

LOW COST COMPUTING DEVICES ANALYSIS TOOLKIT

A series of recommendations on how to compare the specifications of this new family of access devices

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Authors: Alex Twinomugisha Alex.Twinomugisha@gesci.org and Roxana Bassi
Roxana.Bassi@gesci.org

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Please send any comments and suggestions to the authors or GeSCI

(info@gesci.org).

Objectives

This document is intended to serve as a reference guide for Ministries of Education (MoE) when considering the selection and purchase of **portable** low cost computing devices (hardware), as one of a number of solutions intended to meet educational (i.e. teaching and learning) and/or e-administration objectives.

The document can be used as:

- o An evaluation tool, used as a guide during presentations with vendors to ensure that a TCO approach has been employed to evaluate the offering; or
- o As an evaluation tool, to be sent to vendors to complete and return to the Ministry, as part of the discussion phase when considering new devices/tools.

Though presented as a single document, the enclosed evaluation sheets/matrixes can be used as separate documents depending on the context in which they are being used.

- o The first section provides a series of variables that should be considered when analyzing and/or comparing different devices. A simple rating scale should be developed (e.g. with 5 being the highest rating and 1 being the lowest). Note however that any rating scale used should be defined by the country according to its priorities.
- o The **second part** of the document outlines a series of factors to take into account when considering implementation of portable educative devices projects in any given country.

Organisations providing these type of devices:

We suggest that in order to know the different devices available produced by vendors worldwide you access “Quick guide: Low-cost computing devices and initiatives for the developing world” maintained by Infodev located at: <http://infodev.org/en/Publication.107.html>

LOW-COST COMPUTING DEVICES: TECHNICAL CONSIDERATIONS

In recent years a new family of devices has been born: low-cost computing devices for use in education in the developing world. Profiled as a combination of mobile phones, computers and PDAs, they are primarily limited portable computers specifically designed for students to use as a personal study aide and a communications device. Given the drive by many Ministries to effectively deploy appropriate ICT tools/devices into the educational sector, careful consideration has to be given to the choice of device deployed, as an inappropriate choice can limit the educational possibilities. Furthermore, many of these devices have only been developed and tested in the past couple of years and in some cases still need to prove their 'value-add' in terms of their ability to support the sector in meeting educational objectives. As the investment costs are substantial, a careful analysis of the options must be undertaken, to determine, in particular, the Total Cost of Ownership (TCO) for such an investment.

This document seeks to outline, from a technical point of view, a number of factors that should be considered and analyzed when comparing different devices. The matrix as provided intends to identify and describe the different components to consider. The tool asks for information that should be included in any hardware specification for procurement, but oriented towards portable devices for education.

Note: This tool is intended as a hardware comparison ONLY, not including a needs assessment, software or content considerations

The primary audience for this matrix is expected to be MoE staff.

In order to effectively compare the devices, a rating scale has to be defined by each country according to its particular priorities. This rating scale should be provided and explained beforehand to those staff members selected to evaluate the device.

