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In much of the globe,
classroom technology has
become as common place
as the chalkboard, book
and pencil it now replaces.

This is increasingly true
in many classrooms in the
wealthiest nations of
the world.

“Educational technology” or “Information and Communications Technologies (ICTs)” comprise not just computers or the Internet. They may include such diverse tools as videoconferencing, digital television, electronic whiteboards, and gaming. Increasingly ICTs not only include small, portable devices such as tablets, MP3 players, gaming devices, and Smart- and cell phones, but have in fact *become* small portable devices—a trend that will certainly continue.

As we move to a discussion of whether, how and what technologies can impact teaching and learning, two observations, both of which will frame the remainder of this monograph, are worth noting.

The research regarding technology’s impact is variable: Thousands of comparisons between “computing and non-computing” classrooms have been made since the late 1960s and scores of meta-analyses around technology and student learning have been undertaken since 1980 (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011:2), yet the overall quality of research remains variable. Some of this research may be regarded as “high quality”—using control groups, probabilistic sampling, reliable and sensitive instruments and measures, or qualitatively rich case designs; and controlling

for “confounding” influences like maturation or novelty effects. Much more research is methodologically suspect, descriptive or anecdotal. Though this review aims to cull information from more “rigorous” empirical research² outlining how certain technologies and applications can be used optimally for teaching and learning, we cannot vouch for the quality of this research. Each type of technology, as this review will illustrate, offers its share of benefits and drawbacks.

Despite all research data, there is no longitudinal, irrefutable body of evidence that states that computers alone improve learning. Many highly-touted applications and software show no “measurable impact” on or “no significant difference” in student learning, and indeed, much research demonstrates negative impacts of technology on student learning.

And research does not exist for all technologies. For many newer types of technologies, such as Smart Phones and tablets, despite the evident excitement and promise, there is little or no research proving their worth as teaching and learning tools.

Under Certain Conditions Technology Demonstrates Positive Benefits: However, despite such seeming pessimism, there is an increasing body of research that

Figure 1: The Impact of Technology in Poor vs. Wealthy Nations (Banerjee & Duflo, 2011: 100)

“Current research on educational technology’s impact on student learning is mixed—but most of the research comes from “rich” nations where the alternative to being taught by a teacher is being taught by a highly-motivated and highly-qualified teacher. In poor countries, and in poor regions of moderately well-off nations where teacher quality is low, the evidence on the effectiveness of computer assisted programs versus teachers, though sparse, is quite positive. Research in India, for example, showed that children who played a computer math game two hours per week had learning gains as large as some of the most successful educational innovations tried over the years.”

suggests three conditional, promising outcomes vis-à-vis technology’s impact on student learning:

1. Technology can compensate for poor teacher quality: An increasing body of research demonstrates that exposure to ICTs may increase the cognitive abilities of students, allowing them to learn faster. This is particularly true in contexts where teacher quality is poor (Carillo, Onofa & Ponce, 2010:2; Banerjee & Duflo, 2011) (See Figure 1).

2. Technology can benefit special populations: Research increasingly and cumulatively suggests that under certain conditions, technology can promote small to moderate gains in student learning (Tamim, et al., 2011), especially for learners with special needs (Ofsted, 2009) and for pre-school learners in terms of early literacy³ (Penuel et al., 2009).

3. Technology is most successful when part of an overall focus on the key components of teaching and learning: The dominant theme that emerges from technology in education is that content, instruction, assessment and sound policies, practices and support matter far more than the kind of laptop, the software suite or whether or not teachers can make a spreadsheet (Means, Toyama, Murphy, Bakia, & Jones, 2009; Tamim et al., 2011). As research and experience inform us, technology “works” when it supports intended learning outcomes and when it is used to deepen content knowledge, instruction and assessment. Successful use of technology—helping students learn in ways are measurably better or that would otherwise be impossible—still depends, not on boxes, bandwidth or wires, but on that most fundamental classroom transaction—good instruction.

²Such as first- and second-order meta-analyses. A first-order meta-analysis analyzes findings across several primary evaluations/studies that address a set of related research hypotheses and reports measures as an effect size. A second-order meta-analysis summarizes findings of meta-analyses, over a number of years, in the same way that a meta-analysis attempts to reach more reliable and generalizable inferences than individual primary studies (Peterson, 2001, cited in Tamim, et al. 2011).

³One such study was the Ready to Learn Evaluation, an efficacy study that examined the impact of combining repeated home viewing of clips from two educational television programs for children (Sesame Street and Between the Lions) with interactive literacy activities for parents to use with children.

Educational Technology in Lebanon, Jordan, the United Kingdom, and the United States

Across the globe, various nations have made strides in integrating technology into their educational system. This section examines four such efforts—from Lebanon, Jordan, the United Kingdom (Britain), and the United States—discussing their overall stages of educational technology development and implementation. To better situate the educational technology experiences of these four cases, Figure 2 presents a continuum of characteristics that categorize these national efforts as “emerging,” “trialling,” and “achieving” in terms of overall educational technology indicators—policy, provision of technology in schools, the focus of ICT efforts, integration into the curriculum, teacher training, attitudes toward ICT, funding, and supports. Our discussion of each nation’s educational technology efforts will reference this matrix.

01.

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Figure 2: Stages of Educational Technology Implementation (Adapted from UNESCO Bangkok, 2006; Yuen 2000)

Trait	Emerging	Trialling	Achieving
ICT Policy	<ul style="list-style-type: none"> Have national policies but no plans for implementation, or have no national policies and only undertake small scale and ad hoc ICT projects 	<ul style="list-style-type: none"> National ICT in education policies are linked to national ICT policies 	<ul style="list-style-type: none"> Ministries of Education have set national e-learning policies and plans and provided adequate budget for implementation
ICT Provision	<ul style="list-style-type: none"> Constrained by costs and the lack of computers and Internet access There may be schools with ICTs but typically these schools have secured equipment and connectivity through their own initiative, through private donations or as part of a pilot activity 	<ul style="list-style-type: none"> ICT penetration, connection and bandwidth are variable and development is constrained by costs and logistics ICT integration is neither systemic nor nationwide 	<ul style="list-style-type: none"> There are high levels of computer provision and Internet connectivity and low student-computer ratios in classrooms ICT integration is systemic—technology is present in all schools and all types of schools throughout the country
Focus of ICT Efforts	<ul style="list-style-type: none"> Technological adoption model: Emphasis is on providing hardware, software, infrastructure, connectivity, and curriculum resources. Change in educational practice is minimal at best 	<ul style="list-style-type: none"> Catalytic integration model: Emphasis is on staff development. There is some change in curriculum and pedagogical reform. 	<ul style="list-style-type: none"> Cultural integration model: Emphasis is on cultural and organizational change. This is the approach that achieves the most significant change.
ICT in the Curriculum	<ul style="list-style-type: none"> Treat ICT as a subject or an optional or extra-curricular activity, rather than embedding it in subject learning 	<ul style="list-style-type: none"> ICT is treated as a subject in its own right and teachers mainly use ICT for productivity (word processing, spreadsheets and classroom presentation of information) 	<ul style="list-style-type: none"> Curricula are being revised to exploit e-learning ICTs are woven into content-area instruction and/ or are used as a parallel delivery system of education (such as online Learning)
Assessing ICTs	<ul style="list-style-type: none"> Since ICT is a separate subject area, ICT skills are assessed separately, within IT classes No reflection of ICT-related skills or knowledge in the overall assessment system Lack of computer-based or computer-embedded assessment 	<ul style="list-style-type: none"> Some movement toward computer-based assessment or computer-embedded assessment but most assessment is still “paper-based” Movement toward assessing students’ practical ICT knowledge and skills within a particular content area (for example, students must display a particular math concept using spreadsheets) 	<ul style="list-style-type: none"> Use of computer-based, computer-embedded and computer adapted assessment systems ICT knowledge and skills may be one component of the overall set of skills and knowledge that is assessed (for example, as part of overall performance-based assessment) Technology is a medium for content that is assessed (e.g., students are assessed via persuasive essay but essay must be word processed)

Trait	Emerging	Trialling	Achieving
Teacher Training	<ul style="list-style-type: none"> Off-the-job training (i.e., in non-school locations) Limit teachers’ training to ICT skills development No follow-up support 	<ul style="list-style-type: none"> Off the job training but with limited on-the-job training at times Limit teachers’ training to ICT skills development, ICT for teacher productivity and perhaps some strategies for classroom integration of ICTs No or limited follow-up support 	<ul style="list-style-type: none"> Primarily on the job Administrators, headmasters and teachers receive training (increasingly online) not only in ICT skills but in e-learning, website development, telecollaboration, etc. Ongoing follow-up support
Leadership and ICT	<ul style="list-style-type: none"> Teachers and principals are unaware of how to use ICTs for teaching and learning Teachers may be fearful of technology, unconvinced of its worth and slow to change their teaching methods 	<ul style="list-style-type: none"> Many principals are curious (but unsure of what to do) apathetic or antagonistic toward ICT in the classroom 	<ul style="list-style-type: none"> Teachers and administrators are generally positive about ICTs and understand how it can be used to support teaching and learning
Funding	<ul style="list-style-type: none"> May be heavily dependent on international donors and private companies for technology funding 	<ul style="list-style-type: none"> Mix of donor funding, government funding and private companies for technology funding 	<ul style="list-style-type: none"> Mainly government funding, with some private and public philanthropies and private company funding for ICTs
Supports for ICTs	<ul style="list-style-type: none"> There is a lack of technical support, e-courseware and evaluation around ICTs 	<ul style="list-style-type: none"> There is some technical support, e-courseware and evaluation around ICTs. Where support exists, it is still mainly offsite. 	<ul style="list-style-type: none"> Site-based technical support, e-courseware and evaluation around ICTs Performance indicators are used to monitor the impact of ICT in education

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“Most ICT education efforts in Lebanon have focused on securing access and connecting computers to teaching and learning”

Lebanon

Lebanon⁴ differs from the remaining three case sites in this monograph—Jordan, the United Kingdom and the United States—in that it is a post-conflict nation that has had to focus on rebuilding institutions and structures following a fifteen year civil war, and conflict in 2006. Given this reality, Lebanon’s overall educational technology (or “ICT in education”) efforts may best be categorized within the **emerging** category of nations in terms of the overall educational technology efforts.

Formally, Lebanon initiated its educational technology strategy beginning in 2000. In 2007, the Ministry of Education and Higher Education (MEHE) launched an educational vision document. In alignment with this educational vision, MEHE has begun to develop a centralized, national educational technology strategy, as well as the requisite supporting systems and documents to carry out the components of such a strategy.

Technology is not widespread in most Lebanese government schools. Most educational technology initiatives have been funded by private technology companies or initiatives such as SchoolNet Liban (to be discussed momentarily). Technology provision and Internet connectivity are major impediments to and therefore a major focus of large-scale national ICT initiatives. The curriculum, which in 2011 began revision by grade-level cycle, has not yet been modified to support the use of ICTs. The student assessment system has not yet been modified to reflect the new curriculum or technology though such efforts will most likely be undertaken in the next several years (Fayad, personal communication, September 12, 2011). The efforts of the past decade have essentially focused on a “technology adoption model” emphasizing access—the provision of hardware, software, connectivity and resources. At present, there is little coordinated school-based support for teachers to use ICT and most technology use in Lebanese schools occurs in computer labs as part of information technology (IT classes). However, these issues will be addressed through the adoption and implementation of Lebanon’s 2012 national educational technology strategy.

Chronology of Educational Technology Initiatives in Lebanon

In 2000, Lebanon launched its first “ICT in education” project, SchoolNet Liban. Similar to the national SchoolNets found in Africa, Latin America and Europe, Lebanon’s SchoolNet aimed to utilize technology to modernize the overall education system by making instruction more relevant, improving the quality of educational content and introducing technology into the teaching and learning system. Specifically, SchoolNet Liban’s overall objectives were manifold: to facilitate effective learning for Lebanese students; foster life-long learning and a “knowledge-based society;” enhance the capacity of teachers to teach with technology; create a national educational network for Lebanese teachers and students to develop and showcase ICT projects (which has basically become over time the main objective of the project); and to provide linkages and online collaboration opportunities for students and teachers with their peers across the globe (Yammine, personal communication, September 13, 2011).

Since its inception, SchoolNet Liban has been an enduring fixture in the Lebanese educational technology landscape. Since 2002, when it began in 12 public schools, it has expanded to 105 public schools as of 2011, with an overall goal of engaging 200 schools by 2012, which would give it a presence in approximately 14 percent of Lebanese schools. SchoolNet Liban has partnered with a number of technology companies such as Intel, Cisco, Promethean, and Microsoft and with non-governmental organizations (NGOs), such as the Educational Association for IT Development (EAITD) and Interactive Education Technology (IET). Each year, Lebanese students participate in regional SchoolNet competitions with prizes for winning projects.

In October 2003, the Lebanese Government, through the United Nations Development Programme (UNDP) and the Office of the Minister of State for Administrative Reform (OMSAR), completed the development of the “National e-Strategy.” The vision was aimed at “moving the economy and society of

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“Most ICT in education efforts in Lebanon have focused on one of two areas”

Lebanon toward a knowledge-based society in the shortest possible time while at the same time addressing related challenges and opportunities that Lebanon is facing” (United Nations, 2007:5). Thirty-two policies, grouped under seven initiatives, were proposed as vehicles for implementing the strategy. A portal (<http://www.e-gateway.gov.lb>) was designed and developed to incorporate all information and data pertaining to the various initiatives that are related to the project.

After 2006, five US-based companies (Microsoft, Occidental Petroleum, Intel, Cisco, and Ghafari, Inc.) established the Partnership for Lebanon⁵ to aid in its reconstruction. Though not explicitly directed toward the promotion of ICTs in Lebanese society, many of its initiatives did in fact emphasize the role of ICT. In part, through this partnership, technology companies have launched ICT in education efforts in 52 Lebanese public schools, teachers’ regional offices (centers for training) and exam centers.

There have been a number of large-scale technology provisions for Lebanese schools. As part of its Education Development Project for Lebanon, the World Bank supplied and installed 2770 computers and peripherals (printers and faxes) in 1385 intermediate and secondary public schools; nine schools have been equipped with 81 computers for 868 students; and 95 administrators at the Ministry of Education and Higher Education (MEHE), Center for Education Research and Development (CERD) and regional offices have been given computers to help them run daily administrative tasks (World Bank, 2010).

Most ICT in education efforts in Lebanon have focused on one of two areas. The first are initiatives⁶ that focus on securing access (through provision of hardware, software, or connectivity) for teachers and students. The second are efforts to connect computer technology to teaching and learning through the provision of learning opportunities to teachers, students or both. Since these latter are smaller in scale, though of longer durations in some cases, they are defined in this document as programs.

Figures 3 and 4 outline some of Lebanon’s major technology initiatives and programs, implemented in coordination and collaboration with the Ministry of Education and Higher Education constituents and the Center for Educational Research and Development (CERD).

Figure 3: Overview of Major Private Sector ICT for Education Initiatives in Lebanon (Source: Organizations listed in this table⁸)

Organization and Partners	Project Name/Type of Assistance	Stated Goals	Target Audience
Microsoft - IEAD (2002- 2011)	Partners in Learning: Innovative Students	Foster life-long learning to foster greater movement toward a “knowledge-based society”	Teachers and students in 105 schools
	SchoolNet Liban	Enhance the capacity of teachers to teach with technology	6000 students
Intel - Hariri Foundation, YMCA (2005-2009)		Create a national educational network for Lebanese teachers and students to develop and showcase ICT projects	
		Provide linkages and online collaboration opportunities for students and teachers with their peers across the globe	
		Promote learning through discovery	
		Use ICT to acquire and share knowledge	
		Improve students’ communication, presentation and negotiation skills	
	Intel Teach: Teacher professional development	Train teachers to effectively integrate technology in classroom to enhance learning and build 21st century skills, and to shift from a teacher centric approach to an interactive method focusing on the student	6000 Teachers/ Trainees
		Prepare students with 21st century learning skills, such as technology and digital literacy, effective communication, critical thinking, problem solving, collaboration	
		Share experiences among the participants on different adopted approaches	

⁵ See <http://www.lebanonpartnership.org/>

⁶ “Initiatives” in this monograph are defined as large-scale attempts to establish availability and access, training or connectivity around technology as a foundation for greater general educational use. Many of Lebanon’s major technology initiatives have been spearheaded by technology companies.

⁷Cisco’s IT Academies, which are really an extension of its networking initiative (which provided routers and switches as well as a Telepresence system to MEHE), are designed to develop capacity in networking skills and have thus been included in this table as an overall adjunct to Cisco’s main networking initiative.

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Organization and Partners	Project Name/Type of Assistance	Stated Goals	Target Audience
Microsoft (2005-2011)	Partners in Learning: Innovative Teachers	<ul style="list-style-type: none"> Enable MEHE to: <ul style="list-style-type: none"> Improve access to and use of information and communications technology (ICT) in primary and secondary education Bridge the digital divide in public education Improve the teaching and communication skills of educators in public schools Increase the use of ICT as an educational tool in public schools Improve access to, and the use of, ICT for the support of teaching and learning Learn new concepts and best practices 	<ul style="list-style-type: none"> 1937 teachers total (2005-2011)
Cisco - Hariri Foundation (2006)	IT Academies ⁷ Building networking capacity	<ul style="list-style-type: none"> Introduce IT literacy into high schools and among school dropouts Build student networking capacity 	<ul style="list-style-type: none"> 16 Academies
Arab Thought Foundation and Intel - Triple C (2006-2010)	Digital Learning dissemination - Distribution of equipment	<ul style="list-style-type: none"> Introduce Intel eLearning series solution to teachers, including Classmate PCs , and all software embedded within Inspire teachers to use Intel Learning Series technology creatively and to help students acquire knowledge in a 1:1 e-Learning environment Help teachers create student-centered lesson plans for instructional purposes to allow students to use Classmate PC's integrated tools, embedded software, and associated online education materials 	<ul style="list-style-type: none"> 1120 Intel Classmates to Students 40 Intel Classmates to Teachers
Cisco - Hariri Foundation, BMB (2008-2010)	Lebanese National Educational Network (LEBNEN) - Networking	<ul style="list-style-type: none"> Establish a National Education Network using Cisco Networks devices to connect all public high schools across Lebanon Manage the connectivity between any public school and the "data center" of the MEHE Facilitate communication between the schools and 	<ul style="list-style-type: none"> 50 Public Schools

Organization and Partners	Project Name/Type of Assistance	Stated Goals	Target Audience
Microsoft (June 2009 - present)	Live @EDU	<ul style="list-style-type: none"> the relevant directorates in the MEHE Make full use of this infrastructure for e-content development Provide cloud-based email; enterprise-class tools; online document sharing and storage Facilitate alumni communication Improve/facilitate communication among the MEHE, school administrators, faculty, parents and students Introduce ICT in the classroom and prepare students for the future 	<ul style="list-style-type: none"> 5 pilot schools (reduction of initial target set for all teachers and students in Lebanon)
Walid Bin Talal - Promethean and IET (2010-2011)	Interactive Boards (IWB): distribution of interactive whiteboards (IWBs) and teacher professional development	<ul style="list-style-type: none"> Integrate ICT in education based on 21st century education strategies by using IWBs in the classroom Compliance with "green" ICT through student centered learning and sharing digital content Create one for all and all for one teacher's community interactive lessons portal based on 21st century learning skills interactive lessons database 	<ul style="list-style-type: none"> 113 IWBs 3600 teachers and education leaders
Microsoft (2010-2012)	Partners in Learning: Innovative Schools	<ul style="list-style-type: none"> (Same goals as Partners in Learning: Innovative Teachers) 	<ul style="list-style-type: none"> 2010: Two schools 2011: One government school thus far

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These major private-sector initiatives, along with other public sector initiatives (such as World Bank provision of computers to schools mentioned in page 14), and other private-sector initiatives not mentioned here⁸, have laid the foundation for at least some schools to gain the connectivity and technology training necessary to embark on many of the ICT in educational programs that will be outlined in Figure 3. These initiatives also have contributed in some measure to improved access to technology, particularly in Lebanese government schools (though we would need to carefully examine placement to determine to what degree this has occurred). For instance, according to data from the Center for Educational Research and Development (CERD), as of 2008, on average, Lebanese government schools reported having 9.85 computers per school compared to 17.23 per private schools (Nasser, 2008: 680). The same set of CERD data (cited by Nasser, 2008:69) indicated that 5.7 percent of government schools reported having Internet access compared to 52.7 percent of private schools.⁹

Figure 4: ICT for Education Programs in Lebanon (2000-2011) (Data Source: Organizations listed)

Years	Implementer	Project Name	Project Goals	Target Audience
2001-2011	<ul style="list-style-type: none"> International Education Association 	<ul style="list-style-type: none"> YouthCaN Med 	<ul style="list-style-type: none"> Integrate environmental education through online collaborative projects Form a network of youth interacting and taking positive steps about environmental issues in their community 	<ul style="list-style-type: none"> 200-500 students per year
2003-2004	<ul style="list-style-type: none"> International Education Association 	<ul style="list-style-type: none"> iEARN Writing Project 	<ul style="list-style-type: none"> Integrate iEARN English writing projects in the Lebanese middle-school curriculum in a structured manner Enable teachers to deliver training to other teachers in one's school to integrate English projects 	<ul style="list-style-type: none"> Year 1: 32 middle school English language teachers Year 2: 16 middle school English language teachers Total number of schools: 34

2005-2008	<ul style="list-style-type: none"> British Council 	<ul style="list-style-type: none"> ICT in Education 	<ul style="list-style-type: none"> Support development of a strategic educational leadership in ICT Build capacity through a pilot training programme Establish and support regional networking at policy and operational levels 	<ul style="list-style-type: none"> CERD and MEHE decision-makers 100 head teachers 700 teachers
2005-2009	<ul style="list-style-type: none"> World Bank 	<ul style="list-style-type: none"> World Links Arab Region (WLAR)¹⁰ 	<ul style="list-style-type: none"> ICT integration Developing tele-research and tele-collaboration projects 	<ul style="list-style-type: none"> Approximately 1600 secondary school teachers
2008-2011	<ul style="list-style-type: none"> International Education Association 	<ul style="list-style-type: none"> Global Teenager Project 	<ul style="list-style-type: none"> Enhance the quality of education Promote intercultural awareness and communication by introducing schools to the exciting new applications of information and communication technologies (ICTs) Promote intercultural awareness and sensitivity by opening up regular, lively classroom debates in a safe and structured environment. 	<ul style="list-style-type: none"> CERD and MEHE decision-makers 100 head teachers 700 teachers
2008-2012	<ul style="list-style-type: none"> British Council 	<ul style="list-style-type: none"> Connecting Classrooms 	<ul style="list-style-type: none"> Build the learning environment through links (UK/region) to support the development of practitioners and educational institutions to foster better understanding, and remain committed to positive social change Prioritize the development of the systems (curriculum development, policies, practices), knowledge, skills and understanding required 	<ul style="list-style-type: none"> 174 Schools (70 from public schools) 20 ICT Trainers 180 Head Teachers 1339 Teachers 25,000 Students (worked on curriculum projects)

⁸At the Ministry of Education and Higher Education's ICT Round Table in June 2011, technology companies were asked to complete a questionnaire and return to MEHE for inclusion in this monograph. Only companies who returned questionnaires are included in this monograph. Since we have no data on other technology companies, we cannot discuss their initiatives here.

⁹There is a seeming anomaly in these data: "Surprisingly however, 97.8% of these schools reported they had an email address; whereas, 71.1% among private schools had an email address" (p.69).

¹⁰ World Links was originally developed by the World Bank in 1999. It eventually became its own Non-Governmental Organization (NGO). World Links Arab Region (WLAR) in turn was spun off as an NGO separate from but connected with World Links.

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Years	Implementer	Project Name	Project Goals	Target Audience
March 2010-May 2011	<ul style="list-style-type: none"> Cisco - International Educational Association 	<ul style="list-style-type: none"> I-Do 	<ul style="list-style-type: none"> to enable regional educational systems to better equip young people for life in a global society and work in a global economy Deliver partnership International School & Leader Awards throughout the region as recognition of achievements and to benchmark educational system development against international standards. Integrate environmental education through online collaborative projects Improve teaching and learning practices using interactive digital technologies through in-depth science research projects, which culminate in the production of classroom digital media (videos, wikis and blogs) that support the curriculum Leverage the LebNen network by creating digital material that complements/supports the curriculum and provides third party content that is relevant 	<ul style="list-style-type: none"> Year 1: 11 science research projects Year 2: 18 science research projects
2010-2012	<ul style="list-style-type: none"> UNESCO 	<ul style="list-style-type: none"> EduLab 	<ul style="list-style-type: none"> This is a project to develop interactive educational digital tools for grade 7 teachers covering difficult concepts in physics, chemistry and biology. Develop interactive tools for grade 7 teachers Train-the-trainer program in all educational regions. Train teachers to use interactive resources in the classroom. 	<ul style="list-style-type: none"> Approximately 100 science trainers from CERD covering all educational regions. Approximately 360 teachers trained so far (125 electronic activities for grade 7 classes were developed; 11 physics activities; 51 chemistry activities; 63 biology activities)



Discussion

A few words about the information in Figures 3 and 4: First, the programs listed in both tables do not represent all educational technology programs in Lebanon—just some of the major ones (See Footnote 9). There appear to be a number of private initiatives (e.g., computer donations to government schools from Lebanese or international philanthropic foundations or other types of organizations). Second, not all investments are equal. For instance, Intel primarily contributes “in-kind” assistance—training and materials (and in one case its Classmate PC laptops) while other companies, like Cisco, contribute equipment and in some cases funding (Shal, personal communication, July 1, 2011). Next, all information has been supplied by technology companies or organizations themselves and the information in Figures 3 and 4 is taken directly, and verbatim, from those documents. Any omissions of information or lack of clarity and specificity in Figures 3 and 4 are traceable to the documents themselves.

Finally, and most important, we see several patterns emerge from the data in Figures 3 and 4. For the most part, ICT initiatives in Lebanon are small scale, not coordinated, lack consistent follow-up, do not measure impact (as opposed to use or outcomes) and either fail to evaluate or do so in the most rudimentary fashion (e.g., Intel’s teacher self-reporting data, evaluators’ heavy reliance on anecdotal information and post-workshop satisfaction surveys) and with varying levels of quality. The lack of research and evaluation on these pilots represents a missed opportunity to begin building a local knowledge base—not just about ICT in education, but how these tools and approaches mesh with Lebanese educational environment and with the nation’s overall goals for the use of technology for teaching and learning.

These initiatives notwithstanding, Lebanese stakeholders face a number of challenges in integrating ICTs into its schools. None of these (barring the telecommunications situation) is insurmountable, and given the high-quality of both people and institutions in the Lebanese educational system, they are “fixable” from a purely educational standpoint. Some of these major challenges are listed here:

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Curriculum and Assessment: All Lebanese schools are required to follow a prescribed curriculum designed by the Ministry of Education and Higher Education in 1997. Part of this curriculum includes Information Technology (IT) instruction at the secondary level, in grades 7-12 with one class period per week. This instruction is limited to information skills and does not stress the use of ICT in other content areas (Lebanese Association for Educational Studies, 2007). The curriculum also focuses on preparing students to succeed on two “high-stakes” examinations: the Brevet in grade 9, and the official Lebanese Baccalauréat at the end of the secondary level. Students who successfully complete the Baccalauréat obtain the Lebanese Baccalauréat Certificate of Secondary Education and are eligible to move to university. Informatics, or IT, is not one of the areas examined and thus is not assigned any weight in school evaluation or in the official examination. For this reason, it is not taught in many private and most public schools (Lebanese Association for Educational Studies, 2007).

The Lebanese secondary curriculum focuses on the content topics that are part of the Baccalauréat examination,¹¹ and because the examination is so focused on declarative knowledge within subject domains, teachers naturally concentrate their efforts on “covering” as much content as possible via lectures and demonstrations. Given its lack of prominence in the Baccalauréat, and given the high-stakes nature of the examination system in Lebanon, teachers have little incentive to utilize ICTs—except in cases where it can help them demonstrate content (e.g., through PowerPoint slide shows or document cameras).

