology resources, iii) increase access to learning support technologies
<p>Be Relevant</p>	<p>Learning experiences develop:</p> <ul style="list-style-type: none"> -Digital skills -Communication based -Critical Thinking -Creativity -Competency -Digital content 	<ul style="list-style-type: none"> -Teachers can i) implement project based / Experiential learning, ii) Develop more engaging STEM lessons, iii) Learn different pedagogical uses of technology to transform the learning process -Students can i) access rich digital learning materials, ii) engage with personalized learning platforms, iii) participate in remote learning project-based lessons

WHY is this KP designed ?

USE CASE SCENARIOS

We can also explore solutions driven by use case scenarios :

Use Case Scenario	Description & Characteristics	Solution (example)
Management and Administration	<ul style="list-style-type: none"> -Used for administrative purposes by administrator & teachers -Not used by students 	<ul style="list-style-type: none"> -Desktop, Laptop / 2-1, in Admin offices -Tablet / Smartphone for data collection -Server for local storage of data & applications
Teaching & Professional Development	<ul style="list-style-type: none"> -Teachers use devices for lesson planning, delivery & professional development -Teacher can use device at home, in the office, or in classroom with students (with display device) -Device can be brought home or fixed in classroom -Students typically have no access 	<ul style="list-style-type: none"> -Each teacher assigned a mobile device -Teachers share a few mobile devices which can be in teachers' office and used in the classroom with a display device -Teachers use devices fixed in each classroom with display device
Learning	<ul style="list-style-type: none"> -Students use devices to access learning at home or at school -Students have access to the device either in a shared (same device used by several students) or assigned (device used by only one student) mode. 	<ul style="list-style-type: none"> -Each student owns or has assigned a mobile device to be used in the classroom and at home -Students use mobile devices (shared or 1:1) in the classroom -Students go to a PC Lab

WHY is this KP designed ?

USE CASE SCENARIOS

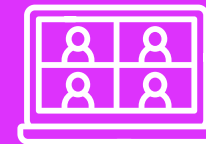
DEVICES IN HYBRID LEARNING SCENARIOS

Indeed, the relevance of solutions deployed depends on the context. For example, a lot of parameters change from a device perspective when we compare remote and classroom learning:



Classroom learning (inside the school)

- Devices can be recharged in school (when electricity is available)
- Storage and security can be provided by the school
- Teachers can control adequate usage of device using classroom management
- Access to content can be done through the school internet access or local content server
- Maintenance and repairs can be done in the school
- Replacement devices can be made available



Remote Learning (outside of the school)

- Student takes device home
- Charging happens at home
- Requires video conferencing capabilities (webcam, microphone, speakers) for synchronous learning
- Access to online content and device management require home connectivity
- Increased maintenance and user-support complexity and costs
- In certain families, student access to the device might be restricted

WHY is this KP designed ?

EVIDENCE

- **Devices are a window into a world of knowledge and information, they enable accessing high quality educational content and instruction that would not be available otherwise (Bold et al. 2017; Fredriksen, Brar, and Trucano 2015)**
- **They level the learning ground, and increasing the number of hours invested in learning (Filmer et al. 2020)**
- **They allow students to reach their full potential by:**
 - Motivating learners to engage more deeply with educational content (Habyarimana and Sabarwal 2018)
 - Enabling individualized instruction and allowing students to learn at their own pace (Duflo, Dupas, and Kremer 2015; Banerjee et al. 2016)
 - Personalizing Learning from the environment perspective, as learners can change personalize the environment to suit their learning preferences
- **Technology is not a luxury or purely a cost. It is as fundamental as other resources⁽¹⁾ (building, electricity, sanitation) and broadly used in business and homes. Schools should not be an exception.**
- **Research⁽¹⁾ shows that improved learning outcomes are dependent on choosing the right technology**
- **Devices facilitate teaching and learning continuity and flexibility (including in hybrid and remote learning models)**

⁽¹⁾ New global data reveal education technology's impact on learning - McKinsey 2020
A Systematic Review of One-to-One Access to Laptop Computing in K-12 Classrooms: An Investigation of Factors That Influence Program Impact - Edward C. Bethel 2014

WHAT are the potential solutions?

DEVICES SELECTION CRITERIA

The right computing device should be chosen based on the level technological readiness of the education system, to use case scenarios it needs to support and the current level of technology integration. This section highlights the key aspect that need to be considered to chose the optimal device.

Aspect	Technical Considerations
Hardware technical specifications that support the usage model	How will you minimize the number of different SKU's (product models and versions) over the lifetime of the project to reduce maintenance costs (stock of different parts and firmware updates) ?
Form factor	What is the most appropriate form factor for the user and use cases? Mobile? Touch? Screen size?
Connectivity and I/O	What connectors will be needed? How are the usage policies enforced (do I accept pen drives or not?) ?
Software stack to be installed - software image and applications compatibility	How many software images will you have to handle? how will you update the software stack over time to ensure latest versions are available to the users and compatibility is ensured?
Embedded or external peripherals required to support the usage model	Does it require card or biometric readers, webcams, digital pens, etc ?
Safety and ruggedness	Is the device well suited for the type of usage (age groups, etc.)? Is it robust and shock-resistant? Is it safe for the user? How is device usage policy implemented (access to content, etc.)?
Storage and charging	How will devices be charged? Stored? Device's power (watts) requirements (Solar versus grid)? Voltage?
Security	How will the device be protected mechanically (theft) and digitally (cyber-security, viruses, malware)?
Privacy	How will user information be kept safe and private?
Maintenance	How will maximum uptime for all devices be ensured? Who will provide maintenance? SLA's? At what cost? How will the device be managed and updated?

