# Research Report for GeSci Meta-Review of ICT in Education
# Phase Two

**In response to:**

Terms of Reference for
GeSci Request for Proposal
Meta-review of ICT in Education Research

(TOR dated 17 February 2009)

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# Abstract

This second phase of a comprehensive meta-review of educational ICT research and practice addresses global developments reflected in the research and development literature appearing since 2006. Completed in April 2009, the Phase One (P1) report comprised a synopsis of research related to GeSci's five thematic inquiry priorities. Preliminary findings identified in the initial P1 report were presented by Dr. Patti Swarts, Manager of the GeSci Africa Regional Programme, in the GeSci-facilitated North-South Research Partnerships in ICT Education workshop conducted in the Irish Aid Centre, Dublin, on 21 April 2009. This Phase Two (P2) narrative builds upon the P1 report and responds to several refined GeSci declarations of purpose and mission.

## Research Report for GeSci Meta-Review of ICT in Education: Phase Two

## Background from Phase One of Meta-review

Phase One (P1) of this meta-review was prepared by John LeBaron and Elizabeth McDonough (2009) of Western Carolina University, a campus of the University of North Carolina (USA). Dr. LeBaron serves as the Jay M. Robinson Distinguished Professor of Educational Technologies, and Ms. McDonough is Education Reference Librarian. The P1 report was produced as a resource for GeSci's North-South Research Partnerships for ICTs in Education workshop conducted in Dublin on 21 April 2009. The major purposes of the P1 Report were to:

1. provide a multi-disciplinary, multi-methodological lens for understanding the global complexity and exponential growth of ICT;
2. reveal trends in contemporary ICT scholarship; and
3. discern relevant research themes.

Readers may find it helpful also to examine a related PowerPoint presentation, which offers discussion points in bullet form, presented at the workshop by Patti Swarts (2009), Manager of the GeSci Africa Regional Programme.

The P1 research was limited to studies conducted between 2006 and 2008 and included articles from traditional peer-reviewed literature and "grey literature," such as policy reports, conference papers, and popular media releases. Although the search scope focused on five thematic streams outlined in GeSci's Terms of Reference (TOR), the comprehensive nature of these combined themes dictated a search methodology that was both broad and deep.

The following five themes were specified in GeSci's original TOR:

1. Educational ICT leadership and management
2. ICT infrastructure, connectivity, and accessibility
3. Integration of ICTs into teaching and learning
4. Teacher education and ICT
5. Educational Content and ICT

**Research Methodology for Phase Two (P2) of GeSci Meta-Review of ICT in Education**

The literature review for the P1 report revealed that published scholarship in ICT is prolific.  While the researchers reviewed approximately 250 studies related to the identified themes, many times that number were published during the time period of 2006-2008.  To better understand how this emergent field is being defined by the academic community at-large, a tighter journal quality screen was adopted for P2 of the meta-review. Studies for review were gathered from a limited number of the most highly-rated educational journals.  To ensure that the most prominent contributors to the education literature were represented, the scope of the study was not limited to ICT journals but includes a broader sector of the education literature.

The *Publishing in Academic Journals in Education* (PAJE) database project (Holbrook et al., 2009), developed by the Centre for the Study of Research Training and Impact (SORTI) at the University of Newcastle, Australia, was selected as an appropriate journal quality measure for the purposes of this project because of the following criteria:  first, it was developed specifically for the field of education and ranks journals within education sub-disciplines;  second, it is current as of December 2008, and so provides a useful snapshot of quality journals in a rapidly-changing publishing environment; and third, it is international in scope, seeking to counterbalance other journal quality measures that have been criticized as being excessively USA-centric (Bourke, 2009; Fairbairn, 2009).