As will be seen throughout the remaining three case examples discussed in this monograph, the issue of examination systems is the tail that wags the dog. Nations that have used ICT with any degree of success (the United Kingdom, Singapore, and in some cases and to a certain point, the United States) have done so first by revising and aligning their curricula to match more collaborative and cognitive models of instruction and to facilitate the use of ICTs to support new instructional models and new ways of interacting with content. They either do not have terminal examination systems, or examination systems that are not high stakes, use alternative forms of examination to determine competence, or have examination systems that measure higher-level skills. Nations that have exhibited uneven uses of educational technology (such as Jordan and India) or who have “back slided” in this area (many states within the United States) have utilized examination systems that examine declarative, versus procedural and conceptual, knowledge.

Lebanon in 2011 began the revision of its curriculum, having just completed Cycle 1 (grades 1-3) (Center for Educational Research and Development, 2011). Though technology is not knitted into the curriculum, the new curriculum for Cycle 1 was

piloted in 60 private and public schools in the 2010-2011 academic year, in 100 schools in the 2011-2012 academic year, and revised based on feedback. This curriculum revision will continue with Cycle 2 and so on, making the possibility of technology-related outcomes, benchmarks and performance tasks all the more possible, indeed probable (Fayad, personal communication, September 12, 2011).

Hardware, software and connectivity: Education in Lebanon primarily appears to be a private undertaking. The majority, if not all, private schools in Lebanon have computer laboratories for their students and use computers for administrative tasks, at least. Many of the educational technology initiatives outlined in Figure 3 and the programs undertaken in Figure 4 have occurred in private schools, whose students outnumber those in public schools.¹² Public, or government, schools are less well-endowed—as seen from CERD data on page 18—though because of a lack of national data, it is not clear what percentage of Lebanon’s approximately 1300 public schools have Internet connectivity.¹³ Because there are so many small-scale and informal programs and donations taking place. It may be that the number of computers and degree of connectivity in public schools is in fact under-represented.

The challenge in equipment provisioning for Lebanese schools is not the placement of computers in schools—Lebanon has a relatively small number of public schools compared to other countries—the issue is where in schools the technology is situated. Presently, computers, for the most part, are housed in separate computer labs for the purposes of IT classes. Yet, as research and international experiences suggest (See Section II), technology has shown greater promise and proof as a learning tool when placed in classrooms—rather than computer labs—to support content and instruction.

Lack of teacher support system: According to the Center for Educational Research and Development (CERD) (2011), teachers receive on average five days of professional development per year. This professional development is provided mainly, though not exclusively, by CERD. Currently, there is no public central entity in charge of coordinating and carrying out school-based teacher support were ICT to be introduced on any degree of scale in Lebanon. The Departement d’Orientation Pédagogique Scolaire (DOPS) is a unit within MEHE tasked with teacher support but is under-resourced, and the CERD, mainly responsible for ICT-based professional development, is not mandated to work in teachers’ classrooms. CERD reports that its “continuous training system” serves as a sort of follow-up. However, training or professional development (which occurs intermittently, is focused on exposure to a new idea or innovation and occurs primarily outside of schools at teacher-training centers) and support (which is ongoing, classroom based and focused on practice) are entirely

¹¹The Baccalauréat measures students’ aptitudes to advance to the next educational level in four different subject areas: humanities and literature; life sciences; sociology and economics; and general sciences.

¹²Because of poor economic and financial conditions in Lebanon, there has been a trend toward moving children from private to public schools (World Bank, 2010).

¹³The D-RASATI/CERD field survey carried out in the summer of 2011 should provide more up-to-date and comprehensive data on the available hardware and internet connectivity in public schools. The Center for Educational Research and Development (CERD) estimates that 40 percent of teachers and 15 percent of principals in Lebanese government schools have had ICT training but caution “there are no accurate statistics about it.”

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different interventions. Further, CERD reports that school principals “rarely” enter teachers’ classrooms for the purposes of offering instructional guidance. Cumulatively, these three realities, combined with research on teacher support, would seem to suggest that a major cause of what appears to be a lack of fidelity, quality or sustainable application of technology by teachers in the many initiatives and programs outlined in Figures 3 and 4, is in part derived from the limited support offered to teachers.

Telecommunications policy: In the 1990s, Lebanon played an important regional role in setting the pace for Internet penetration in the Middle East. That has changed. While from 2000-2005, the Internet sector in all Arab countries grew by 50 percent, growth in Lebanon was 2 percent during the same time period. Lebanon ranks ninth of 12 Arab countries in terms of Internet penetration, ahead of only Iraq, Syria and Yemen (Internet World Stats, 2011).

Telecommunications are under the control of the Lebanese Government with the Ministry of Telecommunications (MOT) owning and/or licensing all fixed, mobile, and wireless networks. L’Organisme de Gestion et d’Exploitation de l’ex Radio Orient (OGERO), which is 100 percent owned by the government, has been the only Lebanese entity responsible for the operations, maintenance, sales, marketing, billing and management of the fixed telecom network in the country. Lebanon has two government-owned networks, operated by Orascom Telecom of Egypt and Zain of Kuwait in return for a management fee, with all revenue going to the government. All prices are set by the MOT. There are seven Internet service providers (ISPs) and five data service providers (DSPs) who own wireless networks and constitute five percent of the Lebanese telecom market. 3G wireless network technology was introduced nationwide in November 2011. All purchase international and local bandwidth from the state-owned telecom firm. Services offered are, dial-up Internet and DSL Internet with maximum speed of 1 MBPS at around USD70.

Because of this traditional monopoly, even though it has a higher Gross Domestic Product than many of its Arab neighbors, Lebanon languishes well behind other Arab countries (for example, Jordan) in ICT development, with the inevitable consequences of lower economic and social outcomes than would otherwise be the case. Indeed, the publication, Research and Markets (a division of Berkshire Hathaway) admonishes: “As the years go by, Lebanon falls further and further behind with inadequate broadband services, restricted mobile services, no HSPA and rampant piracy (2011).” While the overall quality of service of ISP in Lebanon is good, Internet fees are still relatively high in Lebanon compared to other countries in the Economic and Social Commission for Western Asia (ESCWA) region, particularly if one considers the low bandwidth offered (ESCWA, 2011;

Research and Markets, 2011). Besides Yemen, Lebanon has the highest combined Internet prices and the lowest penetration rates in the Middle East. Even though it has been improved, coverage in many parts of Lebanon is slow, erratic and expensive.

The failure to release pent-up demand in the mobile, wireless and broadband Internet market has had several negative impacts that adversely cascade to Lebanese schools. The lack of a Public Data Network in Lebanon enabling ISPs to connect to DSLAM/modem in a local exchange is a major barrier to growth of Internet penetration (ESCWA, Ministry of Telecommunications, 2006). The monopoly limits subscriber numbers and artificially maintains high tariffs, which makes Internet access unaffordable and unattractive to schools. ADSL was only introduced into Lebanon in 2007 so its penetration is still evolving. Microwave connections provided by DSPs have limited bandwidth and are costly. This means however, that even where schools might have Internet, they do not have high-speed access, making use of online immersive learning environments, or use of content-based simulations or access to, for example, instructional mathematics videos, all but impossible.¹⁴ The need to address these issues of affordability and availability as part of a national Lebanese ICT strategy is a recurring theme throughout the literature (UNDP & OMSAR, 2003: 6-70; ESCWA, Ministry of Telecommunications, 2006; Research and Market, 2011).

In addition to the issues of access and cost mentioned above, the failure to release pent-up demand also has a profound perceptual effect on schools. Because the Internet is expensive and connectivity unreliable, schools have little incentive to utilize the Internet (and indeed, computers) for teaching and learning. This in turn has an instructional impact—teachers and students are denied access to rich, real-time, multi-modal resources, learning experiences as well as access to knowledgeable colleagues and peers from across the globe.

Despite the many structural obstacles Lebanon faces in terms of developing a coordinated national ICT in education strategy, Lebanon has many advantages that could support such an effort, not least of which are a manageable number of schools (approximately 1300), overall good infrastructure,¹⁵ well-developed institutions, a generally good system of education, a network of private schools, and top quality education officials. The fact that school instruction occurs in French or English means that Lebanese schools have easy access to a range of Internet and DVD-based subject area content (multimedia, virtual worlds, simulations, text, video, etc.). The country is small; the workforce is skilled; the IT sector is developing rapidly; there are numerous media content providers and web portals, well developed GSM cellular networks, and software developers that are considered among the best in the Middle East (Research and Market, 2011).

¹⁴ From documents accessed, it appears that since 2002 privatization has been promised but deferred, so it is unclear what the status of privatization is at the time of this monograph. There are however, promising developments. Since beginning work in 2007, the Telecommunications Regulatory Authority (TRA) developed a Regulatory Framework designed to cover the entire spectrum of the telecom market. In 2009, the MOT lowered tariffs and increased the maximum number of subscribers for each mobile operator which spurred tremendous growth in Internet access in Lebanon—264 percent overall growth from 2000-2011, most of it in the last several years. While such a rate is high, it is one of the lowest rates in the Middle East. By March 2011, only 1.1 million Lebanese were considered Internet “users” (Internet World Stats, 2011).

¹⁵ Unfortunately, a continuous supply of electricity appears to be the exception to this statement.

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“ Since the late 1990s, the Kingdom of Jordan has undertaken the ambitious task of transforming its education system by revising its curriculum, redefining the roles of teachers and learners, and integrating technology into schools and classrooms. ”

Jordan

Since the late 1990s, the Kingdom of Jordan¹⁶ has undertaken the ambitious task of transforming its education system by revising its curriculum, redefining the roles of teachers and learners, and integrating technology into schools and classrooms, primarily through two initiatives—the Education Reform for the Knowledge Economy (ERfKE) and the Jordan Education Initiative (JEI). In many ways, both initiatives are continuations of education reforms that have been underway for decades. In 1960, Jordan’s adult population had an average of 2.3 years of schooling, lower at the time than every country in East Asia (except Indonesia) and Latin America. By 2000, Jordan’s population had higher average education levels (6.91 years) than Indonesia, Malaysia, Thailand, China, and Brazil—all of which (again, except Indonesia) had higher levels of education in 1960 than Jordan (World Bank, 2008: 17).

In 2001, faced with persistently high unemployment and poverty, the Government of Jordan created a program of economic and social transformation to establish a “knowledge economy.” The top priority in this program was the development of the nation’s human resources, in particular education. The Educational Reform for the Knowledge Economy (ERfKE), launched in 2003 to support these human development priorities, clearly articulates its vision for education: “The ability of the educational system to develop and nurture creativity and innovation among learners [is] a cornerstone of an educational system that contributes to the development of a knowledge economy in Jordan. To do this, the educational system must itself be capable of nurturing an environment that encourages individuals to think in creative ways, innovate to solve problems, and capture what is learned and apply this within the wider system” (Ministry of Education, Jordan, 2005: 18).

To attain these goals of innovation, creativity, problem solving and critical thinking, Jordanian education policy committed the Ministry of Education



(MOE) to reform curriculum to balance traditional subject matter with learning process outcomes (Alnoami, 2011: 106). The Ministry of Education redesigned the entire Jordanian curriculum in all grades and all subjects to be outcome-based, focused on critical thinking (through the use of project-based and inquiry-based instruction). The MOE phased this curriculum in by stages over a number of years and also trained teachers in stages over a number of years in its implementation.

Like Lebanon, Jordan in the 1980’s and 90’s also had a number of small projects placing computers in a few schools. By 2000, the government realized the need for a serious effort to build out the national ICT infrastructure and take active steps to move the country towards a digital future. The Ministry of Information and Communications Technologies (MoICT) launched the National Broadband Network in 2002 to build the backbone of the network with universities, and schools quickly followed in 2003. Under this initiative 300 schools were equipped and connected by 2009 (Alnoami, 2011: 108). But ERfKE has since become the main policy route for equipping schools with computers and 85 percent of schools had computer labs by 2009 (Alnoami, 2011: 111).

In coordination with the School Broadband Network initiative, in 2003 the MOE also signed an agreement with a Jordanian company to create EduWave—a national virtual learning platform. Initially launched for a few schools, the network soon expanded to include all public schools that have computer labs. EduWave functions as a national portal, managed centrally and providing the same content and protected virtual areas to all schools. Students and teachers have email and chat capabilities and can access the Internet within Eduwave. EduWave also hosts all the e-content developed by the Jordan Education Initiative (to be discussed below).

¹⁶Thanks to Daniel Light of EDC for his review of and contributions to this chapter.

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The Jordan Education Initiative (JEI) has four objectives:

1. Improve the delivery of education to Jordan's citizens through public-private partnerships
2. Unleash the innovation of teachers and students through effective use of ICT
3. Build the capacity of the local information technology industry
4. Create a model of reform to be used by other countries

These objectives have been translated into these tracks:

Track 1: Discovery Schools (in-classroom technology; e-curricula development; training)

Track 2: Lifelong learning

Track 3: ICT industry development

Figure 5: Objectives and Tracks of JEI (McKinsey & Co, 2005: 6)

Along with initiatives to equip schools with technology and connectivity, Jordan also initiated a number of professional development programs to prepare in-service teachers to use technology as part of instruction. First, in 2000, the MOE began promoting the International Computer Driving License (ICDL) for all teachers, and by 2003 the MOE launched two professional development programs that are specifically designed to promote ICT in education (Toukan, 2007). World Links for the Arab Region (WLAR) was a Jordan-based division of the World Links program that trained 1,500 teachers between 2003 and 2006 to integrate technology and participatory learning techniques into the classroom to improve educational results (Kozma, 2006). A second professional development offering was the Intel Teach program run by the MOE, which 68,000 teachers had completed by 2009.

In 2004, a Jordanian company, Change Agent for Arab Development and Education Reform (CADER), also began offering teacher professional development in ICT. CADER worked closely with the University of Delft (Netherlands) to develop its materials and to train their initial curriculum developers in the latest innovative teaching approaches.

In tandem with the MOE programs, The Jordan Education Initiative (JEI), a \$380 million public-private partnership between the Government of Jordan and over 30 public and private partners, was established in 2003 to support a number of broad social and economic changes critical to Jordan's transformation toward

global competitiveness. Education was a critical component of JEI, which was mandated to support the MOE's reform processes by creating a "test bed" for experimentation and innovation with various ICT tools and platforms in Jordanian schools (Light & Rockman, 2008). The government's thinking was that an entity like the JEI would have more flexibility to take risks developing new resources and approaches in ways that a ministry could not. Further, JEI was envisioned as a catalyst towards creating a digital economy through ICTs in education. Those experiments that proved effective could then be scaled to the entire public school system. Additionally, another part of JEI's mission was to coordinate and promote the creation of e-content resources for Jordanian classrooms by Jordanian companies in collaboration with international experts.

The first phase of JEI (2003-2007) began with a network of 100 ERfKE schools (called "Discovery Schools"). To create a set of schools to serve as a test-bed, each school was given a common set of resources— a computer lab with 18-20 desktops; connection to EduWave; Internet access in the lab and in some classrooms; a teacher laptop and data show projector; and physical and electrical upgrading. Additionally, teachers in the Discovery Schools received instruction in technology operations, using computers for teaching and learning, and promoting learner-centered instruction and higher-order thinking via technology. JEI also required that all teachers in Discovery Schools take at least one of the core professional development programs sponsored by the MOE— Intel Teach, World Links, CADER, and Relief International/Schools Online.¹⁷ Even though all Discovery Schools were expected to move towards fuller ICT integration across the board, JEI also created numerous pilot experiences with subsets of schools. For example, JEI experimented with different infrastructure models such as Computers on Wheels (COWs), Interactive Whiteboards and 1:1 environments, as well as innovative pedagogical strategies, such as Teaching for Understanding (Jordan Education Initiative, 2009a, 2009b, 2010; Taher, personal communication, April 18, 2011).

In addition to the test bed, JEI supported the development of digital resources or e-content for math, science, Arabic, ICT and English as a Foreign Language (Al Masri, 2005; To Excel Consulting, 2007). E-content straddles two tracks of JEI's mission: supporting a Jordanian IT industry; and promoting the integration of ICT into public schools. JEI developed a model for the creation of e-content that promoted Jordanian capacity to create educational software and e-content aligned with Jordanian curricula (Light & Rockman, 2008). The process was a collaboration of the Jordanian public sector with global companies and local companies. The MOE and JEI selected content areas, and JEI recruited a global entity to become a key sponsor of that curriculum providing funding and international expertise. The sponsor was paired with a local company which developed the e-content. The MOE provided a team of curricula developers to work with the international advisors and the content production team. As the program became more successful, Jordanian companies also started to assume sponsorship roles.

¹⁷The author of this monograph developed RISOL's JEI teacher training curriculum in 2003.

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In 2007, JEI began its second phase, targeting an additional 250 schools, though there has only been funding for 86 additional schools (Bannayan, personal communication, April 26, 2011). The second phase of JEI has continued to add additional types of technologies in schools—for instance, Interactive WhiteBoards—and moving computers into classrooms via a small 1:1 laptop demonstration program.¹⁸

If we refer back to the Stages of Educational Technology Implementation in Figure 2, we see that in most areas—ICT policies, provisions of technology in schools, assessing ICTs, teacher training, support and funding—Jordan’s efforts reside between **trialling** and **achieving**. In terms of the latter designation, MOE has overseen the expansion of basic infrastructure, such as hardware and connectivity, and a virtual learning environment; it has leveraged the public/private partnership structure of the JEI to secure funding, digital content and technology in schools, and has infused technology into its national curriculum. Interviews with those involved in JEI (Bannayan, personal communication, April 26, 2011; Taher, personal communication, April 18, 2011) suggest that since 2007, Phase II of JEI has pushed efforts farther along the **achieving** spectrum as mature interventions are being pushed to scale —such as the focus of ICT efforts, technical support for ICTs, teacher training (on ICTs) and attitudes toward ICTs. However, without clear evaluation results of Phase II of JEI, such observations remain at best inferences.

But many components of their ICT in education efforts still rest in the **trialling** stage. These components deal with the critically important human inputs of any ICT initiative—teacher professional development around true integration of technology as part of content; assessment; leadership and human, instructional support for teachers.

Conclusion

In less than a decade, the Government of Jordan has diffused technology throughout the Jordanian school system. The current student to computer ratio is 14:1, though there are initiatives by the Ministry of Education to bring it closer to the internationally accepted standard of 8:1. Presently all of Jordan’s 3422 public schools have computer labs (with typically 18-20 computers per lab) and all secondary schools have Internet access, though because of nation-wide telecom infrastructure issues, schools outside Amman, even wealthy ones, like the King’s Academy, struggle with low bandwidth. Subject supervisors and Ministry of Education officials also have their own laptops. Information on students is tracked at the central level through an information management system (with teachers inputting much of the information) and Jordan is in the process of writing its second National Educational Technology Plan.

Finally, students in JEI schools have outperformed their peers in non-JEI schools on the latest Programme for International Student Assessment (PISA).

Even though many infrastructure issues have been resolved and many teachers have basic familiarity with ICT, the Jordanian MOE is still not seeing the desired degree of use nor the innovative use of ICT (Alnoami, 2011: 124). In 2007-2008, Education Development Center¹⁹ and Research Triangle International conducted an evaluation of the initial years of JEI. Evaluation data showed that teachers in the Discovery Schools were able to use their ICT resources and that many (73 percent) stated that they used ICT for their own planning and as part of instruction (66 percent) (Light et al. 2008: 11). Yet the most frequently observed uses of ICT did not align with the learner-centered, higher-order thinking paradigm envisioned by JEI and ERfKE. The prevailing use was highly traditional and teacher centered. Even where teachers had laptops and a projector, only 31 percent used this equipment, in contrast to 96 percent who used the chalkboard. In a self-report survey with 476 JEI teachers, fewer than 20 percent reported using word processing, electronic presentation, email and Internet applications “once a month or more” (Light et al. 2008:12).

There appear to be four issues that handicapped the instructional technology vision of both ERfKE and JEI initiatives (Again, it is not yet possible to comment on Phase II).

First, and most critically, though Jordan reformed instruction and curriculum, it did not revise the Tawjihi, its terminal examination system for secondary school. Since this is a high-stakes exam which determines students’ chances of university education, the exam drives instruction. In interviews with EDC evaluators, teachers expressed concern that the highly-centralized examination system makes it difficult or impossible to take risks, implement new practices (Light et al. 2008: 8) or focus on higher-level cognitive practices. In a report summarizing Jordan’s educational initiatives, USAID described the Tawjihi as “an outdated exam used to determine the future career direction of students... As a result of the importance of this exam,” the document says, “The education system in Jordan has become distorted with success on the Tawjihi outweighing preparation of students for the challenges of today’s modern work place” (USAID, 2003:29).

Second, the processes of procuring and placing the computers in schools paradoxically resulted in keeping teachers and students away from technology. Computers were restricted to computer labs or only one was given to a teacher. This had three immediate impacts on teaching and learning. First, computers and disciplinary content were physically segregated by time and place. Because of difficulties scheduling labs (Light et al. 2008) students could not access digital math content in classrooms while learning math. Instead, if computers were to be used in math class, students and teachers needed to physically relocate to the computer lab. Observations of 181 Discovery School classes confirm that the use of technology in labs for content areas suddenly shifted to more regimented, skills-based activities, versus active exploration of content. Next, having one classroom computer simply reinforced the traditional teacher role of standing

¹⁸At the time of this monograph, there were another 12 1:1 schools in Jordan, supported by initiatives from the United States Agency for International Development (USAID) and the United Nations Entity for Gender Equality and the Empowerment of Women (UNIFEM).

¹⁹Daniel Light of EDC, who reviewed this section on Jordan, led this evaluation. As part of this evaluation, the author of this monograph designed classroom observation tools and trained Ministry of Education supervisors in classroom observation methods.

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at the front of the room and lecturing. Even the preferred software tool by JEI teachers (PowerPoint) meant that teachers simply continued traditional practice by writing lectures in PowerPoint instead of on the chalkboard. Finally, students had no chance in their classrooms to actually use the technology. Thus, their interaction with technology was primarily as a passive observer.

Third, despite the goals of JEI and ERfKE, teachers appeared to have little understanding of one of the basic foundations of these programs— critical thinking. Innabi & Sheikh (2007) in a study of educational reforms in Jordan, observed that “a considerable portion” of teachers lacked a “comprehensive view of critical thinking...displaying restricted or inadequate understanding of the aspects of critical thinking...This may reflect cultural patterns dominating their local communities, where persons do not question their practices and only tend to think critically when they face a dilemma or a very serious situation” (p. 64). This may also reflect the professional development teachers received and is most likely a reinforcement of the first point—that there is no incentive for teachers to learn about or engage in critical-thinking activities with students since the examination system doesn’t measure such skills.

Finally, teachers received limited, if any, in-class instructional support. Where teachers reported receiving in-class support, they carried out activities, such as the tele-research and tele-collaborative activities that were part of World Links trainings (Kozma, 2006). Many teacher concerns—their fear of ceding control; their fear of students witnessing their trepidation about technology; their fear of not knowing how to use certain programs; their inability to use one computer in more learner-centered ways; and their traditional view of their role as a teacher—are all indicative of a lack of ongoing support.

The second phase of JEI appears to be addressing some of these issues. As mentioned earlier, more types of technologies (laptops and Interactive Whiteboards) and configurations (pods of computers in classrooms; mobile labs and 1:1 classrooms) are now being deployed. Professional development offerings to JEI teachers appear to be diversifying from technology “skills training” to change management, classroom management, more critical thinking and even instructional design through Harvard’s online Teaching for Understanding course (a pilot offered to 8 teachers).

Based on Phase I evaluation data, ERfKE and JEI had not, as of 2007-2008, fulfilled their core goals. Nonetheless, ERfKE and JEI have positively impacted education in Jordan. Within the Arab world, Jordan is viewed as a leader in the area of educational technology with a national initiative that is nothing if not ambitious. Every Jordanian school has at least one computer with Internet access. Many schools have technology, not just in labs, but in classrooms where

they can be accessed as part of actual content-based instruction. Though there are certainly implementation gaps and uneven application, Jordan has reformed its curriculum to align with how students actually learn. The Jordanian Ministry of Education has worked to build buy-in and consensus from Jordan’s teachers in these new educational directions and has been very forthright in admitting, and learning from, its failures (Taher, personal communication, April 18 and 20, 2011).

Most important, Jordan’s educational system has been recognized as the world’s 20th “most improved” (Mourshed, Chijioke & Barber, 2010: 18, 25) gathering a designation of “Fair” (one standard deviation below the mean score for all 20 nations).

The experience of Jordan holds multiple lessons learned in terms of building a nationwide educational technology “system.” First, the Jordanian example demonstrates that reform is an ongoing and uneven process with many successes and failures, but one that requires buy-in from all stakeholders—from educational policymakers, the business community, educators and government leaders. Reform requires openness and honesty about success and failure manifested by ongoing evaluation, using evaluation results for program improvement and openly disseminating results with an eye toward improvement. To this extent, Jordanian educational reforms have been laudatory.

Next, the educational reform efforts of Jordan illustrate the importance of aligning all elements in the educational system—curriculum, instruction, assessment, leadership, and the teacher evaluation system. Jordan attempted to align most but not all elements, foregoing revision of one of the most important components—assessment. Assessment, especially high-stakes assessment like the Tawjihi, is the imprimatur for teachers. It drives what teachers teach, how they teach it, and the materials and tools they select and use for instruction. As the examples of both Britain and the US will reiterate, without assessment reform that is aligned with how technology should support students’ ways of learning, technology will not serve as a tool for reform, and if used, will only be employed in the most mechanistic and rudimentary fashion. As Jordanian teachers themselves implied, and in some cases stated, in 2007 interviews, unless the assessment system changes, they have little incentive to change how they teach or use technology as part of instruction.

Third, examples from Jordan speak to the importance of moving beyond a parsimonious definition of “access” to a broader definition that sees access not just as provision but as also establishing the conditions for use. In Jordan, as in almost all countries where educational technology initiatives are first initiated, access is primarily viewed as placing computers in schools (typically in a lab) and teaching teachers how to use various software applications and the Internet.

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However, as seen from Phase I of JEI in particular, and global experiences in general, teachers and students need technology—not in a computer lab down the hall, in another building or on the third floor—but in their classrooms where teaching and learning occur.

Thus, “access” must move beyond simple technology operations or technology as an “add on” to standard lessons, toward a greater understanding of how technology can be integrated with content-specific pedagogy to help students master curricular objectives. “Access” needs to involve helping teachers understand what types of technologies can facilitate certain types of student learning and how they do this. It should comprise assisting teachers in linking specific technology applications to content-specific pedagogies to assure mastery of content. Finally, access should involve providing teachers with appropriate content that is not simply digitized but that dovetails with examples and models of how technology can add value to students’ content knowledge. In recognition that access is a broad term that encompasses physical proximity and a full range of skills—mechanical, logistical, conceptual and instructional—Phase II of JEI is providing more technology to classrooms and moving teachers away from professional development focusing on computer operations toward professional development that is more grounded in curriculum, instruction and change management.

Fourth, the Jordanian experience informs us that teacher professional development is not enough. Teachers need ongoing professional development, not in some centralized computer lab, but in classrooms that mirror the constraints that teachers themselves face—teaching in learner-centered ways with only one computer, managing 30 students and one computer, placing students in groups where there is a lack of space or where desks don’t move. Besides professional development, teachers need ongoing instructional support so that they can begin to integrate whatever technology they have at their disposal into their classroom.

Finally, the Jordanian path to integrating ICT highlights the importance of self-reflection and experimentation. Only by piloting, evaluating and researching even the smallest pilot experiences, has Jordan been able to develop the variety of experiences, local expertise, professional development programs (CADER) and virtual platforms (EduWave) that continue to drive the reform and integration process in Jordan and that potentially serve as a model for the Arab region.

