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Evaluation of the
Jordan Education Initiative

Synthesis Report

OVERVIEW AND RECOMMENDATIONS TO THE JORDAN EDUCATION INITIATIVE

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Synthesis Report

Overview and Recommendations to the Jordan Education Initiative

Submitted to:
USAID/Jordan

Submitted by:
Daniel Light, Education Development Center
Frank Method, RTI International
Charles Rockman, Education Development Center
Gordon M. Cressman, RTI International
John Daly, Consultant to RTI International

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Abbreviations

1–12 ..... Grades 1–12
ADSL..... Asymmetric Digital Subscriber Line
CD ..... Compact Disk
CEB..... Computer Engineering Bureau
CMS ..... Content Management System
CoSN..... Consortium for School Networking
COW..... Computers on Wheels
DSS..... Decision Support System
EDC..... Education Development Center, Inc.
e-Arabic…... Electronically mediated learning of, or electronic content for learning, Arabic
e-content..... Electronic content
e-learning.... Any technologically mediated learning
e-math……..Electronically mediated learning of, or electronic content for learning, math
e-resources. Any resource delivered electronically or to support electronic learning
EFL..... English as a Foreign Language
EMIS ..... Education Management Information System
ERfKE ..... Education Reform for a Knowledge Economy
ERP..... Enterprise Resource Planning
ICT..... Information and Communication Technology
IMS..... Instructional Management System
IT ..... Information Technology
ITG..... Integrated Technology Group
IWB ..... Interactive White Board
JEI ..... Jordan Education Initiative
KB..... Kilobyte
LMS..... Learning Management System
M&E ..... Monitoring and Evaluation
MoE..... Ministry of Education
MoICT ..... Ministry of Information and Communication Technology
NBN..... National Broadband Network
NGO ..... Nongovernmental Organization
PC ..... Personal Computer
PDA..... Personal Digital Assistant
PMO ..... Project Management Office
PPP ..... Public-Private Partnership
RTI..... Research Triangle International
SIS/SMS.... Student Information and School Management System
TCO..... Total Cost of Ownership
UNESCO... United Nations Educational, Scientific and Cultural Organization
USAID ..... United States Agency for International Development
WEF ..... World Economic Forum

Contents

1 Introduction

1.1 The Jordan Education Initiative

The Jordan Education Initiative (JEI) was created in 2003, with the assistance of the World Economic Forum (WEF), to leverage public-private partnerships to improve the application of information and communication technology (ICT) in grades 1–12 in Jordanian schools. The four primary objectives of the JEI are as follows:[1]

1. Improve the development and delivery of education to Jordan's citizens through public-private partnerships, and in the process help the government of Jordan achieve its vision for education as a catalyst for social and economic development

2. Encourage the development of an efficient public-private model for the acceleration of educational reforms in developing countries based on unleashing the innovation of teachers and students through the effective use of ICT

3. Build the capacity of the local information technology industry for the development of innovative learning solutions in partnership with world-class firms, creating economic value that will lead to mutually beneficial business opportunities

4. Leverage an environment of national government commitment and corporate citizenship to build a model of reform that can be exported to and replicated in other countries.

To achieve these objectives, a partnership was formed involving international and domestic companies, international funders and Jordanian government agencies. The efforts of the partners have been coordinated and managed by the JEI Project Management Office (PMO). As indicated by Objective 4 above, the JEI has been viewed by the WEF as a flagship effort to produce a model, lessons-learned, and best practices that can be applied to other countries with similar objectives.

The project has developed content to enrich the curriculum in core subjects, including math, science, Arabic, English as a Foreign Language (EFL), and ICT. This content is provided electronically through the EduWave portal and used by students in computer labs and by teachers equipped with laptops and projectors in the classroom. The JEI uses a test bed of 100 selected "Discovery Schools" where teachers and laboratory technicians are trained and supported by Ministry and partner staff under the guidance of the PMO staff.

Jordan has made considerable investment in ICT infrastructure, as part of its national Education Reform for a Knowledge Economy (ERfKE) initiative, begun in 2002. This included development of the National Broadband Network (NBN) and establishment of one or more computer laboratories in most schools. The Discovery Schools had more ICT infrastructure, hardware and software, technical support, and training than the other ERfKE schools. In addition to training and pedagogic support for teachers as part of the content development and piloting in the Discovery Schools, JEI partners augmented the ERfKE ICT provision in the Discovery Schools with laptops and datashow projectors for use by teachers, wireless access points for the classrooms, upgrading of the laboratories and replacement of some of the laboratory desktop computers, training for the laboratory technicians and close monitoring of technology maintenance and use.

[1] Government of Jordan and World Economic Forum (2004). *Jordan Education Initiative: A Public-Private Partnership Model for Effective and Advanced Learning Deployment.* Amman: Authors. This text is slightly revised from: World Economic Forum (2003). *Jordan Education Initiative Baseline Proposal*. Geneva: Author.

There also was limited provision of Interactive White Boards (IWBs) in multi-media classrooms and of Computers on Wheels (COW carts) as an alternative to laboratories. However, the IWBs and COW carts were not central to the JEI e-learning approach and received less analytic and monitoring/evaluation attention compared to the use of laptops and projectors in the classrooms and the e-learning activities in the laboratories.

The WEF project was limited to three years and most partner support for content development and partner provision of ICT inputs was completed in early 2007. Fortunately, the JEI PMO has been able to continue working with the Ministry of Education and with partners to coordinate remaining activities, conduct further training, and monitor the use of ICTs and other activities in anticipation of further development of the e-learning approach and the scaling up of the approach to the other ERfKE schools.

Though initially seen mainly as a mechanism for coordinating partner activities, the JEI PMO has evolved into an essential input to the development of the e-learning approach and ICT support. It has become a professional organization providing technical expertise, training and monitoring as well as management and executive functions. No other organization appears to be positioned to play this important role moving forward. The JEI PMO has now become a nongovernmental organization (NGO) in order to continue and expand its activities in support of Jordanian education.

1.2 Objectives of this evaluation

Education Development Center (EDC) and Research Triangle International (RTI) were asked to conduct a four-part evaluation of JEI program strategy and implementation. All four evaluation reports, while addressing directly only their discrete topic areas, do so with regard for how the structures and activities evaluated serve the goal of improved learning. In this synthesis report, we aim to continue in that vein. The four parts of the assessment are as follows:

- Task One: EDC examines the current state of ICT use and pedagogical practices in the Discovery Schools. The evaluators used a combination of survey studies and case studies to understand the emerging paradigm of teaching and learning in ten Discovery Schools.

- Task Two: EDC analyzes the nature of the public-private partnership. The authors interviewed representatives of key partner organizations, focusing on the partners' goals and expectations for participating in the JEI, the collaboration across organizations, and the benefits and challenges of participating in the JEI.

- Task Three: RTI assesses the information technology hardware, software and infrastructure and the adequacy of these platforms to support e-learning in the Discovery Schools, including management and technical support issues affecting use, functionality and maintenance.

- Task Four: RTI assesses the costs of JEI activities and ICT inputs in support of e-learning in Discovery Schools and the cost implications of scaling up the JEI technology platforms and e-learning approaches to additional schools.

The objectives of this synthesis report are to summarize the findings from all four task reports and to provide the JEI and its partners with a comprehensive set of recommendations for building on achievements to date and increasing the program's impact on improved learning in Jordan.

1.3 Data collection

Each task had a specific research plan with distinct strategies. In total, the combined efforts included surveys of teachers, principals and 10th grade students in 20 schools, interviews with 61 school-based educators and 28 JEI stakeholders, focus groups with 36 students, visits to 14 schools and observations in 184 classrooms, interviews with the relevant Ministry of Education Directorates and PMO coordinators, and reviews of JEI site survey data and project documentation. For more detailed information, please see each task report[2].