WHAT are the potential solutions?

DEVICES SELECTION CRITERIA

WHAT IS THE BEST DEVICE FOR EACH TYPE OF USE CASE SCENARIO?

Education Objective	Use case scenarios	Mobile					Portable	Stationary		Desktop
		Smart phone	Tablet	Laptop	2 in 1	Chrome book*	Portable All-in-One	All-in-One	Thin Client / Mini PC	
Management & Administration	Data collection, processing	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
	Online learning & support	Optimal	Optimal	Optimal	Optimal	Optimal	Lacks mobility			
Teacher PD	Using scripted lessons	Inadequate	Optimal	Optimal	Optimal	Optimal	All content for all teachers has to be preloaded on all PC's			
	Developing digital content	Inadequate	Inadequate	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
Numeracy and reading skills	Reading	Optimal	Headphones	Headphones	Headphones	Headphones	Requires Headphones			
	Writing	Optimal	+Stylus	Touch	+Stylus	+ Design Pad / touch screen				
	Mathematics	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
Remote Learning	Video conferencing	Optimal	Inadequate	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
	Collaboration	Inadequate	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
	Drawing / handwriting	Optimal	+Stylus	Touch screen	+Stylus	+ Touch Screen / a Design Pad				
	Submitting Assignments	Inadequate	Inadequate	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
Digital Skills	Basic / intermediate ICT Skills	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
	Adv. Digital skills/ Coding / AI	Inadequate	Inadequate	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
21st Century Skills/ Higher Order Thinking	STEM Projects	Optimal	Optimal	Requires extra SW, probes & sensors			Optimal	Optimal	Optimal	Optimal
	Digital content creation	Inadequate	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal
	Personalized eLearning	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal	Optimal

● Optimal
 ● Limited
 ● Inadequate

WHAT are the potential solutions?

DEVICES SELECTION CRITERIA

MOST IMPORTANT DEVICES FEATURES FOR EACH LEVEL OF TECHNOLOGICAL READINESS?

	No Electricity	Unreliable Electricity	Reliable Electricity
No Internet (Satellite only)	Mobile, low power, large battery capacity, large storage	Mobile, low power, average battery capacity, large storage	Unlikely scenario
Mobile (3G) only	Mobile, low power, large battery capacity, large storage	Mobile, low power, average battery capacity, large storage, 3G optional	Average power, average battery capacity, low storage, 3G optional
Fixed (DSL / Fiber) and High-speed Mobile (4/5G)	Unlikely scenario	Low power, average battery capacity, low storage, 4G optional	Average power, average battery capacity, low storage, 4G optional

WHAT are the potential solutions?

DEVICES SELECTION CRITERIA

WHAT IS THE RIGHT DEVICE GIVEN THE LEVEL OF TECHNOLOGICAL INTEGRATION? 1/2

Level of technology integration: Latent opportunistic (start ramp)
Few devices deployed

ADMINISTRATIVE PC

Computer used for administrative purposes



Desktop or Laptop
+ Internet access

CLASSROOM / TEACHER PC + PROJECTOR

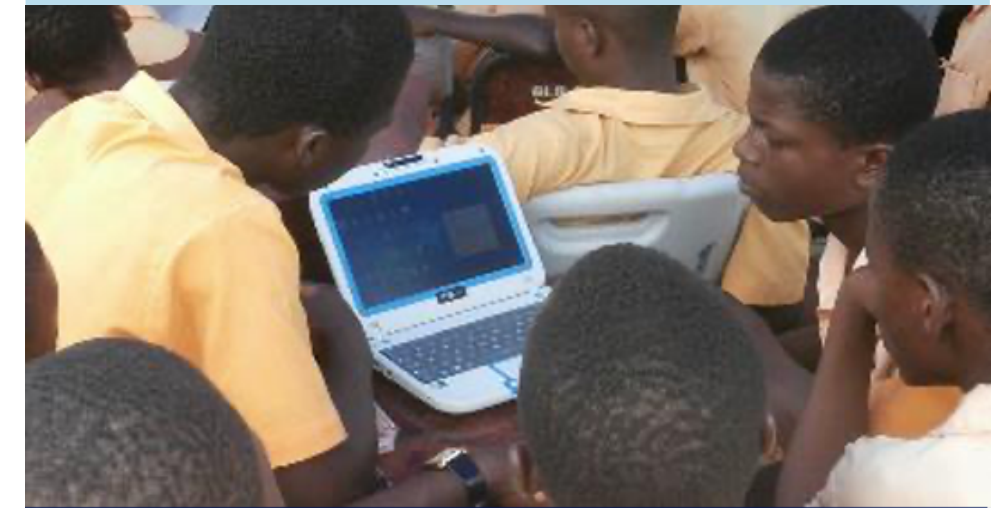
Desktop that stays in the classroom or teacher assigned laptop



Desktop PC or Laptop
+ Projector or Interactive screen
+ Internet access

SHARED COMPUTER

Several Students share the same computer



Laptop or Desktop
+ Internet access

WHAT are the potential solutions?