“ In 1997, a newly-elected British government embarked on a series of centrally-driven education reforms ”

United Kingdom

In 1997, a newly-elected British government embarked on a series of centrally-driven education reforms including national strategies to improve student learning in literacy and math in early elementary school; efforts to turn around failing schools; and teacher training and pay reforms. An important, though not central, piece of this reform was the extensive provision of Information and Communications Technologies (ICTs) in British classrooms across all grade levels. The government committed itself to spending £1.6billion in order to meet its targets for ICT in education in the period from 1998 to 2002 (DfES 1999: 3). This effort included connecting every school in the country to the Internet and providing additional computer equipment for every school to meet government targets of at least one computer for every 11 pupils in primary schools and at least one computer for every seven pupils in secondary schools (DfES 2001b).

In addition to this £1.6billion, further funding was made available for:

- £60million to establish a number of Centres of Excellence for IT, and High Technology Training and Skills Challenge projects (DfES 2001a);
- £230million from the Lottery-funded New Opportunities Fund: Training every teacher in UK state schools to make effective use of ICT as a tool to support teaching in other subjects. This included funding to train librarians. (Twining & McCormick 1999);
- £35million to cut bureaucracy in schools through the use of ICT (Becta, 2001)

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As part of this extensive ICT provision were the following major initiatives:

The National Grid for Learning (NGfL): NGfL’s overall focus was to increase the provision of provision of ICT hardware, digital content, Internet access in schools and Internet connectivity between schools (Twining 2000). The major component of NGfL was a “meta-depository” (Peters, 2005: 99) for digital educational materials that included, for instance, artifacts from museums and universities. The NGfL network included sites for parents (Parents Online), students (Grid Club), and teachers (Teachernet and the Virtual Teachers’ Center²⁰) (Peters, 2005: 99). The NGfL, funded by £710million of new money from 2002-2004, was eventually absorbed as Curriculum Online, a mix of free- and pay-content, including pupil assessment software and interactive video. A proportion of this content was vetted by Teachers Evaluating Educational Multimedia (TEEM), “experienced classroom teachers” (Peters, 2005: 99) with a history of using software for instruction who were trained to assess educational digital content (Peters, 2005: 99).

British Education Communications and Technology Agency (Becta): Becta was created as a research and evaluation agency arm of the government to enable the educational system to continually improve educational technology initiatives through continuous research and evaluation (Peters, 2005:100). Becta quickly established itself for the frequency and quality of its reports, in particular its IMPACT studies, and was a common resource not simply for British educators, researchers and policymakers, but for international ones as well. Becta was decommissioned in 2008.

The UK’s Educational Technology Efforts: Achieving

These educational investments and initiatives produced demonstrable results: By 2000, the lowest performing school districts in reading were outperforming the average in 1997, and as a result of these educational initiatives, the United Kingdom (UK)²¹ has been considered a global leader in education reform with the world’s sixth most improved educational system (Mourshed, Chijioke & Barber, 2010: 18). Additionally, the UK has been regarded as a global leader in the area of educational technology in schools—100 percent of its schools are connected to the Internet and it has spent close to £2 billion from 1997-2008 (Ofsted, 2008:33). The belief that technology confers an educational benefit—not simply a vocational one—has formed the rationale for huge investments by

the central government, and many parents, in Information and Communications Technologies (ICTs) in schools.

British schools are generally quite well-resourced in terms of technology. Eighty-nine percent of primary schools provide “good”²² Internet access levels to teachers (BESA, 2010:1). Nearly 80 percent of primary schools have Interactive Whiteboards (BESA, 2010:2) and the median pupil-computer ratio for primary schools is 6.9 and for secondary schools is 3.1 (Becta,2010:8). In special schools, where levels of ICT provision have traditionally been higher, the pupil-computer ratio in 2007 was three students per computer (UK Government Statistics, 2007). Eighty-eight percent of secondary schools and 74 percent of primary schools have wireless access (BESA, 2010:4). The average secondary school has 310 Internet-connected computers for students while the average primary school has 46 (NERP, 2010: 4). Many UK classrooms enjoy 1:1 or “ubiquitous” learning environments. In England, 92 percent of primary school teachers, 91 percent of special school teachers, and 74 percent of secondary school teachers reported “regular use of ICT in teaching and learning” in 2004 (UK Government Statistics, 2004:17).

Britain, like Jordan and Lebanon, and unlike the US, has a highly centralized educational system which makes standardization and coherence of educational initiatives possible (in England, Wales and Northern Ireland—though not Scotland). Along with generous provision of ICT in schools, the UK Department for Education (DfEd) has provided teachers with ongoing professional development and mentoring to help teachers use and integrate ICTs into content areas (though the adequacy and efficacy of such efforts are subject to debate, as will be discussed momentarily). DfEd has improved the occupational prestige of the teaching profession with greater pay and greater accountability. It has furnished schools with abundant digital content, materials, mandatory standards²³ and detailed curriculum for using ICT across all subject areas and “key stage” areas (See Figure 6).²⁴ The Qualifications and Curriculum Authority (QCA) links ICT within all content areas to “Key Stage” assessments. These assessments measure students’ content-area and thinking skills and provide both national data on students’ capabilities and information on individual students pertinent to classroom-level instruction. These Key Stage assessments (fully rolled out in 2006) have garnered the attention of numerous ministries of education across the globe.

²⁰ As its name suggests, The Virtual Teachers’ Center offered online professional development to teachers.

²¹ “Schooling” in the United Kingdom—England, Scotland, Wales and Northern Ireland—is a rather complex affair. Scotland and Northern Ireland have separate educational systems. Sometimes their data are included in overall data about education in the UK and sometimes not. Thus, much of the data reported here may include all four territories or just England and Wales. We will explicitly note this where possible. There are also a number of different types of schools—maintained schools (government schools), specialist schools (though they follow the National Curriculum, they focus on a particular subject area, such as sports, technology or visual arts); community schools (run by the local authority, which employs the staff, owns the land and buildings, and decides which ‘admissions criteria’ to use to allocate places if the school has more applicants than places); independent schools (these schools set their own curriculum and admissions policies, are funded by fees paid by parents and income from investments, and just over half of them have charitable status); and private schools (the latter follow the national curriculum to varying degrees.) (Directgov, n.d.)

²² “Good” is not defined in this document.

²³ The UK’s ICT standards are the most detailed of any country in Europe and these standards were adopted in stages.

²⁴ See <https://www.education.gov.uk/publications/Search/List>

01. Educational Technology in Lebanon, Jordan, the United Kingdom, and the United States

Figure 6: Key Stage Designations for UK Schools

Key Stages	Designation	Subjects Assessed ²⁵	Years (England and Wales) ²⁶	Based on...	Age of Pupils
KS1	Pre-school/infant school	<ul style="list-style-type: none">readingwritingmaths	<ul style="list-style-type: none">Year 1 and Year 2	<ul style="list-style-type: none">Teacher's assessment, taking into account child's performance in several tasks and tests.	5-6
KS2	Primary	<ul style="list-style-type: none">Englishmathsscience	<ul style="list-style-type: none">Four years of schooling in maintained schools. Years 3-6	<ul style="list-style-type: none">Teacher's assessment and child's national test results.	7-11
KS3	Junior Secondary	<ul style="list-style-type: none">Englishmathssciencehistorygeographyforeign languagesdesign and technology ICTart and designmusicphysical educationcitizenshipreligious education	<ul style="list-style-type: none">Three years of schooling in maintained schools. Years 7-9	<ul style="list-style-type: none">Teacher's assessment	11-14
KS4	Senior Secondary		<ul style="list-style-type: none">Two years of school education which incorporate GCSEs²⁷ and other exams, in maintained schools in England, Wales, and Northern Ireland. Years 10-11	<ul style="list-style-type: none">GSCE exams	14-16
A-Level	University Preparation		<ul style="list-style-type: none">Years 12-13		17-18

Learner-centered instruction is based on four beliefs—all grounded in belief of individual differences:

1. Individual learners have different, or unique, learning styles, thus instruction should be differentiated and individualized to address these styles.
2. Individual learners have different working styles, thus instruction should attempt to match these working styles through collaborative and solo learning that focus on a variety of ways of working (writing, role play, reading, hands-on experimentation, etc.)
3. Individual learners learn in different ways depending on learning resources/tools, thus instructional activities should employ a variety of learning tools, experiences, and resources (computers, books, people, artifacts, etc.)
4. Individuals process information and construct knowledge in different ways, thus instruction should allow for a variety of “knowledge generating” modes, for instance, inductive and deductive learning.

Figure 7: Learner-centered Instruction

The overall dominant instructional paradigm in British classrooms is a learner-centered one. Technology use, even in urban schools that serve students from poorer communities, involves teachers facilitating student learning as these students work in collaborative teams using technology to search for information, collaborate on a project or report, or carry out assignments via a learning management system or handheld device.²⁸ Additionally, until 2008 budget crises intervened, the British Government continuously researched the role and impact of technology on student learning through the now-decommissioned British Educational Communications and Technology Agency (Becta)—primarily via its IMPACT2 study and the yearly Harnessing Technology reviews of research (Becta, 2007, 2008, 2009, 2010; Condie, Munro, Seagraves, & Kenesson, 2007)—the Department for Children, Schools, and Families (DCSF) (also decommissioned) and the still-extant Office for Standards in Education (Ofsted).

Based on all of these efforts, the educational technology efforts of the United Kingdom may best be categorized as **achieving** on the overall Stages of Educational Technology Implementation continuum shown in Figure 2 (pages 10-11). However, despite heavy investments in technology, teacher training and supports for teachers, the benefits for British students remain a subject of debate. For the most part, research within Britain demonstrates positive effects on students regarding the use of ICTs. For instance, Becta reported that schools with good ICT resources, such as high-speed broadband access and Interactive Whiteboards, achieve better results in KeyStage 4 national exams than those lacking such resources (Commission of the European Communities, 2008:8). When comparing schools with “very good” ICT resources²⁹ and schools with “poor”³⁰ ICT resources, more than half of the schools in the “very good” category were achieving above national standards in science, compared to less than a third of the schools with “poor” ICT resources. A similar picture was seen for Key Stage 2 English and mathematics.

Similarly, Becta’s IMPACT2 study (2004) reported that at Key Stage 2 there is a consistent trend for pupils³¹ in schools with better ICT resources to achieve better grades for English, mathematics and science. In schools that have been commended for high standards or good improvement, ICT is being used widely in a range of subject areas. This was true even for schools where students came from low socioeconomic backgrounds.

In Britain, one area where ICT is perceived to have an important influence is on learner motivation. A study of pupils and teachers in 17 primary and secondary schools in England in 2004 (Passey, Rogers, Machell, & McHugh, 2004) found that ICT use had a positive effect on motivation across the age ranges for both boys and girls. This was shown in a variety of ways, including improvements in behavior in school and completion of homework. In particular, ICT was found to

²⁵ See http://www.direct.gov.uk/en/Parents/Schoolslearninganddevelopment/ExamsTestsAndTheCurriculum/DG_10013041

²⁶ Scotland and Northern Ireland, which comprise the remainder of the United Kingdom (Britain), have different types of school systems. Scotland does not use the Key Stage System and Northern Ireland schools calibrate the ages and years of schooling differently.

²⁷ The General Certificate of Secondary Education (GCSE) is an academic qualification awarded in a specified subject, generally taken in a number of subjects by students aged 14-16 in secondary education in England, Wales and Northern Ireland.

²⁸ Based in part on the author’s observation of East End London schools in 2007.

²⁹ It is not clear what constitutes “very good” ICT resources.

³⁰ It is not clear what constitutes “poor” ICT resources.

³¹ In the UK, “pupils” refers to children in primary schools, while “students” is used for children and young people in secondary schools. We follow that designation in this monograph.

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Types of Knowledge

Declarative (or propositional) knowledge is knowledge of facts and comprehension of ideas. Sometimes referred to as “knowledge of” or “knowledge that,” declarative knowledge is uncovered by What, When, Where or Who questions.

Procedural knowledge is knowledge used to carry out procedures or solve problems. Procedural knowledge is sometimes referred to as “skills.” Procedural knowledge can be uncovered by How questions.

Conceptual knowledge is knowledge that helps learners understand major abstract or concrete concepts within a system. It addresses why something is significant, how it relates to other issues, how it can be assimilated into larger understanding. Conceptual knowledge can be uncovered through Why, How and What if questions.

Epistemological knowledge is often not considered as a type of knowledge but rather a branch of philosophy. Nonetheless, it focuses on the nature and limitations of knowledge. It also focuses on how we know what we know about a particular domain, how we acquire information and how we distinguish between information, knowledge and beliefs.

Figure 8: Types of Knowledge

help motivate and engage pupils with disabilities, and those who were disaffected with traditional forms of learning. ICT was also perceived to have a positive impact on helping children with special educational needs (SEN) in the 2004 ICT in Schools Survey. A majority (71 percent) of special schools in England reported that ICT had a substantial impact on helping SEN pupils. While this overall figure was much lower for both primary schools (19 percent) and secondary schools (30 percent), only a few schools (8 percent of primary, 5 percent of secondary and 1 percent of special schools) reported no impact.

But the investment in technology is not without its weaknesses, two of which will be discussed here. The first is teacher professional development in the area of ICTs, in particular the initial stages of these major initiatives (1997-2004). As Peters (2005) notes, “In contrast to other expenditures, the United Kingdom’s approach to ICT professional development seems miserly—a one-time lottery payout of £230 million or about £500 per teacher” (p. 100). Studies show that

most professional development efforts were short-term offerings initially focused on technical operations, with little or no focus on instruction and assessment. Ignored in the panoply of ICT efforts by the United Kingdom was “an entire body of research suggesting that for professional development to be effective, it must be long-term and integrated into the ways teachers solve problems” (Peters, 2005:101).

Next, the extensive provision of ICTs appears to have had little or no impact on measures of British students’ proficiency as measured by the Programme for International Student Assessment (PISA).³² It is important to note here that the PISA does not measure students’ technology proficiency or technology-related learning. Nonetheless, it is frequently employed as an international comparative metric to gauge how well 15 year olds are doing in certain subjects compared to their peers and, however unfairly, as a measure for how “well” or “poorly” technology has impacted student learning. Because PISA scores and technology has been linked in public debates in Britain,³³ we make reference to PISA scores in this monograph.

On the latest (2009) PISA, British students were ranked 16th in the world for science, 25th for reading and 28th for maths. That compares with a 2000 PISA ranking of 4th for science, 7th for reading and 8th for maths. The OECD has studied the link between student computer use and PISA exam scores (Fuchs & Wößmann, 2005) but concludes that while higher technology use, in particular home computer use, is linked to higher PISA exam scores, technology serves as a proxy for income—and it is income—not access to computers in schools—that is highly correlated with educational achievement. Partially as a result of slipping PISA scores, Britain is expanding the number of independent academies to replace local-authority comprehensive schools and allowing for the creation of a certain number of “free schools” which are run by parents, charities and local groups (Economist, 2011b:25).

Like Jordan, Britain’s educational technology initiatives can provide policymakers and practitioners with useful and actionable information as they move forward with ICT in education efforts. UK organizations and universities have been very diligent in documenting best practices and “lessons learned.” Some of these lessons learned—offered by the Office for Standards in Education, Children’s Services and Skills (Ofsted)³⁴ in a three-year study (2005-2008) of how ICT was used in 177 maintained³⁵ schools—are discussed below.

³² The PISA is a global evaluation of 15-year-old school students’ academic performance from (primarily) OECD countries. The exam is administered every three years. Separate scores for England, Scotland and Northern Ireland (2009) showed that the three countries scored at around the OECD average while Wales underperformed in every area. Students in Finland, Singapore and South Korea were top performers. In addition to the PISA, there are two additional international measures that compare student performance across educational systems. The Progress in International Reading Literacy Study (PIRLS) is a reading test for 4th graders last administered in 2006. The Trends in International Mathematics and Science Study (TIMSS) compares the performance of 4th- and 8th-grade students in math and science, recently administered in Spring, 2011 (no data are available as this monograph was being written). The last year for which there are TIMSS results is 2007. Since PISA results are most recent (2009) of all of these international comparative exams and since PISA is regarded as “the world’s report card,” PISA results are utilized in this monograph as part of our discussion.

³³ See, for instance, <http://blogs.oii.ox.ac.uk/cobo/?p=283>

³⁴ Ofsted is a non-ministerial government department of Her Majesty’s Chief Inspector of Schools in England (HMCI).

³⁵ Maintained schools are those that are funded by the local education authority. They include foundation schools, community schools, voluntary controlled schools, and voluntary aided schools.

Learning focused on development of conceptual skills is linked to higher-level technology use: The type of knowledge formation in which students are engaged (See Figure 8) drives technology use. Ofsted (2009) notes the link between conceptual or higher-level cognitive use thinking and more higher-level uses of technology:

Where standards in handling data were higher, pupils were taught how to collect data using sensors and how to interpret the data using software. For instance, in a Year 6 science lesson, pupils used temperature probes to record a hot potato cooling down and used a spreadsheet to record the data... (p.8)

Similarly, in schools where technology use was considered low level, Ofsted noted:

Too much emphasis (was) sometimes placed on pupils using ICT to present their work well, at the expense of developing their skills in handling information, programming and modeling data...Pupils reached lower standards in the use of data logging and spreadsheets than they did in using ICT to communicate ideas.This (was) because pupils (had) insufficient opportunities to develop their understanding of data collection and modeling and because some teachers (were) less confident with these aspects (p.8)

In schools with “weaker” uses of ICTs, Ofsted reported that technology was used “in isolation and links to other subjects were insecure. Pupils had a limited range of applications to choose from in supporting their learning and there was an overemphasis on using ICT to develop communication and presentation skills.” (p. 13). The coverage of higher-level aspects of using technology—such as using spreadsheets for data modeling—was “superficial” (p. 13).

These observations point squarely to the importance of technology-related professional development that focuses on enhancing or building teachers’ own procedural, conceptual, and epistemological knowledge, particularly within the content areas they teach. Teachers cannot teach students procedures, skills or concepts with which they themselves are not comfortable. For teachers to develop students’ critical thinking skills, as noted by Innabi & Sheikh (2007), they themselves must become critical thinkers and understand how to develop critical thinking with reference to a particular domain. For teachers to help students become better writers, teachers themselves must understand characteristics of good writing and know how to teach, versus simply assign, writing. Indeed, it may be argued that teachers need to learn conceptual skills first and technology second. (For example, the taxonomical design of databases using paper and pencil before learning database operations, and various methods for organizing information using mind maps before learning concept mapping software)

Figure 9 outlines some commonly found classroom technology applications and devices (to be discussed more fully in the next section) and outlines the conceptual skills that underlie the effective use of such tools as well as the

“teaching skills” needed for students to utilize the technology application or tool in ways that support higher-level learning.

Figure 9: Common Classroom Technologies and the Conceptual and Instructional Skills Underlying Each

	Example	Conceptual Skills Underlying Software Design	Teaching Skills Needed
Type of Application/ Technology Computer-Based Productivity Applications	Concept-Mapping	<ul style="list-style-type: none">- Analysis and synthesis- Organization of information- Thinking visually and relationally- Knowing which types of concept maps to use for what purpose (e.g., cause-and-effect maps vs. Venn Diagrams, etc.)	<ul style="list-style-type: none">- Help students think analytically (moving from general to specific) and synthetically (moving from specific to general)- Help students think relationally- Strong questioning techniques
	Word Processing	<ul style="list-style-type: none">- Knowledge of writing process (brainstorming, drafting, editing, revising, rewriting)- Synthesis (pulling separate ideas from different sources and knitting them together to create a coherent argument)- Communication of key ideas in a coherent, organized and evidence-based fashion (thesis statement, main ideas and supporting evidence)- Knowing how to make a claim and support this claim through evidence- Understanding various “genres” of prose writing—expository, narrative, persuasive, etc.	<ul style="list-style-type: none">- Know how to teach the writing process (brainstorming, drafting, editing, revising, rewriting)- Help students develop disparate ideas from different sources and weaving them together to create a coherent argument- Help students develop a thesis statement with supporting ideas and evidence and present in an organized fashion- Teach grammar, language conventions, mechanics, word choice, spelling and punctuation
Visually-Based Applications	Interactive WhiteBoards	<ul style="list-style-type: none">- Understanding relationship between multimedia and text (for example, corresponding words and pictures are presented simultaneously rather than successively)- Knowing how to access visual information that illustrates concepts and complements text- Using visual information to add to, not detract from, main concepts to be learned- Visual literacy: Selection of types of visuals (motion vs. still, diagrams; charts; types of graphs, etc.)	<ul style="list-style-type: none">- Help students analyze moving and still images- Ability to use IWB to promote interactivity among students- Ability to develop distributed learning activities that allow all students to utilize IWB- Develop students’ visual literacy skills- Ability to relate text and still/moving images visually so they complement student acquisition of key concepts

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Educational Technology in Lebanon, Jordan, the United Kingdom, and the United States

Multimedia Applications

Example

Conceptual Skills Underlying Software Design

Teaching Skills Needed

Student Response Systems

- Propositional knowledge (about a topic)
- Understanding areas of difficulty for students
- Understanding most important points of a domain

- Formulate open-ended and probing questions
- Diagnostic and formative assessment
- Promote student reflection
- Setup cooperative learning opportunities

Digital Learning Games/Simulations/Virtual Worlds

- Subject-domain knowledge
- Persistence, problem-solving, willingness to collaborate, self-directedness
- Appreciation of “play” as essential to learning

- Strong content knowledge
- Content-specific pedagogical knowledge
- Scaffold students when they are lost or disoriented

Provide ongoing professional development to teachers: Such educational technology-related professional development should focus, not on the development of technology skills but on the larger conceptual issues of teaching with and through technology—how to use various software applications to support student learning outcomes; how to organize the classroom environment to take advantage of minimal technology so that students can collaboratively utilize computers in meaningful ways that support learning; how and when to use computers for some instructional tasks and how and when not to use computers for other instructional tasks. The somewhat truncated (at least initially) practices around ICT-related professional development for UK teachers highlights one of the real tensions in the integration of technology into any educational system—the belief that technology integration should focus on building teachers’ technology skills versus minimizing the use of ICT to develop skills and instead using it to help teachers augment curricular, instructional and assessment capacity.

Cluster or “bundle” integrated interventions and apply with fidelity: In cases where technology has been successfully utilized in British schools (i.e., where student achievement on Key Stage exams has been observed and linked to ICT use), this use is traceable, not to one factor or two factors (such as access of hardware and training) but to several integrated interventions—though as Oftsed notes in its report (2009), some factors vary from school to school. Overall, in the area of effective uses of ICTs, these interventions include ongoing, high-quality professional development in ICT use and in ICT for instruction and assessment, provided by the school itself; ongoing, skilled support for teachers from local authorities and helpful national guidance

in linking content, curricular objectives and assessment to particular types of ICTs; better access to resources, including computers from the Laptops for Teachers scheme, and on-site technical support.

A word about technical support: In British schools where technical support was readily available, teachers were more inclined to experiment with ICT and to encourage pupils to do the same. In many schools, however, technical support had to be summoned from outside when problems arose and this limited teachers’ willingness to try out new hardware and software. Some schools got around these issues of technical support by training its most able Year 4, 5 and 6 pupils to support other pupils and thus assist the teacher. Such programs have been generally successful since these pupils are often highly motivated and take their responsibilities seriously (Ofsted, 2009:14).

In schools that Ofsted designated as having high levels of technology use coupled with “outstanding” teaching, several characteristics or practices were common across schools:

- Planning was meticulous, with assessment used precisely to inform tasks and the next stages of learning.
- Teaching was highly motivating, using engaging and relevant contexts: For example, a classroom simulation of a shop till with a working bar code scanner was enlivened by a visit to a local supermarket; pupils were allowed to work real tills and see how the bar codes were used to generate spreadsheet data for retail stock management.
- Teachers asked challenging questions skillfully to assess pupils’ understanding and to build on their knowledge.
- Teachers provided regular feedback to pupils on how well they were doing.
- Pupils were given the opportunity to collaborate and critically review their own work and that of others; as a result, they were able to demonstrate ICT capability at a higher level.
- Good use was made of teacher assessment to track pupils’ progress and achievement and pupils knew the areas they needed to improve.
- The well-used final plenary session of such lessons tested pupils’ understanding and achievement of the lesson objectives.
- Detailed curriculum guidance and a portfolio of assessed work with examples of work in ICT at different levels provided overall established consistency (p. 12)

The effectiveness of bundling a certain set of interventions to improve school systems is corroborated by research. Mourshed, Chijioke & Barber (2010) state that in the highest-performing and “most improved school systems” throughout the globe (such as Singapore, South Korea and England), policymakers and planners select an integrated set or “critical mass” of actions from the menu of the interventions appropriate to their level of performance, implement them with fidelity, and sustain and “carefully maintain” the integrity of these interventions (p. 26).

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“Educational technology has a long and deeply embedded presence in American schools.”

United States

Educational technology has a long and deeply embedded presence in American schools. Every public school has at least one instructional computer with Internet access and 92 percent of classrooms have one or more instructional computers (excluding laptops on carts). Though the computer-student ratio in 2008 was 3:1, it is most likely much lower now as more states embark on 1:1 laptop programs and as districts begin to launch BYOT (Bring Your Own Technology³⁶) programs which allow students to bring their own laptops or tablets from home to use in school. Though computers are the most common technology, public schools provide numerous other technology devices for instruction, including liquid crystal display (LCD) and digital light processing (DLP) projectors (97 percent), digital cameras (93 percent), and Interactive Whiteboards (73 percent)³⁷ (Institute of Education Sciences, 2008). Figure 10 provides the latest, though dated, official overview of technology in US public schools.

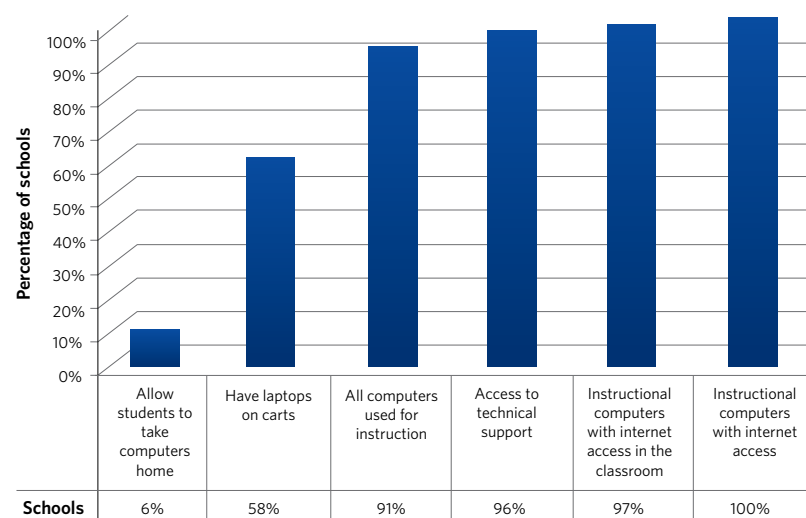


Figure 10: Technology access in US schools (2007) (National Center for Educational Statistics, 2010)

This extensive infrastructure was made possible in large measure by a government funding scheme that was attached to a 1996 Telecommunications Act called the “E-Rate,” essentially a Universal Access Fund to provide discounted Internet access and telecommunications technologies to schools and libraries, through a tax on every American’s phone bill. Since its formal launch in 1998, the E-Rate has provided approximately \$19 billion in discounted services to schools and libraries.



Technology is used in a multitude of ways in US schools. According to US Department of Education data, 91 percent of teachers report that they use computers for instructional purposes. Eighty-seven percent of teachers report using technology for standardized assessment; 85 percent of teachers use digital data to inform instructional planning at the school; and 65 percent of teachers report using digital content (IES, 2008). Seventy-two percent of US teachers report receiving between one and 16 hours of technology-related professional development annually (IES, 2008).

Data from school administrators about their teachers’ technology use are generally consistent with teacher self-reporting data. Figure 11 displays school administrators’ perceptions of teachers’ interest and abilities in using ICTs as part of teaching and learning. Again, these official US Department of Education data are dated (2007) but show that while a majority of US teachers feel comfortable with the amount of technology-related professional development they receive, as with the teacher-reported data in the above paragraph, a significant minority (30-35 percent) still need help in using technology in their content areas, as part of instructional design, and in integrating technology into overall lessons.