1.4 A brief introduction to the findings

The familiarity gained from interviews, surveys, visits and observations have helped us understand where the JEI is on the path to integrating ICT into the Discovery Schools and promoting the MoE's reforms at the classroom level. The JEI has been able to mobilize its network of partners to provide the Discovery Schools a broad range of ICT resources, including hardware and software as well as development of e-content. While the student-computer ratio is still higher than that of wealthier nations and there are on-going challenges to providing stable connectivity, the data show that teachers are able to use the ICT resources they have. However, the most frequently observed uses of these new resources do not yet align with the vision of use desired by the JEI and MoE. The data indicate that most educators still have a traditional view of their role as teachers. Teacher-centered practices still predominate among most of the teachers we interviewed and observed. Innovation requires taking risks, and many teachers expressed concern that the highly centralized education system, and the emphasis on coverage in the curriculum and preparing for the tawjihi exams, limited their flexibility to experiment with new practices.

Nevertheless, there are some bright spots that suggest where the JEI should focus its work going forward to promote deeper changes in the use of e-learning resources in Jordanian classrooms. Within the ten case study schools chosen from among the nearly 100 Discovery Schools, there are a number of capable principals and teachers who have embraced the new approaches, are integrating active learning strategies and student-centered practices and are using the e-learning resources in more innovative ways. Our research suggests that a few key factors have facilitated and supported these changes. In the most exemplary schools, we observed:

1. Pedagogical vision: Teachers shared and could articulate a vision of teaching and learning as well as beliefs about the teacher's role, and both sets of understandings appear to have shaped their practice in the classroom.

2. Leadership: The principals were strong instructional and institutional leaders.

3. Professional development and ongoing support: Overall, many teachers reported having engaged in little professional development. However, the most exemplary schools had created multiple opportunities, in addition to the formal participation in training courses, for teachers to learn about and share new practices.

4. Effective resource management: The best schools had developed strategies to effectively share resources to ensure that teachers had access to the technology when it fit into their

[2] Light, D., & Rockman, C. (2008). *Evaluation of the Jordan Education Initiative: The Emerging Paradigm of Teaching and Learning in Discovery Schools.* Washington, DC: Education Development Center.
Light, D. & Rockman, C. (2008). *Evaluation of the Jordan Education Initiative: An Evolving Partnership for Change: Stakeholders' Reflections on the Jordan Education Initiative.* Washington, DC: Education Development Center.
Cressman, G., & Daly, J. (2007). *Evaluation of the Jordan Education Initiative: Review of the Technology Employed to Deliver E-Learning*. Washington, DC: Education Development Center.
Method, Frank (2008). *Evaluation of the Jordan Education Initiative: Cost Assessment of Technology Support for E-Learning.* Washington, DC: Education Development Center.

curricular needs and that teachers could plan for technology access in the lab or in their classrooms.

In relation to the public-private partnership, the findings suggest the following elements of success:

1. The Project Management Office: Most stakeholders hailed the creation of the PMO as the key element for the long-term success of the JEI. The PMO plays an important role in facilitating and in coordinating between the MoE and private sector partners. Because of its independence and flexibility, the JEI is positioned to play this important role, while no other organization is.

2. Communication: The PMO has worked hard to build effective communication among all the partners. This has been a major success, although keeping communication open is an ongoing challenge. JEI-related communication between and among the private companies, the non-profit organizations and the relevant branches of the MoE is complex. The complexity is only increased by the fact that these collaborations have an international component. The opportunity for synergies requires that the different content teams are coordinated effectively with each other and with the MoE.

3. Flexibility: The JEI offers an easy and flexible way for the private sector to participate with the public sector. The JEI can accept funds, product donations, or actual programs. The JEI has the flexibility to experiment and pilot innovative activities without the same repercussions that ministries face if they expend resources on a project that "fails". Finally, stakeholders in the MoE appreciate the support the JEI gives in overseeing complex infrastructure and logistic issues.

4. Human capacity development: The JEI offered the educational entities in Jordan the opportunity to share and learn much more about ICT and innovative pedagogy through contact with experienced educators from abroad, and the MoE gained experience working with the private sector at different levels of its bureaucracy.

2 The Nature and Growth of the JEI Partnership (Task 2)

2.1 Formation and evolution of the partnership

The Jordan Education Initiative grew out of the 2003 World Economic Forum, where private companies and the government of Jordan launched an effort to support a number of broad social and economic initiatives to foster Jordan's transformation to a globally competitive country in the 21st Century. Initially based in the Ministry of Information and Communication Technology (MoICT), JEI was to be a collaborative effort harnessing the entrepreneurial spirit of business to support the social objectives of the public sector, or as one interviewee told us, "to leverage the competencies of each partner" to improve the work of all. The JEI was established at least partly to promote innovation in the use of ICT in schools by creating e-content resources and deploying them in a set of 100 pilot schools.

The stakeholders we interviewed felt Jordan was a promising site for this public-private partnership (PPP) model because it has traditionally exhibited strong leadership and a stable governance structure. In addition, it is a country looking for, and open to, change and has proven to be a "hotbed" for innovation and creativity. In light of Jordan's new Education Reform for a Knowledge Economy (ERfKE) policy, which fosters 21st century skills and supports Information

and Communication Technologies (ICT) in schools, they felt a project like the JEI would be a good fit. Additionally, the country is small enough that the participating partners and other stakeholders felt the initiative could work on a national scale. One interviewee said Jordan was a "promised land" for this unique PPP initiative.

Once the JEI international board of directors, staff, and organizational structure were in place, the partners created a Project Management Office (PMO) to mediate among the diverse partners and to provide the necessary leadership to keep the project moving forward. While the PMO was not part of the original JEI plan, the stakeholders we interviewed came to consider it a key driver to the initiative.

The JEI encountered significant challenges once the three-year commitment of WEF ended. The PMO was without a director for an extended period of time and stakeholders saw that the JEI was losing strategic focus. With help from USAID, the office of Her Majesty Queen Rania, and the MoE, the JEI was reorganized and become a separate NGO.

2.2 Outcomes of the partnership: Benefits and challenges

Among the key benefits of the structure and organization of the JEI, according to our interviewees, are its flexibility, which facilitates public-private collaboration and allows for innovation; its ability to attract and channel resources, financial and otherwise, to Jordan's education sector; and its facilitation of human capacity development among all partners.

JEI has played a critical role in supporting the development of e-curricula for math, science, Arabic, EFL, civics, and ICT. The JEI developed a model for the creation of e-content that attempts to build the capacity in Jordanian ICT companies to develop educational software while producing e-content that is aligned with the Jordanian curricula. Once the MoE and the JEI established a list of content areas to target, the PMO led the formation of a three-way partnership for each content area, consisting of a sponsor, a developer, and a curriculum team from the MoE. The sponsor, recruited by the PMO, provided funding, technology, advice and expertise to the other two partners. Though initially most sponsorship was international, Jordanian companies have started to assume the sponsorship role. The content developer was a Jordanian partner, also identified by the PMO.

Interviews with stakeholder representatives show that the involvement of international expertise, although costly, is seen as fundamental to the effective transfer of knowledge and the creation of local capacity. One sign of the growing sophistication of Jordan's fledgling educational IT industry, at least partially attributable to the JEI partnership, is the revised approach companies have taken to develop a second generation of e-content (for example, the science curricula). In stakeholder interviews, teacher and principal interviews, and classroom observations, it was found that the second generation of e-content is viewed as more dynamic, customizable and interactive. There are also indications that the MoE is developing a better understanding of e-resources. Stakeholders reported that the MoE curriculum team and the developers integrated new design principles into the process. Instead of starting with the textbook as the guide, the design team first identified the topics that are most challenging to teach and attempted to find possible solutions that would use the potential of ICT to create new and different learning opportunities.