DEVICES SELECTION CRITERIA

WHAT IS THE RIGHT DEVICE GIVEN THE LEVEL OF TECHNOLOGICAL INTEGRATION? 2/2

Level of technology integration: From ramping to scaling and sustaining
Devices deployed for students

PC LAB

One room in the school with computers (usually desktops)



- Desktop PCs or Thin Client
- Internet access
- Requires user authentication for personal content access

SHARED 1:1

Set(s) of laptop for all students in a classroom that are shared amongst classrooms



- 1) Ruggedized Tablets for students <7 years old or 2) Laptops / 2:1's for students > 7 years old (can use keyboard)
- Wifi Internet access
- Requires user authentication for personal access*

ASSIGNED 1:1

All students in a classroom / grade or school are assigned or given a computing device



BYOD

All students bring their own Computing Device

WHAT are the potential solutions?

DEVICES SELECTION CRITERIA

COST-BENEFIT BASED ON LEVEL OF TECHNOLOGY INTEGRATION

Deployment Model	Benefits	Costs (\$-\$\$\$\$)	Indicative cost benefit (Scale 1-5)
Administration PC or shared teacher device	Digitizing Data & communications. Basic use	\$	● ○ ○ ○ ○
Mobile device for teacher + Projector	Flexible approach to integrate technology to support pedagogics	\$\$	● ● ● ● ●
Shared 1:1	Offer all student in a classroom the possibility to use technology for learning during part of the schedule	\$\$\$	● ● ○ ○ ○
Assigned 1:1	Each students in a classroom, grade or geographic region has their own (or assigned) mobile device where technology is fully integrated.	\$\$\$\$	● ● ● ● ○

WHAT are the potential solutions?

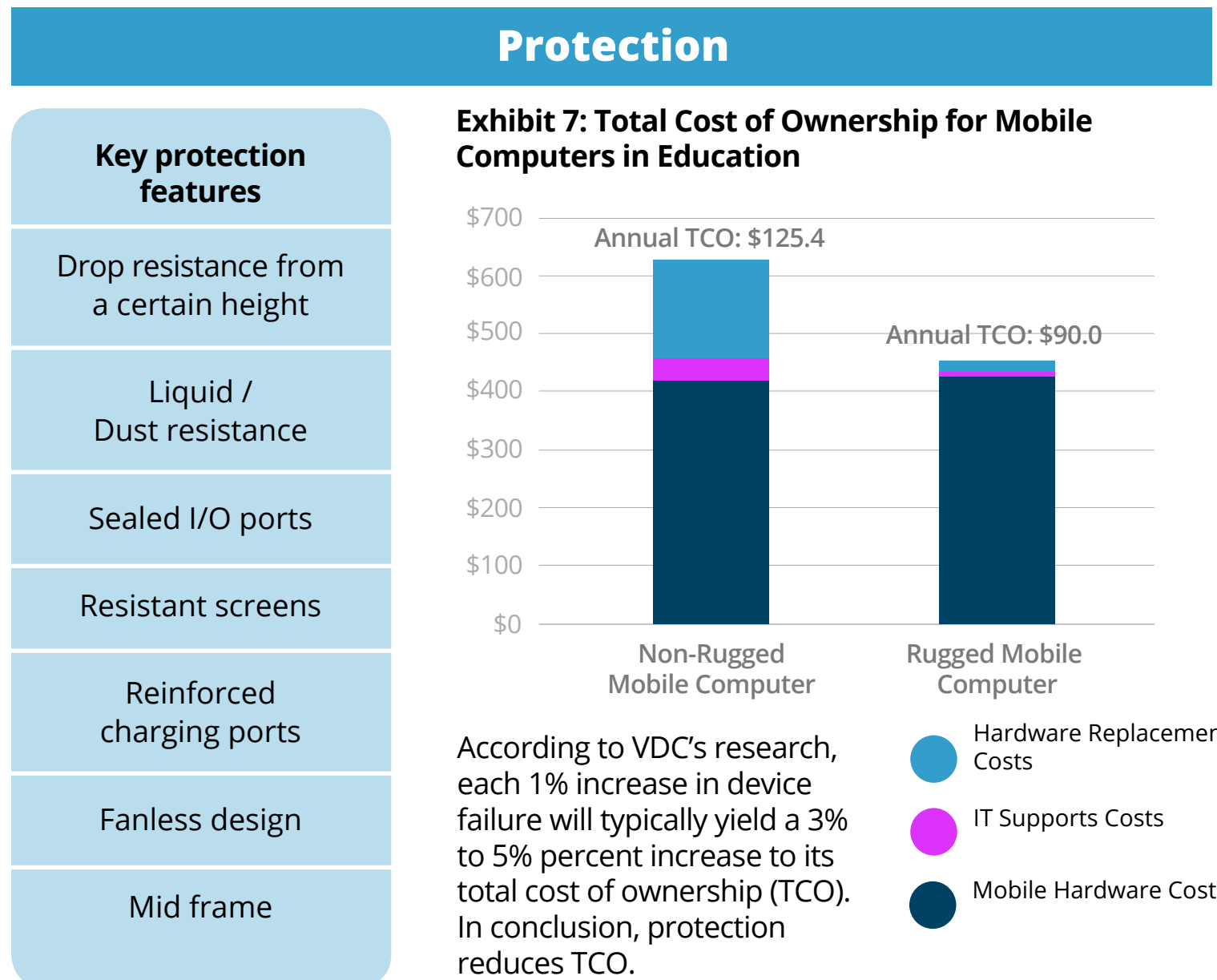
CHALLENGES AND TRADE-OFFS

OTHER IMPORTANT CONSIDERATIONS AND OPTIONS WHEN SELECTING DEVICES: OS, ROBUSTNESS, POWER CONSUMPTION AND LOW CONNECTIVITY