³⁶Also known as BYOD (Bring Your Own Device) programs.

³⁷These are 2007 data.

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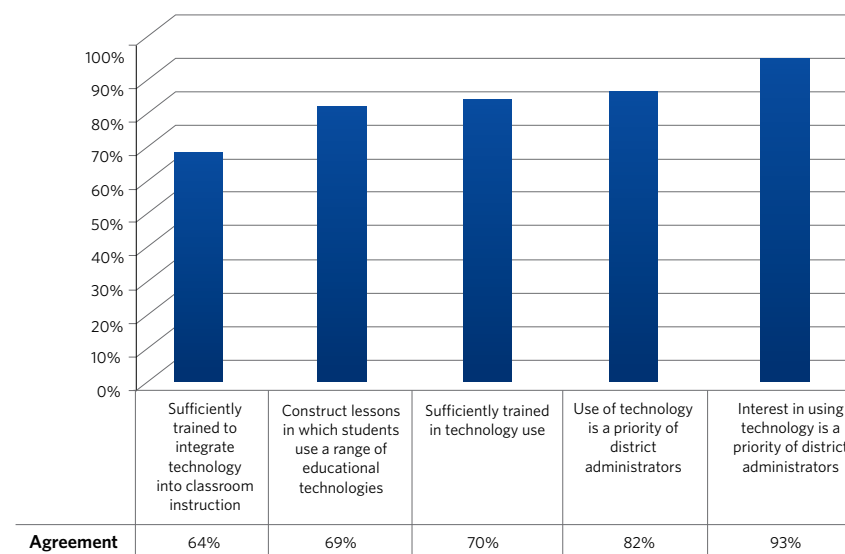


Figure 11: School Administrators Perceptions of Teachers' Technology Skills (National Center for Educational Statistics, 2010)

Though technology is ubiquitous and learner-centered instruction generally the norm, there are significant differences between computer use in low-income and high-income schools in three areas: how technology is used; the types of technology used; and instruction. In low-income schools,³⁸ 83 percent of teachers report that their students use technology sometimes or often to “learn or practice basic skills,” compared to 17 percent of teachers in high-income schools.³⁹ Low-income students are more likely to use “drill and practice” software (Computer Aided Instruction). For example, teachers in low-income schools are more likely to use computers for “remediation of skills” and “mastering skills just taught” and to view computers as valuable for teaching students to work independently (Becker, 1999). Meanwhile, their counterparts in higher-income schools use more simulations, games, and multimedia applications that allow for more rich exploration and expression. Finally, in high-income schools, computer use involves more innovative and constructivist learning approaches. For instance, students in high-income schools are more likely to prepare written texts; conduct research; analyze information; correspond with others; create or use graphics or visual displays; develop and present multimedia presentations; create art, music, movies, or webcasts; or design and produce a product using technology than their low-income counterparts. In low-income schools, computer use often involves traditional practices and beliefs about student learning.

Overall, US educational technology efforts, like those of the United Kingdom, may be best classified as **achieving** in the Stages of Educational Technology Implementation outlined in Figure 2. The US has invested more money in absolute terms in educational technology than any other nation. However,

in general, the results of technology investiture are still often measured—inaccurately we believe—by student performance in state-level assessments and in international exams like the PISA. In the 2009 PISA, US 15-year olds scored slightly higher (500) than their UK counterpart 15 year olds (494) but well behind 15 year olds in Korea, Finland and Canada. Critics point to these results as evidence that technology investments have failed to some degree; yet the PISA is not designed to measure student technology use or learning via technology. The most that can be said from PISA results is that while technology has not helped student performance in PISA exams, it certainly hasn't hurt it either. Nonetheless, American public anxiety about US students' performance vis-à-vis their international counterparts often leads to attacks on spending on ICTs (as well as other educational initiatives).

Each of the 50 US states employs standards⁴⁰—for curriculum, instruction (both online and face-to-face), content, technology use, content development and teacher training. States are free to develop their own standards but 45 states have adopted “Common Core” content standards; and for technology use, many states use the National Educational Technology Standards (NETS) developed by the International Society for Technology in Education (ISTE). These standards are designed to provide guidance and consistency to programs that integrate technology in states, districts, schools and teacher education institutions. ISTE has also developed accreditation standards for teacher preparation programs with a view to encouraging educators to take positions of leadership in ICT.

US Educational Technology Trends

Trends and activities in the US will continue to reverberate throughout the globe for a number of reasons: the sheer size of the US population; its wealth; the largest educational publishing sector in the world; a robust education, technology and educational technology private sector; an extensive university system and non-governmental and private organizations that produce more research, in absolute terms, on school-based technology and learning than any country in the world; and not least, the vast decentralization and autonomy of the US educational system (50 states and 16,000 school districts) provides “incubators” for new ideas around ICT in education. Cumulatively, information from these areas, suggest that several discrete but intersecting trends in US educational technology are worth watching:

Growth of online learning: Growth in online learning is faster than any other innovation in US education. This is particularly true in the area of “virtual” schools, which are essentially online schools. As of 2011, 40 out of the 50 US states presently have state virtual schools or significant online learning initiatives.

Three states now require their high school students to have an “online learning

³⁸These are schools where 75 percent or more students are eligible for free or reduced-price lunch.

³⁹These are schools where 35 percent or fewer students are eligible for free or reduced-price lunch. Since schools in the US are funded via property taxes on homes, neighborhoods with homes that have a high assessed value have wealthy schools. Neighborhoods with homes that have a low assessed value have poor schools.

⁴⁰Not all states have “state” standards for content, teacher professional development, online learning, etc. Many states, for example, Michigan, Maine, Connecticut and New Hampshire are “local control states” and thus each school district within those states may develop or adapt from other sources its own standards for the items listed in this paragraph.

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experience” as a high-school (secondary school) graduation requirement and nearly five million American high school students (as of 2011) are enrolled in online educational programs. As online learning expands, it changes the calculus of teaching and learning—in particular inputs (such as the need to help teachers learn how to teach in an online environment; preparation for students to learn effectively in an online environment; increases in digital content, objects and media; how online schools are funded) and measures (how quality is assessed; student proficiency determined; and online schools accredited).

The US has an ever-evolving array of virtual school programs as Figure 12 outlines. These may be state public online schools; online private schools; state charter schools;⁴¹ university-based virtual schools (for high school students who want advanced placement or extra credit); consortium-based schools; district or local education agency-based schools; non-profit and for profit-virtual schools and non-profit and for-profit providers of content or curriculum for existing virtual schools.

Figure 12: Categories of Virtual Schools (Clark, 2007)

Type	Description
State-sanctioned; state-level	<ul style="list-style-type: none">Virtual schools operating on a state-wide level (Florida Virtual School)
College and university-based	<ul style="list-style-type: none">Independent university high schools or university sponsored delivery of courses to K-12 students (University of California’s College Prep Online [UCCP])
Consortium and regionally-based	<ul style="list-style-type: none">Virtual schools operated by a group of schools or school districts (the Virtual High School Global Consortium)
Local education agency-based	<ul style="list-style-type: none">Virtual schools operated by a single school or school district,
Virtual charter schools	<ul style="list-style-type: none">Virtual schools created under the charter school legislation in many states (Connections Academy). (Commonly known as cyber schools)
Private virtual schools	<ul style="list-style-type: none">Virtual schools that are operated in the same manner as a brick and mortar private school (Christa McAuliffe Academy)
For-profit providers of curricula, content, tools and infrastructure	<ul style="list-style-type: none">Companies that act as vendors for the delivery of courses or the use of course materials (APEX Learning)

21st Century Skills: A major driver of education reform in the US is the business community. Thus educational quality is often explicitly linked to economic competitiveness. One outcome of US concern about economic competition with China and India is a focus on “21st Century” readiness (This is by no means unique to the US. Almost every nation talks about 21st Century learning.). Several US states are attempting to move from or augment “traditional” curriculum and content standards with 21st Century Standards (See Figure 13) by focusing more on digital literacy and critical thinking and by adding courses in financial literacy, for example. Many states are also exploring how to assess 21st century skills and proficiencies.⁴²

Figure 13: 21st Century Skills (Partnership for 21st Century Learning)

Twenty-first Century Skills

Information, media and technology skills	<ul style="list-style-type: none">- Information literacy- Media literacy- ICT literacy
Learning and innovation skills	<ul style="list-style-type: none">- Creativity and innovation- Critical thinking and problem solving- Communication and collaboration
Life and career skills	<ul style="list-style-type: none">- Flexibility and adaptability- Initiative and self-direction- Social and cross-cultural skills- Productivity and accountability- Leadership and responsibility

Ubiquitous Computing: Within the past decade, US schools have increasingly shifted toward “ubiquitous” access to technology for learning. This has commonly meant 1:1 computing using personal laptops. The “1:1 laptop” programs, as they are known colloquially, were established specifically with economic competitiveness and the inculcation of 21st century skills in mind. A substantive body of research suggests that well-implemented laptop programs facilitate acquisition of such skills. In Maine, which initiated the country’s first statewide middle school one-to-one program in 2002-2003, more than one-third of students report using laptops up to several times daily to gather data from multiple sources to solve problems, evaluate information obtained on the Internet, critically analyze data or graphs, solve complex problems by analyzing and evaluating information, explain problem-solving processes and thinking, and visually represent or investigate concepts (Silvernail & Gritter, 2007). With the advent of more mobile devices (see below) there is an emerging shift away from

⁴¹ Charter schools are public (government) schools that receive public funding but are exempt from certain regulations in exchange for meeting certain accountability standards.

⁴² See http://www.p21.org/images/stories/otherdocs/Assessment_Landscape.pdf

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“device-specific” solutions towards Bring Your Own Device (BYOD) approaches that use virtual learning environments where students can access their work on the cloud from any type of device (Smart Phone, cell phone, laptop, tablet, etc.) (New Media Consortium, 2010, 2011).

Shift Toward Mobile Computing: Within US education, there is a dominant belief that learning should be “anywhere and anytime.” Thus, US schools, like British schools, have engaged in a dramatic shift from fixed-desktops and computer labs (which have done little to support technology integration in content areas) toward laptops (58 percent of schools had laptop carts as of fall 2008; the number is certainly higher now), netbooks and tablets (both iPads and Android-based devices). A number of states have begun to digitize content for tablet platforms; school districts have purchased iPads for teachers, administrators and students; and the use of the iPad (in particular) as part of classroom teaching and learning has exploded. This, in turn, has spawned greater acceleration in the development of digital textbooks and more modular and adaptive digital content that adhere to Common Core standards. The availability and increasing affordability of laptops has also spawned the “BYOT” movement—Bring Your Own Technology—in many school districts. Since many students have their own laptop or tablet, numerous school districts are limiting technology purchases by shifting the onus of technology access onto students’ families.⁴³

Both these trends toward ubiquitous and mobile computing have spawned, and in turn have been reinforced by, a push toward greater school choice for students and redefining accreditation as based on fulfilling a set of competencies versus “seat time”—spending a certain amount of time within a grade or subject area.

Open Educational Resources (OERs): The trend toward mobile devices has increased the demand for content, particularly interactive and multimedia-based content. In California, the William and Flora Hewlett Foundation has awarded funding to the Community College Open Textbook Project to centralize information on open textbooks and document a workflow model for developing open textbooks (Caswell et al., 2008). The US state of Maine has funded multiple grants to identify OERs in the following content areas: health education and physical education; math; science; career and education development; world languages; English; visual and performing arts; career and technical education; and social studies (Syntiro, 2011).

Local teachers determine what educational resources are good for their teaching, and can apply for grants through the Maine Support Network. The Maine Department of Education has given funding to the Maine Support Network to help them research, identify and use open content in their subject areas (Syntiro, 2011). One part of the Maine OER grants is devoted to researching the process that teachers go through when evaluating content to be included in an

educational registry (website) to house the metadata teachers collect around the resources they wish to use. The goal of this registry is to help teachers find, catalog, categorize, and add other informative data to quality resources and allow teachers to share with others what they did with the content, whether the material worked, in addition to any other related useful descriptive information. (Creative Commons, 2010).

Maine has a list of “approved” OER providers (although schools/districts are not required to select from that list) such as the Accessible Instructional Materials for Maine Students with Print Disabilities.⁴⁴ The state also links to free and open content from its web site (for example, free e-books through its state library).⁴⁵

Gaming: Digital Learning Games have moved into the education sphere as they continue to gain credence as legitimate learning and assessment tools (New Media Consortium, 2010).⁴⁶ Games are increasingly being used to help students learn procedural and conceptual information; to make content engaging to students who struggle or are disinterested in schools; as immersive experiences to help correct misconceptions about content topics; and as a form of embedded formative and summative assessment. Quest 2 Learn, a private New York City grade 6-12 school, teaches its entire curriculum through educational gaming.

Changing Assessment: US schools employ multiple forms of assessment—performance-based assessment; paper and digital portfolios; and so forth. Since 2002, the US has had a national “high-stakes” assessment system implemented by all 50 states using their own tests.⁴⁷ Many of these tests measure rote, fact-based skills, often in contrast to content standards which promote higher-order learning and critical thinking. (Even if they don’t actually measure fact-based skills, many teachers employ rote, fact-based instruction to prepare students for these assessments). Since 2009, two consortia of US states have worked to develop a student assessment system aligned to a common core of academic content standards. This assessment system, under development, would create a “state-of-the-art” adaptive online exam, using “open-source” technology to provide accurate assessment information to teachers and others on the progress of all students, including those with disabilities, English-language learners and low- and high-performing students. The system will include the required summative exams (offered twice each school year); optional formative, or benchmark, exams; and a variety of tools, processes and practices that teachers may use in planning and implementing informal, ongoing assessment. These assessments will hopefully assist teachers in understanding what students are and are not learning on a daily basis so they can adjust instruction accordingly (Gewertz, 2011).

Because of its size (both demographic and geographic), its diversity, its highly-

⁴⁴See <http://maine-aim.org/>

⁴⁵See <http://www.maine.gov/msl/topics/ebooksfree.htm>

⁴⁶EDC received a five-year grant from the U.S. Department of Education as National Research and Development Center on Instructional Technology to study the impact of gaming on student learning (particularly in science and literacy). See <http://possibleworlds.edc.org/> and <http://portablewordplay.edc.org/>

⁴⁷Some smaller states, like Rhode Island, Vermont and New Hampshire, share a common assessment, in this case the NECAP—the New England Common Assessment Program

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decentralized (indeed, fragmented) educational system, and its wealth, the US is really sui generis versus representative of most countries' educational technology efforts and may not serve as the best example for nations striking out on the ICT in education journey. Nonetheless, there are important educational technology lessons to be drawn from the US experience.

First, though many in the US would argue otherwise, the United States has made significant investments in technology-related teacher professional development that focuses on using computers to improve the "instructional core"—how to teach content and assess content learning using technology. For instance, the 2002 federal law, No Child Left Behind, focused on the provision of developing "highly qualified teachers" and mandated that 25 percent of funds used for technology must be spent on teacher professional development (Peters, 2005:98).

The second lesson concerns assessment. The introduction of a national high-stakes testing system from grades 3-12 has radically altered the educational landscape in the US. Each state is allowed to design (or purchase) its own summative test. In states or districts where tests focus on more rote-based learning, or in "at-risk" schools where students are in danger of failing the state assessment, there is more evidence of rote instruction and either limited uses of technology or more mechanical use of technology for teaching and learning. In states, such as Massachusetts, where the assessment system is both rigorous and focused on higher-order thinking, one sees more innovative instructional approaches as well as innovative uses of technology.

But on closer look, if we move from the state level to the "sub-group" level, there is enormous variation in both instructional practice and technology use tied to assessment and closely linked to students' socio-economic backgrounds. Generally speaking, wealthier students (i.e., students in school districts with high property-tax valuation and from families with high area median incomes) typically score higher on state exams, than their less wealthy counterparts. They also enjoy the benefits of more diverse instructional practice (direct instruction, cognitive modeling, and collaborative learning) and more innovative and diverse uses of technology (technology for demonstration purposes, expository learning, creativity and communication) than students in poorer districts (i.e., districts with low property-tax valuations and low area median incomes).

Third, technology plays a vital and integral role in all US schools and school districts. In fact, it is inconceivable to think of even decoupling technology from instruction, assessment, data collection, information management, record keeping, or communication. For instance, district officials communicate to school principals and teachers via email; students in rural or small districts can avail themselves of online "advanced placement" or courses; teachers and schools set up websites so parents can monitor the progress of their children; and teachers house their grades in digital grade books.

However, as seen in the US, technology in isolation does little to reform education. While it may be used to support such reform initiatives, US-based experience and research are clear that "pockets of excellence" (for instance, the state of Massachusetts) or "pockets of improvement" (schools districts such as Boston or Chicago or Long Beach, CA) owe such designations to other reforms.

These include the following three elements:

- **Professionalization of education:** This includes raising the caliber and qualifications of teachers and principals entering the school system through revised pre-service instruction that focuses on more school-based experiences; more rigorous selection and certification processes; high-leverage induction, in-service and support programs (such as coaching and/or mentoring); more rigorous performance evaluation systems; access to a community of peers; greater decision-making authority; continuing education and the offering of challenging career tracks and promotions based on performance. Such practices have been shown to be an effective suite of interventions that improve overall educational quality and technology can certainly play a role in any number, or all of these interventions (Mourshed, Chijioke & Barber, 2010:26).
- **System-sponsored experimentation/innovation across schools:** This includes districts or states encouraging school-based, district-based or state-based innovations; providing funding for such innovations (either at the federal, state level) or through philanthropic organizations (such as the Gates Foundation); risk taking and allowing failure as long as failure is documented and there is a plan to learn from it; and sharing innovations with all entities (Mourshed, Chijioke & Barber, 2010:26).
- **Continuity of the system's leadership:** Within the US there has been a focus on building principals' and superintendents' "instructional" leadership (this term also encompasses assessment, technology and curriculum) not simply their administrative and management skills; on providing the supports and resources to lessen attrition among school leaders; and on enhancing components of state, district and school leadership. Such innovations ensure that the priorities, mindset and resourcing of change is sustained across leaders even when there are personnel changes at the top. School districts have also worked to foster the development of the next generation of system leadership from within to ensure continuity of purpose, a common set of values and behaviors, and knowledge of the community, schools, teachers, students and parents.

Technologies for Teaching and Learning



In contrast to most reports on technology for teaching and learning which compare the effectiveness of computers on learning, this section examines the impact of specific technologies and computer applications on student learning. Figure 14 enumerates many (though not all) common types of technologies and applications found in Lebanon, the United States, the United Kingdom and Jordan, attempting to categorize them by a set of shared characteristics. The convergence of technology functionality (for instance, the Internet alone encompasses many of the applications below) and platforms (most of what is listed in Figure 14 is available via Smart Phones) blurs the distinction among technologies. It also makes discussion of each prohibitive. This section will therefore select those technologies and applications from each category that have shown the greatest potential to impact student learning and those that are gaining popularity among teachers and students.

02.

02. Technologies for Teaching and Learning

Figure 14: Educational Technology Applications by Type

Type of Application/Technology	Examples
Computer-Based Productivity Applications	<ul style="list-style-type: none">■ Word-processing■ Spreadsheets■ Databases■ Electronic presentations■ Concept-mapping
Visually-Based Applications & Technologies	<ul style="list-style-type: none">■ Television■ Interactive WhiteBoards■ Student Response Systems■ Video-conferencing■ Video■ Augmented Reality
Internet-Based Applications & Technologies	<ul style="list-style-type: none">■ Online learning■ Web 2.0 applications■ Webinars■ Virtual Worlds
Multimedia Applications	<ul style="list-style-type: none">■ Multimedia■ Computer-Aided Instruction■ Intelligent Tutoring Systems■ Digital Learning Games■ Simulations
Mobile Technologies	<ul style="list-style-type: none">■ MP3/MP4 players■ Cell phones and Smart Phones■ E-readers■ Tablets■ Probeware■ Graphing calculators
Assistive Technologies	<ul style="list-style-type: none">■ Screen readers■ Voice-to-text systems/text-to-voice systems■ Braille readers

Computer-Based Productivity Applications

Often termed office or productivity applications, word-processing software, spreadsheets, databases and electronic presentation software are (along with the Internet), arguably, the most commonly used classroom computer-based applications across the globe. This section describes the teaching and learning potential of three types of productivity software applications listed in Figure 14: spreadsheets, concept-mapping and word-processing software.

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Spreadsheets. Spreadsheets are essentially analytic tools. They enable students to organize data numerically in rows and columns and perform a range of mathematical calculations and analyses from arithmetical to trigonometric to statistical. Spreadsheets demand both abstract and concrete reasoning skills and involve students in the mathematical logic of calculations.

Spreadsheets enable learners to model complex and rich real-world phenomena by making assumptions, coding assumptions as variables, manipulating these variables, analyzing outcomes, and evaluating and displaying data both quantitatively and visually (Burns, 2005: 50; Jonassen, Carr & Yueh, 1998). Despite evidence that spreadsheets can help students visualize numerical concepts better than other, non-dynamic tools, spreadsheet use lags behind that of other Office applications with 61 percent of computer-using teachers reporting that they use spreadsheets for instruction (IES, 2008). Few studies have attempted to capture the comparative impact of spreadsheets on student achievement.

In one small study, Sutherland & Rojano (1993) investigated the ways in which two groups of eight students used spreadsheets to represent and solve algebra problems and related these to their previous arithmetical experiences and evolving use of symbolic language. The spreadsheet environment supported students' move from specific to general thinking and helped students develop "higher-level" concepts, such as 'what-if' analytic ability and algebra problem solving. Hauger (2000:891) reported that spreadsheet use helped students appreciate the fundamental relationship between average and instantaneous rates of change in calculus.

Wenglinsky (1998) found a relationship between using spreadsheets for data analysis and higher Scholastic Aptitude Test (SAT)⁴⁸ scores when compared to using ICT for practice drills.

Structure of Concept Maps

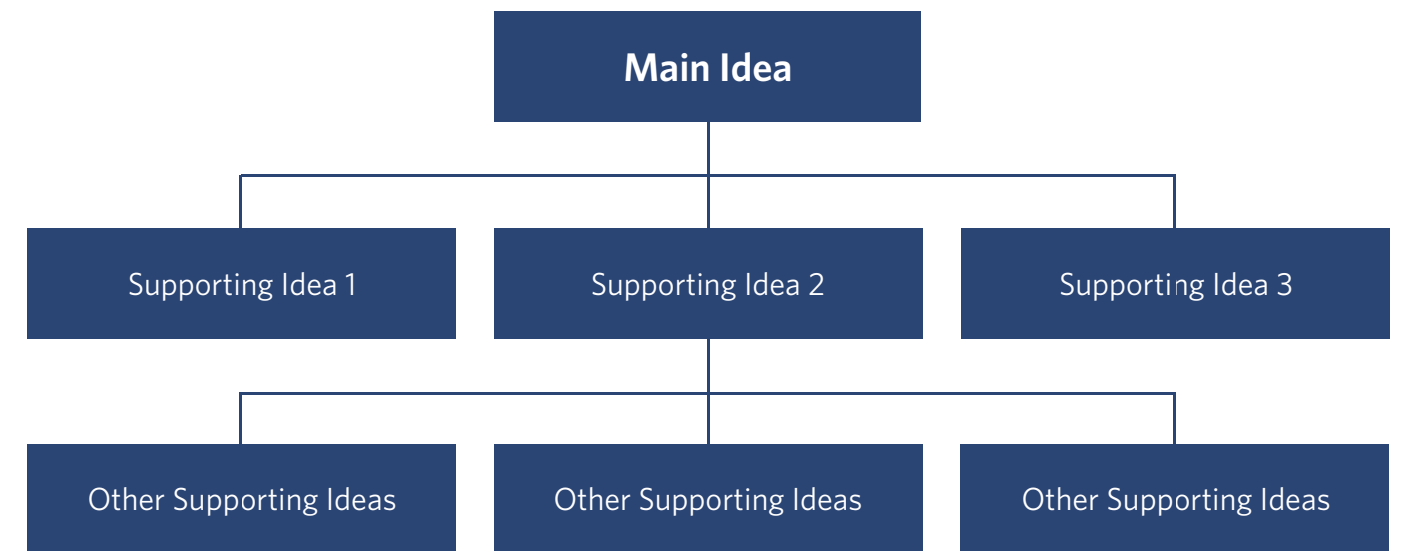


Figure 15: Structure of Concept Maps. (Concept maps are hierarchical in structure, with a main idea connecting to levels of supporting ideas via "links.")

⁴⁸ The SAT is a standardized test for university admissions in the United States.

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Concept Mapping Software. Concept-mapping software (or “mind maps” or “graphic organizers”) is software that demonstrates the visual relationship of concepts (words, ideas or numbers). Figure 15 illustrates the structure of a concept map.

Concept maps have been proven to improve student reading comprehension and writing skills (Halliday & Martin, 1993; Gouli, Gogoulou & Grigoriadou, 2003; Conkilin, 2007; Crane, 1998). This effect is the same whether concept maps are drawn by hand or by computer. The US National Reading Panel (2000) urges teachers to use concept maps for instruction for a number of reasons: Concept maps help the learner and teacher determine what the learner knows; they can help students meaningfully integrate new information into existing cognitive structures; visual depictions of relationships can help learners extract meaning from the information through manipulation, and clarify difficult-to-understand text and abstract concepts; and concept maps help students understand main ideas and how they are related, and can reveal misconceptions of understanding. Finally, concept maps can help teachers see how and what students are thinking, how their thinking changes over time, and can help students clarify their constructs and revise their concept maps (NRP, 2000).

Word Processing Software. Perhaps nowhere is the argument for using computers for learning stronger than in the area of writing. Research (Russell & Abrams, 2004; Kulik, 2003; Shapley, 2008; Silvernail & Gritter, 2007) has consistently demonstrated that technology can improve students’ writing if students are given open-ended prompts and if they go through the formal writing process—brainstorming, drafting, revising and rewriting. In the US state of Maine, where all 6th, 7th and 8th graders were provided with their own laptop, a five-year study of laptops and writing demonstrated that students who write with computers (i.e., primarily the use of word processing software) have a greater probability of success in achieving proficiency in state writing standards and have more developed writing responses and higher scores (about 75% higher) on state tests (Silvernail & Lane, 2004) than students who take the same state assessments with paper and pencil.⁴⁹



Figure 16: An example of an Alpha Smart

Another US study (Russell & Abrams, 2004) on 4th and 8th grade classrooms followed students who had access to digital writing tools such as a laptop, an E-Mate or an Alpha Smart (Figure 16 displays an Alpha Smart). At the end of the school year, these students—even when they took the state test using paper and pencil—did better on state writing tests than their peers who had access to no such tools. The study concluded that open-ended writing prompts that require students to generate responses using paper and pencil underestimate the achievement of 4th and 8th grade students used to writing with computers.

Students have numerous options for writing—specialized writing software, multimedia author ware, web logs or “blogs,” wikis and web pages. Yet basic word processing software, either open source (such as Open Office) or proprietary programs such as Microsoft Word remains the most popular classroom-based software (used by 96 percent of US computer-using teachers) because writing remains one of the most fundamental of learning tasks. Research states that when supplemented by other applications, such as graphics, word processing can become an even more powerful learning tool since the use of graphics, when combined with text-based information, can enhance students’ long-term retention of information (Mayer, 2001).

There are other technology applications that can build on the potential of word-processing software. Email provides opportunities for peer review and group editing, and the use of Internet publishing sites, blogs and various Web 2.0 tools can allow students to both share and publicize the fruits of their research and writing (Adams & Burns, 1999: 31; Harris, 1995: 157, 165, 168). Students consistently take more time and care in writing when they know their writing will be read by peers or by a larger audience.

⁴⁹ The validity of one of these findings from Maine has been critiqued. The author of this critique (Bowen, 2007) claims that researchers relied too heavily on subjective data and made selective use of Maine Education Assessment data. Bowen’s critique is available online at [http://www.mainpolicy.org/Portals/0/Issue Brief, No. 25.pdf](http://www.mainpolicy.org/Portals/0/Issue%20Brief,%20No.%2025.pdf).