Note: (D) means a desirable characteristic, all others are mandatory

VARIABLES TO CONSIDER WHEN ANALYZING AN EDUCATIONAL DEVICE

Variable Category	Variable Sub-category	Considerations	Notes	Rating
PHYSICAL CHARACTERISTICS	Dimensions	– Size of device – size of keyboard and screen	Small children should be able to carry the device without tiring.	
	Weight	– Weight of device		
	Durability	<ul style="list-style-type: none"> – Chassis materials and design (i.e. a rugged child-friendly design capable of withstanding rough handling and heavy usage) – Keyboard and pointing device material and design, screen materials and protection systems (the parts that are most easily damaged) – Temperature it supports. Does it get very hot when on for several hours? – Endurance to adverse physical conditions likely to be found in rural schools and houses of the developing world (cold, heat, heights, humidity, dust) 	Device should be able to withstand children's use and general adverse conditions. These variables are critical but often not very easy to test.	
	Indicator leads (D)	<ul style="list-style-type: none"> – Power/ battery remaining – Connectivity (connected/unconnected/network detected) – Devices status 	Informative lights	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
HARDWARE CHARACTERISTICS <i>Relate to expected median life of the device and will define and limit the software possibilities</i>	Processing power	<ul style="list-style-type: none"> - Processor type and speed. - Processor compatibility (with other processors). - Cache in MB - Possibility to upgrade processor? (D) 	The processor defines the speed of calculation and also the compatibility with software already developed. Life could be extended if the processor could be upgraded (replaced) in the future.	
	BIOS	<ul style="list-style-type: none"> - Type - Size - Updating mechanisms (D) 	BIOS defines the minimum device information stored on a chip in order to perform boot and maintenance tasks.	
	Memory	<ul style="list-style-type: none"> - Memory type, size and speed - Easy to perform upgrade (D) (empty available slots, memory compatibility, easy to replace and add) 	Memory defines the space available for applications to execute. Upgrade means adding more memory.	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	Storage Media	<ul style="list-style-type: none"> - Type, size and access/transfer speed. - Estimated median life of each storage media (with average estimated use) - Optional external storage devices. (D) (type, connection type, maximum size) 	<p>Storage determines where applications and data can be stored.</p> <p>There are several storage types, like hard disks or flash memories, each with its own advantages and disadvantages.</p>	
	Power supply	<ul style="list-style-type: none"> - Type of battery. Non contaminant (D) - Energy consumption under normal use - Battery easy to remove? (D) - How many hours do the batteries last (normal use, watts/hour). - How can the batteries be charged (i.e. mechanical, standard AC, DC, type of connectors, charging time?). How many recharging cycles are guaranteed? - Input voltage and connector type. - Can the device work in several modes in order to save power? (i.e. b/w screen, disconnect peripherals, ebook, no network) (D) 	<p>This defines how the device will be powered or charged, a critical issue outside urban areas. Think of your context – number of hours per school day, reliability of present electricity supply, standard configuration of class room e.g. number of sockets to charge during actual class time.</p>	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	Screen	<ul style="list-style-type: none"> - Screen: type, dimensions, maximum definition and colors. - Video card (type, memory MB) - Other options (i.e. grayscale to reduce power consumption) (D) - How easily can it be read in sunlight? (D) - Can it be rotated? (D) - Can it be used as sketchpad? (D) - Touch screen? (D) 	The screen is the most delicate and expensive part of the device. A strong, versatile design can help expand its uses.	
	Keyboard	<ul style="list-style-type: none"> - Size. Materials. Layout - Localized with national symbols and letters (D) - Resistance to use and stress - Ease of typing for children (configurable repetition of keys, sensibility, etc) 	The keyboard and pointing device are the parts that are most easily damaged. Also, they are in	
	Pointing device	<ul style="list-style-type: none"> - Type (i.e. Touchpad, mouse, button) - Solid enduring design? - Can the sensibility be configured? - Availability of other external pointing devices (D) 	permanent contact with the child, so ease of use as well as durability/ rugged design is critical.	
	Peripheral compatibility	<ul style="list-style-type: none"> - Type of ports available (type, standard, speed) - Standard peripherals available - Drivers available 	Existing standard ports might be used to connect other peripherals to the device.	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	System Security	– Hardware enabled Theft/Security Control (D)	As these devices are small enough to be easily mobile, many devices currently come with built-in security features – think of these in relation to the context in which the device will be operating.	
	Other	– Audio support: card, speakers, microphone – Camera (D) – Other (D)	Other multimedia capabilities.	
SOFTWARE	Operating system (OS)	– Operating software use of the storage capacity and memory (MB) – Is it commercial or open source? – Is there one OS or several options available? – Is the OS tested or is it a specifically designed new version? – Is it easily adaptable to local languages? (i.e. error messages, menus) (D) – How is it updated? Automatic update available? (D)	One of the most critical points, since OS defines the interface and the applications supported. Updating is critical because of security reasons.	
<i>will determine the possible uses of the device</i>	Administrative applications	– Hardware management – Device management – User management – Command line options	Software included to control the peripherals and the device's resources	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	User management and configuration	<ul style="list-style-type: none"> - Does it allow several user profiles? (I.e. teacher/student/parent profiles). - User identification methods (password, other) - Encryption/security for files - Separate Information storage available - Back-up mechanisms available (D) 	This defines how the device can be personalized for several persons using it, or for teacher/student/parent profiles.	
	Applications	<ul style="list-style-type: none"> - Memory and storage left for applications (that is, apart from operating system and administrative applications) - Are the applications easy to install? - How is the software uninstalled? - Are there any applications already available? (especially in local language) - Are there any software development tools (programming/compilers) available for students/teachers? - Does it include anti-virus/anti-spyware software? Can this protection be bypassed? - Are there ways to verify software integrity? 	This intends to evaluate the application management capabilities of the device.	
	Educational applications	<ul style="list-style-type: none"> - List of Educational Applications available. - Are they aligned with National Curricula or can they be adapted? - Known application's limitations (i.e. memory size, storage size, processing speed, video, multimedia) - Is there a Developer's toolkit for local developers? - What Developing languages are supported? 		