Operating System (OS)						
DEVICE TYPE	Microsoft Windows	Google ChromeOS	Linux	Apple MacOS	Google Android	Apple iOS
Desktop	✓		✓	✓		
Thin client	✓		✓			
Laptop	✓	✓	✓	✓		
2-1	✓	✓	✓	✓		
Tablet	✓	✓			✓	✓
Phone					✓	✓
Market Presence	All markets	High income (connectivity)	Uncommon	High income (High cost)	Low & Medium income (Low cost)	High income (High cost)

Guide for the decision of the OS:

- Who is the user? ▶
- What do you want them to do? ▶
- What type of device to choose? ▶
- Which are the required application? ▶
- What OS?



WHAT are the potential solutions?

CHALLENGES AND TRADE-OFFS

OTHER IMPORTANT CONSIDERATIONS AND OPTIONS WHEN SELECTING DEVICES: OS, ROBUSTNESS, POWER CONSUMPTION AND LOW CONNECTIVITY

Power

	Charging Power Requirements	Size and duration of batteries
Smartphone	5.0V ~ 6W-10W	
Tablet	5.0V-12V ~ 10W- 24W	3500mAh-6000mAh -9h+
2-1	12V ~ 18W - 24W	3500-5000 mAh - 10h +
Laptop	12V ~ 24W - 65W	4000mAh - 6000mAh - 3-12h
Desktop	100-200W	

Servers

Functionalities of a school / Classroom Server:

- Shared Computing capability (virtualization / Thin Clients)
- File/ content Storage
- Centralized User Management (ex : Microsoft Active Directory)
- Learning & Content Management (ex: Moodle)
- ERP / Administrative management (EMIS)
- Web Server (host a local instance of a website for instance Wordpress)
- Print server
- Network services: DHCP / firewall / Caching and streaming services
- Email server (ex: exchange server)
- Backup

School / classroom Content Servers



Critical Links C3 Hybrid JP.IK / ECS Content AP RACHEL-Plus 3.0

Classroom servers provide offline access to pre-loaded learning content for a group of students

Classroom Thin Client Architecture



The computing power from a central PC in the classroom is shared amongst several terminals

Schools Servers






Critical Links C3 School

School servers provide many of the functionalities listed above at the school level, so not needing to rely on connectivity for many of them

WHAT are the potential solutions?

CHALLENGES AND TRADE-OFFS

OPTIONS FOR CLASSROOM LARGE SIZE DISPLAYS

Display				
	Technology Key features	Implications for objectives & use cases	Pros & Cons	Indicative TCO*
 TV/monitor	-LCD TV Image size up to 60". Computer monitor typically up to 23" -HDMI connection	Used by teacher to improve conceptual understanding	-Well-supported by local services industry -Least foreign to teachers -LCD larger screen size can be expensive	\$ (TV) \$-\$\$ (monitor) \$\$\$ (LCD/plasma)
 Projector	-Very large image projection -Image quality varies according to luminosity -Mobility facilitates sharing -HDMI or Wifi connection	-Used by teacher to improve conceptual understanding -Might allow interaction with content	-Moderately well-supported by local services -Modern LED projectors have long life and are less expensive than DLP -Ambient light of the environment may require higher luminosity from the projector	\$\$-\$\$\$
 Interactive whiteboard	-Allows user to make changes on whiteboard, which is recognized by the application -Requires internal or external projector	Used by teacher to improve conceptual understanding in a highly interactive way (students can draw on board)	-Not well-supported by the local services industry (both procurement and maintenance) in developing countries -May not be appropriate for teachers with lower ICT skills	\$\$-\$\$\$



When defining a display device, you need to consider the following aspects:

- Size of classroom and distance from the projection area
- Ambient luminosity and device luminosity (for small dark classroom min 2500 lumens. For a large, bright room minimum of 4500 lumens)
- Portability - the need to move the equipment to different classrooms
- I/O ports (minimum 2 x HDMI, flashcard / USB, audio in and out)
- Power consumption and battery life (especially in environments where solar power /UPS might be required)
- Durability and- LED projectors are more durable under harsh conditions than DLP.
- Easy maintenance – does the supplier have a local presence or partners. Are parts easily available and low cost?
- Security features (can the device be attached, locked)
- Software included (management and learning content)
- Connectivity (Wifi, Ethernet)

WHAT are the potential solutions?

CHALLENGES AND TRADE-OFFS

UNDERSTANDING CONNECTIVITY REQUIREMENTS TO SUPPORT DIFFERENT USE CASE SCENARIOS

Connectivity

How much data do students / teachers need?