Visually-Based Applications and Technologies

This section examines visually-based technologies with a special emphasis on Interactive WhiteBoards (IWBs) and student-response systems.

Interactive Whiteboards. An Interactive Whiteboard (IWB) is a large display that connects to a computer and projector which then displays the computer's desktop onto the board's surface, where users can control the computer with a pen, their finger, or other device (See Figure 17). The board is typically mounted on a wall or floor stand. Various accessories, such as student response systems and Whiteboard-specific software, enable additional interactivity. Games and multimedia applications stored on a teacher's computer can be viewed by students who can interact with the content either alone or in groups. IWBs are ubiquitous in British schools, common in many American schools and are presently employed in 100 JEL pilot schools in Jordan⁵⁰ and in 113 Lebanese schools. As a presentation tool, the size and interactivity of an IWB, is certainly attention-getting. IWBs can also be a starting point for the integration of other technologies. For example, a teacher can integrate a document camera with an interactive whiteboard, and physical objects that would be passed around hand to hand can be immediately digitized and seen by everyone in the class or lecture hall.



Figure 17: German students study math on an interactive white board.

In the United Kingdom, where every classroom has an IWB, there has been extensive research suggesting that IWBs enhance student enjoyment of learning and allow teachers to present information in a more dynamic fashion. Research on IWB use in UK schools appeared to result in improved test performance for low-achieving students, particularly in writing, math and science (Commission of the European Communities, 2008:8). The gesture-based or touchscreen features of IWBs (Figure 17) are especially helpful to students who may have certain kinds of motor and learning disabilities that make keyboarding difficult (Becta, 2006).

In the US, Marzano (2009: 80) examined student outcomes in 175 classes where 85 teachers conducted lessons with and without Interactive Whiteboards. In this study, using Interactive Whiteboards was associated with a 16 percentage-point gain in student achievement and "significant benefits" for students of teachers who had been using IWBs for more than two years, who were confident in their use, and who used them for at least 75 percent of class time. Marzano cited three IWB features that have a statistically

significant relationship with student achievement. The first was the learner-response device—handheld "voting" devices that students use to enter their responses to questions (this will be discussed momentarily).

A second feature was the use of visuals (downloaded pictures and video clips from the Internet, sites such as Google Earth, and graphs and charts) to represent information. Use of visual aids was associated with a 26 percentage-point gain in student achievement (p. 81).

A third feature was the Interactive Whiteboard re-enforcer—applications that teachers could use to signal that an answer was correct or to present information in an unusual context. These applications included dragging and dropping correct answers into specific locations, acknowledging correct answers with virtual applause, and uncovering information hidden under objects. These practices were associated with a 31 percentage-point gain in student achievement⁵¹ (Marzano, 2009: 81).

IWBs are not without their limits, however. They are expensive, take up space and teachers need a lot of time

and practice so they can integrate IWBs into their content areas. There is the real danger that the teacher will use them as expensive, digital chalkboards, in a "stand and deliver" mode of instruction and not capitalize on their interactivity. Like all technologies, they are ineffective if not accompanied by sound instructional practices. In fact, in the study cited above, students in 23 percent of classes without IWBs did better in measures of achievement than their peers in IWB classes. Research attributed this to the teachers' being so enamored of the technology that good instructional practices were abandoned. For instance, in these classrooms where students using IWBs did worse than their non-IWB counterparts, the teachers used the voting systems but did not use deep questioning techniques to unearth why students gave such answers. These teachers did not pace or organize IWB content; they utilized too many visuals so students were unsure of what was most important; and they paid too much attention to the IWB re-enforcers (e.g., applause sounds) versus focusing on content (Marzano, 2009: 82).

⁵⁰ Approximately 80 of the discovery schools use the Interactive Whiteboard and its software. Additionally, six Jordanian schools for students with disabilities use wireless IWBs in each school. Fourteen schools have multipurpose rooms which contain IWBs TV, Video, PCs, and satellite connections.

⁵¹ This means that a student at the 50th percentile in a classroom without the technology to increase to the 66th percentile in a classroom using whiteboards.

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Student Response Systems. Student Response Systems or “classroom response systems” or “clickers” are wireless, hand-held response systems that allow students to respond to a teacher query by “clicking” the answer on a response pad which is then transmitted via a radio signal to a receiver attached to a computer (See Figure 18). The response can be displayed on the teacher’s computer screen or on an Interactive Whiteboard. The percentage of students providing the correct answer is then immediately displayed on the board in a bar graph or pie chart.

SRSs function as both assessment and instructional tools. Essentially SRS generate “just-in-time” visual data that help teachers and students assess students’ levels of understanding. By quickly assessing students’ understanding of a topic, the teacher can adopt “just-in-time teaching” corrections—modifying content delivery, differentiating instruction, engaging students in peer tutoring, or working one-on-one with a struggling learner.

Like all technology, where SRSs have been used without good instructional practice, they show minimal impact on learning (though evidence of student engagement is high). For instance, simply having students vote for a response without opportunities for re-teaching, peer instruction or discussion and reflection, yields limited learning benefits.

However, where SRSs (coupled with IWBs) have shown learning gains for students, they have been utilized as “technology-enhanced formative assessment (TEFA)” (Beatty & Gerace, 2009) or as part of learner-centered instructional strategies (Freeman et al. 2007). The instructional effectiveness of the SRS depends on three highly effective pedagogical techniques: “question-driven instruction” (Beatty & Gerace, 2009); opportunities for peer reflection; and student reflection and meta-cognition. Together, these work in the following way:

The teacher poses a multiple choice conceptual or probing question at strategic junctures in the lesson to which students respond using their “clickers” (See Figure 18). Rather than revealing the correct answer, the teacher asks students to discuss answers and come to a consensus on the correct answer via discussion, sharing evidence and reasoning.

He/she then repeats the same question with the same multiple-choice responses and students “re-vote” using the SRS. The teacher and students examine differences in responses and the teacher asks students to share what they learned that led to a change (or no change) in their responses. Where this type of questioning, peer instruction and reflection have occurred, the SRS is associated with higher-student achievement (Marzano, 2009).

When used with sound instructional and assessment practices, like the formulation of good questions and good distractors (the incorrect multiple-choice responses), SRS can serve several functions: formative assessment of student learning; helping students communicate what they know; peer teaching; and promoting student discourse.



Figure 18: A Student-Response System (SRS) or “Clicker”

Since the effectiveness of electronic response systems is so instructionally dependent—contingent on the quality of questions (closed-response questions do not show the learning gains of open-ended questions), discussion and reflection, the use of SRS begs a very basic question: couldn’t the same results be attained without an expensive SRS (and interactive whiteboard) or with less expensive types of response systems (for example, colored cards)?

Interestingly, results lean in favor of SRS. Though much of the existing research around SRS has focused on the technology instead of the pedagogy, studies focused on technology-based pedagogies appear to suggest that even when clickers are used minimally or in place of non-digital response systems (like flash cards), their use has a small, positive effect on exam scores (Morling, McAuliffe, Cohen & DiLorenzo, 2008) and on long-term retention of content (Crossgrove & Curran, 2008).

However, earlier research by the same authors (Crossgrove & Curran) found “no significant difference” in learning between students using clickers and those not using them (p.150). One argument for this difference is that teachers had a year to learn how to use SRS in instructionally sound ways, thus the demonstrated benefit for student learning.

“Clickers” do facilitate the types of actions that educational research has identified as essential to student learning—diagnostic assessment, formative assessment, instant feedback, differentiating instruction, visual displays of data, and student engagement and participation. They also allow all students (not simply the most vocal or the one who raises his/her hand fastest) to participate in assessment and instructional activities.

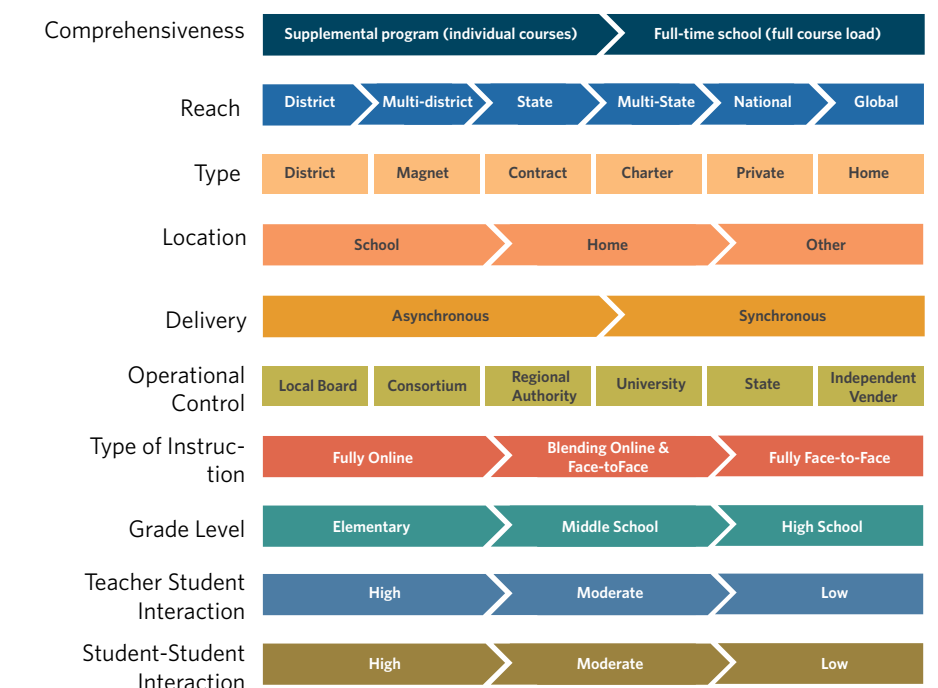
Internet-Based Applications and Technologies

Web-based approaches to learning encompass a number of practices—computer mediated communication (such as email, list servers, and bulletin board systems); online courses (via tutors, self-paced learning and learning communities); social media; online tutorials; online communities; e-mentoring; webinars; webcasts; tele-collaboration and tele-research projects; and virtual schools that foster content-based creation and collaboration with virtual professional learning communities. To explore each in detail would require more space than is available here, so this section limits itself to formal online learning courses and Web 2.0 or social media.⁵² It is important to note that forms of online or “e-learning,” mentioned above, are, despite their attractiveness, still evolving and have yet to establish a performance-based track record.

Online Learning. One of the fastest evolving models of distance education is web-based or online learning (also referred to as cyber learning, virtual learning or e-learning). In the US and Britain—countries that enjoy prevalent broadband access and students who have a relatively high degree of technical literacy—online learning opportunities are growing at a dramatic rate. In the US, online learning among primary and mainly, secondary, students is increasing 30 percent annually (Patrick, 2011). The main drivers of such growth are credit recovery (50 percent),⁵³ access to courses not offered in the curriculum (27 percent), advancement (24 percent), remediation (24 percent), and dual credit (18 percent) (Patrick, 2011).⁵⁴

Online learning programs vary in type, length, administration, degree of learning that occurs online, teacher-student interactions, location, etc. For instance, online learning programs may be full-time or supplemental; delivery may be asynchronous or synchronous; there may all, some or no face-to-face interaction with the instructor and other students; students may study at home, in a computer lab or in their classroom; and online courses may be controlled by a school board or even by a for-profit technology company. These and other dimensions of online learning are visually displayed in Figure 19.

Figure 19: Defining Dimensions of Online learning Programs in the US (Vanourek, 2006)



⁵² EDC has developed a distance education guidebook (Distance Education for Teacher Training: Modes, Models and Methods)—that explores each of these methods of web-based learning in detail. See <http://idd.edc.org/resources/publications/modes-models-and-methods>.

⁵³ In the US system, students need a certain number of credits to graduate with a diploma from high school and university. Credit recovery is the process by which students who have dropped out of school take shortened versions of academic courses to gain the credits to graduate from high school.

⁵⁴ Dual credit allows high school students to receive credit for a high school course and university course at the same time. This means that the student may graduate early from university.

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The popularity of online learning rests in large part with its ability to provide access to learning opportunities for students who are unsuccessful in “traditional” learning environments—students at risk of or who have dropped out of school;⁵⁵ students with disabilities; gifted and talented students who may be bored by traditional schooling; and students who are out of school as a result of medical conditions or incarceration. Its popularity is also derived from its ability to provide multi-channel instruction—encompassing print, audio, visual and video-based content; multiple formats for text-based, audio and video-enabled real time communication and collaboration with peers across the globe; and anytime, anywhere learning—provided learners have access to the Internet. Capitalizing on all of these benefits, many schools in the US and the UK are increasingly offering their secondary and university students online content, instruction and interaction with a community of peers, typically through a learning or course management system (like Moodle) and via email, chat and certain Web 2.0 tools like Skype.

Despite the above advantages and the rapid growth of online learning, particularly in the United States, research on the effectiveness of online learning for teaching and learning remains meager. Most research is exploratory—attempting to understand a rapidly evolving field or comparing online learning with face-to-face instruction. There is not one single, large-scale, national study comparing students taking online courses with traditional students in “brick and mortar” schools using control groups in the instructional design (Patrick & Powell, 2009: 4).

The most in-depth, large scale study to date is a meta-analysis and review of 51 online learning studies from the U.S. Department of Education. This meta-analysis found several results: Blended learning approaches (part online and part face-to-face) yielded better learning results than experiences where students took courses completely online or completely face-to-face. Where online learning was effective it was not confined to a particular content type. Elements such as videos and online quizzes did not appear to influence the amount students learned online. Online learning can be enhanced by giving students control of their interactions with media and prompting student reflection. Time-on-task, whether online or face-to-face, is a better predictor of student learning. Finally, when online learning is “done well,” it can be as effective as “face to face instruction” if it too is done well (US Department of Education, 2009: xiv-xv). Cavanaugh, Barbour & Clark (2009) in their review of literature on virtual schools (a particular type of online learning) cite numerous benefits. These include greater administrative efficiency, expanding educational access, increasing student motivation and providing high quality learning opportunities.

There are documented benefits to students as a result of formal online learning programs—benefits that are linked to improvements in learning—though the degree of research for each varies. These include: evidence of enhanced communications among students and between students and the online teacher; accommodations of different learning styles; unlimited, flexible access to curriculum and instruction; frequent assessment; and the ability to “share” excellent instructors with students across numerous locations (versus one location) (Hassel & Terrell, 2004:4).

Educational publishers in the US and the UK (and other regions) are rapidly making the transition to curriculum distribution via the World Wide Web. It is not uncommon now for textbook purchases to be augmented by online materials, such as additional problems, quizzes, tests and review materials, and special projects and lab work. Furthermore, in the US, online providers like the Florida Virtual School are teaching students across the US and selling their online content to other state online programs. For-profit companies, like Connections Academy, are creating content, training teachers and running many online programs.

Web 2.0 applications. Web 2.0 applications are broadly characterized by “blogs,” “wikis,” micro-blogging sites such as Twitter, media creation sites such as YouTube or PodOMatic, and social media sites such as Facebook. In contrast to “Web 1.0”—the “read” web in which content creation was limited only to owners of the website and where users could only interact with the site itself; Web 2.0 is the “read/write” web, characterized by what Hargadon (2009) calls the “three Cs”—contributing, collaborating and creating.

While traditional websites are static, centralized and closed, Web 2.0 applications are dynamic, open and decentralized. And while with traditional websites there exists a separation between producers and consumers of content, in the Web 2.0 universe, consumers are the producers of content (Burns & Bodrogini, 2011). Because of this, Web 2.0 applications are often called, “collaboration ware.”

Web 2.0 has become a very attractive educational option for a number of reasons. Since applications reside in “the cloud” (on distant servers) and are often free or open-source, schools don’t need to purchase software. Web 2.0 tools have very simple interfaces and are therefore much easier to learn and use than traditional desktop applications. They are technologies with which young people across the globe are fluent and frequently engaged. Finally, they are truly collaborative, allowing students to create and share content in real-time with their peers (in the same room, same country or across the globe). However, their biggest advantage—that they are Internet-based applications—is also their biggest drawback. Web 2.0 applications demand robust Internet connectivity; since information resides on the cloud it can be vandalized or removed; and many formerly free Web 2.0 sites have been monetized (Burns & Bodrogini, 2011).⁵⁶

⁵⁵ See the UK organization, NotSchool.net at <http://www.otschool.net/>

⁵⁶ A complete list of Web 2.0 applications can be found at Go2Web20

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There are many compelling arguments for the use of Web 2.0 tools in classrooms. For instance, students, studying a historical event can create a re-enactment of the event, filming it via a cell phone and uploading the video on SchoolTube, inviting other students to discuss the historical event. Students can establish Facebook sites for historical figures and immerse themselves in that figure's life and achievements via social networking. Students can create electronic portfolios via blogging applications such as Blogger or WordPress and invite their classmates to review, edit and give feedback on their portfolios. They can use online digital photos and Google Earth to show population and land use changes in Beirut over time. And in "flipped teaching," teachers can record their lectures via podcasts or video-sharing applications such as Vimeo and make them available for students to download on cell phones or laptops and listen (repeatedly, if necessary) at home, thus freeing up the teacher in class to work with students on practice-based activities related to that particular topic.

Web 2.0 technologies are still so rapidly mutating that research has had a difficult time keeping pace. Most research on the benefits of Web 2.0 technologies are inconclusive, though there is evidence that certain types of Web 2.0 tools, such as blogs and wikis, because they involve writing for a public audience, offer greater benefits than file-sharing sites, for example.

However, Web 2.0 tools show educational promise on two fronts. First, Web 2.0 sites by design embody many of the characteristics associated with student learning. For instance, social media sites, like Facebook, epitomize many of the qualities of good "official" education technology in their reflective elements, mechanisms for peer feedback and goodness-of-fit with the social context of learning (Mason, 2006). In particular, the conversational, collaborative and communal qualities of Facebook are seen to "mirror much of what we know to be good models of learning, in that they are collaborative and encourage an active participatory role for users" (Maloney, 2007: 26). Web 2.0 applications, in particular social media, can potentially offer a range of specific learning opportunities in a "personalizeable" and differentiated social space (Selwyn, n.d:5). As a participation-based network, social media may help learners collaborate with peers in group work, create and share content, and build communities of practice. In addition, learning may be facilitated in multiple ways, from the "community-managed etiquette" (Selwyn, n.d: 5) to built-in apps that offer users a range of experiences.



The second area is in terms of "informal" learning. Informal learning in this context means learning that is educational but that is not required by the school curriculum and that does not occur during the regular school day or as part of school requirements. Whereas formal learning is typically institutionally sponsored, classroom based and structured, informal learning "is not typically classroom based or highly structured, and control of learning rests primarily in the hands of the learner" (Marsick & Watkins, 1990:12). Web 2.0 applications allow learners to informally engage and collaborate in socially connected networks of peers and online services, allowing learners to take control of the how, when and why of their own experiential learning. However, educators need to be cautious in "importing" or co-opting students' home uses of Web 2.0 technologies into classrooms. As research on Web 2.0-using UK students notes, "Young people resent having their cultural forms (mis)appropriated into schools...older students do not necessarily expect or even want to use technology in educational settings in the same manner as they do at home" (Selwyn, 2006; n.d:7).

Multimedia Applications and Technologies

Multimedia is media that combines a number of content forms—text, audio, full-motion video, still images, animations or applets. Multimedia applications and technologies are potentially beneficial as learning tools for two reasons.

First, the combination of text, audio, video, color and animation and the various “ways” of learning afforded by multimedia may better address students’ individual learning styles and their “frames of knowing” (Gardner, 1983). This “dual coding” in which the learner processes text and images simultaneously may aid learners’ working memory. Research on cognitive theory (Mayer, 2001) suggests that multimedia can help all individuals—both students and teachers—learn more effectively and meaningfully. For instance, Mayer’s research shows that individuals learn better when text is accompanied by corresponding images or graphics. Individuals learn better from animation when text is spoken versus printed. Individuals learn better when key words are highlighted using different colors and font styles, when information is organized by color coding and by clear headings and outlines (Mayer, 2001). This is supplemented by additional research that shows that combined use of visual and auditory symbol systems resulted in more recall by students than visual-only and audio-only presentations.

The second reason—related to the first—is that multimedia allows learners to simultaneously process multiple types of symbols—text, audio, animation, still or moving images. Multimedia can be used to aid students in constructing links between symbolic domains, such as graphs, and the real world phenomena they represent, which can in turn influence the mental representations and cognitive processes of learners. Novice learners within these environments benefit from structured experiences of progressive complexity which help them build and elaborate their mental models (Kozma, 1991).

This section examines two types of multimedia applications—one quite established in classrooms (Computer Aided Instruction and Intelligent Tutoring Systems) and one that is emerging in classrooms across the globe (digital learning games). Though not discussed here, we briefly note that simulation programs that promote higher-order thinking⁵⁷ have been associated with learning gains in mathematics and science (Wenglinksy, 2005).

Computer-Aided Instruction. Computer-Aided Instruction (CAI) is instruction delivered by a computer. The computer acts as a “teacher” and presents content, problem sets, etc. with which the student interacts. CAI programs vary greatly in their quality. Some programs are behaviorist, drill-based applications while others offer more iterative problem-sets and feedback to address specific student weaknesses adjusted by the computer.

Though often derided as “drill and kill” applications, CAI have become far more sophisticated and complex, and an increasing body of research appears to demonstrate the learning benefits of more cognitively complex types of applications. One example of Computer Aided Instruction that has demonstrated learning benefits to students is SimCALC’s Mathworlds,⁵⁸ a math-based simulation program that can be downloaded for free onto Texas Instrument graphing calculators or onto computers. Students who used Mathworlds had a better understanding of rate and proportionality than similar students who used the standard curriculum. Mathworlds also had a statistically significant effect on students’ math scores, particularly on knowledge of complex math concepts (Roschelle, Tatar, Schectman, Hegedus, Hopkins, Knudsen & Stroter, 2007).

The main attraction of CAI is its computer-based “tutoring” component. Evaluation studies carried out during the 1970s and 1980s found that computer tutoring has positive effects on student learning. A major meta-analytic review (Kulik, 1994, 2003), for example, reported that the average effect of computer tutorials was an increase in student test scores from the 50th to the 64th percentile.⁵⁹ These 58 studies included many evaluations of computer tutorials in mathematics and reading but very few evaluations of computer tutorials in science. In fact, too few studies were available in science or social studies, to warrant separate conclusions about the effectiveness of CAI in these subjects (Kulik, 2003: viii).

Intelligent Tutoring Systems (ITS) are a variation of Computer Aided Instruction. There are multiple types of ITS (cognitive tutors; example-tracing tutors). They are computerized learning environments that dynamically adapt content to the learning goals, needs, and preferences of a learner. The ITS interpret student problem-solving behavior using a cognitive model that captures the skills that the student is expected to learn. The ITS then applies an algorithm called “model tracing” to monitor a student involved in a problem. It compares the students’

⁵⁷ Higher-order thinking here conforms to Bloom’s Taxonomy of analysis, synthesis and evaluation.

⁵⁸ See <http://www.kaputcenter.umassd.edu/products/software/>

⁵⁹ This is an increase of 0.36 standard deviations.

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actions against the appropriate expectations and misconceptions that are appropriate according to a cognitive model and modifies instruction accordingly.

Some research (Graesser, et al. in press) has shown Intelligent Tutoring Systems to be more successful with learners than human tutors. For example, Cognitive Tutors,⁶⁰ a mathematics-based ITS developed by the University of Pittsburgh and Carnegie-Mellon University (USA), has shown learning gains in experimental and classroom settings (Corbett, 2001, cited in Graesser, Conley & Olney). Morgan & Ritter (2002) compared students taking algebra with a traditional curriculum versus those taking algebra with Cognitive Tutor (CT) software in five US middle schools. They found that students in CT courses felt more confident about their math abilities and were more likely to rate math skills as useful. Many ITS programs have outperformed human tutors in granular, versus approximate, learner assessment; fine-tuning and adapting to individual learners' needs; identifying students' problem-solving strategies ("model tracing"); and ordering learning topics from simple to complex.

Digital Learning Games. Digital learning games, in contrast to the larger genre of general computer "games," have an explicit educational focus. They are virtual worlds⁶¹ or designed experiences (Squire, 2006) in which learners "play at" some role as they solve problems and make connections by learning to "think like" scientists, historians, journalists, soldiers, diplomats, or any other group that employs systematic methods of inquiry and problem framing in order to investigate the world. Digital learning games can be CD-ROM or DVD based, or they can be Internet based, such as Skoolaborate,⁶² EcoMUVE,⁶³ or Urgent Evoke.⁶⁴ They can be both off- and online, collaborative (multi-user/multi-player) or solitary. They can also be played on mobile devices such as portable gaming systems (e.g., the Wii, Xbox or PlayStation), televisions, computers, iPads and Smart Phones.

There is some long-term research on the benefits of digital learning games for students. Digital games in general have been linked to the acquisition of computer literacy, improvement of cognitive and attention skills, and development of positive attitudes toward technology (Lucas & Sherry, 2004).

Recent theories and empirical research on learning with games have focused on games as tools with which to develop conceptual thinking by interacting with and manipulating complex systems (Gee, 2003; Squire, 2006; Squire & Barab, 2004) and as alternate, virtual environments in which learners outfit themselves with virtual identities or avatars in order to practice ways of knowing within a situated, authentic context (Gee, 2003; Gee & Shaffer, 2010a; Shaffer, 2005; Shaffer & Resnick, 1999; Shaffer, Squire, Halverson, & Gee, 2005).

Gee & Shaffer (2010a:12-15) state that digital learning games are optimal learning tools for the following reasons:

- **Games are built around problem solving:** Players must use facts, artifacts, and evidence to make decisions.
- **Games inherently require and assess 21st century skills:** Games require players to collaborate, modify the game, map out complex variables and find solutions to challenging problems. All of these skills can be classified as 21st century skills. (See Figure 13)
- **Games track information across time:** Games are developmental in nature and are thus designed in terms of levels. For a player to go from one level to another, he/she must have mastered a certain set of skills.
- **Games integrate learning and assessment:** Learning and formative and summative assessments are "inseparable" in games. Players are provided feedback on what worked and what didn't and are informed about their progress.
- **Games can be collaborative and social:** In multi-user games, learners play "against" or "with" other players simultaneously and often must collaborate as part of the game itself.
- **By design, games can be higher-order learning tools:** Games embody adaptable challenges, clear criteria, personalized feedback, and a broad range of challenging topics as intrinsically motivating ideas (Prensky, 2001 cited in Gee & Shaffer, 2010a). Furthermore, games can serve as "entry-points" into conceptually complex content in ways that lead learners to investigate a concept further through immersion in the process (Klopfer, Osterweil & Salen, 2009).
- **Games provide information that players can use to improve their knowledge and skills:** Games often provide "actionable" information to players so players can make decisions about what to do to improve and succeed. As such, players know where they've succeeded, where they've failed and can take corrective actions in order to succeed.

In their study of all types of multimedia, Sivin-Kachala & Bialo (2000) summarized 311 reviews and reports on educational technology research and concluded that the following multimedia design features provide students with extra benefits:

- Packages that offer students some control over the amount and sequence of instruction, as opposed to those that control all instructional decisions;
- Programs with feedback identifying why a response is wrong, instead of identifying only what is wrong; and
- Software that includes embedded strategies, such as note-taking techniques, outlining, drawing analogies and inferences, and generating illustrative examples.

⁶⁰ See <http://www.learnlab.org/>

⁶¹ This definition is under dispute by certain technology specialists. Klopfer, et al. (2009: 14) states that defining digital games as virtual worlds is "erroneous."

⁶² See <http://www.skoolaborate.com/>

⁶³ See <http://www.ecomuve.org/>

⁶⁴ See <http://www.urgentevoke.com>

Mobile Technologies

In recent years, mobile technologies have exploded as tools for student learning. Learning via mobile devices is referred to as mobile or m-learning or as ubiquitous learning (u-learning) and nations like South Korea and the United Kingdom are regarded as leaders in this arena. In Jordan, the King's Academy is an entirely tablet-based, and thus an m-learning environment. M- or U-learning essentially involves learning through small mobile networked devices (cell phones, Smart Phones, personal digital assistants (PDAs), tablets, and portable media players) so that learners can access information, colleagues and resources ubiquitously.