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	GUI (Graphical user interface)	<ul style="list-style-type: none"> - Usability and accessibility considerations - Compatibility with existing GUIs. Is the OS too different from commercially available OS? Is this a PRO or a CON? (Think of the learning curve for the future). - Must be very intuitive (for small children) - Is personalization possible? - Reasonable interface speed in responding to commands - Command line interface available (D) - Keyboard short-cuts available (D) 	Interface is critical to reduce the learning curve and guarantee ease of use.	
	Licensing	<ul style="list-style-type: none"> - What is the type of licensing agreement of the OS and included software? - Duration/cost of licensing agreement (if any) 	This is relevant for costing reasons and also to know if the OS can be modified locally.	
	System Security	<ul style="list-style-type: none"> - Does it support security standards in communications? - Can it support encrypted storage of files? - Is the OS open? 		
	Other	<ul style="list-style-type: none"> - Parental control? (D) - Teacher applications/control? (D) - Teacher control of the device (D) 	This is important so that students cannot hide information or access prohibited resources.	
CONNECTIVITY	Amongst machines	<ul style="list-style-type: none"> - Can the devices connect among themselves? How? (Standard? If wireless, check spectrum frequencies and security issues) - Can the devices share their resources? (If so, security measures, access) 	This section seeks to find out the ability of the device connect with other	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
<i>describes ways to connect the device to other resources</i>	Local area networks	<ul style="list-style-type: none"> – What are the connectivity options available? (Technology, standard, speed). – What additional external connectivity options exist? (i.e. wireless with PC cards or USB) 	devices/tools and the Internet	
	Internet	<ul style="list-style-type: none"> – Internet connectivity options (configuration, automatic/manual detection) – Proxy / Parental control – Available Internet applications (email, web browser) – Available Internet administrative tools available (i.e. ping, tracer) 		
Other considerations	Maintenance & Support – Hardware considerations	<ul style="list-style-type: none"> – Median life of components (i.e. storage)? – Is there information about the expected failure rate of each component under normal use, and the cost of replacements? – How easily can components be replaced? Are they standard or device-specific? – Local availability of spare parts – Can some parts be repaired locally? – Can the device be maintained locally by trained technicians? 	This serves to determine the life-span of each component and if repairs can be made locally	
	Maintenance & Support – Software considerations	<ul style="list-style-type: none"> – Can the software be installed/restored from an image? – How can user stored data be preserved/backed up? – Can software be installed by people with almost no specific training? – How can application changes be protected from children? – How is the OS updated? (especially for security bugs) 		

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	Anti-theft	<ul style="list-style-type: none"> - Can the device be easily stolen? - Can it be easily re-sold? 	As these devices are small enough to be easily mobile, many devices currently come with built in security features – think of these in relation to the context in which the device will be operating. An important consideration since the device can be stolen unless it's somehow protected and/or difficult to sell.	
	Environmental impact	<ul style="list-style-type: none"> - Does the device comply with environmental standards like EPEAT? - How contaminants are its components? - Does it provide options for ecological ways of discarding after end life? - How much energy does it require to operate? 		