As with any innovation, the JEI public-private partnership is not without its challenges. The key concerns arising from our interviews included significant turnover of the leadership in key positions; communication among the partners; and the lack of a plan for upgrading and maintaining the e-content. Additionally, there were concerns about creating outreach strategies so that teachers, principals and mid-level bureaucrats would feel more ownership and participation in the educational mission of the JEI. There also were challenges of coordinating the variety of technology inputs and of monitoring their use and their effectiveness. The IWBs and COW carts appear not to have been monitored effectively. Further, much of the content

being developed by partners requires more interactivity, more caching of content, larger files for rich media and more bandwidth than is currently supported by the current networking infrastructure.

The structure and organization of the JEI have allowed for change and growth to meet challenges to date, suggesting that, as a newly-established NGO, the program can continue to confront those challenges successfully.

3 Teaching and Learning in Discovery Schools (Task 1)

3.1 State of ICT use and active learning strategies in Discovery Schools

In line with the Jordanian education reforms, the JEI supports the emergence of more active, learner-centered teaching approaches using ICT. Our survey of Discovery School teachers shows that, even though the most common uses of ICT are still in support of a teacher-centered pedagogy, a reasonable number of teachers have begun to experiment with ICT among their teaching resources. The most widespread use of ICT by the teachers is in their planning and preparation, where 73.1% of teachers report using ICT for planning (see Table 1). Next, 66.4% of teachers reported experimenting with using ICT with their students at least once. But this experimentation has not yet resulted in most teachers frequently assigning their students ICT activities. More detailed data, showing that only about 20% of all teachers have students use ICT consistently (once a month or more frequently), suggests that many teachers are still struggling to find meaningful and practical ways to integrate student ICT-use into their teaching.

Table 3.1: Teachers' reported use of ICT for educational purposes

	Case Study Discovery Schools	Random Discovery Schools	Total
Use ICT for their own planning	78.9%	67.8%	73.1%
Use ICT with students	75.7%	58.1%	66.4%

Data source: Teacher Survey, N=476

Table 3.2: Teachers' reported use of e-content in their teaching

	Total
Never	32.9%
Seldom	8.7%
Often	58.4%

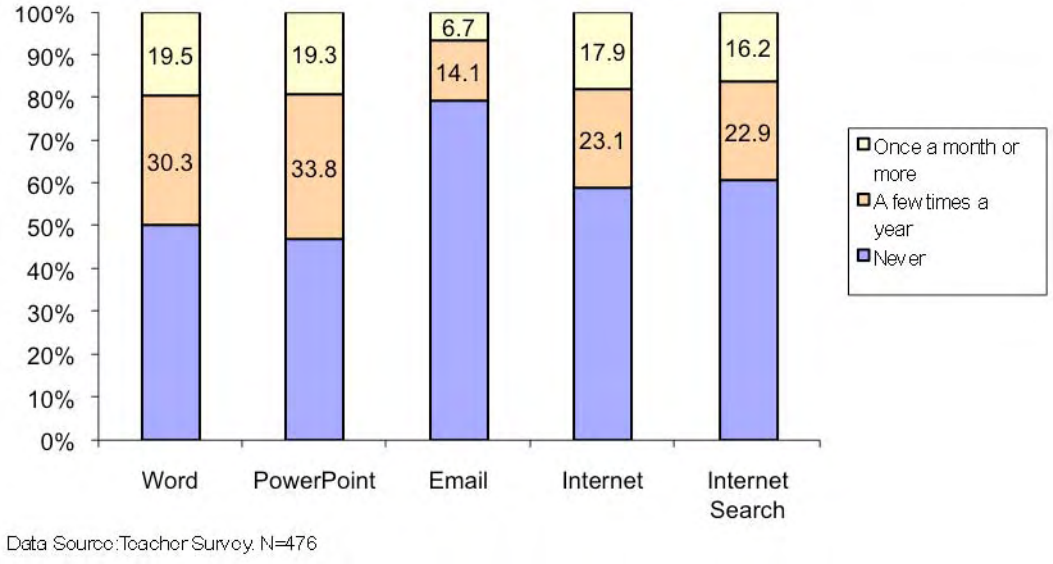
Data source: Teacher Survey, N=334

The most frequently used resources are the subject-specific e-content resources. Among teachers in content areas where e-content is available, 58.4% reported using e-content once a month or more frequently and another 8.7% have at least tried them.

Looking across a range of ICT resources, such as productivity software (i.e. Word or PowerPoint) and the Internet, slightly less than 20% of the teachers are frequent users of these resources with their students. Microsoft Word and PowerPoint are the most frequently used ICT packages at just

under 20% each. The Internet is used by 17.9% of all teachers, and search engines are used by 16.2% of all teachers. As discussed in the next section, the evaluation suggests that the challenges teachers face in using ICT frequently are connected to the teaching model most commonly used in Jordanian classrooms.

Chart 1: Teachers who report using ICT with their students



Data Source: Teacher Survey. N=476

3.2 Teaching and learning practices

Many of the practices encouraged by the JEI and the ERfKE are student-centered activities, and ICT resources are provided with the intention of facilitating such activities. Until the teachers are knowledgeable and comfortable with these pedagogical approaches, they will be unable to use them frequently and effectively in their classrooms. At the core of student-centered approaches is the belief that learning is most meaningful to the students when they are actively engaged in creating, understanding, and connecting to knowledge.[3] In a student-centered environment, teachers work along side their students to facilitate students' learning. Instead of the teacher being the sole source of information, the teacher shares control of the classroom and students are allowed to explore, experiment, and discover on their own. The students are not just memorizing information, but are expected to work with and use the information alone and or with peers.

The formal and informal observations of classroom activities suggest that most teachers who use ICT with students principally perceive it as a tool to support student memorization and practice, and not yet as a productive tool for student-centered learning. The pattern of ICT use was relatively similar in the computer labs and in the classrooms. When technology was used in either locale, it was used as a digitized version of paper-based lessons. Teachers used their laptop to project their notes onto the board in roughly 80% of the observed computer lab sessions. The field notes indicate that usually teachers created lecture notes in a PowerPoint file and then projected the lecture notes onto a screen or whiteboard or used e-content in a similar way. In this ICT usage model, the teacher generally was the only person using a computer whether in a lab or in a classroom.

[3] McCombs and Whistler (1997). *The learner-centered classroom and school: Strategies for increasing student motivation and achievement.* San Francisco: Jossey-Bass Inc.

However, there were a number of teachers who were implementing student-centered learning processes. These teachers spoke about creating lessons where students explored and debated the material in groups, where students found their own solutions to scientific questions or identified mathematical patterns or properties, or where they might have responsibilities to teach each other. We spoke to a third grade teacher who said it was important to have the students talk together about what they were learning and to figure it out together. She said that, "these strategies really help students remember the material for the test." The schools and teachers who were in this group of exemplary schools had an understanding of the value of student-centered approaches and saw how ICT can play a role within the classroom. The challenge for the JEI, in coordination with the MoE and ERfKE, is to help more schools understand and value these new approaches.

3.3 Challenges to transforming the learning environment with ICT

Vision of teaching and learning differing from that espoused by educational reform program
There are a number of factors that help explain why many teachers may not have their students use computers. Teachers' beliefs about teaching, learning and the role ICT plays in supporting learning are essential determinants in how teachers will use ICT with their students.[4] We investigated teachers' beliefs about ICT and learning through the surveys, interviews and observations. Many teachers fear that the technology, and more specifically computers, would be a distraction. These teachers do not want the students "on the computers so that they will focus on the lesson," as one lab technician commented.

Teachers also expressed hesitancy about student ICT use because they were not sure if these e-learning activities would help students learn. This exposed their discomfort with the technology and exposed a vision of teaching and learning different from that embraced by ERfKE: one that requires the teacher controlling the entire learning process.