As with computers, these technologies have provided an alternative way to engage students in the learning process. For the most part, these technologies are cheaper, more portable and easier to use (but not maintain) than desktop or laptop computers. While the UK is a leader in the area of m-learning, most so-called "developed" nations are not. Asia and Africa can offer more innovative examples of learning with many types of mobile devices than the US, Canada or Europe. Many developing country educational initiatives have used cell phones to reinforce language learning and mathematics, conduct homework assignments, and provide Internet access.

Portable devices are used for learning in numerous ways. Students send homework assignments to teachers via Short Message Services (SMS) or Multimedia Message Services (MMS). Personal Digital Assistants or PDAs (fast succumbing to Smart Phones) can be utilized to conduct Internet research or location-based data collection. Probe ware can measure noise levels and water quality for science and geography projects; and portable media players have been used to promote language acquisition, with students listening to and practicing along with recordings of language instructional sessions.

This section briefly examines two types of mobile technologies that appear to hold real potential as teaching and learning tools—tablets and e-readers.

Digital tablets ("tablets") include the iPad, Xoom and other touch screen portable devices. Because these devices are so new, research is limited, though much is underway. In the US, a major multi-year study is attempting to determine the quality of iPads as teaching and learning tools (Schaffhauser, 2010). Despite their novelty, however, tablets, particularly the iPad, are already having a profound effect in terms of how educational content is stored, displayed and communicated.

Apple's iPad is the best known of tablets. It is essentially a large iPhone with a 7-10 inch screen, dual camera, and built-in wireless and Internet networking for "always-on" Internet connectivity (depending on the version). The iPad has a long battery life (approximately 8 hours) and it can be used to store and play audio and video, view images, and access the Internet. Like the iPhone and numerous Smart Phones, the iPad uses a touch screen for navigation and keyboarding. Like SmartPhones, the iPad accommodates thousands of apps, which technically makes it a productivity tool. Though there are peripherals (such as a keyboard) that can be added to the iPad, its still-awkward touch screen keyboard, lack of a USB drive, and optical CD or DVD drive, render it primarily a consumption device (Burns 2011: 115).

Nonetheless, the potential promise of a device so new is impressive. Tablets functions like a netbook, allowing students to communicate, create documents and develop multimedia; an e-reader whereby students can access digital content; a learning device through which students can interact with thousands

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of education-related applications or “apps;”⁶⁵ like an MP3 player, with which students create, store, download and listen to audio and video files and podcasts; and like a personal digital assistant that allows for note taking, scheduling, gathering and storing data and so forth (Burns 2011: 115).

Because of this versatility, the iPad in particular, and tablets in general, are revolutionizing not just learning but web-based and mobile learning. Thousands of “apps” are being developed daily for the iPad and Android tablets. In March 2012, Lebanon’s Ministry of Telecommunications and Ministry of Education and Higher Education will unveil two tablet pilots that will ultimately benefit thousands of Lebanese students.

Numerous US districts are exploring the use of iPads as digital textbooks and in place of more expensive desktop computers. A pilot project in four California school districts will replace 400 students’ eighth-grade algebra textbooks with Apple iPads in an attempt to prove the advantages of interactive digital technologies over traditional teaching method. Another pilot program in Virginia has placed all social studies curricula on the iPad. Each day in the US, Europe, Canada and Australia emerges another story about how school districts are trading-in paper-based textbooks for iPads. (Burns 2011: 115).

It should be noted however, that though there are a number of large-scale studies on tablets underway (in the US, for example), there is almost no research to support their efficacy as teaching or learning tools. While Reed College’s study on iPads (versus the Kindle DX) (Marmarelli & Ringle, 2010) is often cited as proof of their efficacy, the study simply looked at student use of and perceptions about the iPad.

E-Readers. E-readers, “e-books” or “digital readers” are digital books: slate-like devices that use electronic ink. Unlike tablets, they tend to be focused exclusively on reading. They function just like a paper book—students can turn pages, skip ahead to the end of the book, highlight text, annotate sections, and bookmark their page. The benefit of e-readers as a learning tool is that hundreds of books and documents can be stored on the e-reader, thus giving students a portable, lightweight library.

E-readers, such as the Kindle have grey backlighting, making them ideal for reading in bright sunshine (while the iPad’s adjustable white and grey background make it ideal for reading in sunlight and darkness) and battery life that lasts for weeks.

Like the iPad, E-readers, such as the Kindle and Nook, can access cellular networks that allow the user to download a book onto his/her e-reader. For all their benefits though, e-readers can make for an awkward and “flat” reading experience.

In contrast to the codex structure of paper-based books (manuscripts held together via binding with writing on both sides of pages) which allows for non-linear reading (jumping back to a particular page in the book), reading on a tablet or e-reader is primarily a linear exercise and efforts to move around the text, from one “page” to another, are alternatively awkward and frustrating (Grossman, 2011). In this sense, books are still superior to digital tablets and e-readers (Burns 2011: 116).

E-readers are so new that there is little research on them. There is some evidence that they may enhance student enjoyment of learning. A survey of 2000 US students aged 6-17 reported that students who normally dislike reading paper-based books enjoyed reading from digital readers and would read more books if they had e-readers (Bosman, 2010). One reason for this may be that the adjustable font sizes and types make reading easier for those with vision problems than is the case with print.

As digital readers become more popular—Amazon.com, the maker of the Kindle, now sells more digital than paper-bound books in its North American and European markets (Kirsner, 2010)—the price point drops and more commercial and free books are created to take advantage of the medium. E-book makers are looking to distinguish their products by adding new features such as support for audio books or other types of media or digital rights management allowing users to loan e-books to friends. Presently e-readers, such as the Kindle, are proprietary but the trend is likely that e-readers will become more open source (Burns 2011: 116).

Tablets are certainly more multipurpose in design and offer a better aesthetic user experience. However, e-readers have several advantages over tablets. They are generally more light weight, less expensive and have a longer battery life because of the use of electronic ink and grey backlighting. Because e-readers such as the Kindle serve primarily as an electronic book, readers cannot become distracted by the games, apps, music and video found on a tablet. At the same time, other e-readers, such as Sony’s e-reader, function also as consumption tools, allowing users to write, draw and create audio books.

Whether one uses an e-reader or a tablet, the probable outcome is the same. Not just books, text and information promise to be fundamentally redefined, but also what we understand as “reading”—perhaps the most common formal educational activity—promises to be transformed.⁶⁶

In the US and Britain, textbooks are already becoming interactive with video and three-dimensional clips of objects of study. “Diginovels” feature video that supplements or replaces text, and increasingly books are becoming interactive as the touchscreen interface of the iPad allows users to modify the size of characters in picture books (Economist, 2011a:33).

Publishers of digital content are exploring the development of digital books that add collaboration tools, immersive worlds and three-dimensional environments in the hopes of making reading more multi-sensory, participatory and non-linear.

⁶⁵ See <http://speirs.org/blog/tag/theipadproject> for a list of secondary-school apps for the iPad.

⁶⁶ See The Future of Reading video at http://vimeo.com/15142335?utm_source=twitterfeed&utm_medium=twitter

Assistive Technologies

For many students—those who have vision problems, who cannot hear, who have gross or fine motor impairments, who are ill, aphasic, dyslexic or dysgraphic or who suffer from a range of undiagnosed and misunderstood physical and cognitive ailments—the computer, and in particular the software and peripherals it supports, may be their only link to education, indeed to the world beyond the physical confines of their own body.

As such, no educational community has embraced technology more than teachers of learners with disabilities and these learners themselves. In the US and the UK, by law, students with disabilities must be provided technology devices and “reasonable accommodation” that make learning and school completion possible.

Assistive technologies are applications or technologies that have been modified in some way so they can “assist” individuals with disabilities in performing functions that might otherwise be difficult or impossible to do. A non-educational example of an assistive technology would be a wheelchair. In education, assistive technologies include hardware, software, and peripherals that assist people with disabilities in accessing computers or other information technologies.



Figure 20: Computer adaptive devices may have switches, keys and touch windows to allow students with a range of disabilities to communicate information.

02. Technologies for Teaching and Learning

Assistive technologies have been shown to significantly increase student access to materials, experiences, and learning. Computers can juxtapose, or transform, information in one symbol system to that in another (Dickson, 1985). A learner who is aphasic—who cannot speak—can type her communication into a computer with a voice synthesizer that transforms text into speech. In the reverse, a learner with cerebral palsy or problems with motor coordination can speak into a microphone and MS Word’s voice-recognition system will convert the speech into text.⁶⁷

The most common assistive applications are those that help students overcome physical challenges or enhance communication abilities. There are numerous types of assistive technologies and each has a different compensatory function: adapted trackballs, joysticks and alternate keyboards help students compensate for motor problems; screen magnifiers, voice-to-text software and dynamic Braille readers help students who are blind or have some form of visual impairment; and DAISY⁶⁸ books and cognitive tutors provide scaffolds such as human narration, synchronized audio and text markings, and model tracing to gauge where students have difficulties and where they need interventions.

However, hardware, peripherals and software are not enough. Increasingly there is awareness that for many learners, with undiagnosed or mild disabilities, information is not always accessible. Commensurately, there is an increased recognition that students enter the classroom with a variety of needs, strengths and deficits and that these students face barriers in learning because of the design of information, instruction or technology. As a result, within education in the US, the UK and a number of other European and Australasian nations is the recognition that digital materials must be “universally designed” so that all learners can navigate a website, access content, and participate in interactive web activities regardless of their disability.

Universal Design for Learning (UDL) is a design technique that focuses on creating the least restrictive environment. If we use a building as an example, a ramp would be an example of a universal design technique. Unlike stairs, which make access to the building difficult, or impossible, for individuals in wheelchairs, elderly frail individuals, or people with no mobility impairments, a ramp allows for “universal” access to a building—equally by those with physical impairments and those without.

Educators, including curriculum and assessment designers, can improve educational outcomes for diverse learners by applying the following principles to the development of goals, instructional methods, classroom materials and assessments:

- Provide multiple and flexible methods of presentation to give students with diverse learning styles various ways of acquiring information and knowledge;
- Provide multiple and flexible means of expression to provide diverse students with alternatives for demonstrating what they have learned; and
- Provide multiple and flexible means of engagement to tap into diverse learners’ interests, challenge them appropriately, and motivate them to learn (Rose & Mayer, 2002).

Little research has been conducted on the technologies used by education agencies and schools to provide education to students with special needs. There is some research from the United Kingdom (Becta, 2008:31) suggesting that assistive technologies can positively impact affective outcomes—student motivation, perseverance, and collaboration—though Becta cautions that such findings need to be supported by larger research studies. There is also little evidence, from the US at least, suggesting that schools use any systematic screening process to identify learners who potentially might benefit from assistive technologies.

⁶⁷ See The Future of Reading video at http://vimeo.com/15142335?utm_source=twitterfeed&utm_medium=twitter

⁶⁸ The DAISY (Digital Accessible Information System) Consortium is an international association that develops, maintains and promotes international DAISY Standards. The DAISY Consortium was formed in May, 1996 by talking-book libraries to lead the worldwide transition from analog to Digital Talking Books.

Summary

Several themes emerge from this examination of classroom technology and application by type. First, there is no one “right” type of technology for use in teaching and learning. Indeed, teachers’ objectives for students’ computer use often vary by the subjects they teach (Becker et al. 1999) and by their instructional objectives.

Social studies and teachers of mixed academic subjects may be more interested in students researching ideas, while language teachers may be more interested in students expressing themselves in writing. In contrast, math and computer teachers report more traditional objectives focused on “mastery” of skills and thus are more likely to select games, Computer Aided Instruction or particular “office” applications (databases and spreadsheets) to help students master such skills. Teachers who express more than one instructional objective may use a greater variety of applications. For example, those interested in having students find out about ideas and information may not only have students use CD-ROM reference software, and the World Wide Web—two applications naturally associated with information retrieval—but they may also have their students use word processing software (Becker, et al. 1999).

Next, there is also no “right” age at which to begin using technology. Research (Wenglinsky, 2005) concludes that technology is beneficial when it is developmentally appropriate for the students who use it. The optimal role of technology for high school students is different from its optimal role with younger students. High school students benefit from using generic technology-driven processes across subject areas, rather than the subject-specific applications needed at the primary and junior secondary levels. Young learners benefit from multimedia and visually-based technologies far more than they do from text-based applications.

Third, there is no “right” configuration of students per computer. Indeed, there are trade-offs when deciding whether students should use technology collaboratively or individually. Students who work in groups at the computer have been found to interact more with their peers, use more appropriate learning strategies, and persevere more on instructional tasks. Students who work individually at the computer have been found to spend more time actually engaged with the software and complete their assignments more quickly, but require more help from the teacher (Sivin-Kachala & Bialo, 2000).

However, there is a “right” approach to using technology. Technology provides learning benefits when its use is coupled with what research has identified as best practices in instruction and assessment: learner-centered, inquiry-based or problem-

based instruction; deep questioning techniques; peer instruction; diagnostic assessments that measure what children know and that help teachers tailor instruction to begin at their same “starting point;” differentiating instruction and learning tools based on students’ level of understanding; using formative assessment to take the measure of student understanding and revising instruction based on this; checking for student understanding; and developing students’ expressive, reflective, analytic and creative capacities through discussion and open-ended writing.

The fundamental rationale for placing technology in schools rests on a belief that technology is an instrument of reform—that technology can qualitatively enhance the teaching and learning process.

Decades of false starts, hits and misses and lessons learned about technology reveal a more fundamental truth: Improvements in student learning only occur as a consequence of improvements in the level of teachers’ content knowledge, pedagogical content knowledge and instructional skills; and students’ degree of interaction with content. This relationship of the teacher and student in the presence of content is what City & Elmore (2010:23) call “the instructional core.” Any innovation that aims to improve “schooling” must fundamentally improve and alter this instructional core. In short, good teaching still trumps good technology.

The next and final section of this monograph addresses strategies and practices from our case sites that provide some guidance on how technology may best support the instructional core.

Using Technology for Teaching and Learning: Best Practices

The combined experiences of instructional technology efforts in Lebanon, Jordan, the United Kingdom and United States offer much guidance for developing a comprehensive strategy of ICT for teaching and learning system both in terms of positive and negative examples. But we should not look to these four nations exclusively. South Korea and Singapore are arguably the two highest global performers in ICT for teaching and learning and there is much to learn from their experiences as well as from the failures of large-scale technology innovations. The remainder of this document draws from the experiences of these countries, as well as research findings, about the conditions necessary for utilizing ICTs or educational technology to support high-quality teaching and learning.

03.

Technology must be one part in a larger system of educational reform

The idea that ICT can reform an educational system, that it can “fix” poor teaching or that it can improve student learning is a widely held, but unfortunately false, belief.

Research (Culp, Honey & Mandinach, 2003) and experience (the United Kingdom, Singapore, South Korea) demonstrate that successful educational reform must focus on the core components of teaching and learning—leadership at the national, regional and school levels; reforming curriculum to align with what we know about how students learn and the types of skills necessary to succeed in a highly competitive global economy; improvements in recruiting, hiring and paying qualified teachers and then continually improving their skills and holding them accountable to standards of professional behavior; using instructional practices that have been shown to help students master content; and aligning the assessment system with the instructional system.

A focused approach to using ICTs can support these efforts but it cannot substitute for them and it cannot drive them. Focusing on technology at the exclusion of the core components of teaching and learning—content, curriculum, instruction and assessment—has been repeatedly tried across the globe, and it has repeatedly failed.

Develop a vision of how technology should be used

Policymakers and educational designers must develop a vision of what classroom teaching and learning will look like as a result of technology investment and provision.

This vision-building is often the most important, and most overlooked, part of planning for computers in schools. Failure to create, articulate and accommodate a common vision predictably results in technology projects that meander or sputter toward an unanticipated and unwelcome end (Burns, 2012). In nations like Lebanon, Jordan, South Korea and Singapore, vision-building has been an integral component of their “ICTs for teaching and learning” plans, initiatives and strategies. A well-defined and clearly articulated vision developed by all stakeholders (including teachers and students) in the education system provides coherence to a program, serving as the organizing framework within which all goals, policies, actions, infrastructure, and activities can be developed, and against which results can be evaluated. Interviews with Jordanian educators revealed that the process of creating a common vision, though intensely time consuming, can also help to build engagement, ownership and commitment among all education stakeholders.

Visions allow stakeholders to dream big, but visions also need to be plausible, feasible, dialectical (based on discourse) and ultimately practical if they are to be made operational.

Develop a shared language about teaching, learning and technology

Educational technology visions are often undermined by a failure to develop shared taxonomies, shared technical language, common definitions that further the vision itself, and the policies, plans, implementation strategies and evaluations that follow from the vision. Terms such as “Information and Communications Technologies” have different meanings to different stakeholders. (They even have different meanings to the same stakeholders). Essential instructional constructs, such as “learner-centered instruction,” are often incompletely or divergently understood by policymakers and teachers. In part, confusion around terminology is due

to rapid technological changes. However, a lack of clarity around terminology often reveals a lack of consensus among stakeholders, a failure to think through how and why technology should be used in educational settings, a deeper omission of defining outcomes and impact, and incongruent philosophies of implementation among stakeholders. As a result, profoundly central requisites for effective technology use, concepts like “integration” or “higher-order thinking,” become clichés devoid of real meaning and their implementation uneven or superficial (Burns, 2012).

Part of establishing a common vision around how teachers can teach with technology includes the development of a common language, with shared definitions, standards, levels and outcomes (e.g., through the use of rubrics, matrices or logic maps). By thinking through what terminology means and developing a shared lexicon of terms related to its implementation, educational planners can begin to think in terms of “levels of use” and thus help to further define their vision. To better illustrate this point, the rubric in Figure 21 is one example of a strategy to help schools better define terminology, in this case, “technology integration.”

Figure 21: Dimensions and Levels of Technology Integration (Burns, 2007:10)

Level of Integration/Examples	Emerging	Intermediate	High
Learning Objective: What should students know and be able to do?	<ul style="list-style-type: none">Objective is to learn about technology (e.g., learning how to word process) or how to do research or communicate with technology	<ul style="list-style-type: none">Content objective substitutes the use of a technology tool for a conventional tool (e.g., population forecasting using a spreadsheet)	<ul style="list-style-type: none">Content objective uses technology with embedded knowledge (e.g., using SimCity to help students learn about land use planning in science class)
Appropriateness: Is this the most appropriate tool(s) to attain stated learning outcomes?	<ul style="list-style-type: none">Software stimulates relatively passive involvement on part of student and focuses on cultivating “basic skills”—memorization, identification and recall of information	<ul style="list-style-type: none">Software is more active and cultivates more advanced levels of learning—comprehension and application of information	<ul style="list-style-type: none">Software stimulates active intellectual involvement on the part of the user

Figure 21: Dimensions and Levels of Technology Integration (Burns, 2007:10)

Use: How are students using technology applications and digital content?	<ul style="list-style-type: none">- Test preparation, remediation, improved basic skills- Enrichment or reward for completing work (e.g., games, online sites geared for teens)- Some basic research and information presentation	<ul style="list-style-type: none">- Access data (e.g., via Internet or DVDs), some degree of data manipulation (e.g., creation of graphs)- Data presentation (electronic presentation, publishing and word processing software)	<ul style="list-style-type: none">- Access, manage, integrate and evaluate information- Construct new knowledge- Solve problems; analyze, synthesize and evaluate information- Present and communicate this information in a clear, effective multimodal manner
Type of Instruction: How does the teacher use technology for learning	<ul style="list-style-type: none">Primarily teacher-centered instruction (demonstration)	<ul style="list-style-type: none">Mixture of teacher-centered and learner-centered instruction (mainly demonstration with some collaborative and project-based learning)	<ul style="list-style-type: none">Primarily learner-centered instruction (problem-based, project-based, case-based, inquiry-based and collaborative learning)
Fungibility: Can the same learning objective occur without using technology?	<ul style="list-style-type: none">Teachers can perform the same tasks without technology (e.g., using MS Word as pen, PowerPoint as an overhead projector, skill and drill software for memorization and recall, etc.)	<ul style="list-style-type: none">Can perform the same tasks without technology, but technology deepens and enriches student experiences and learning (e.g., using interactive web-based mapping tools)	<ul style="list-style-type: none">Instruction that makes possible experiences and learning that would otherwise be impossible (e.g., using “Ask an Expert” sites to access hard to reach expertise; simulation software that allows students to have otherwise unavailable learning experiences (e.g., dissections, building a city, etc.)
Learning/Literacy: What levels of learning and types of literacy are students attaining?	<ul style="list-style-type: none">- Functional literacy: phonemic, verbal, numeracy- Possibly some degree of “technical” literacy (e.g., learning how to use spreadsheet, etc.)	<ul style="list-style-type: none">- Functional literacy- Technical literacy- Information literacy (knowing how and where to find information online)	<ul style="list-style-type: none">21st century literacies (visual, spatial, information, media, etc.)
Access/Location: Where is the technology located? Can students get to it when they need it?	<ul style="list-style-type: none">Computers are mainly found in computer lab or some centralized location	<ul style="list-style-type: none">“Pods” of technology (e.g., laptops or desktops) (2-5) are located in classrooms	<ul style="list-style-type: none">1:1 laptop/tablet programs
Hardware: What kinds of hardware are being used? (fixed, portable)	<ul style="list-style-type: none">Computer-based (primarily or exclusively desktops)	<ul style="list-style-type: none">Computer-based (desktops or laptops) supplemented by portable technologies, such as digital and/or video cameras	<ul style="list-style-type: none">Portable special purpose technologies (GPS, video cameras, digital cameras, MP3 players, etc.) as well as multi-purpose computer-based (desktops, tablets, Smart phones, and/or laptops)
Computer Applications/Digital Content: What applications are students using?	<ul style="list-style-type: none">Digital content (Internet, content-specific software, and integrated-learning packages) used to enhance textbook information and help students access data.	<ul style="list-style-type: none">Blended resources: text-based and digital resources (Internet, CD-ROMs, online learning objects and tools, content-based multimedia software)	<ul style="list-style-type: none">Mainly digital content: digital learning resources, Internet-based, immersive applications and simulations

Develop a comprehensive national ICT in education policy with a designed focus

As the examples of Jordan, United Kingdom and the United States suggest, effective ICT use in the classroom begins at the national policy level.

As Kozma (2005) notes, without the guidance of national policies, the details they offer and the resources of corollary programs:

It is less likely that individual school and classroom innovations will be sustained. Nor is it likely individual effects will accrue across the country to have an overall impact on the educational system. Similarly, without the shared vision of a national policy the efforts of NGOs and corporations may very well go in divergent directions or work at cross-purposes, and their contributions to the nation's education effort are more likely to be marginalized or even neutralized. In brief, without a strategic rationale to guide the national use of technology in education, ICT policy is only operational. Policy becomes techno-centric, promoting the purchase of equipment or the training of teachers without providing a strong educational purpose or goal for the use of technology (p. 1084)

National ICT policies serve several important functions. Strategic policies can provide a rationale for ICT in education use. For Britain, the rationale was part of overall education reform; Jordan's ICT in education policy was driven by a national focus on economic and social transformation and was a response to persistently high unemployment. Lebanon's strategic plan emphasizes the importance of preparing learners to take their place in a "digital age" and "knowledge society." For a nation like Singapore, ICT in education is part of their drive to be a 21st century leader. Finland's ICT policy focuses on the social impact of ICT with a high value on collaboration and knowledge sharing. ICT policies reveal a set of national values; provide a framework of vision and goals for how technology should function within schools; and explain how students, teachers, parents, and the general population might benefit from its use in schools (Kozma, 2005: 1084).

Define and promote the roles of multiple stakeholders

Within the US and Jordan, in particular, a variety of stakeholders from the public and private sectors have played essential roles in implementing the national ICT-in-education policy and sustaining the technological infrastructure in education.

The national ICT-in-education efforts of Jordan and Britain emphasize the importance of governmental support, especially at the central level, but also at local levels. The examples of Jordan, Britain and the US demonstrate the necessity of long-term, sustained commitment for the development of the technological infrastructure that extends to the classroom level. Indeed, Jordan used public-private partnerships to re-engineer its educational system and leverage technology to all government schools in less than a decade. The overwhelming cost of establishing an adequate technological infrastructure has required that these three nations build a long-term and large-scale strategy for meeting schools' infrastructure and technical needs by drawing on leadership, equipment and financial support from public/private partnerships, local communities, and professional organizations (Culp, Honey & Mandinach, 2003: 14). However, it is important that the roles of stakeholders be clearly defined and decision making rest where there is expertise. In an effort to "fast track" teachers' technology literacy or place computers in schools, Ministries of Education have often devolved teacher instruction, curriculum development, and professional development to technology companies.

Align national and school goals and expectations around the use of technology for teaching and learning

Changes in ICT policies can both contribute to and benefit from corresponding changes in curriculum, pedagogy, assessment, and teacher training.

As one example, in 1998, the Singaporean government charged the National Institute of Education (NIE) to carry out Singapore's (first) ICT master plan.⁶⁹ The NIE, Singapore's only pre-service teacher institution, was entrusted with integrating ICT into initial teacher training programs. The NIE created a new teacher training curriculum to include three kinds of ICT courses for student teachers: basic ICT workshops, a 30-hour ICT foundation course, and a 26-hour elective course. In addition, pre-service teachers received between 6 and 12 hours of ICT integration into every curricular subject. This articulation between policy and practice has resulted in a high standard of ICT competence and integration among Singapore's teachers and students.

Additionally, ICT policymakers within ministries of education should coordinate their policymaking efforts with those in other departments or ministries (Kozma, 2005). As a case in point—though not ICT per se—Finland, despite an influx of poor immigrants to its schools, and contrary to the experience of many European nations and the US, sees only modest variation (5 percent) in PISA scores among its wealthiest and poorest schools. Finnish schools however, offer a variety of services to students—hot meals, health care, counseling and after school tutoring. Many of these programs are coordinated by other Finnish ministries, but taken together, all contribute to the overall health and well-being of children, which in turn contributes to their learning.

Finally and critically, the use of technology for teaching and learning has a greater chance of succeeding when the curriculum, instruction and assessment are aligned to support students' use of computers for exploration, creativity, problem-solving, and higher-level thinking. The most successful education systems set goals for the curriculum and for student achievement that emphasize the attainment of complex, higher-order thinking skills and the ability to apply those skills to problems they have never seen before, rather than the mastery of the kinds of basic skills they formerly settled for as a minimum standard.

Curriculum and instruction must support these skills while assessment systems must use flexible, authentic and multiple measures to assess them. Nations that have realigned all components of the system to accommodate new ways of learning, like Korea, Britain, and Singapore, have successfully integrated technology into this larger aligned structure. They use data to evaluate the learning needs of students and are constantly expanding their repertoire of pedagogical strategies to differentiate instruction and address the diversity of students' needs and aptitudes (OECD, 2009:252), sometimes with technology, sometimes without. In Finland, considered to have one of the best educational systems in the world—but not regarded as a leader in the area of educational technology—the curriculum is inquiry- and project-based and the predominant instructional style is learner-centered. Finland uses no external standardized tests used to rank students or schools, and most teacher feedback to students is in narrative form, emphasizing descriptions of their learning progress and areas for growth. As in the National Assessment of Educational Progress (NAEP)⁷⁰ exams in the United States, samples of students are evaluated on open-ended assessments at the end of the 2nd and 9th grades to inform curriculum and school investments. The focus is on using information to drive learning and problem-solving.

In contrast, nations where ICT efforts have failed—and they are too numerous to list here—have often inserted computers into an educational framework that promotes traditional instruction, a curriculum overly focused on declarative knowledge, a traditional assessment system that measures facts and discrete information, and a teacher evaluation system that does not measure teachers' uses of ICT or learner-centered instruction as part of the formal evaluation process. They have, in essence, attempted to insert an innovative, dynamic tool into a static system. Jordan, for all its efforts to offer leading technologies and create curricula focused on higher-order thinking, still struggles because its very traditional, rote-based examination, the Tawjihi, still out-muscles innovative instruction and technology. Because students and teachers will be evaluated based on Tawjihi results, many teachers, even in JEI schools, still “teach to the test.”