	Req. Bandwidth Depending on CODEC's	Data consumption
1:1 video conferencing SD (480p)	3 Mbps	540 MB / hour
Group video conferencing SD (480p)	5 Mbps	810 MB / hour
Webinar / Video / Youtube Streaming SD (480p)	3 Mbps	560 – 800 MB / hour
Online course / Social media	1 Mbps	100 MB /hour
Searching the web /online gaming	1 Mbps	200MB / hour
Podcast / Music streaming		40-150 MB / Hour
Video Streaming / Group Video conf. HD (720p-1080p)	10 Mbps	2 - 3 GB / hour
Video Streaming UHD (4K - 2160p)	15-35 Mbps	7 – 16 GB / hour

Remote Learning Students – single student using Standard Definition Video conferencing would require a minimum *bandwidth of 10Mbps (smooth experience)* and a monthly data bundle / *data cap > 100Gb* (allowing for 4h-6h/day group video conferencing / webinars + web browsing / LMS usage)
Solution: Home Connectivity through Fiber, ADSL or Fixed Wireless is the best option where available (not 4G)

Students attending classes in School / Campus – Connectivity would be mostly provided by the School or TEI and mobile data would be used when out of campus & at home after school hours.
Solution: data bundle of Mobile internet access (4G) with 5-10GB data cap. Data cap can be extended when required.

Education Activities Bandwidth requirements

Activity	Broadband speeds
Taking an online class (LMS)	0.25 Mbit/s
Searching the web	1 Mbit/s
Checking / sending e-mail	0.5 to 1 Mbit/s
Downloading digital instructional materials (including OER)	1 Mbit/s
Updating content or SW in the device	1 Mbit/s
Sending commands to the device (manage device)	0.03 Mbit/s
Engaging with social media / messaging	0.03 Mbit/s
Completing multiple choice assessments	0.06 Mbit/s
Music streaming	2 Mbit/s
Video streaming – standard definition quality	3 Mbit/s
Video streaming – HD quality	5 Mbit/s
Video streaming – Ultra HD quality	25 Mbit/s
Streaming HD video or a university lecture	4 Mbit/s
Watching a video conference	1 Mbit/s
Participating in HD videoconferencing	4 Mbit/s
Participating in a video conference (per user)	1 Mbit/s
Engaging with a simulation and gaming	1 Mbit/s
Engaging with two-way online gaming	4 Mbit/s

MDM activities

Source: ITU Last Mile connectivity Solutions Guide

WHAT are the potential solutions?

CHALLENGES AND TRADE-OFFS

REDUCING RISK OF DEVICES BEING STOLEN OR UNUSABLE

A common issue with education devices is that users change configurations and delete application many times rendering the device unusable. Also, in many situations devices get lost, stolen or locked by criminals looking to get paid to unlock those devices (Ransomware). We can reduce these risks by ensuring the Persistence of applications and theft deterrent solutions and by personalizing the devices shell.

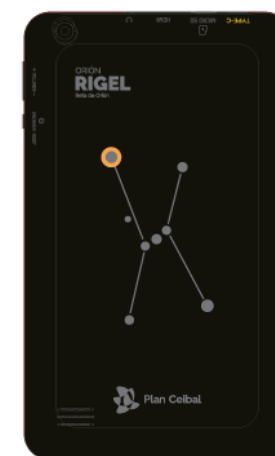
Example of software theft deterrent - CUCo

CUCo is an endpoint security solution that is factory-embedded into the firmware of the OEM devices. CUCo enables customers to control their entire endpoint population from a single console of glass, even when devices are off the network.

CUCo Security Solution also serves as a theft deterrent successfully locking down the device in case it is lost or stolen. In conjunction with hard drive encryption, sensitive data is kept out of the hands of anyone who should not have access to it. The owner of the device simply makes a phone call to the support team and, after confirmation of the identity, the device is immediately locked down.

Source: <https://cuco.inforlandia.com/>

Cover personalization through printing or engraving logos



Source: <https://www.ceibal.edu.uy>

HOW to implement next steps ?

DEPLOYMENT PROCESS

HOW TO DETERMINE THE RIGHT DEVICE FOR EDUCATION?

1 Identify the Use case scenarios that will achieve your objectives and goals.

- List all the use case scenarios you want to support – what do you want the users to be able to do to support better learning?
- Check each use case scenario within each readiness scenario and see what might not be possible and define mitigation approaches

2 Assess your current situation: Geographic diversity, tech environment, skills, resources of your country where the technology will be deployed

Define each Readiness Level scenario you want to address within your country.

The technological solutions would be different between major cities where electricity is stable and internet bandwidth is high versus rural areas where infrastructure access is limited, and connectivity is poor. Hence the technological solutions would be different.

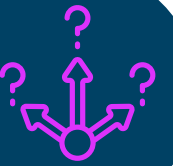
3 Identify solutions (the technology stack components and infrastructure) most adequate and cost effective according to their Total Cost of Ownership to support each case scenario according to the technology readiness

This is the point when you should define which devices are the most adequate to improve learning.

Making these decisions before assessing the current situation and use case scenarios will most

4 Iterate to improve your choices by evaluating previous experiences and the real TCO

For instance, the costs of user support and maintenance can vary significantly from one level of readiness to another and from one device to another



Deployment Key Decisions

Do I spread my budget to cover everyone by purchasing cheaper technology?

Or do I start with one group and provide the right technology?

Do I start with early grades or older learners

Which subjects do I focus on ?

How often do I need to replace the devices (lifetime)?

How do I start the project?