Lack of resources and time to use ICT with students
There are also logistic or scheduling reasons why teachers may not use the computers frequently. School leaders face challenges trying to schedule lab time for so many classes and teachers. If the scheduling is not done effectively, teachers may not have access to labs, or at least not when ICT-enhanced lessons fit into their lesson planning.

The physical classroom environment was also problematic for some teachers. Items that appear relatively simple, such as curtains or working electrical outlets, are important for teachers to be able to use the data projectors effectively. In interviews teachers complained about not being able to project a visible image on the walls of their classroom without curtains and without working electrical outlets in their classroom.

3.4 Importance of school leadership in promoting effective change

The research found that the principals played key roles in the most successful cases. Schools are complex social organizations that can be highly resistant to change because any one segment can block change.[5] Research on technology integration and pedagogic reform across many countries suggests that teachers who make the most progress in changing their practice

[4] Honey, M., & Moeller, B. (1990). *Teacher's Beliefs and Technology Integration: Different Understandings* (No. 6). New York: Center for Technology Education, O'Dwyer, L. M., Russell, M. K., & Bebell, D. J. (2004). Identifying teacher, school and district characteristics associated with elementary teachers' use of technology: A multilevel perspective. *Education Policy Analysis Archive, 12*(48).
[5] Cuban, L. (1993). *How Teachers Taught: Constancy and Change in American Classrooms 1890-1990*. New York: Teachers College Press.

have supportive, engaged and visionary school-level leadership.[6] Instructional improvement is much more than just policy changes. [7] Change will only come as part of a school culture of mutual respect and caring, a common vision of teaching and learning and commitment to change and improvement. Two dimensions of leadership were important in the most successful Discovery schools.

Instructional Leadership
The leader's vision of teaching and learning is important to providing the instructional leadership necessary to guide a school through a process of change. Principals in the most successful schools spoke about giving students more autonomy and a more active role in learning. They also had clear strategies to share this vision with their teachers. During their observations, these principals expected to see students working in groups, discussing and debating problems and presenting information back to teachers and peers. Additionally, these principals spoke about what they did not want to see: teachers who lectured the whole time; were unprepared; or only focused on the good students.

The strongest principals also had warm relationships with their teachers and fostered an emerging community of learners centered on experimenting and promoting innovative teaching practices. These principals have developed a number of strategies to get teachers to share and discuss what they have learned and experienced from different workshops, and to encourage collaboration on instructional improvement and innovation. One strategy was to create shared planning time for teachers in the same grades or same departments, and then create expectations for teachers regarding how they would use this time. The principal of an 8th through 12th grade school explained that she schedules a shared planning period for teachers in the same department. She commented that "the scheduling is not impossible, but it takes work." She felt that many principals did not value planning time, and only wanted their teachers to "cover the text book", but she feels that planning time is important to raising the quality of the teaching.

Another principal, of one of the exemplary schools, used a number of different strategies. First, she encourages teachers to work in teams to create lessons and materials and to create a culture of sharing successful ideas. Second, she has a formal staff meeting every two weeks where she specifically praises and thanks teachers who have been using technology or experimenting with new techniques and where teachers share experiences. This principal was very familiar and comfortable with technology and personally worked with teachers who lacked confidence with technology to help them build their own technological capacity. In a lesson observed in this school, teachers experimented with students preparing presentations so they had the opportunity to "teach" sections of the content to their peers.

Strategies like these are important to helping teachers implement what they learn in training courses because a training course alone is seldom sufficient; change requires much more support inside the classroom.[8]

Institutional Leadership
Another important facet of the principal's job consists of the administrative and managerial tasks of running a complex organization. These aspects have implications for classrooms and teacher

[6] Hawkins, J., Panush, E. M., & Spielovogel, R. (1996). *National Study Tour of District Technology Integration Summary Report* (CCT Reports No. 14). New York: Center for Children and Technology, Light, D., McMillan Culp, K., Menon, R., & Shulman, S. (2006). *Preparing teachers for the 21st Century classroom: Current findings from evaluations of the Intel Teach to the Future Essentials Course*. New York: EDC/Center for Children and Technology, Pérez, P., Light, D., Vilela, A., & Manso, M. (2003). Learning from the pioneers: A Study on the Best Practices of the network TELAR. *Interactive Educational Multimedia*(6), 17-39, Teacher Foundation. (2005). *A Comparative Study of ICT Leadership in Schools: A Case Study of 4 Government-aided Schools in Gujarat.* Bangalore: Author.
[7] Fullan, M. (1997). Emotion and Hope: Constructive Concepts for Complex Times. *Yearbook (Association for Supervision and Curriculum Development), 1997*, 216-233, Fullan, M. (2001). *The new meaning of educational change* (3rd ed.). New York: Teachers College Press.
[8] Garet, M., Porter, A. C., Desimone, L., Birman, B., & Yoon, K. S. (2001). What Makes Professional Development Effective? Results from a National Sample of Teachers. *American Educational Research Journal, 38*(4), 915-945.

practice through everything from resource management, to maintaining the physical installations, to funding all the incidental costs that can come with technology.

- Resource management: The principals named the computer labs as the most complex resource to manage in the Discovery Schools. This is still a limited resource that is under high demand – or should be under high demand if all teachers are making use of them. Those scheduling plans that appeared most effective were the ones that involved the classroom teachers in the process. This took more work on the part of the principal and lab technicians, but the two schools that had this type of process also reported nearly constant usage of the labs. Additionally, these were schools with more innovative teaching practices happening in the labs. Some of the principals included the laptops as part of the ICT resources available for their teachers and students. Although the laptops were originally given to the teachers trained in e-content, some school communities decided these resources could be used more effectively as a shared resource for all teachers.

- Technical support: The principals and lab technicians reported a number of on-going challenges with technical support. The only substantial problem with connectivity, which everyone reported, was the Internet speed. This is a systemic bandwidth problem outside the control of school leaders. (See Cressman and Daly, 2007) Interviewees complained that it was often quite slow. Some schools also reported a slow response time for repairs from the ICT Directorate (where the local MoE technical support staff is housed), especially concerning replacement parts. The strongest case study school principals were using other strategies to provide technical support to their labs. Generally, the lab technicians were able to maintain and repair the equipment, but some schools were also able to reach out to parents with IT skills to help. Also, many schools were buying their own replacement parts whenever possible because the response time from the MoE was considered to be too long.

- Funding: None of the principals reported having difficulties covering the costs of related materials including printer paper, printer ink, batteries, etc., that come along with ICT use, although all schools have to monitor the use of these items. However, none of the principals had thought about replacement costs for the hardware and assumed this would be covered by the MoE or other sources such as the JEI. However, some teachers with less supportive leadership reported insufficient funding for some basic resources that the principal did not see as necessary (i.e. batteries, curtains, printer ink, and printer paper).

4 Review of the Current Infrastructure in the Schools (Task 3)

4.1 The state of Discovery Schools' technology infrastructure

The JEI has piloted two ICT models for the delivery and use of e-content: computer labs, and portable laptop computers and projectors issued to teachers for use in classrooms. All Discovery Schools have at least two labs, have at least 512 kb connectivity through ADSL lines and broadband connections, and are connected under the National Broadband Network. Classrooms used for e-content have wireless access points and projectors.

Most computer labs are reconfigured classrooms of approximately 50 m² with about 20 workstations per lab. Though the desktop computers in the Discovery School laboratories are relatively new and well-maintained, this is less true for other ERfKE schools, many of which have fewer labs, with fewer and older computers.

Both laboratories and classroom instruction are used for each e-content area, varying by subject, with e-math making the most use of the laboratories and e-Arabic the least. The number of teachers using laptops and projectors in the classrooms depends on the e-content deployment and the teachers trained in using it. In addition, there was limited experimentation with the use of Computers On Wheels (COW carts) to augment the laboratories and of Interactive White Boards (IWBs) to create multi-media environments in the classrooms.