Education journals included in PAJE (Holbrook et al., 2009) are ranked with a quality indicator called a "Qscore."  Such journals fall within 27 sub-disciplines ranging from "Administration, etc." to "Vocational, etc." education. Based on our  P1 report and core GeSci mission declarations, and following our Web meeting with GeSci's Mary Hooker and Jyrki Pulkkinen on 21 May 2009, the researchers decided to focus on four major themes:

1.  Leadership and management promoting effective ICT deployment
2.  ICT and educational transformation
3.  ICT and learning relevance to 21st Century phenomena
4.  Equity of access to the resources of technology

During the process of narrative development stemming from the database scan, it was determined that items 2 and 3 overlapped, and separating them appeared counterproductive. Therefore, the middle two items were combined into a single item labeled "Transformational migration to a new century." Accordingly, we selected the following sub-disciplines deemed particularly germane to the established themes. From each of these sub-disciplines, we selected the top five journal titles, except for the core sub-discipline "Educational Technology/Computing/ICT" where we selected the top ten of 57 titles (see Table 1, below):

1.  Administration/Leadership/Educational Management policy (5 journals)
2.  Comparative/Cross-Cultural/Indigenous/Ethnic Education (5)
3.  Comprehensive (5)

4. Technology/Computing/ICT (10)
5. Pedagogy & Curriculum/Theory & Practice (5)
6. Special Education Including Gifted (5)
7. Teacher Education (5)

Using this approach, we intended to examine a considerably smaller number of research studies in greater depth than we did during P1. However, there were two unexpected outcomes of our review: first, more studies were published in this limited set of journals than we anticipated (N=253); and second, most of those studies were published in ICT journals, with disappointingly few results appearing in non-ICT educational disciplines (See Table 1, below). The latter outcome raises the very real possibility that, when educational literature is broadly considered, ICT researchers may be spending much energy communicating among themselves. This phenomenon supports a general conclusion that ICT research remains very much an emerging field that has failed to enter the conversational mainstream of educational policy and practice.

Table 1

*Journals Included in P2*

| Journal/Category | Q-Score | ICT Articles |
|---|---|---|
| Admin/Leadership/Educational Management/Policy | | |
| J. of Education Policy | 18.64 | 0 |
| Educational Administration Quarterly | 15.82 | 0 |
| Educational Management, Administration & Leadership | 15.39 | 2 |
| J. of Educational Administration | 15.21 | 4 |
| School Effectiveness & School Improvement | 14.18 | 2 |
| Comparative/Cross-cultural/Indigenous/Ethnic | | |
| Comparative Education | 18.65 | 3 |
| Globalization, Societies & Education | 16.48 | 1 |
| Comparative Education Review | 15.99 | 2 |
| Compare: A J. of Comparative Education | 15.05 | 2 |
| International Review of Education | 13.89 | 2 |
| Comprehensive | | |
| American Educational Research J. | 29.33 | 1 |
| British Educational Research J. | 29.30 | 4 |
| Review of Educational Research | 29.21 | 4 |
| Harvard Educational Review | 25.90 | 0 |
| Australian Educational Researcher | 24.34 | 0 |

| Educational Technology/Computing/ICT | | |
|---|---|---|
| British J. of Educational Technology | 20.84 | 26 |
| Computers & Education | 20.22 | 75 |
| Australasian J. of Educational Technology | 18.65 | 17 |
| A L T -J: Research in Learning Technology | 17.37 | 0* |
| J. of Computer Assisted Learning | 16.21 | 5 |
| Australian Educational Computing | 14.36 | 33** |
| Educational Technology & Society | 14.01 | 13 |
| J. of Technology & Teacher Education | 13.63 | 9 |
| Technology, Pedagogy & Education | 13.21 | 28 |
| Educational Technology, Research & Development | 12.76 | 4 |
| Pedagogy and Curriculum | | |
| J. of Curriculum Studies | 19.16 | 9 |
| Curriculum Inquiry | 17.45 | 0 |
| Curriculum & Teaching | 14.24 | 0 |
| Curriculum Perspectives | 11.53 | 1 |
| Teaching & Learning: J. of natural inquiry | 11.07 | 2 |
| Special Education | | |
| Exceptional Children | 23.81 | 0 |
| J. of Learning Disabilities | 18.84 | 5 |
| Language, Speech & Hearing Services in Schools | 18.56 | 1 |
| International J. of Inclusive Education | 18.23 | 3 |
| American J. of Mental Retardation | 18.05 | 0 |
| Teacher Education | | |
| Teaching & Teacher Education | 17.39 | 6 |
| Teachers College Record | 15.97 | 11 |
| Asia-Pacific J. of Teacher Education | 14.92 | 8 |
| Australian J. of Teacher Education | 14.05 | 3 |
| Asia-Pacific J. of Teacher Education & Development | 12.95 | *** |
| * Higher education focus | | |
| ** Not reviewed due to technical difficulties | | |
| *** No access to indexing and abstracting – no journal website | | |