HOW to implement next steps ?

DEPLOYMENT PROCESS

PLANNING



- Establish Project Management Team
- Vision, Goals and Objectives
- Define Use Cases
- Evaluate Readiness and interdependencies
- Identify appropriate devices
- Adoption & Change management
- Budget (considering TCO)
- Risk & Mitigation
- Communication

- Request For Information (market consultation)
- Define Technical specifications
- Define Software stack
- Request for Proposal
- Procurement
- Delivery
- Distribution
- Set-up

- Capacity Building and Skills Development
- Governance & Compliance
- Partner & Stakeholder Management
- User Support
- Maintenance
- Decommission
- Replace / update
- e-waste management

CONTINUOUS MONITORING AND EVALUATION OF PROJECT KPI'S

HOW to implement next steps ?

COSTS AND BUDGETING

Bill of Materials (BOM) = Assembly cost + Packaging cost + Chargers costs + Freight costs + Cost of any other component used in the device.

Note: Devices are built by assembling several components, usually purchased from different manufacturers. Freight cost is usually FOB (Free-on-board) which means the device is delivered in the port closest to the factory where it was assembled. Transportation costs can vary greatly depending on distance and vehicle. One device shipped in a container can add US\$1 - US\$2 (takes 1-2 months) to the cost while air shipment could be US\$10- US\$20 (takes 1-2 weeks).

Example of BOMs

2-1 (convertible laptop) - 11.6" 4GB/64GB Wifi/ LTE		
	Brand 1	Brand 2
Electrical Components: PCBA, Gyro, Sensors, LCD, Touch Panel, Battery, Power Adapter, Camera(s)	\$120	\$153
Mechanical Components: Hinges, Handle, IO cover, Antenas, Keyboard, Pad	\$45	\$44
Other: Stylus, Packaging, Royalties	\$21	\$30
Comodities: CPU, Wifi/LTE, Memory, Storage	\$95	\$58
TOTAL	\$281	\$284

Total Cost of Ownership (TCO) =

Acquisition costs (Hardware, Software, Infrastructure) + **Deployment costs** (Logistics, Installation, Training) + **Operation costs** (Maintenance, support etc) + **Disposal / replacement costs:** refresh, recycling, etc.)

Example of TCOs

Entry / Mid range Tablet	Entry / Mid range Laptop / Convertible
<ul style="list-style-type: none"> Usually lower acquisition cost (100-300 USD) Lifespan of 2-3 years Hand-held device, so prone to being dropped by user Smaller, more sensitive parts (touch screen, charging connector) – low-cost models usually not ruggedized More difficult and costly to service as most components are soldered Assumption: Maintenance during lifetime estimated as much as initial cost (especially screen and motherboard) 	<ul style="list-style-type: none"> Higher acquisition cost (200 -450 USD) Lifespan of 4-5 years Usually used laying in a desk, so less prone to falling Can be designed to be ruggedized Easier to service as it can be broken down in many components' parts (HDD/ SDD is easy to replace) Maintenance during lifetime estimated 50% of initial investment
TCO on a \$100 USD Tablet replaced every 2 years \$400 USD over 4 years	TCO on a \$250 USD Laptop replaced every 4 years \$375 USD over 4 years

Any change to a single component will alter the cost of the device and can affect its performance and functionalities.

Devices with same high-level specificities can have very different performance and price. Detailing specificities in RFP and running comparison benchmarks improve decision making.

HOW to implement next steps ?

MONITORING AND EVALUATION

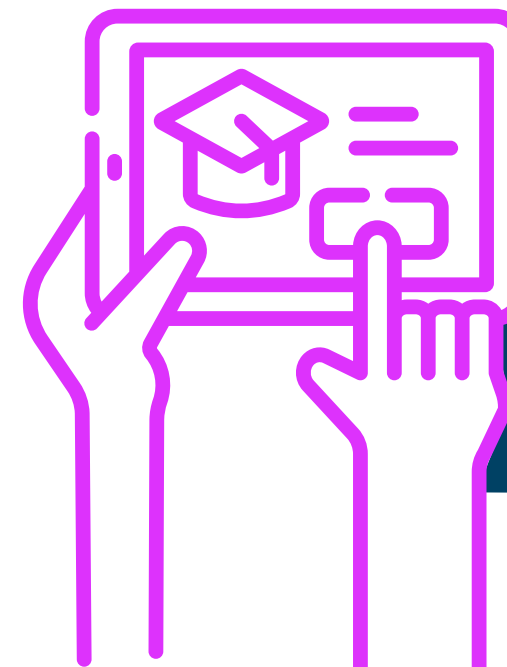
Key performance indicators (KPIs) are measurable values that track the progress of a project towards its key implementation goals/milestones. KPIs form the core of a monitoring system, providing fast and actionable information that can be used to course-correct, reallocate resources, target problem areas, and inform long-term strategy.