Schools have access to e-content through the EduWave e-learning platform. In addition, teachers are able to develop their own materials and lesson plans using content from the internet and other resources. The EduWave software includes Learning Management System (LMS), Content Management System (CMS), Instructional Management System (IMS), Student Information and School Management System (SIS/SMS), Education Management Information System (EMIS), Decision Support System (DSS), and Enterprise Resource Planning (ERP) features. The system also includes authoring and individual student assessment tools, as well as collaborative tools, such as discussion forums and audio/video conferencing. However, little use is made of these functions at present. Furthermore, there are restrictions imposed by the current technical standards on the size of media files that are presenting challenges to the effective utilization of the e-content, limiting the use of video and other applications such as video conferencing. EduWave functions as a national portal, managed centrally and providing the same content to all schools. Its current deployment does not support a distributed model that would enable off-line access to data and content at the school level while automatically synchronizing data and content with a centralized database. EduWave offers such functionality (through EduWave Offline Viewer) which could be added at modest additional cost.

5 Costs of JEI Activities and Scale-Up (Task 4)

5.1 Cost comparison

Though expensive in terms of total cost, the ICT support for e-learning under the JEI is judged to be relatively cost-efficient compared with the experience in other countries, and with respect to identified options for cost savings, discretionary choices on hardware and software and the current level of technical support and maintenance under the approaches supported by JEI.

Annualized costs: The annualized costs of scaling up the inputs provided under JEI (excluding any additional computer laboratories and associated PCs) are $17,724 per school, $2,215 per teacher and $19 per student, per year.

The annualized incremental costs to ERfKE, (recurrent costs plus additional laboratory hardware and infrastructure amortized on the basis of estimated useful life) are $27,607 per school, $3,451 per teacher and $28 per student.

Financing expansion: The overall assessment is that the total costs will be large relative to Jordan's economy and education budget. Given Jordan's current high level of education expenditure, it is unlikely at least in the short term that Jordan will be able to finance from its own resources the requirements for fully scaling up the e-learning ICT requirements for all schools. This will have to be accomplished in planned stages over a number of years and will depend critically on the availability of external funding and partnerships. A period of at least 5 years appears required for full scale implementation.

Component costs: Computer laboratories (including the associated PCs, software and laboratory technicians) are the most expensive component on an annualized basis. The computer technicians are the major cost associated with the computer labs. PCs are about 5.7% and laptops are about 8.4% of the total annual cost. Recurrent costs, including software and

maintenance/parts, lab technicians and operations support, are about 47% of the total. Datashow projectors are the most expensive hardware input, about 19% of the annualized costs, reflecting in part the costs of maintenance and replacement bulbs.

5.2 Options for reducing costs and improving cost-effectiveness

The main options for reducing ICT investment costs are to manage with fewer additional computer laboratories, relying more on classroom support of e-learning and targeting the next phases of scale up on schools with at least two existing computer laboratories with well maintained PCs. Using fewer IWBs or selecting lower cost computers would reduce total costs only marginally.

If anything, some additional investments are needed beyond that provided for the Discovery Schools, particularly for anti-virus software, more adequate help desk support, development of multi-media resource rooms, computer access for students outside the classroom, and content support additional to that of the existing e-learning curriculum.

Among the options for improving cost-efficiency are to increase usage and adopt strategies for reducing the amount of lost time due to inoperable computers (PCs as well as laptops), projectors and other hardware. Possible strategies include decentralized stocks of replacement parts, better arrangements for maintenance, provision of a spare laptop for each school, and increased use of CDs or other storage strategies to overcome bandwidth and connectivity problems. Such options do not increase costs significantly.

Recurrent costs: It is likely that the initial investment costs will be financed by the MoE or met with help from donors and partners more easily than will the recurrent budget requirements of ongoing technical support, maintenance, software licenses, training, laboratory technicians and other personnel costs. These costs, including the replacement of equipment and updating of software over time, must be anticipated and budgeted annually. These recurrent costs will be required for ICT provided “free” by partners and donors as well as for ICT provisions through Ministry resources.

Planning toolkits: None of the existing cost estimation and cost management toolkits reviewed for the assessment are fully applicable to Jordan’s administrative and policy context and to the ICT approaches employed in Jordan in support of e-learning. Jordan may find it useful to develop its own Total Cost of Ownership (TCO) toolkit, based on Jordanian conditions and the relatively uniform and centralized ERfKE systems management and school support models. Such a toolkit may be particularly useful if Jordan moves toward a cluster-based or school-based planning and assessment approach allowing for some differences in ICT provision and support arrangements at the cluster or school level.

6 Recommendations

In this section we present recommendations for JEI to consider, including strategies that might help the organization more effectively extend its programs to teachers and principals to promote both new teaching models and the effective use of e-learning resources.

6.1 Develop JEI capacity

6.1.1 Expand and deepen JEI’s vision of the role of ICT and clearly communicate this vision to students, teachers, principals and other educators.

The current success of the JEI in motivating widespread excitement and collaboration among global and local partners to support Jordanian education[9] suggests that the JEI's vision and mission are relevant to those stakeholders. But in order for the JEI to effectively reach teachers, principals and eventually students, the JEI needs a clear message of how ICT can support teaching and learning in a language that is both meaningful to educators and aligned with the MoE's ERfKE reforms. To ensure the relevance and utility of the JEI e-resources to classroom educators, the JEI should work closely with the MoE in developing a more "practical" vision of how JEI's efforts and resources can support quality teaching. The JEI needs to present clear and consistent messages that, among other things, ICT can provide access to more and better information, can support a learning paradigm were students, with teacher support and guidance, are active learners, and can extend communication and learning outside the classroom. Strategies to effectively share this message with educators might include activities such as school-based awareness workshops, school principal conferences, videos or images of exemplary Jordanian teachers using ICT, and print materials about what ICT can do. These latter suggestions could take advantage of the group of innovative teachers who participated in this study.

Not only would this help energize those educators who already share aspects of that vision, it would help other educators begin to understand how the e-learning resources and the new teaching strategies could help their students. Other research suggests that teachers are more likely to embrace change if they understand how it is helpful to their students.[10]

6.2 Deepen local evaluation and monitoring capacity for education technology

6.2.1 Prove these solutions work in Discovery Schools before scaling up.

ICT models introduced in Discovery Schools have been successful, but have also highlighted key challenges of technology management, maintenance, technical support, and security. Discovery Schools provide an excellent environment in which to develop, test, and adjust solutions to these issues. We believe it is essential for the JEI to continue working closely with the MoE and other JEI partners to resolve these key challenges for the 100 Discovery Schools before these models are introduced to other schools in Jordan.

6.2.2 Create an internal research and evaluation capacity within the JEI.

As an organization that oversees a test bed for ICT and educational innovation, the JEI should establish an internal capacity for formative research around the new products and approaches that are being piloted in the Discovery Schools. As part of such ongoing refinement of materials and approaches, more support is needed for research as well as for monitoring and assessment. The site surveys by JEI have been useful in monitoring the use of technology by teachers. However, there has been inadequate support to date for carefully structured research on changes in classroom pedagogy, the use of the technology by students and the effectiveness of the ICT provision and e-learning materials in terms of specific learning outcomes. The PMO staff has identified the need for a more detailed understanding of what is happening in the classroom and has trained NetCorps interns to provide a basic level of observational data from the classrooms,

[9] McKinsey and Company. (2005). *Building Effective Public - Private Partnerships: Lessons Learnt from the Jordan Education Initiative*. Geneva: World Economic Forum.
[10] Hawkins, J., Panush, E. M., & Spielovogel, R. (1996). *National Study Tour of District Technology Integration Summary Report* (CCT Reports No. 14). New York: Center for Children and Technology, Pérez, P., Light, D., Vilela, A., & Manso, M. (2003). Learning from the pioneers: A Study on the Best Practices of the network TELAR. *Interactive Educational Multimedia*(6), 17-39.

but this research capacity should be formalized and expanded. Developing a research and evaluation capacity would allow the JEI to give feedback and guidance to the content developers, the schools, and MoE.