For P1, we had undertaken a comprehensive literature review, broadly sweeping literature from a defined time frame (2006-2008) according to themes and topics derived from the contracted terms of reference.  In order to achieve this, we used a tightly-structured, controlled vocabulary search of Educational Resources Information Center (ERIC), the world's largest index of educational research.  Since P2 targeted a select list of journals, we were able to focus individually on each journal.  Whenever possible, the individual journal was searched by keyword.  When that was not possible, the tables of contents for the time period under study were reviewed. Notwithstanding our intent to narrow and deepen our narrative, we nonetheless generated a prodigious number of possible entries and have thus used our professional judgment in selecting studies for the main P2 narrative. The P2 Report section labeled "Full bibliographic results of the P2 search," however, lists the citations of all the studies revealed from the search process.

For the following reasons, we determined not to attempt culling conference papers or other document types that were not published in the identified journals:

1. Research quality screens for non-journal documents seem rather subjective.
2. The best work of the best thinkers typically turns up in high-quality refereed journals, even though the time-lag between authorship and publication is occasionally excessive.
3. Reference to a broader sweep of multi-faceted literature sources may be found in the P1 Report and in other research databases.

In the reference lists, Web-linked URLs may be labeled "Available from" or "Retrieved from." "Available" links are not accessible on the open Web, but may be secured on-demand, typically for a document or subscription fee. "Retrieved" links are available on the open Web at no cost to the user.

This P2 review offers a clear picture of the nature of the ICT dialog occurring in, or absent from, the educational literature.  Complementing the themes of interest in this study, the review uncovers significant gaps in ICT research, revealing a discussion taking place in narrower scholarly and professional circles than we had previously thought.

## References

Bourke, S. (2009). Development of a journal quality measure. In A. Holbrook et al. (Eds.), *Publishing in academic journals in education*. Available from http://www.newcastle.edu.au/research-centre/sorti/paje/.

Fairbairn, H. (2009). Development, scope and content. In A. Holbrook et al. (Eds.), *Publishing in academic journals in education*. Available from http://www.newcastle.edu.au/research-centre/sorti/paje/.

Holbrook, A., et al. (2009). *Publishing in academic journals in education*.  Available from http://www.newcastle.edu.au/research-centre/sorti/paje/.

LeBaron, J., & McDonough, B. A. (2009). Research report for GeSci meta-review of ICT in education: Phase One . Dublin, Ireland: Global e-Schools and Communities Initiative. Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/000001 9b/80/45/4f/5e.pdf.

Swarts, P. (2009). Perspectives: North/South research partnerships in ICT education. Paper presented at the *North-South Research Partnerships in ICT in Education Workshop,* Dublin, Ireland.  Retrieved from http://gesci.org/old/files/docman/Presentation_ARP_GeSCI_-1.ppt.

<center>**Narrative Analysis of Key Findings**</center>

**Leadership and Management Promoting Effective ICT Deployment**

    **What are the major research trends?**

In the past 20 years, much reporting has associated beneficial ICT curricular integration with effective educational leadership. Tondeur, Vlacke, and van Braak (2008) reinforce this notion from a Belgian perspective. Factors such as school-based openness to change, effective planning, and related manifestations of competent leadership are co-related with curricular efficacy. As outlined in the previous section of this document, Mukama and Andersson (2008) present multi-method research from Rwanda on newly-certified teaching practitioners, suggesting an incipient enthusiasm for the integration of ICT into their teaching. To maintain these high levels of motivation, the researchers urge the robust provision of resources, curriculum, pedagogy, and professional development by educational leaders. Teo's (2009) research from Singapore links teacher perceptions of ICT efficacy to implementation behaviors in schools. Over time, of course, if the reality of performance fails to match positive perceptions, those perceptions will ultimately turn negative with corresponding long-term consequences for practice.