Potential KPIs

- Ratio of students per operating device
- Percentage of trained facilitators/teachers to instruct with devices
- Percentage of schools ready to offer EdTech devices programs (internet connectivity, security, devices configuration and insurance)
- Percentage of devices that are not operational, broken-down by cause (theft, broken screen, electrical failure...)
- Percentage of learners who do not have the digital skills to productively use e-learning programs
- Percentage of learners that attend X hours of sessions per week, disaggregated by relevant demographics
- Minimum and average number of hours that learners are active on the educational software per week, broken-down by relevant demographics
- Percentage of learners that are behind schedule in their progress on the usage of educational software, broken-down by relevant demographics
- Percentage of class time during which computers are used
- Percentage of teachers enabled with laptops
- Percentage of teachers actively using emails
- Percentage of assessments that can be conducted online
- Percentage of tech-enabled students using online content

Rigorous impact evaluation of a program is frequently more challenging than tracking KPIs. Some useful evaluation approaches are:

- **Process evaluations.** Assessing whether project implementation is running on schedule. Compare what happens on the ground to the steps laid out in the theory of change.
- **Impact evaluations.** Understanding the impact of the project on the desired outcomes (e.g. improving math literacy).
 - » A/B testing. Piloting and evaluating different approaches of a program to identify the most cost-effective solutions to enhance learning.
 - » Structured experiential learning (MEe). Structured experiential learning is an approach in which project implementers use many impact evaluations to continually learn and improve their implementation over the course of a project. (see Pritchett et al 2013).



In EdTech devices projects, the challenges (and need) to evaluate are likely to be greater than in well-established, unidimensional education projects.

Conclusion

WHO

In this KP framework, **MoE, MoICT and WB TTLs** are the adequate **decision makers** who can act and make a difference for the **students, teachers, parents and community** who use the education devices.

WHAT

In order to define the right computing device, it is necessary to consider **technical considerations**, and to adapt the device to **technological readiness**, to the **use case scenario** it applies to and to the **level of technology integration**. Selecting a solution also includes underlying challenges and trade-offs in terms of **device OS, protection, power, servers, display and connectivity**.

WHY

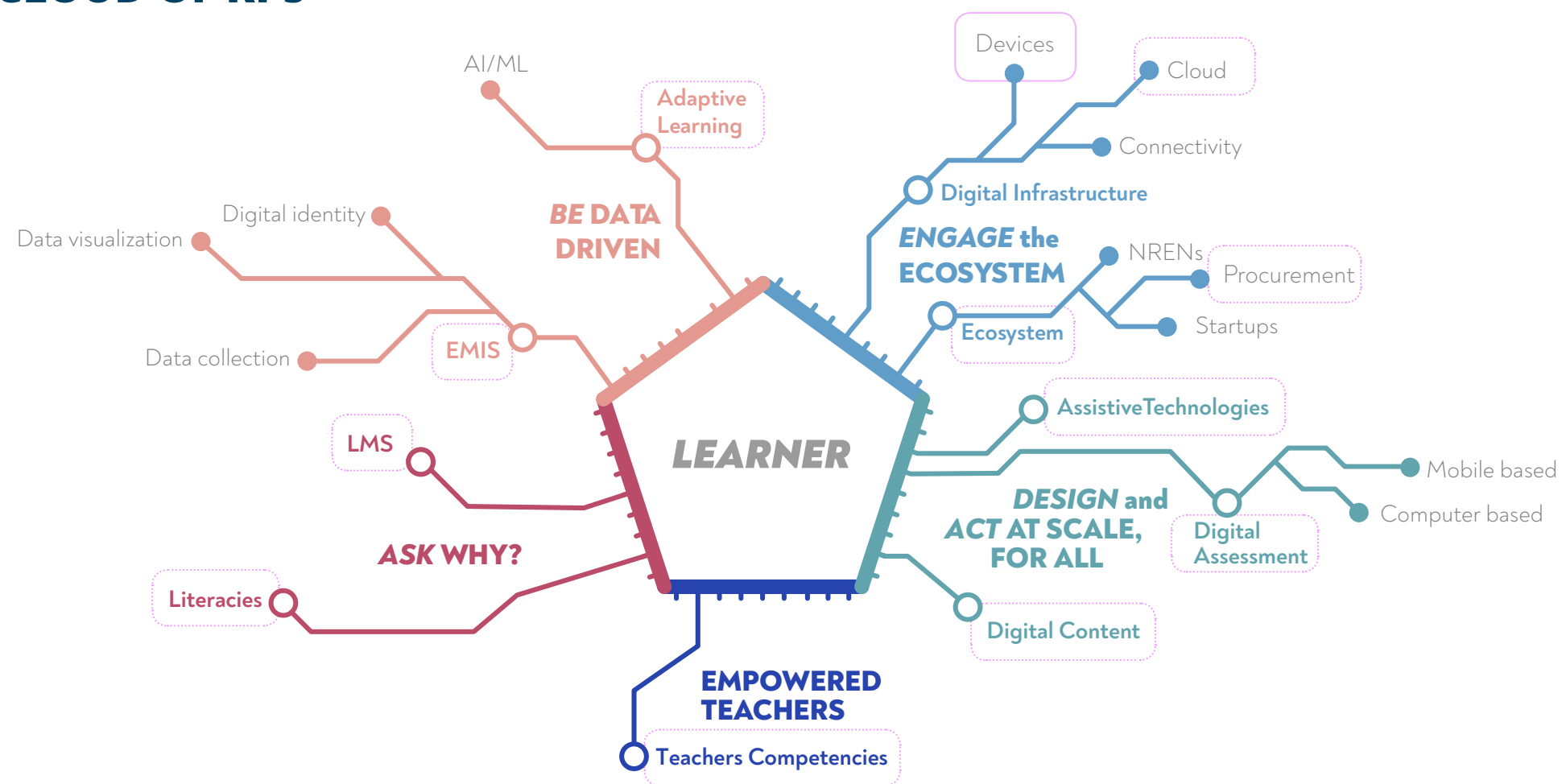
Identifying the right devices to be provided is an **element of the solution** that aims at **enhancing learning in a specific context** and it should be guided by a clear and precise vision of **bettering education's quality, accessibility, equity and relevance**. The devices question addressed in this KP is only one component of a larger set of EdTech interventions lead by the 5 principles: **(i) Ask why, (ii) Design and act at scale for all, (iii) Empower teachers, (iv) Engage the ecosystem, (v) Be data driven**.