6.2.3 Develop Continuous monitoring and assessment strategy for e-content quality and use.

The JEI site survey has been used very effectively by the JEI team to identify problems and to take and monitor corrective action in Discovery Schools. However, there is no regular monitoring system to measure the reliability and performance of the e-content delivery system to the classroom. The JEI could play an important role in facilitating and designing effective monitoring and evaluation systems and in managing a program of research on the effectiveness of the ICT provision and e-learning approaches in terms of specific education objectives, particularly learning outcomes. An increasingly important role for JEI may be the exchange of Jordanian experience with the use of ICT and e-learning approaches with other countries and managing joint research initiatives with relevant research institutions outside Jordan.

6.2.4 Support the development of a system-wide process that enables the MoE to monitor and evaluate progress towards its overall goals for quality educational outcomes.

The MoE is undertaking the complex ERfKE reform process and it is important to establish valid and robust outcome measures. The system should be designed with the help of national and international experts in this field. Without such a system, Jordan has no way to measure whether the JEI is achieving its intended results.

6.2.5 Require the developers of the on-line environment to adapt their resources to actual needs in the field.

The MoE should insist that the local IT providers (content developers, network connectivity providers, and server hosting engineers) work together to observe problems firsthand and diagnose and resolve them collectively. ITG should send its software engineers into computer labs to observe how teachers use EduWave and to observe challenges.

6.3 Provide more learning opportunities for principals, teachers and supervisors

6.3.1 Support the development of a wider variety of high quality professional development programs for principals and teachers.

Research demonstrates that the effective use of ICTs is dependent on teachers' ability to select instructionally appropriate ICTs and to use them in the context of effective instructional strategies.[11] Therefore, nations engaged in ICT-enhanced educational reform must make teacher education, both pre-service and in service, a high priority for investment, since the quality of instruction is central to improving academic achievement.[12] A key factor in successful professional development around reform efforts is its relevance to the particular context in which teachers work and teachers' ability to make a connection between the content and their own interests and experience.[13] Increasingly, research is substantiating that for professional development to have lasting impact, teachers need professional development experiences that

[11] Webb, M., & Cox, M. (2004). A Review of pedagogy related to information and communications technology. *Technology, Pedagogy and Education, 13*(3), 235-286.
[12] Cohen, D., Raudenbush, S., & Ball, D. (2000). *Resources, Instruction and Research* (CTP Working Paper No. W-00-2). Seattle: Center for the Study of Teaching and Policy.
[13] Lieberman, A. (1995). Practices that support teacher development. *Phi Delta Kappa, 76*(8), 591-596, Little, J. W. (1993). Teachers' professional development in a climate of educational reform. *Educational Evaluation and Policy Analysis, 15*(2), 129-151, Olsen, B., & Kirstman, L. (2002). Teacher as mediator of school reform: An examination of teacher practice in 36 California restructuring schools. *Teachers College Record, 104*(2), 301-324.

give them the opportunity to make sense of the ideas upon which reforms are based, to experiment with them in their own classrooms, and to develop an understanding of how the reform ideas and practices can support student learning.[14]

Given the importance of professional development to the JEI's long-term goals and to Jordan's education reform, the JEI should consider investing as much energy and focus on encouraging the creation of quality professional development programs as they have on creating e-content. The JEI involvement should extend beyond coordinating international support to provide professional development programs for Jordan, to include working closely with the Training Directorate at the MoE to ensure the quality and alignment of the professional development programs by providing formative evaluation and monitoring of the programs while they are in the development and pilot phases.

6.3.2 Support the development of a more robust set of professional development offerings for teachers about ICT integration and new, student-centered strategies for teaching and learning.

This entails two components. First, all teachers need to have a high quality basic course on ICT as a pedagogical tool to support learner-centered or active approaches. This is more important than an intense ICT-skills only course. Second, Jordanian teachers need a variety of course options as a second phase of their professional development. Offering a selection of courses that focus on different aspects of ICT integration and teaching (i.e. project based learning, special education, ICT to teach English, etc.) will allow teachers to pursue work in the areas they find most relevant to their students and their teaching. Teacher training in the use of ICT should be coordinated with training in corollary skills in other aspects of reform policy, such as pedagogical practice, assessment, curriculum implementation and school organization. UNESCO[15] provides a comprehensive set of standards which JEI might find as a useful base for developing its own training courses or identifying appropriate offerings from other training providers.

Currently there are a number of offerings that could fulfill part of the professional development needs. There are two course options which are identified as basic ICT and teaching courses, Intel Teach Essentials Course and World Links for Development, but relatively few teachers have been able to take these courses. These courses are all quite long at 160 hours, with content ranging from basic to more advanced topics. These courses could be divided into smaller units where some would cover basic ICT and teaching, but others could be options for more advanced teachers. The MoE and JEI should consider whether these aforementioned courses are effective as they are and, if so, develop strategies to reach a larger number of teachers in the Discovery Schools through these courses.

There are subject-specific training courses lasting only a few days that introduce e-content to the teachers, but these courses may be too short to be anything more than just a basic introduction to the resources. Teachers perceive these trainings as lacking: (i) enough pedagogy on how to use the content in the classroom teaching, (ii) a link with the ERfKE teaching strategies and (iii) a good quality control mechanism. The JEI should consider ways to develop the subject-specific trainings further with hands-on experience in teaching strategies and classroom practices, ensure synergy with ERfKE new curricula and teaching strategies, and maintain a quality control system to monitor and enhance the training.

6.3.3 Create a professional development program for school leadership.

[14] Carrigg, F., Honey, M., & Thorpe, R. (2003). Putting local schools behind the wheel of change: The challenge of moving from successful practice to effective policy, *Scaling up Success Conference*. Harvard University, Cambridge, MA, Cohen, D. K., & Hill, H. C. (2001). *Learning policy : when state education reform works*. New Haven: Yale University Press.
[15] UNESCO (2008). ICT competency standards for teachers: Policy framework. http://portal.unesco.org/ci/en/ev.php-URL_ID=25733&URL_DO=DO_TOPIC&URL_SECTION=201.html. UNESCO (2008). ICT competency standards for teachers: Competency standards modules. http://portal.unesco.org/ci/en/ev.php-URL_ID=25731&URL_DO=DO_TOPIC&URL_SECTION=201.html.

School leadership plays an important role in ensuring that the school and classroom conditions allow teachers to experiment and innovate. Our research in the Discovery Schools strongly suggests that strong leadership from the principals is crucial to creating change. There is a need for more training of principals on management and monitoring of the technology and infrastructure, scheduling to enable more effective use of the laboratories, and ways to facilitate collaboration and exchanges of experience among the teachers. In addition to off-site training programs, peer-to-peer approaches among groups of principals may be the most effective and cost-efficient way of providing such training. The JEI, in collaboration with the MOE, should develop a leadership training course for principals on how to support the use of ICT and reform.

6.3.4 Create a professional development program for MoE supervisors.

The guidance provided by the MoE to teachers and principals in the classrooms is important to creating the conditions where schools feel that they are able to innovate and succeed. The MoE supervisors are a vital link to promoting change. The JEI, in collaboration with the MOE, should develop a professional development course for supervisors on how to support schools and teachers in the use of ICT and reform.