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	Localization (adaptation to unique local characteristics)	<ul style="list-style-type: none"> - Can the keyboard be localized? - Can the OS be localized? (error messages, interface, command line) - What is the support of extended characters? (local symbol support i.e. date, currency, units, letters) - Local electrical input: voltage, cycles and electrical connectors according to local specifications. 	This serves to determine the degree to which the device can be adapted to meet local language requirements.	
	Political / Legal	<ul style="list-style-type: none"> - Where will the device or components be built? Can it be done locally in order to benefit local IT makers? - What about software development? Is there any way for the local IT industry to develop software for the device as a new business and maybe also export it? - Does the software/hardware have any copyrighted material/component that is prohibited in the country? - Does it use any part of the radio-electrical spectrum that need to be assigned by law or that is already in use? - Intellectual property: does the software upload content to specific sites where intellectual property has to be leased to the owner of the site? Make sure the rights of the content created by teachers and students remain protected. 	This describes a series of delicate legal and political issues that can affect and limit the deployment of the devices.	
	Ergonomic considerations	<ul style="list-style-type: none"> - Adaptation to a children's use: chassis material, keyboard, pointing device, GUI 	Critical and not easy to test.	

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	Testing	<ul style="list-style-type: none"> - Are there any devices already available for testing? - Can we develop a testing lab? - Can we do a trial deployment? 	It is critical that testing of any devices be carried out in real life-like situations to assess the suitability and adaptability of the device to the local conditions.	
	Developers/Supporters	<ul style="list-style-type: none"> - What companies and organisations support this device? - How long have they been planning this device? - Do these companies have developing world experience? - Do these companies have a local presence? 	This serves to determine the level of industry support it has, since this might affect maintenance, support and upgrading over the years.	
	Deployment	<ul style="list-style-type: none"> - Has any other country signed supply contracts/ installed these devices already? - How long does it take to install each device? - What other infrastructure (if any) needs to be place prior to deployment? 		
Economic considerations	Price	<ul style="list-style-type: none"> - Cost of the device - Cost of available peripherals - Cost of required infrastructure (i.e. networking, electrical, servers, etc) - How is such a low price obtained? (No marketing costs? Open source software? Mass production? Cheap components?) 		

Variable Category	Variable Sub-category	Considerations	Notes	Rating
	Other Costs to be considered	<p>One time/ initial costs:</p> <ul style="list-style-type: none"> o Initial Software licensing costs o Installation costs (initial installation and configuration) o Transportation costs (transport, insurance, paperwork) o Cost of importing devices (tax exemption possible?) o Deployment costs (transportation, security, insurance, installation, support infrastructure) o Initial training costs <p>Recurring costs:</p> <ul style="list-style-type: none"> o Annual Software licensing costs o Permanent Training costs o Maintenance cost o Support costs o Monitoring and Evaluation costs 	Do not forget that buying the equipment is only the initial cost, but other cost components have to be considered.	
	Payment	<ul style="list-style-type: none"> - Payment method - Sources of funding for the acquisition, maintenance, support, training, software, etc. 		

Notes

About the rating scale

- The rating scale for each of the variables is empty because each government has to determine the weights according to their particular situation and needs.
- We suggest that you determine a number of maximum points (ie 1000) and then assign a portion of points to each of the categories and subcategories, according to the variables that seem more critical to you.
- It is best to rate all mandatory characteristics first, and then assign a bonus of points for the desirable (D) ones.
- Please consider that some of the characteristics will require testing the devices in their normal use environment (i.e. battery life), so you will have to set up a testing lab.

IMPLEMENTATION OF LOW COST COMPUTING DEVICES IN SCHOOLS

If a country should decide to go ahead and consider purchasing low cost educational devices for all, or a proportion of students, this will require designing and executing a detailed plan involving several government bodies and probably complex logistics.

This list explores some of the issues that may be taken into account.