HOW

To implement the solution, the deployment process should include three phases : **Design, Deploy, and Sustain**. It should be accompanied by the choice of **KPIs continuously monitored and evaluated**. Important decisions should be reflected on beforehand, relying on **key decisions trees**, and calculation of costs and budgeting should take into account devices' **BOMs and TCOs**.

To go further

CLOUD OF KPs



OTHER EXISTING RELATED KPs



[Tv](#)



[Radio](#)



[Mobile Phones](#)

BLOG RELATED



[What is Hybrid Learning?](#) After the global school lockdown due to the COVID-19 pandemic, countries have been exploring a variety of hybrid learning modalities as they re-open schools.

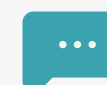
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Annexes

REFERENCES

REPORTS

- Learning in One-to-One Laptop Environments: A Meta-Analysis and Research Synthesis - Binbin **Zheng**, Mark Warschauer, Chin-Hsi Lin, Chi Chang
- A Systematic Review of One-to-One Access to Laptop Computing in K-12 Classrooms: An Investigation of Factors That Influence Program Impact Edward C. Bethel
- Technology-Enabled Learning: Policy, Pedagogy and Practice - Mishra Sanjaya, Panda Santosh
- The Impact of a One Laptop per Child Program on Learning: Evidence from Uruguay - Gioia de Melo, Alina Machado, Alfonso Miranda
- SABER-ICT Framework Paper for Policy Analysis

Insights from the reports are available in [next slides](#)

BLOGS

- <https://www.edweek.org/technology/1-to-1-laptop-initiatives-boost-student-scores-study-finds/2016/05>
- <https://www.edweek.org/technology/why-ed-tech-is-not-transforming-how-teachers-teach/2015/06>
- <https://msutoday.msu.edu/news/2016/does-learning-improve-when-every-student-gets-a-laptop/>
- <https://www.mckinsey.com/industries/public-and-social-sector/our-insights/new-global-data-reveal-education-technologies-impact-on-learning#>

Annexes

REFERENCES

“Just putting a laptop before a student doesn’t really help them with anything,” Zheng said. “Technology should not be implemented for technology’s sake.” But one-to-one laptop programs, in which each student in a class, grade level, school or district gets a computer, can improve educational outcomes when there is teacher buy-in, suitable technical support and professional development for teachers, and appropriate implementation with the curriculum. In addition to improved scores on standardized tests, the benefits of successful laptop programs include an improved writing process. “Students received more feedback on their writing, edited and revised their papers more often, drew on a wider range of resources to write and published or shared their work with others more often,” Zheng said.

Source: [Learning in One-to-One Laptop Environments: A Meta-Analysis and Research Synthesis](#)

Where technologies were used as learning tools such as cognitive supports (0.59), communication supports (0.31) and search and retrieval tools (0.54 –not significant) larger effects were found than when technologies were used as content delivery mechanisms (0.24). It should be noted also that in both meta-analyses, although technology used as delivery mechanisms resulted in the smallest gains, these gains were significant nonetheless. Media influence learning after all, small though that influence might be. [...] The two variables that had the deepest impact on technology use, proficiency and achievement were technology integration and program duration. Unsurprisingly, the degree of technology integration impacted both technology use and student achievement. In fact technology integration was more important moderator of student achievement than technology use.

Source: [A Systematic Review of One-to-One Access to Laptop Computing in K-12 Classrooms: An Investigation of Factors That Influence Program Impact](#)

Annexes

REFERENCES

Research shows the prevalent misconception that putting technology in the hands of students will reduce access issues and transform education (cf. Mitra & Crawley, 2014). A meta-analytics study by Tamim et al. (2015b) for COL on teaching and learning from tablets further corroborated this. The study showed a significant preference for more student-centred pedagogical use of technology. The researchers found that when the devices were used with a student-centred approach, rather than within teacher-led environments, the effect size was greater. Further, it was reported that the use of mobile devices elicited positive perceptions within more student-active contexts.

Source: [Technology-Enabled Learning: Policy, Pedagogy and Practice](#)

Both Nesta (2012) and Fullan and Langworthy (2013) highlight that technology cannot impact learning unless the teaching-learning process is transformed. In order to impact learning, technology must no longer be conceived as a tool to gather information, but rather as a tool that radically changes the teaching and learning process. In this context, the role of teachers should no longer be to transmit knowledge but to convey learning attitudes, support peer learning, and help children in converting information into knowledge (Nesta, 2012; Fullan and Langworthy, 2013)

Source: [The Impact of a One Laptop per Child Program on Learning: Evidence from Uruguay](#)



Supported with funding from