6.3.5 Encourage informal opportunities for teachers and school principals to learn and share strategies.

JEI should consider encouraging schools to create other types of learning opportunities for the teachers such as study groups, teacher collaborative projects, or inter-school collaborations. Additionally, activities such as conferences and exhibits of teacher and student work can be another way to reach teachers and encourage sharing of best practices. An event like a Discovery School conference for teachers to share and showcase exemplary student-centered teaching techniques and habits can help teachers see and understand what can be done. Alternatively, the JEI could create an online space for teachers to collaborate and share, as well as an online (and onsite) mentoring system to further promote shared practices and help teachers develop both their pedagogical and technical skills. Similar strategies could be developed for a principal network with conferences and an on-line space.

One of the challenges “traditional” teachers face when trying to move towards student-centered practice is that they may not know what a student-centered classroom looks like and they may not have a vivid image of the goal. Although the general use of ICT may not be aligned with the end vision of the JEI, in our visits we did meet teachers who were doing innovative activities and experimenting with new approaches (like role plays, cooperative groups or student research) and new tools (from the e-content to PowerPoint presentations and email collaborations). The JEI may want to consider developing strategies to share these teachers’ experiences through workshops and trainings led by these teachers, written material about innovative teachers, or simple video case studies.

6.4 Continue supporting thoughtful innovation and distribution of e-content and infrastructure

6.4.1 Provide additional ICT resources to the Discovery Schools.

The research suggests that there are number of ICT resources that would be a great benefit to the schools. The schools could benefit from additional software for virus protection and buffering/filtering software for all the computers. Other requirements include caching systems at the school level and more support for peripherals, particularly printers and copiers. Consideration should be given to providing a spare laptop for each school.

Additional computer laboratories will also be needed. Demand projections by the Directorate of Curriculum and Textbooks and the Supporting Jordan’s Education Project (2006) suggest that, based on curriculum e-content requirements, 2,180 new computer labs will be needed by the

2008–2009 school year. While this number may be high, it is unlikely that anywhere near this many computer labs can be constructed and equipped to keep pace with increasing enrollment and the scaling up of e-content pedagogy. In addition, there are problems maintaining the availability of computers in existing labs.

There are also simple strategies that can create more efficient use of resources. Sharing laptops among teachers is an efficient use of scarce resources. Shared laptop computers and projectors can be used by teachers to increase access to e-content when construction of new computer labs cannot keep pace with increased enrollment.

6.4.2 Develop simple, sustainable solutions to critical infrastructure problems.

Desktop PCs and data-show projectors are important aspects of ICT enrichment of education in grades 1–12 and should be affordable in Jordan. It should also be possible to sustain a limited number of laptop computers and projectors shared among teachers. The development of Arabic e-content specifically designed to enrich the curriculum provides essential tools for the blended learning approached introduced by the JEI. The hardware and software infrastructure for such services are mature and their use is justified to achieve ERfKE objectives. The JEI has selected ICT models that should be scalable and within the capacity of the MoE to sustain.

The MoE does not yet, however, have the capacity to manage, support, or sustain the ICT infrastructure. Fundamental security, management, technical support, and long-range planning are not in place. There is some evidence that the JEI and MoE ICT consultants have made progress in helping the MoE in some of these areas.

6.4.3 Continue piloting with new technology platforms and tools.

There are many other technologies and applications of technology that could be piloted in the future. This evaluation encourages further experimentation and piloting of additional technology strategies. Possible options include personal digital assistants (PDAs), cell phones, a variety of data storage arrangements, additional functionality for EduWave, and increased availability of peripherals in the schools. However, this needs to be more than demonstration projects showcasing other possibilities. It is strongly suggested that, as part of any partner offers to provide technology on a demonstration or experimentation basis, there be funds available for systematic assessment and monitoring against specific learning outcomes.

6.4.4 Institutionalize the process of improving e-content and innovating in the use of ICT in grades 1–12 in public school education, using the Discovery Schools as a test bed for future improvements and innovations.

Content developers and MoE officials expressed concern about the ability to maintain, update and modify the e-content. There are numerous reasons why educational resources need to be updated and improved upon, but there are currently no provisions for updating or modifying the developed e-content. The MoE does not have trained personnel to alter the e-content, nor are there any contractual provisions for the developers to update or change the content once it is finalized. Digital resources should go beyond text and multimedia “content” to support student-centered learning by providing the content in the context of a pedagogically rich set of classroom practices, such as teacher-supervised, student-led projects, research studies, investigations, and case studies that draw on subject disciplines to explore timely topics of student interest. These materials can include computer simulations and models and incorporate data collection, analysis, and presentation tools. Such materials, along with teacher training in their use, can support the increased use of student-centered pedagogical practices.

To support this process it is important that the MoE develop effective formal policies and procedures for reviewing and updating e-content guidelines, standards, and content. This will

ensure that the e-content developed meets the needs of Jordanian schools. The JEI could play an important role in facilitating this work.

However, provisions need to be made for funding on-going curriculum and materials development; it would be a false economy to assume that the e-learning materials and approaches have been fully developed. Accepting that the e-learning approaches required about $9,000,000 for the 3-year development phase[16], a continuing commitment to refining and augmenting the materials might be on the order of 10% of the development costs, or $300,000 annually.

6.4.5 Share the e-content being developed by teachers and students.

Teachers and students are creating their own content using a variety of software tools. These are good examples of how these resources can work in real Jordanian classrooms and can be very motivational for other teachers to see and use. Additional e-content created by teachers and students could be shared online using a peer-review system that would reward innovation and encourage distributed learning and collaboration. EduWave might be used to provide this sharing facility. If for any reason EduWave is unable or unwilling to provide such a facility, there are a variety of inexpensive or free sites available for managing such exchanges.

6.4.6 Create strategies to support the off-line use of technology.

There appears to be no technical reason why e-content must be served live to all schools from a single location. It should not be necessary to replicate all EduWave functions at the school level. The JEI and the MoE should work with ITG to enable schools to use e-content off-line. This may include developing a simple school-level proxy caching solution.

6.5 Expand and fortify the technical support and maintenance strategies to enable the ICT initiatives to go to scale

6.5.1 Train more lab technicians to prepare for the increasing demand.

In addition to the constraint of how rapidly additional laboratories can be built and equipped, or existing classrooms reconfigured and equipped, a major limiting factor on the feasible rate of expansion is the rate at which additional laboratory technicians can be recruited and trained. For the next year or two, it may be possible to train up to 200 additional technicians a year. Some attrition must be assumed, as such technicians are in demand and the current salary may not be a sufficient incentive to hold all the trained technicians. As the ICT and e-learning approaches scale up to all ERfKE schools, as many as 500 technicians may need to be trained each year.

6.5.2 Expand the internship program to further strengthen technical support capacity.

The JEI intern program has been very effective in overcoming resistance to change, transferring knowledge, and strengthening the capacity of lab technicians. It may be possible to expand this program to strengthen technical support capacity in education directorates and the central ICT Directorate. However, it is unlikely, and unnecessary, for the program to be scaled at the same ratio as for the Discovery Schools (17 interns for 100 schools). The most effective use of the interns has been for site surveys and monitoring, which can continue to be effective for a substantially larger number of schools using appropriate sampling procedures.

6.5.3 Experiment with decentralization and/or outsourced maintenance systems.

[16] McKinsey and Company. (2005). *Building Effective Public - Private Partnerships: Lessons Learnt from the Jordan Education Initiative*. Geneva: World Economic Forum.

Good technical support and maintenance, with periodic planned replacement of equipment, are necessary if computer labs are to meet the demand for access to e-content. The lab technicians are a key component but there are other maintenance needs that need to be considered. It is unlikely that technical support and maintenance can be managed centrally and some consideration should be given to decentralizing these functions to the district level and to outsourcing of technical support and maintenance to Jordanian firms and NGOs. An important central function will remain the monitoring and assessment of the maintenance, utilization and functioning of the technology and infrastructure. Such monitoring will be critical to ensuring good maintenance, reducing down time due to inoperable equipment and connectivity problems and will help to ensure full value is obtained from these expensive investments.