VARIABLES	Issues/tasks
MANAGEMENT / CONTROL	<ul style="list-style-type: none"> - Design of a plan to organize, execute and supervise the deployment of the project¹ - Define a team of experts that would plan and execute the project - Define and execute a Lab test of a first batch of devices. Define testing procedures. - Monitoring: define variables to measure success and failure factors, best practices and make adjustments.
EDUCATIONAL	<ul style="list-style-type: none"> - What are the educational objectives to be achieved through the deployment of these devices?² - How will the devices improve teaching and learning? - What will be the criteria to assign the devices? (i.e. per region, per student age, per type of school, rural schools, etc) - Usage- who will use the device and where will the device be used? <ul style="list-style-type: none"> o Will they be assigned one per student or per class or per school? o Will they be assigned to teachers also? o How can the teachers use the devices in the classroom? o How can the devices be used pedagogically? - Design training plan for teachers, students, headmasters, community members. - Digitalization of educational resources, online resources to connect - Educational Software development and testing

¹ For more information please refer to Gesci's "Practical Guide to Pilot projects and large scale deployments of ICTs in the Education Sector - Guidelines on deploying IT in schools at a regional or national level" <http://www.gesci.org/ict-infrastructure-connectivity-and-accessibility.html>

² For more information please refer to Assessing Technology Options for Schools - A Report on Framework and Tools <http://www.gesci.org/ict-infrastructure-connectivity-and-accessibility.html>

VARIABLES	Issues/tasks
POLITICAL	<ul style="list-style-type: none"> - Integration of curricula into existing software - How will the government justify choosing to participate in this project over another? (technical evaluation is one means) - How will the government justify the direct acquisition of the devices without a bid? - If relevant: How will the MoE justify the fact that some of the students/schools will receive the devices and others won't? (transparency in choosing destination) - Have Press strategies ready: press information, web site, board of advisors - Search for ways to obtain support of the local IT industry. Options: build hardware or peripherals locally, mount equipment locally, local technical support, local software development.
ECONOMICAL	<ul style="list-style-type: none"> - What sources exist for the money required? (E.g. universal access fund). Perform a full TCO analysis³. Consider additional costs for transport and insurance. - Financing scheme and participation of other organisations (i.e. UNDP, WorldBank) - Applicable local taxes, can be avoided by law?
TECHNICAL / INFRASTRUCTURE	<ul style="list-style-type: none"> - What local adjustments have to be performed on the standard design (localization)? (i.e. electrical, keyboard, batteries, cables, OS, applications, other) - electrical installation in schools, wifi access in schools, classroom infrastructure and furniture (ergonomics) - other infrastructure and devices to build/buy per school (i.e. servers, printers, storage, networks)
PROCUREMENT PROCEDURES/ PROCESSES' LOGISTICS	<ul style="list-style-type: none"> - Through which process will the equipment be acquired? - Design test batch and procedures - How will the equipment be distributed? - Define the batches and arrival date of each - Logistics to distribute the equipment locally - Transportation and insurance of the equipment?
LEGAL	<ul style="list-style-type: none"> - Who will legally "own" the equipment- the central government, local government, schools, teachers, parents or students? - What kind of agreement will the government sign with the school / or the school with the parents, to assign the property of the computer to the children? - What will happen with the intellectual property of the content developed by students and teachers using the device?

³ For more information access our TCO tools <http://www.gesci.org/ict-infrastructure-connectivity-and-accessibility.html>

VARIABLES	Issues/tasks
	<ul style="list-style-type: none"> - What laws must be passed or modified in order to create the best environment for such a large scale IT project deployment? I.e. Law on electronic documents, intellectual property, open source, digital signature, will be advisable. - If necessary, what will be the spectrum assigned for the communication among the devices? - Will the equipment be insured against theft or damage? Who is responsible for insurance, loss? - What other measures can be taken in order to reduce the possibility of these devices being sold?
<p>TECHNICAL / SOFTWARE AND HARDWARE</p>	<ul style="list-style-type: none"> - Work on local version of the OS and GUI - Work on the specifications for the development of application software for the devices - Work on the design/adaptation of specific devices for the machines - Work on updating mechanisms for software (OS, applications) - Work on local support/repair of the devices - Work on local educational software development
<p>TECHNICAL / IT MARKET</p>	<ul style="list-style-type: none"> - Think how to develop local IT market for specific software development for the devices - Develop local technical support - Support local hardware development for the devices