⁶⁹Singapore revises its ICT in education master plans every five years.

⁷⁰ Often referred to as “the nation's report card,” the National Assessment of Educational Progress (NAEP) is the largest nationally representative and continuing assessment American students in mathematics, reading, science, writing, the arts, civics, economics, geography, and U.S. history.

Change the teacher evaluation system to reflect technology integration supported by learner-centered instruction and assessment

“Evaluations should provide all teachers with regular feedback that helps them grow as professionals, no matter how long they have been in the classroom. Evaluations should give schools the information they need to build the strongest possible instructional teams, and help districts hold school leaders accountable for supporting each teacher’s development. Most importantly, they should focus everyone in a school system, from teachers to the superintendent, on what matters most: student academic success.”

Figure 22: The Importance of Teacher Evaluations (The New Teacher Project, 2010)

Next to assessment systems, the greatest systemic motivator on teacher practice is the teacher evaluation system. In many educational systems still, curriculum, content, culture and most important, the examination system (which drives the first three components) overwhelmingly favor traditional, teacher-centered, fact-based, rote instruction and fail to account for the use of technology. Any teacher who wishes to use technology or shift his/her instructional or assessment practices does so of his/her own volition and personal force of will. And any initiative that relies on the personal goodwill or compliance of members, in the absence of formal leadership or supporting structures, is completely unsustainable. Thus, school systems must re-engineer teacher evaluation systems so that the use of technology to support learner-centered instruction and assessment is part of any teacher’s ongoing and final appraisal. Unless all components of the educational system cohere, learning, culture and instruction are fractured and working at cross purposes.

Ensure adequate classroom access to technology

For technology to impact teaching and learning, teachers and students need a sufficient number⁷¹ of computers, not just in school, but in their classrooms.

Though studies are inconclusive about the optimal number of computers in classrooms, research is clear that students are best served with consistent, convenient and frequent access to technology (Mann, 1999).

Technology programs rarely have a positive impact on students when schools are limited to one computer for every 30 students or when available computers are in computer labs. In such situations, teachers revert to “traditional” instructional styles—standing at the computer and lecturing or in lab situations focusing on IT skills or having students follow a task in lock step (Stratham & Torell, 1999a; Rivero, 2006). Data from the US and the UK shows that secondary school teachers who have at least one computer in their classroom for every four students are more than three times likely to have students use computers on a regular basis than those who do not have classroom access or who use computers in labs.⁷² For instance, Mann & Shafer’s (1997) study of 55 schools in New York

found that an increase in instructional technology, in addition to teacher training, was strongly related to mathematics passing rates on the New York State Regents exam. Researchers further discovered that 42 percent of variation in math scores and 12 percent of variation in English scores could be explained by the addition of technology in schools (Mann & Shafer, 1997:1).

A review of over 200 US studies on the effects of technology on student learning (Stratham & Torrell, 1999a; Waddoups, 2004) concludes that, when integrated appropriately, the introduction of technology into classrooms holds several benefits: It can increase teacher-student interaction and encourage cooperative learning, collaboration, problem solving, and inquiry. Students in “computer-rich” classrooms were found to have fewer absences and lower dropout rates than students in classrooms where there was no technology or where technology was limited. Finally, the use of

technology in the classroom is tied to increased student motivation, more positive attitudes, and higher levels of self-esteem. Research (COSN, 2011) suggests that greater student technology access, including one-to-one laptop initiatives, well-equipped classrooms, digital content and software applications, and distance learning opportunities, can translate into increased student engagement and measurable academic improvement.

The presence of hardware, software and connectivity is one half of the equation of “access.” The other half is how students use this technology for learning. Equity of access is not achieved when some students, like those in wealthy schools, use technology in ways that promote higher-order learning, critical thinking and creativity, while students in poorer schools use technology in ways that re-enforce lower-order, rote-based learning, such as for drill-and-practice or remediation.

⁷¹ “Sufficient” is a fluid term. Some research says one computer for every four students. Stratham & Torrell (1999b) suggest a 1:5 student-to-computer ratio. Cooley (2001) suggests that one computer is needed for every two to five students.

⁷² In this research, 62 percent are “frequent” users compared to 18 percent of those who have no computers in their classroom or who use labs for their students’ computer work.

Develop standards for quality education

Standards are guidelines for what the essential components of “schooling”—teaching, technology, professional development, curriculum development and content knowledge—look like in practice. Standards help educators bring focus and clarity to their work and provide benchmarks against which quality can be assessed and measured.

Countries that have been deemed “successful” in the use of ICT for teaching in learning specifically and in education generally—nations like Britain, South Korea, Singapore, the US and Finland—have either developed their own or utilized existing standards as a common framework around which initiatives are organized and implemented and against which practices are measured. Australia, China, Ireland, and many Latin American and European nations have also adopted or adapted national or regional standards around technology use for teaching and learning; instruction; leadership around technology and teacher professional development.

As reported earlier, standards shape all educational inputs in Britain in the US, not just the use of technology. For instance, many US school districts apply ISTE’s National Educational Technology Standards which inform school principals, teachers and students how to maximize productive use of technology. These standards are designed to provide guidance and consistency to programs that integrate technology in states, districts, schools and teacher education institutions.

Additionally, many US states utilize the online teaching and curriculum development standards of the International Association for K-12 Online Learning (iNACOL). Teacher professional development standards are guided by the standards of the National Staff Development Council (NSDC).⁷³ These standards in turn help to determine the type and content of professional development that teachers receive. In the UK, a detailed curriculum for the use of ICT in teaching specific subjects accompanies national standards.

Examples of Indicators of Standards-based Teaching and Learning

1. Develop clear statements of what students should know and be able to do.
2. Standards apply to all students with high expectations for their success.
3. Teacher knows how each lesson relates to academic standards.
4. Students know what they are learning, what standards are related to it and why they are learning it.
5. Standards are constant; instructional strategies, time and technologies are the variables.
6. Planning begins with standards—not materials and not technology.
7. Students know how the teacher expects them to show what they’ve learned.
8. Feedback to students is related to performance-level criteria not based on comparisons to other students.
9. Assessment system does not rely on one measure but on multiple authentic measures—portfolios, performance, examinations that measure growth over time.
10. Student performance data are used to revise curriculum and instruction.
11. Assessment of student achievement is consistent across teachers and schools, using common performance indicators.

Figure 23: Examples of Indicators of Standards-based Teaching and Learning (California State Board of Education, 2011)

Finally, within classrooms, content standards in the US and “key stage” standards in the UK determine what students should know and be able to do at certain levels of school, while instructional standards govern how teachers should teach. The prevalence of standards ties together many of the points made in this section—a clear vision; a common language and framework; the alignment of goals and expectations; and as will be discussed, leadership around best uses of technology; technology integration; teacher professional development and evaluation.

Build strong leadership

Administrative leadership is considered an important factor affecting the successful integration of technology into schools.

Research clearly indicates that schools with effective technology programs also have strong leadership who support and understand the benefits of technology for teaching and learning (Culp, Honey & Mandinach, 2003). Sandholz, Ringstaff & Dwyer (1997) found school leadership crucial in determining whether or not teachers integrate technology in their classrooms.

Schools that have made the most progress toward technology adoption and integration have school leaders with a vision of what is possible through the use of technology. These school leaders model the use of technology, support best practices in instruction and assessment, and provide professional learning opportunities for their staff. Strong leadership by school boards, superintendents, district administrators, and principals is a key factor in developing school environments conducive to the effective use of technology. Strong leaders advance a shared vision, provide a financial, long-term commitment to the program, and communicate regularly with schools and stakeholders about program implementation.

In the US, ISTE has developed a set of standards for school administrators that can serve to guide and support administrators as they assume their role as technology leaders—the National Educational Technology Standards for Administrators (NETS-A).⁷⁴ These standards represent a national consensus among educational stakeholders of what best indicates effective school leadership for comprehensive and appropriate use of technology in schools.

Providing strong technology leadership has become one of the many requirements of an effective school leader. As Mehlinger & Powers (2002) assert: “It is no longer possible for administrators to be both naïve about technology and be good school leaders” (p. 218).

Models of Teaching and Learning

Research and practice suggest that student attainment can be enhanced by the consistent use of specific teaching and learning models. The models outlined here have been developed as a direct consequence of theories about learning:

1. **Direct teaching models** are effective in helping students learn new skills and procedures and acquire academic knowledge. These models include modeling and sequencing for teaching reading and writing.
2. **Cognitive teaching and learning models** help learners to process information, build concepts, generate and test hypotheses, and think creatively. These models include inquiry, inductive learning and teaching through analogy.
3. **Social models** require learners to collaborate and learn together, and help them to construct new knowledge and understand concepts. These models include learner-centered instruction and group-problem solving.

Figure 24: Models of Teaching and Learning (Department for Education of the United Kingdom)

Recruit, hire and continually train high-quality teachers

Effective reforms, such as utilizing ICTs for the teaching and learning process, depend on having good teachers.

Countries whose students exhibit the highest scores of academic achievement measured by international examinations like the PISA—Finland, South Korea and Singapore—recruit teachers from the top 10 percent of university graduates.

Measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and mathematics. Research (Hanushek, 1992) estimates that the difference between having a good teacher and a bad teacher can exceed one grade level in annual achievement growth. Sanders (1998) and Sanders and Rivers (1996) state that lower achieving students are the most likely to benefit from increases in teacher effectiveness. Research on teacher effectiveness often uncovers the following five inputs (Darling-Hammond & Bransford, 2005; OECD, 2008) noted here:⁷⁵

Content Knowledge: Student achievement is significantly related to whether teachers are fully prepared in the field in which they teach. Good teachers have strong subject matter knowledge. Research demonstrates that the amount of college coursework that math and science teachers have taken in their content areas is positively related to student achievement gains. Teachers’ courses in content area and scores on subject matter tests strongly correlate with student achievement—though the former (courses in content area) show more frequent positive effects than the latter (test scores) (Hanushek, Rivkin & Taylor, 1995; Darling-Hammond & Bransford, 2005; OECD, 2008).

Structured Instructional Approach: Good teachers adopt a structured, planned approach to instruction. This can be a traditional, more direct, structured approach or a constructivist approach (See Figure 24). Research (OECD, 2008) suggests that these different teaching styles be adopted as the teaching context requires.

⁷⁴ Now called Learning Forward.

⁷⁵ The following three pages are taken verbatim from Burns, M. (2011). Distance Education for Teacher Training: Modes, Models and Methods, pp. 130-133.

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In terms of which approach is better in terms of student achievement—traditional or constructivist (learner-centered)—evidence weighs in favor of activities that are considered part of a constructivist approach: hands-on learning (social models of learning) and activities that emphasize higher-order thinking (cognitive learning models). Further supporting a constructivist pedagogy, research suggests that students are better able to acquire complex thinking skills when their teachers help them understand the underlying concepts and patterns that tie together the ideas they are studying; provide models for how to approach the task and reason through problems; provide scaffolds or structured steps that support the learning process; and coach students as they apply their knowledge to real-world tasks. Finally, students become more proficient when their teachers help them learn to evaluate and regulate their own learning (OECD, 2008).

Pedagogical Content Knowledge: Good teachers have strong pedagogical content knowledge. Teachers' preparation in content and pedagogy is associated with teaching practices, which in turn influence achievement. Pedagogical content knowledge (Shulman, 1986) essentially means that teachers know, not just their content, but specific strategies for teaching this particular content. Some of the key elements of pedagogical content knowledge are listed below:

- Selection of topics, useful forms of presentation, analogies, illustrations, examples, explanations and demonstrations;
- Understanding of what makes learning of specific topics easy or hard for students (including knowledge about conceptions and misconceptions students bring to the subject);
- "Deep knowledge" about content and structure of subject matter area;
- Knowledge of appropriate teaching materials, technology and media, and strategic knowledge in application of teaching strategies;
- Teaching specific topics or skills by making clear the context in the broader fundamental structure of a field of knowledge.

Knowledge about how students learn: Teachers with a good understanding of child development and learning are more likely to be effective in the classroom. Teachers who have had coursework in learning and development are more likely to stay in teaching. And teachers who understand how learning occurs are more able to select and develop curriculum that supports, rather than undermines, the learning process. Research on successful teacher education programs in the US has noted that many of these programs have particularly strong coursework in child and adolescent development tightly linked to clinical observation and analysis of learning within school and out-of-school environments (Darling-Hammond & Bransford, 2005).

Efficacy: Most studies (OECD, 2008) have found a positive relationship between teachers' beliefs about their efficacy and student achievements in core academic outcomes. Efficacy is a broad term that deals with attitudes, beliefs and perceptions. Teachers with strong self-efficacy believe that they can be

successful. Teachers with strong self-efficacy also have strong beliefs in their students' efficacy (a belief that students can be successful). Teachers who have strong efficacy are better able to motivate students because they set high standards for students and believe that they can teach the student what he/she needs to know to attain these standards. Teachers with high efficacy also demonstrate caring and respect for students and provide a safe learning environment. This concept of efficacy underlies the importance of motivation in teachers' work (OECD, 2008).

There may be more qualities for "good teaching" than those listed here and the process of developing good teachers is not as straightforward as simply blending these ingredients together. Four points are worth noting. First, recruiting high-quality teachers is of little use if they enter a school system that they perceive is not committed to quality or that does little to continually maintain and upgrade their knowledge and skills.

Next, these characteristics of "good teaching" call for a change in the way that teachers are prepared. Though in-service professional development programs can address some of these areas, it is difficult for any in-service professional development system to compensate for a poor selection process of teacher candidates or "reverse engineer" teachers to help them gain knowledge in content and the other characteristics that they should have learned in their pre-service formation.

Third, as mentioned repeatedly throughout this document, many nations have embarked on technology in education programs believing or hoping that technology will promote or cultivate these above five characteristics. It will not. It is far easier to help a "good" teacher use technology effectively than teach a poor or mediocre teacher how to use technology and expect it will reform his practice.

Finally, the latter two comments do not suggest that professional development for teachers is an unworthy effort. Teachers in high-performing educational systems, such as Finland, Singapore, South Korea and Hong Kong, receive substantial professional development—and ongoing professional development for the most part has been linked to student achievement.⁷⁶ It means that effective use of technology for teaching and learning demands professional development that focuses on using technology in content areas; using technology to support content-specific pedagogies; understanding how children learn using technology and which technologies and technology-related tasks are developmentally appropriate; and cultivating in teachers the embedded beliefs that children can use technology well and use it to support their own learning.

⁷⁶ A US Department of Education study examining the impact of professional development on math teachers showed that the professional development had no impact on student math achievement. See <http://ies.ed.gov/ncee/pubs/20104009/pdf/20104010.pdf>

Provide teachers with a variety of different types of high-quality professional development

To effectively integrate technology in classrooms and do so in a way that supports learner-centered pedagogies and higher-level thinking, teachers need “high-quality” professional development that is itself standards-based and that focuses on the “instructional core”—the relationship of the teacher and student to content.

High-quality professional development exhibits the following characteristics:

- **It addresses teachers’ needs**, as well as the needs of students and systemic educational goals
- **It is aligned with broader educational goals** to ensure that professional development is supported by policy and by national, school and classroom improvement plans
- **It is long term, ongoing and sustained**, giving teachers the opportunity to gain new knowledge and skills, reflect on their practice, and increase their abilities over time
- **It is sequenced or scaffolded** so that activities build on each other in a comprehensive and cumulative way
- **It focuses on student outcomes** in ways that enable teachers to use their new knowledge and skills to directly impact student learning.

Teacher-Centered Professional Development

1. Teachers, like their students, need opportunities for learning that are differentiated, ongoing, sequential and cumulative.
2. Teachers, like their students, need ongoing support, feedback and time for practice and revision in order to be productive learners.
3. Teachers, like their students, need learning opportunities that are situated and authentic—therefore, the most effective professional development occurs in a teacher’s school or classroom.
4. Teachers, like their students, learn best when they can collaborate with their colleagues. Teacher-centered professional development focuses on cultivating school-based communities of practice.

(Table continues on p. 108)

Figure 25: Teacher-centered Professional Development

- **It addresses teachers’ ideas about learning**, about their roles in the classroom, the roles of their students and how students learn
- **It combines various learning experiences** that promote observation, direct experience, reflection, lesson design and practice
- **It models learner-centered instruction and learner-centered and higher-level uses of technology** so that teachers experience and reflect on the learning activities that they will lead
- **It supports collaboration and peer support** among teachers, enabling them to share knowledge and experiences of the implementation of new ways of teaching
- **It includes vigorous follow-up** that guides teachers in their approach toward change in teaching and learning
- **It engages school leadership** in creating a school environment that promotes learning and experimentation and that supports the specific goals of professional development
- **It incorporates formative evaluation** and direct feedback from teachers, leading to summative evaluation that gauges change based on teachers’ practices, student activities, and learning outcomes
- **It targets lasting and systemic change**, so that teachers know they are part of a larger movement toward improvement and that they are the lynchpins for implementing what has been learned
- **It is provided annually in sufficient amounts.** A small amount of professional development per year has little value. Yoon et al. (2007) report that 14 hours or less per year shows no effects on student learning while longer duration professional development—an average of 49 hours per year focused on a specific topic or strategy—shows positive and significant effects on student achievement
- **It models for teachers how to individualize technology** applications to support different student learning styles.

Figure 25 collapses many of these best practices into what we call here “teacher-centered professional development”—professional development squarely focused on the needs and realities of teachers.

Professional development is typically regarded as a “workshop” or “training”—a one-to-many instructional approach that is popular because it is seen as less cost- and resource-intensive than other professional development options. Yet

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5. Teachers, like their students, learn from a variety of tools and resources. Technology should be accessible to teachers (in classrooms) and technology professional development should focus on how technology can support the core areas of teaching—content, instruction, and assessment—not on technology operations alone.
6. Teachers, like their students, should move along a trajectory of higher-order learning—from understanding a concept or strategy to applying it, evaluating its use, revising it and adapting and appropriating it to match with curricular and instructional objectives.

Figure 25: Teacher-centered Professional Development

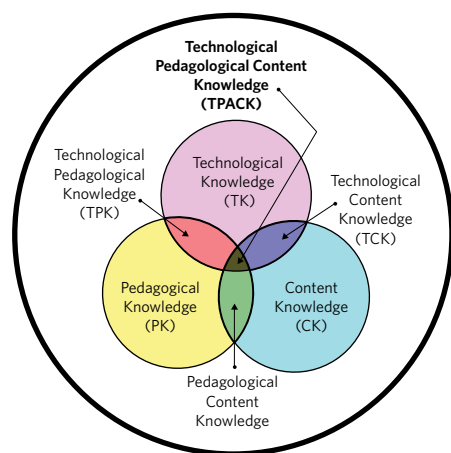


Figure 26: Technological Pedagogical Content Knowledge (TPACK)

workshops have limited research showing their efficacy. While they are helpful in exposing teachers to new ideas, they do little to help teachers plan for, use, integrate or evaluate a particular innovation, like technology for use in their own classroom (Sparks & Loucks-Horsley, 1989). Similarly, many of these workshops follow a cascade or train-the-trainers approach, a financially popular mode of disseminating expertise through teacher ranks, which also shows little impact on the acquisition of knowledge. Though there is minimal research on the impact of cascade approaches, O'Donoghue (2002) suggests that cascade approaches work poorly in systems where overall expertise is low and suffers from high leakage: In his study of educators in Zimbabwe, two-thirds of those receiving initial training in the cascade approach never delivered training to the next group of educators.

Other forms of professional development, on their own, or in concert with workshops, may be used as a support measure following workshops or periodically throughout the school year. One example is **Observation/Assessment** in which the professional development provider or master teacher observes teachers in their classrooms, assesses their instructional practices and provides structured feedback. It usually includes a pre-observation conference, observation, analysis of data, post-observation conference, and (in some instances) an analysis of the observation/assessment process. In the pre-observation conference, a focus for the observation is determined, observation methods selected, and any special problems noted.

In an **Open Lessons** model, teachers create lessons and invite colleagues to observe the lesson and provide feedback in a post-observation session. The focus of Open Lessons is on teacher behavior. Open Lessons have a long tradition in Russia, China and Azerbaijan and are used informally throughout the globe. Where there is structured feedback, time for discussion, and teacher incorporation of feedback into a future lesson, open lessons can help teachers build on and refine skills.

In a **Case Study** approach, teacher teams examine components of classroom instruction and apply what has been learned to their own classroom. This approach can use print, the Internet, and/or video case studies of classroom episodes. Case studies differ from Open Lessons in that they involve more in-depth analysis of all elements of instruction. Video case studies are an attractive professional development option since they allow teachers to “see” one another’s classes. As digital recorders fall in price, computers become more common, and video editing software becomes easier, educational organizations may begin to build their own “libraries” of video case studies for teacher training purposes.

Video case studies and open lessons are particularly effective modes of professional development because they provide models of what teachers are supposed to be doing. In interviews with those knowledgeable about JEI, this need for, and lack of, models for Jordanian teachers was cited as one of the weaknesses of the professional development that Jordanian JEI teachers received.

Integrate technology into the curriculum by helping teachers with instructional design

Technology works best, not when treated as a separate subject or an occasional project, but when it is used as a tool to promote student learning on a daily basis.

Instructional technology has been utilized successfully when teachers select technologies or applications that supplement or support classroom instruction and use them to reinforce, enhance, and elaborate on existing instructional practices. Teachers often need help considering how technology can be used to support the curriculum and how integrating technology into instruction will support broader instructional goals.

Studies of K-12 teachers’ instructional applications of educational technologies to date show many to be pedagogically unsophisticated—often limited in breadth, variety, and depth, and not well integrated into curriculum-based teaching and learning (Harris, Mishra & Koehler, 2008:393). Specifically, large-scale technology education and integration initiatives and approaches have tended to initiate and organize their efforts according to the educational technologies being used, rather than students’ learning needs relative to curriculum-based content standards (Harris, Mishra & Koehler, 2008: 395).

Technological Pedagogical Content Knowledge (TPACK) is a framework for teacher knowledge that emphasizes the connections among technologies, curriculum content, and specific pedagogical approaches, demonstrating how teachers’ understandings of technology, pedagogy, and content can interact with one another to produce effective discipline-based teaching with educational technologies (See Figure 26). Within the TPACK framework, teacher knowledge consists of three interdependent components—content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK)—all framed within and influenced by contextual knowledge.

Equally important to this framework are the interactions among these bodies of knowledge, represented as pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) (Harris, Mishra

& Koehler, 2008: 396-399). TPACK is a framework for teacher knowledge, and thus may serve two purposes. First, it may be helpful to those planning professional development for teachers by illuminating what teachers need to know about technology, pedagogy, and content and their interrelationships. Next, it may be helpful for teachers who are designing learning activities to help them see how technology intersects (or doesn’t) with content, pedagogy, and content-specific pedagogy. This offers promise for technology-driven activities with little content value or activities that use technology as an “add on.”

Incentivize teacher use of technology to support learner-centered instruction

In many cases where technology in education projects have failed, there has often been no compelling reason for teachers to change their instructional practice and/or use computers.

On the student-performance side, the curriculum, content, and most important, the assessment system, may overwhelmingly favor traditional, teacher-centered, fact-based, rote instruction (As discussed with the Tawjihi in Jordan and in the high-stake tests of many US states). On the teacher-performance side, many nations, states or provinces may have no standards against which to assess teachers' instructional practice and use of computers as part of classroom instruction; no indicators that evaluate the impacts of the adoption of new techniques and tools; no mechanisms through which to tailor ongoing professional development inputs; and no coherent framework for the provision of mentoring and support to teachers grappling with the crucible of change prompted by new pedagogy (learner-centered instruction), new tools (computers) and high expectations. Oftentimes, teachers who change their practice do so of their own volition and personal force of will. They are but a small portion of the overall teaching force (according to change literature, about 2.5 percent of any population [Rodgers, 1995]) and not surprisingly, the persistence of those changes typically attenuates over time.

Teachers need compelling reasons to change their instructional practice and to use technology in ways that supports inquiry-based and learner-centered instruction. We have discussed earlier the need for alignment among content, curriculum, instruction, the use of technology and assessment but other incentives are also needed. For instance, in Jordan, teachers were given their own laptops as an incentive to take courses to learn ICT. Additionally, Jordanian teachers who took 160 hours of MOE-approved technology related professional development (World Links, Intel Teach, Relief International/Schools Online)



received a 10 percent pay raise and a “special designation.” Teachers who attained a certain level of proficiency were promoted. In the US, there is a move to link teachers’ pay to “performance” and many nations (Britain, the Netherlands, Singapore and Korea) have increased teacher pay as part of their effort to recruit high-quality candidates as part of overall educational reform. More important, learner-centered and higher-order uses of technology should be built into the teacher evaluation system.

Incentives can be extrinsic, such as pay, promotion and laptops. However, incentives can also be intrinsically derived. Most teachers will adopt a practice or tool if they see that it adds value to what they do, if it helps students learn better, if it helps teachers teach better, and if it adds meaning to their work. This reality touches on several other factors listed

in this section—the need to build a vision and include teachers in the vision building process; high-quality professional development; ongoing support; and rigorous and reliable evaluations that demonstrate how and why teachers’ technology and instructional practices have resulted in improved student learning.

Provide teachers with ongoing support

Asking teachers to change the way they teach, and their paradigms of “instruction” and “learning;” to use new technologies to support new modes of instruction, assessment and classroom organization; to teach with a new curriculum; and to fundamentally change their role from the sole provider of knowledge to a facilitator of learning is an ambitious undertaking and one that requires constant and various modes of support.

As Figure 27 outlines, “support” is multi-dimensional and multi-layered. Teachers need physical resources (computers in their classroom; digital and paper-based learning materials; tables and chairs). They need support from administrators and colleagues—indeed if their school principal does not support their instructional efforts with technology or if there is not a critical mass of teachers at the same school all focused on the same goals, teachers will be unlikely to undertake the time, effort and difficulties associated with changing instructional practice. Teachers need instructional supports (guides for utilizing technology within a lesson, a curriculum that supports the types of learner-centered, open-ended exploration that technology can facilitate).

Technology—the use of Web 2.0 applications, cell phones, video, online communication—can furnish teachers with a great number of these supports. However, most of all, teachers still need human support in the form of a knowledgeable, skilled and caring resource person who can help teachers with the technical, logistical and conceptual challenges associated with attempting to integrate technology in their classrooms to support new ways of teaching and learning. The calculus is simple—when teachers receive this kind of support they are much more likely to utilize an innovation. When they do not,

nothing changes (Gaible & Burns, 2007; OECD, 2008; Darling-Hammond & Bransford, 2005) and ICT investments are wasted. Research is also clear that teachers, especially new teachers, who receive mentoring and coaching are less likely to leave teaching (OECD, 2008; Darling-Hammond & Bransford, 2005).

In England, teacher support is infused throughout the teacher professional development system. Teachers participate in formal professional development networks, individual and collaborative research, mentoring and peer tutoring, and study groups (OECD, 2008: 72). The majority of US states now have some sort of coaching or mentoring system in place to successfully help teachers integrate any innovation, not simply technology, into their classrooms. The State of North Carolina has an online mentoring and coaching program where teachers are assigned an online coach who helps them integrate new technologies in their classrooms.

What Is “Support” for Teachers?

“Support” is not simply one type of assistance but rather a multi-layered array of different types of “infrastructure” to help teachers successfully carry out their professional responsibilities. For teachers, “support” often includes:

Administrative support: Leadership; compliance monitoring by principals; official recognition; serving as interlocutor between school and district or school and community; expressions of support for implementation of new innovations; and administrative decisions that provide teachers with time and resources to carry out new instructional practices.

Instructional support: Typically, this is a coach, mentor, or in-class support person who guides, co-implements or helps the teacher with content, instruction, assessment, classroom management and the conceptual and logistical issues arising from change.

School-based community: A community of colleagues also undergoing the same professional development. Such a community can increase the “social capital” of a school as the whole school may function better because the collective ties of its members lead to an improvement in the “common good.”