The JEI site survey of Discovery Schools currently provides the most useful M&E information on trends in hardware failures and the availability of ICT infrastructure. A unified help desk ticketing system and a hardware and software asset management system would provide the MoE with better information for technology management and long-term planning. The existing Computer Engineering Bureau (CEB) database provides a good foundation.

6.5.4 Standardize hardware across schools.

Standardization of hardware for each school or cluster of schools will help to streamline procurement, reduce costs and improve the efficiency of maintenance. If, as is likely, it is necessary to use more than one vendor--for example, if some of the hardware is provided by more than one funder or partner--the MoE should endeavor to limit the diversity of hardware at any one school or cluster of schools.

6.6 Provide opportunities for students and the community

6.6.1 Increase the opportunities students have to use ICT in meaningful ways.

The main recommendation for improving cost-effectiveness is to increase the use of the technology by students, both in the classroom and labs and for projects and other learning activities outside classroom hours. Reducing costs by limiting ICT provision is unlikely to increase the effectiveness of the investment in supporting more active learning by students and more interactive pedagogy by teachers. Further development of the e-learning approaches should consider scheduling changes to allow for longer time in the classrooms and laboratories, further training and pedagogic support for teachers, greater use of multi-media rooms and additional arrangements for students to access computers outside of class time, either in the schools or in community centers.

6.6.2 Leverage infrastructure investments to create community outreach and after school activities which provide students and the community more access to the technology.

Many of the students and teachers we spoke to, especially in the poorer neighborhoods, reported that the schools were the only point of access to technology for students. There are various available strategies to make these resources more fully utilized and to create opportunities for students and parents, including:

1. After school programs: There are existing after-school programs that could be established in the Discovery Schools. Some programs, such as Intel Learn, are already working in the region. These programs can be effective ways to help students learn more technology skills and engage them in innovative learning opportunities.

2. Community outreach programs: School computer centers can be valuable resources for their communities and there are ways in which they can support life-long learning activities for the parents and the broader community. Schools in the US have established

"parent universities" that offer ICT training or educational activities for parents. As en example, the Syria Trust for Development and the Syrian Ministry of Education have established a program in Syria called *ICT literacy for citizens* in which students train community members on ICT using the school labs. These types of initiatives would also help the JEI meets its objectives to support life-long learning.

6.6.3 Develop a model for scaling up that fosters, rewards, and disseminates success.

The JEI has observed that effective use of ICT to improve teaching and learning is closely related to the initiative and motivation of school principals and teachers. Strategy for scaling up the use of e-content should be based on a system that motivates principals and teachers; rewards motivation, innovation, and achievement; and shares and promotes innovations and best practices.

Exemplary schools and teachers can be used as "vanguards" through reward and exchange programs that demonstrate what can be achieved and that help to promote change. ICT upgrades would be introduced into schools that meet certain basic criteria and have demonstrated their intention to use the technology effectively. This "organic" scaling approach also enables support system capacity to be scaled at a sustainable rate. Such a strategy will help avoid the waste and negative affects that result when technological innovations are forced on users without demonstrating potential benefits, overcoming resistance to change, or providing adequate technical support.

6.6.4 Create opportunities for students to acquire technical knowledge and experience in schools by establishing student tech support programs.

The lab technicians are a vital and effective part of the Discovery Schools and they do provide sufficient tech support. However, creating student tech teams could be an effective way to give students an active role in their schools, to give students practical skills and experience, and to create a quicker and more responsive tech support structure. Involving students allows fewer lab technicians to support more computers. Additionally, as the Discovery Schools distribute more computers throughout the building with teacher laptops, student tech support for simple troubleshooting would relieve a lot of the pressure on the lab technicians and on the teachers. There are many models available at the Student Tech Support Initiative of the Consortium for School Networking (CoSN) (http://www.studenttechsupport.org/). Some examples include:

- Generation YES program entitled Generation TECH Student Technology Support teams (www.genyes.com)
- C.R.E.A.T.E. for Mississippi (http://www.create4ms.org/stt/index.html)
- MOUSE Squad (http://www.mouse.org/)

7 Conclusion

The overall conclusion of the evaluation of the JEI is that the approach is cost-efficient but further efforts are needed to make the program cost-effective, have a deeper impact on classroom practice, and ultimately transform Jordanian education.

JEI has not yet achieved all of its goals. The JEI has helped stimulate the establishment of a Jordanian education software and e-content media development capacity, has developed a first generation of e-content in six content areas, has begun the process of training teachers, principals and other school personnel in the use of ICT to support e-learning, and has accelerated the investments in connectivity and ICT provision for the schools.

Further progress in using ICT infrastructure to support interactive and problem-based learning will require: changes in pedagogy to enable more student use of technology in the classrooms and laboratories; increased access of students to the Internet outside the classrooms and laboratories; curriculum and scheduling changes to facilitate such changes in student use of technology; modest additional investments in ICT capacities and software, particularly anti-virus and changes in the networking infrastructure and protocols to allow larger rich media files; and increased training for teachers, principals and laboratory technicians. The JEI can build on the experience of the exemplary principals, teachers and supervisors identified within the Discovery Schools Further progress also will require a strong role for JEI, or an equivalent mechanism, providing essential coordination, management, executive and monitoring functions for the development of e-learning resources and approaches in Jordan, and the capturing of lessons learned from the experimental and development phases of each iterative stage of e-learning innovation.

References

Carrigg, F., Honey, M., & Thorpe, R. (2003). Putting local schools behind the wheel of change: The challenge of moving from successful practice to effective policy, *Scaling up Success Conference*. Harvard University, Cambridge, MA.

Cohen, D., Raudenbush, S., & Ball, D. (2000). *Resources, Instruction and Research* (CTP Working Paper No. W-00-2). Seattle: Center for the Study of Teaching and Policy.

Cohen, D. K., & Hill, H. C. (2001). *Learning policy : when state education reform works*. New Haven: Yale University Press.

Cressman, G., & Daly, J. (2007). *Evaluation of the Jordan Education Initiative: Review of the Technology Employed to Deliver E-Learning.* Washington, DC: Education Development Center.

Government of Jordan and World Economic Forum (2004). *Jordan Education Initiative: A Public-Private Partnership Model for Effective and Advanced Learning Deployment.* Amman: Authors.

Lieberman, A. (1995). Practices that support teacher development. *Phi Delta Kappa, 76*(8), 591-596.

Light, D., & Rockman, C. (2008). *Evaluation of the Jordan Education Initiative: The Emerging Paradigm of Teaching and Learning in Discovery Schools.* Washington, DC: Education Development Center.

Light, D. & Rockman, C. (2008). *Evaluation of the Jordan Education Initiative: An Evolving Partnership for Change: Stakeholders' Reflections on the Jordan Education Initiative.* Washington, DC: Education Development Center.

Little, J. W. (1993). Teachers' professional development in a climate of educational reform. *Educational Evaluation and Policy Analysis, 15*(2), 129-151.

McKinsey and Company. (2005). *Building Effective Public - Private Partnerships: Lessons Learnt from the Jordan Education Initiative*. Geneva: World Economic Forum.

Method, Frank (2008). *Evaluation of the Jordan Education Initiative: Cost Assessment of Technology Support for E-Learning.* Washington, DC: Education Development Center.

Olsen, B., & Kirstman, L. (2002). Teacher as mediator of school reform: An examination of teacher practice in 36 California restructuring schools. *Teachers College Record, 104*(2), 301-324.

Webb, M., & Cox, M. (2004). A Review of pedagogy related to information and communications technology. *Technology, Pedagogy and Education, 13*(3), 235-286.

World Economic Forum. (2003). *Jordan Education Initiative Baseline Proposal*. Geneva: Author.