Technical support: This includes help on how to use a particular application, troubleshooting help and someone on site to fix computers when they break down (as the inevitably will).

Community and/or family support: Formal and informal recognition and approval by parents of teachers’ efforts. This support can manifest itself in terms of resources or materials for the classroom.

Teaching and Learning Materials: The most basic level of support. Teachers need access to authentic resources or need to be able to purchase or create curriculum-specific teaching and learning materials.

Time: Release time for teachers to meet in-class support person; dedicated time during the school day or week to engage in the extensive planning that is a requisite for learner-centered instruction. “Time” is also invoked by teachers who feel unsure of how to embark on change.

Figure 27: What Is “Support” for Teachers? (Burns, 2011: 204)

Build reliable, valid and rigorous evaluation systems

One of the greatest existing areas of weakness in “technology in education” is the evaluation system. Program evaluations are notoriously tricky affairs, particularly in education and particularly in contexts where people may be ill-acquainted with evaluations.

As Dede (2005:5) notes, it is exceedingly difficult to assess the impact of any innovation within school settings:

Assessing “impact” (the degree of transformation in practice) and “reach” (the number of teachers and organizations influenced) are important, but complicated. Often, within the complexity of educational settings, where multiple school change and ... initiatives may be underway simultaneously and students move from teacher to teacher, it can be difficult to isolate and attribute the contribution of one ... program on a teacher’s development, and even more difficult to gauge the effect ... on student achievement or understanding.

Globally, there are numerous problems with evaluations of technology initiatives, especially those that are donor funded. First, they often focus on inputs (the number of computers delivered, number of teachers trained) or outputs (number of students who can use Excel) but fail to measure results or impact. Next, there is often confusion about evaluation-related terminology—for example, conflation of terms such as “outcomes” (proximal changes or intermediate effects on participants at an individual or group level) and “impact” (distal changes that deal with longer-term changes where the unit of analysis is the school or district). Third, there are often no internationally comparable or even local standards by which to measure the impact of computers on student learning. It is often therefore impossible, or meaningless, to compare results from one classroom technology program to that of another in a different geographic location or even among schools in the same location.

Core Indicators

An indicator is a piece of information which communicates a certain state, trend, warning or progress to an audience. Core indicators are context-specific ways to understand the inputs and outcomes of a program or project that we may or may not be able to observe directly. These include:

- 1. Input indicators:** For example, the type of ICT equipment and/or software and/or organizational design features deployed in a classroom.
- 2. Outcome indicators:** For example, student and teacher impact (affective, cognitive, and behavioral)
- 3. National educational and socio-economic indicators:** For example, educational enrolment rates, literacy, gender equity, etc.
- 4. Cost indicators:** For example, fixed and recurrent costs.

Figure 28: Core Indicators (Kozma & Wagner, 2006: 21)

Finally, impact evaluations are the most useful evaluations in gauging the effectiveness or lack thereof of the relationship between instruction, technology use and student learning. But change is not a linear or direct or immediate process. Impact takes years to accrue but many technology initiatives are short lived (1-5 years). In truth, many “impact” evaluations are conducted in programs that are not mature enough to be evaluated. Indeed, donors are beginning to realize that traditional systems of evaluation yield little meaningful or actionable data.

Over the past years, evaluations have shifted toward systematic examinations of new technologies as one among many elements in the educational environment. As such, these evaluations have increasingly begun to study the inter-relationships among new technologies with other “inputs” such as instructional style, content, and social interactions within the classroom. In the US and the UK in particular, evaluations have become more empirical in nature, and in the US, more “scientifically-based” (focused almost exclusively on randomized controlled trials⁷⁷ (RCTs) and on clearer evidence regarding the efficacy of a range of specific types of technology use in classrooms.)

As evaluation systems have evolved in Jordan, the US and the UK they have made a number of accommodations to strengthen the evaluation process—providing more time and funding for evaluations; co-designing evaluations along with, not after, program design; focusing on better and clearer evaluation questions; more rigorous measures (e.g., national and international assessments or customized program or project-specific assessments) and on developing “core indicators” (Kozma & Wagner, 2006:21) such as those outlined in Figure 28. In addition to technology-based evaluations, Britain, and in particular the US, have focused research efforts on learning-related disciplines and fundamental work on educationally relevant technologies; early-stage research aimed at developing new forms of educational software (such as games for learning), content, and technology-enabled pedagogy; and empirical studies designed to determine which approaches in the use of technology are most successful for student learning.

⁷⁷ The US Department of Education in December 2010 stated that single case studies doing interrupted time series designs are also capable of providing results in which one can have the same confidence as an RCT study and will therefore be accepted by the US Department of Education.

Summary

Globally, technology has been regarded as an instrument of, indeed a shortcut to, school reform. Countless ministries, donors and NGOs have placed computers in schools, taught teachers how to use them and waited, in vain, as nothing or little changed.

Initially (and continuously) such disappointments are addressed by blaming teachers for impeding technology's progress. More recently we have expressed our disappointment by blaming technology itself. A number of careers have been shaped and cottage industries created, all focused on the epic disappointments associated with technology in schools.

Technology has not failed educational systems; rather many educational systems have made successful implementation of innovations like technology impossible because they have failed to develop the terrain, the conditions, the initiatives, the supports—the reforms—necessary to ensure that innovations take root and flourish. Reform involves the restructuring, change, improvement and/or enhancement of the following:

- *inputs* (improving the quality of the pool from which they recruit their teachers);
- *school leadership and financing education systems* (so that all students have access to the educational resources they need to meet high standards);
- *processes* (the development of visions, shared language, and standards);
- *educational framework* (curriculum, assessment, instruction and the roles of teachers, principals and students);
- *training and formation* (helping teachers become ICT literate, but more important literate in teaching with and through technology and in utilizing new modes of instruction, communication, assessment and designing lessons that use technology)
- *outcomes* (defining success; asking the right evaluation questions; developing indicators for success; using reliable measures; and providing the time and resources for meaningful evaluations).

Reform is not “tinkering” or recalibrating an educational system—it is the re-imagining and restructuring of that very system, and technology alone cannot reform what ails school systems. While technology should support and extend reform of the above components, it cannot be the only component. The components that are part of school reform cannot be independently conceived and executed—when one component is missing or poorly functioning, it adversely impacts the whole system. In school systems that have experienced genuine improvement, like those of Singapore, South Korea, Finland, the United Kingdom, and Ontario (Canada), reform has occurred because policies and practices are aligned across all aspects of the system.

For example, these nations recruit teachers from the highest-achieving university graduates and pay them at levels that are comparable with or comparative to salaries in other professions. They insist that teachers possess and demonstrate expertise in the content they teach and, in the case of Finland, in content-related pedagogies and in general instructional methods, assessment and classroom management. They implement and augment,

rather than waive or dilute, high standards for teacher licensure. Essential components of day-to-day instruction—curriculum, assessment and technology use—are aligned and framed by a set of standards toward which teachers and students strive. They are coherent and consistently implemented over sustained periods of time (OECD, 2009:252).

Technology can certainly be introduced and disseminated across an educational system without an eye toward reform of critical components such as curriculum, instruction or assessment. Technology can certainly be introduced to merely provide students with a basic set of operational and vocational skills to help them attain the minimum technical literacy to function in a 21st century digital society. However, as the experiences of Lebanon, Jordan, the UK and the US, and the research findings of this monograph suggest, such use of technology will in the long run prove equally unsatisfactory to funders, implementers, teachers and learners.

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10. Intel (YMCA project)
11. International Education Association (YouthCaN Med)
12. Microsoft (LIVE@EDU)
13. Microsoft (Partners in Learning)
14. Microsoft (Partners in Learning: Innovative Students)
15. Microsoft (Partners in Learning: Innovative Teachers)

Annex 1: Glossary of Terms

3G: 3G are third-generation mobile telephone services which allow higher rates of transmission for more types of data, such as voice, video and Internet content.

Accessibility: Materials, technology and learning experiences are said to be accessible when individuals with auditory, visual, or motor disabilities can utilize, understand, interact with and learn from these materials, technology and experiences to the same degree as individuals with no disabilities.

ADSL: ADSL (Asymmetric Digital Subscriber Line or DSL for short) is a high-speed Internet access service that utilizes existing copper telephones lines to send and receive data at speeds that are far faster than conventional dial-up modems.

Applications (“apps”): Apps are software applications that can run on Smart Phones, tablets or any other portable electronic device.

Asynchronous: Asynchronous communication is a communication where there is a lag between a message being sent and a message received, i.e., communication that does not occur at the same time. Typical examples of asynchronous communication include list servers, bulletin boards, email and discussion forums.

Avatar: A computer user’s representation of himself/herself or alter ego, whether in the form of a three-dimensional model used in computer games or a two-dimensional icon (picture). “Avatar” can also refer to the personality connected with the screen name, or handle, of an Internet user.⁷⁸

Bandwidth: The carrying capacity or the data transmission rate of a network. Bandwidth is typically measured in bits per second. A bit (from “binary” + “digit”) is a unit of measurement of information. There are 8 bits in a byte.”⁷⁹

Blog: Also known as a “web log,” a blog is a publicly accessible journal that is kept online and can allow for others’ comments. Often the person is not identified by name and can write “anonymously.”

Blended Learning: In distance education, an instructional approach that blends or combines face-to-face instruction with some form of distance-based or technology-based instruction (online courses, radio-based instruction, etc.). Also called “hybrid learning.”

Broadband: A range of frequencies wider than that required for voice communications. Also a term used to describe systems and equipment with wide bandwidth that can carry these ranges of frequency.

Chat: A piece of software, such as AOL’s Instant Messenger (AIM), ICQ, or IChat that allows users to communicate synchronously or “real time” (at the same time) with people who are also online, and are logged into their the same “chat” software.

Cloud computing: Cloud computing is Internet-based computing. Applications do not reside on the computer’s hard drive but rather are stored on servers (the cloud) so users can access them as needed without paying for a software license or devoting computer storage space to house them. Web 2.0 applications are examples of cloud-based applications and cloud computing.

⁷⁸ Retrieved from Wikipedia: <http://en.wikipedia.org/wiki/Avatar>
⁷⁹ Retrieved from Google: <http://www.google.com>



Computer Aided Instruction (CAI)/Computer Aided Learning (CAL): Computer Aided Instruction or Computer Aided Learning is instruction delivered by a computer. The computer acts as a “teacher” and presents content, problem sets, etc. with which the student interacts. CAI programs vary greatly in their quality. Some programs are behaviorist, drill-based applications while other offer more iterative problem-sets and feedback to address specific student weaknesses adjusted by the computer.

Connectivity: Refers to technologies that specifically allow computers and other electronic devices to communicate with one another, particularly the use of such telecommunications technologies, such as email, the Internet, chat.

Constructivism: A learning theory which has its roots in a number of disciplines—philosophy, anthropology, the natural sciences, semiotics, socio-linguistics and education. The central idea of constructivism is that knowledge is not fixed but rather constructed by the learner. Some of the other major concepts of constructivism are that learners bring unique, prior understandings to any learning situation; learning is an adaptive activity; learning is situated and tied to the circumstances; learners may resist, accommodate or assimilate new learning; and learners interact through interaction with materials, resources, experiences and other learners.⁸⁰ The instructional offspring of constructivist learning theory is learner-centered or student-centered instruction.

Course Management System: A Course Management System (CMS) is a digital platform that enables instructors to organize and post course content materials over the Internet for their students. Examples include Moodle, Sakai, and Blackboard. Also known as a Learning Management System.

Cyber Schools: See “virtual school.”

Dial Up: Dial-up Internet access is a form of Internet access that uses a public switched telephone network (PSTN) to establish a dialed connection to an Internet service provider (ISP) via telephone lines. The user’s computer or router uses an attached modem to encode and decode Internet Protocol packets and control information into and from analogue audio frequency signals, respectively.⁸¹

Digital Game: A game played by manipulating some form of electronic media (game console, cell phone, computer). Web-based digital games can be played across media, time, and social spaces.⁸²

Digital-learning Game: In contrast to entertainment games, digital learning games target the acquisition of knowledge in a particular domain or set of domains and habits of mind (creativity, problem-solving, conative skills, inquiry, distributed cognition, heuristic methods, etc.) across all academic content areas.⁸³

Digital Subscriber Line Access Multiplexer: DSLAM (pronounced dee-slam) allows telephone lines to make faster connections to the Internet. It is a network device, located in the telephone exchanges of the internet service providers, that connects multiple customer Digital Subscriber Lines (DSLs) to a high-speed Internet backbone line using multiplexing techniques.⁸⁴

Distance Education: An educational process and system in which all or a significant proportion of the teaching is carried out by someone or something removed in space and time from the learner. Distance education requires structured planning, well-designed courses special instructional techniques and methods of communication by electronic and other technology, as well as specific organizational and administrative arrangements.

DVD: “Digital Versatile Discs” or “Digital Video Discs” are an optical disc storage media format that can be used for data storage, such as movies with high video and sound quality. DVDs resemble compact discs in terms of physical dimensions but they can store much more data than a CD.⁸⁵

E-learning: “E” refers to how the course is digitized and stored in an electronic format. “Learning” is the content and the way students achieve educational goals.⁸⁶ E-learning typically, but not always, refers to web-based learning.

E-reader: An electronic book, like the Kindle or Nook, that stores hundreds of books and allows users to read, bookmark, annotate, purchase and store books in digital format. Text is displayed via electronic ink.

Education Management Information System: An EMIS is a computer-based system of hardware, software (and people) that allows institutions to store, search and retrieve data in order to make educational decisions (about enrollment, resources, cost, etc.). An EMIS is typically a database program.

Formative Assessment: Assessment that is ongoing and continuous and used not to certify mastery or assign grades. Formative assessment is instructional in nature—it provides information about the learner’s progress and understanding of a certain concept or skill.

Handheld Devices: Any digital device, such as a Palm Pilot or cell phone, that is small and light enough to be portable, and is self-contained enough as to allow the user to complete specific tasks.

High Speed Packet Access: High Speed Packet Access (HSPA) is an amalgamation of two mobile telephony protocols—High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA), that extends and improves the performance of existing WCDMA protocols. A further 3GPP standard, Evolved HSPA (also known as HSPA+), was released late in 2008 with subsequent adoption worldwide beginning in 2010.⁸⁷

Hybrid Learning: See blended learning.

Immersive Digital Environments: An artificial, interactive, computer-created scene or “world” within which a user can engage or “immerse” him or herself. Immersive digital environments could be thought of as synonymous with Virtual Reality, but without the implication that actual “reality” is being simulated. An immersive digital environment could be a model of reality, a complete fantasy user interface or abstraction, or some sort of simulation.⁸⁸ Also known as a “multi-user virtual environment” or “virtual world.” One such example is Second Life.

Inquiry-based learning: Inquiry-based learning is an instructional approach. Typically used in science, it follows the following approach: *1) Question:* Learning begins with a learner’s scientifically oriented question/inquiry. *2) Observation:* Learners observe and question phenomena. *3) Hypothesis:* Learners pose explanations of what they observe. *4) Experiment:* Learners devise and conduct experiments in which data are collected to support or contradict their theories. Learners give priority to evidence in responding to questions. *5) Generation of knowledge:* Learners analyze data and draw conclusions from experimental data. Learners formulate explanations from evidence. Learners connect explanations to scientific knowledge. *6) Test and application of knowledge:* Learners design and build models and communicate and justify explanations.⁸⁹

Instant Messaging: A form of real-time communication between two or more people based on typed text. The text is conveyed via devices (desktop, laptop or handheld computers) connected over a network such as the Internet. Also known as “chat.”

Interactive Whiteboard: Also known as a “smart board” or “electronic white board,” Interactive Whiteboards (IWBs) allow network participants to simultaneously view one or more users drawing on an on-screen blackboard or running an application from their computer.

Internet Service Provider (ISP): An ISP is a company that provides customers with direct access to the Internet.

Instructional Design: Often very broadly defined (as a process, a science or a discipline), instructional design in this document is defined as the process of creating instructional tools, content, experiences and activities to help learners attain a specific set of learning goals. Instructional design can be done with or without technology. Instructional design consists of diagnosing the needs of the learner, defining the end goals of instruction, determining how learning goals will be assessed and evaluated, and developing “interventions” and activities to assist in the learning transaction.

Instructional Strategies: The activities teachers design and students must do to achieve learning outcomes.

Intelligent Tutoring System: An outgrowth of Computer Aided Instruction (CAI), ITS is a learning

⁸⁰Boethel, M. & Dimock, K.V. (1999). Constructing Knowledge with Technology: An Overview of the Literature. Austin, TX: Southwest Educational Development Laboratory.

⁸¹Taken verbatim from http://en.wikipedia.org/wiki/Dial-up_Internet_access

⁸²Klopfer, Osterweil & Salen, 2009

⁸³Adapted from Ibid.

⁸⁴Retrieved verbatim from Wikipedia: http://en.wikipedia.org/wiki/Digital_Subscriber_Line_Access_Multiplexer

⁸⁵Retrieved from Wikipedia: <http://en.wikipedia.org/wiki/DVD>.

⁸⁶Commonwealth of Learning. (2003). Education for a Digital World, p. 13. Vancouver: Author.

⁸⁷Retrieved verbatim from Wikipedia: http://en.wikipedia.org/wiki/High_Speed_Packet_Access

⁸⁸Retrieved from Wikipedia: http://en.wikipedia.org/wiki/Immersive_digital_environment

⁸⁹Retrieved from National Science Teachers Association: <http://www.nsta.org> (search term)



technology that dynamically adapts learning content to objectives, needs, and preferences of a learner by making use of his/her expertise in instructional methods and the subject to be taught.⁹⁰

Internet: A network of networks on a world-wide scale with millions of computers interconnected through a set of computer protocols.

Learner-centered Instruction: A broad variety of pedagogical strategies that acknowledges that students bring unique prior knowledge, experience, and beliefs to a learning situation. Learner-centered instruction helps students construct knowledge in multiple ways using a variety of authentic tools, resources, experiences, and contexts; promotes learning as an active and reflective process; and encourages students to interact socially and collaborate in order to solve real world problems and create their own understanding of situations. Learner-centered instruction is also known as “child-centered,” “interactive,” “student-centered” instruction or “active learning.”

Learning Management System: See Course Management System.

Media: The means and ways of distribution and communication from text, audio, graphics, animated graphics to full-motion video. Multimedia is the mix or combination of media.

Microwave: Microwaves are radio waves with wavelengths ranging from as long as one meter to as short as one millimeter, or equivalently, with frequencies between 300 MHz (0.3 GHz) and 300 GHz.⁹¹

Mobile Learning: Also known as m-learning, mobile learning is learning through portable, handheld electronic devices, generally with wireless communication capabilities. Mobile technologies include cell phones, personal digital assistants, handheld computers, or mobile gaming devices.⁹²

MP3: Developed by the Moving Picture Experts Group (MPEG), MP3 and MP4 are audio compression standards for encoding audio so it can be transmitted via the Internet or another network. An MP3 Player is a piece of handheld technology (such as an iPod) that allows a user to listen to MP3 files.

Netbook: Netbooks are “mini” computers that are cheaper and lighter than laptops. Initiated by MIT’s XO project, the idea of a low-cost notebook has been accelerated by a number of technology companies, such as Intel and Acer. They often lack a hard drive so are suitable for use with cloud-based applications. They are also better suited for writing, email and web-surfing versus high-graphics applications such as gaming or virtual worlds.

Network: An arrangement of objects or people interconnected electronically or not. In communications, the transmission channels interconnecting all client and server stations also support hardware and software.

Online: When a computer is connected to a network and logged in. On-line is the opposite of off-line. In this guide, “online” is synonymous with “web-based.”

Open Education Resource: Open Educational Resources (OER) are public domain and/or copyright-free teaching and learning resources that can be openly used or re-purposed by teachers and learners. The types of materials that fall under the rubric OER are vast—for example, full courses, course materials, modules, textbooks, videos, tests, software, images, and any other tools, learning objects, or any other materials that can be used for teaching and learning.

Open Source Software: Software for which the underlying programming code is available to the users so that they may read it, make changes to it, and build new versions of the software incorporating their changes. There are many types of Open Source Software, mainly differing in the licensing term under which (altered) copies of the source code may redistributed. Sometimes referred to as Free/Libre Open Source Software (FLOSS) though there are some differences between OSS and FLOSS.

Performance-based Assessment: A form of alternative summative assessment in which learners are asked to create, produce, or do something, often in settings that involve real-world application of knowledge and skills.

Personal Digital Assistant (PDA): A handheld computer for managing contacts, appointments and tasks. It typically includes a name and address database, calendar, to-do list and note taker, and serves as a personal information manager. Wireless PDAs may also offer e-mail, Web browsing and cellular phone service.⁹⁴

Podcast: iPod broadCASTs are audio broadcasts that have been converted to an MP3 file or other audio file format for playback in a digital music player or on a computer. Podcasts contain primarily text as well as music, images and video (known as vodcasts). Podcasts can be automatically downloaded to a computer via a subscription or “RSS” feed.⁹⁵

Post/Posting: In an online environment, posting means creating and uploading a written communication to a blog, discussion forum, bulletin board, wiki or list server. The term is used as a noun and a verb.

Project-based learning: An instructional philosophy in which learning is organized around a driving question or issue. Learners collaborate to address this issue, find information, and then present their findings. Project-based learning, like problem-based learning, is complex, involves student collaboration, and is characterized by a high level of learner autonomy. Unlike problem-based learning, with which it is erroneously conflated, a project-based approach may not involve a real-world problem (many project-based activities are simulations of real-world issues) and is not as loosely structured as problem-based learning.

Server: A computer that provides a service across a network. The service may be file access, login access, file transfer, printing and so on.

Simulation: A computer program (often web-based) that models/imitates an entity, state of affairs, or process. Simulations provide users with experiences that might otherwise be unavailable because of cost, difficulty or logistics. Some examples of simulation programs are flight simulation programs (to train airplane pilots), virtual dissection kits (students can dissect a frog or cat for biology class) or web-based simulations to teach scientific or mathematical concepts.

Smart Phone: A mobile cellular telephone that has many of the same functions as a handheld computer, including e-mail, photo and video capture, document viewing, and development and web browsing.⁹⁶

SMS: Short Messaging Service is a text message composed on and sent via cell phone.

Social media: User-created media (video, audio, text or multimedia) that are published and shared in a social environment, such as a blog, wiki or video hosting site. Examples include YouTube and Flickr.

Social Networking Sites: Internet sites that enable the creation of online communities of people who share interests and activities, or who are interested in exploring the interests and activities of others. Most social network services are web based and provide a variety of ways for users to interact, such as e-mail and instant messaging services. The best known examples of social networking sites are Facebook and Orkut, both of which contain professional interest groups, such as teachers.

Software: Instructions for the computer. A series of instructions that performs a particular task is called a program. Two major categories of software are system operating software and application software.

Summative Assessment: Final assessment such as an exam administered to learners for the purpose of judging performance, grading, or certifying a learner’s level of knowledge.

Synchronous Collaboration Tools: Web-based technologies that allow for real time or “synchronous” communication such as synchronous text chat, audio-conferencing, video-conferencing, Voice over IP telephony (such as Skype), and Multi-user domain Object Oriented environments (MOOS).

Tablet: A wireless personal computer (PC) that allows a user to take notes using natural handwriting with a stylus or digital pen on a touch screen. A tablet PC is similar in size and thickness to a yellow paper notepad and is intended to function as the user’s primary personal computer as well as a note-taking device.⁹⁷

Total Cost of Ownership (TCO): Total Cost of Ownership is the financial estimate of all costs associated with a particular program, purchase or intervention. It includes all capital and recurrent costs for—using

⁹⁰Retrieved from Erudium: <http://www.erudium.polymtl.ca/html-eng/glossaire.php>

⁹¹Taken verbatim from Wikipedia: <http://en.wikipedia.org/wiki/Microwave>

⁹²Pouezevera, S.L. & Khan, R. (2007). Training Secondary Teachers in Rural Bangladesh Using Mobile Technology, p. 87. In ICT in Teacher Education: Case Studies from the Asia-Pacific Region. Bangkok: UNESCO.

⁹³Wikipedia. Retrieved from http://www.wikieducator.org/Open_Educational_Content/olcos/introduction

⁹⁴The Free Dictionary. Retrieved from <http://encyclopedia2.thefreedictionary.com/PDA>

⁹⁵PC Magazine. Retrieved from http://www.pcmag.com/encyclopedia_term/0,2542,t=podcast&i=49433,00.asp

⁹⁶Pouezevera, S.L. & Khan, R. (2007). Training Secondary Teachers in Rural Bangladesh Using Mobile Technology, p. 87. In ICT in Teacher Education: Case Studies from the Asia-Pacific Region. Bangkok: UNESCO.

⁹⁷Retrieved from Search Mobile Computing: <http://searchmobilecomputing.techtarget.com>

technology as an example—equipment, connectivity, supplies, supporting infrastructure, training and support over a particular period (five years, a decade, etc.).

Two-way Audio: Voice-only communication that allows for two-way communication (listening and speaking). Audio can be transmitted via telephone, satellite, the Internet or high frequency radio. The most famous example of two-way audio instruction for distance learning is Australia's Schools of the Air.

Universal Design for Learning: A design principle (for buildings, technology, the environment, industrial products, etc.) that aims to be "barrier free." UDL advocates equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use.⁹⁸

Virtual Learning: See online learning, e-learning or distance learning.

Virtual Reality: According to Wikipedia, virtual reality is "a term that applies to computer-simulated environments that can simulate places in the real world, as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications."⁹⁹

Virtual Schools: A virtual school describes an institution that teaches courses entirely or primarily through online methods. Though there are tens of thousands of commercial and non-accredited courses available online, the term "virtual school" is generally reserved for accredited schools that teach a full-time (or nearly full-time) course of instruction designed to lead to a degree. At the primary and secondary level, accreditation means that virtual schools tend to receive public funding. Some publicly funded and private universities also provide accredited online degrees. See also "cyber schools."

Virtual World: A computer-based simulated environment intended for its users to inhabit and interact via avatars. These avatars are usually depicted as textual, two-dimensional, or three-dimensional graphical representations, although other forms are possible (auditory and touch sensations for example). Some, but not all, virtual worlds allow for multiple users. In a virtual world, the computer accesses a computer-simulated world and presents perceptual stimuli to the user, who in turn can manipulate elements of the modeled world and thus experiences some degree of telepresence.¹⁰⁰

Voice over Internet Protocol (VoIP): A transmission technology for delivery of voice communications over the Internet. Also known as Internet telephony. Using software such as Skype or CoolTalk, users can use the digital audio features of the Internet to talk with another person using his/her computer. Typically computer to computer calls are free and computer to phone calls involve a nominal charge.

Web 2.0: The term used for the second "generation" of the World Wide Web. Where Web 1.0 is largely a "read" medium, Web 2.0 is a "read/write" medium in which users create and publish content without complicated authoring tools (such as web design software). Examples of Web 2.0 content include web logs ("blogs"), wikis, and social networking sites.

Webinar: An interactive web-based seminar where instructors and learners interact using documents (such as PowerPoint), video, audio and chat tools.

Wiki: From the Hawaiian word for "quick," wikis are an example of a Web 2.0 technology. A wiki is a page or collection of sites designed to enable anyone who accesses it to contribute or modify content, using simple formatting rules. Wikis are often used to create collaborative websites and to power community websites. The collaborative encyclopedia Wikipedia is the best-known example of a wiki.¹⁰¹

Wireless: The ability of one ICT device (computer, cell phone) to communicate with another without cables or wires.

World Wide Web: An information-distribution method that operates via the Internet to enable users to access information resources linked to Uniform Resource Locators (URLs) or other codes. Web "pages" are displayed in browsing software, and may contain links (often called "hypertext") to other resources.

⁹⁸ Retrieved from Center for Universal Design: <http://www.design.ncsu.edu/cud/>

⁹⁹ Taken verbatim from Wikipedia. See http://en.wikipedia.org/wiki/Virtual_reality

¹⁰⁰ Retrieved from Wikipedia: http://en.wikipedia.org/wiki/Virtual_world

¹⁰¹ Retrieved from <http://en.wikipedia.org/wiki/Wiki>