Recent ICT literature focuses on the mismatch between the traditional, industrial model of public schooling and the new socio-informational configurations emerging from the information revolution. For example, Albirini (2007) describes this dissonance as a systemic malfunction, suggesting that it is irresolvable within the current industrial framework of schooling. He feels that new theoretical configurations are needed to transform schooling in a manner that can realize the full potential of information technologies. Hayes (2007) labels typical technology implementation in Australian schools in ways that support and supplement, rather than transform, existing classroom practice. This outlook is reinforced by Turvey (2006), who laments the lack of inspiration among British primary schools in optimizing the nation-wide installation of high-speed Internet connectivity. Reminding us of Seymour Papert's warning a quarter of a century ago, Whalley (2007) joins a chorus of colleagues in urging educators to abandon the industrial metaphor for school organization.

Haydn and Barton (2007) discovered a positive correlation between teacher self-image and satisfaction with the ICT curriculum resulting from professional time regularly made available for collaboration and communication about ICT practice, suggesting that time committed to peer mentoring can create a positive influence on curricular efficacy. As Gao (2008) points out, in Chinese schools contemporary transformational demands of ICT on teachers increase teacher vulnerability. Good leadership, therefore, manages the risks of well-calculated innovation without stifling it. In order to use technology effectively, teachers need to migrate their practice from instruction to knowledge construction in ways that promote critical, independent thinking among students. Different cultures tolerate deviations from orthodoxy in different ways, but this phenomenon is hardly confined to China.

Much of the research on this topic focuses on effective practices in teacher education (Andersson, 2006; Clarke, 2009; Davis, Preston, & Sahin, 2009; Goktas, Yildirim, & Yildirim, 2009). Other reports stress the locus of leadership (Gokce, 2009) suggesting the key role of the local school principal.  Crow (2006) is particularly concerned about the challenge of socializing new principals to public schooling in a post-industrial era. Crow's opinion about the role of the principal is supported by Thomson, Nixon, and Comber (2006), who write about ICT implementation in an Australian context. This research conveys concern about the excessive concentration on technocratic determinism at the expense of focus on the skills of transformational teaching and curriculum integration. ICT development is described by this research as "fragile."

Gülbahar and Guven (2008) cite the lack of adequate training or resources to support transformational ICT integration in Turkish schools, but Martin and Vallance (2008) report superior migration from didactic to constructivist teaching techniques on the part of initial teaching trainees when they apply "informed" synchronous communication integration with their own studies. Several studies focus on the prevailing structure of public education, and its constraint on innovation. Martinez Arbelaiz and Correa Gorospe (2009) describe this as the "grammar of schooling," suggesting that a new structural syntax is needed to release the grip of traditional rules.

Several studies address the question of globalization and education, making the point that ICT holds unprecedented potential for cross-border, intercultural learning, teaching, and curriculum development. Spring (2008) presents a theoretical discussion in the context of broader international institution building (e.g., OECD, UNESCO, the World Bank), suggesting that educational policy and practice need to reflect and draw support from such global institutions. He points out that current efforts comparing student learning outcomes, such as PISA and TIMSS, are already moving in this direction. Diamantopoulou (2006) chronicles the benefits of the European Commission's Comenius Project for Greek students. Notwithstanding the passionate opposition to globalization in some circles, these researchers view this trend continuing into the indefinite future despite countervailing pressures to protect local cultures and language.

### What works; what does not?

Writing about initial teacher preparation in the United Kingdom, Clarke (2009) delineates the effectiveness of online "communities of practice (COP)" and "professional online district (POD)" strategies to promote professional collaboration among student teachers. So, Hung, and Yip (2008) report similar results from Hong Kong; Dalgarno and Colgan (2007) declare the efficacy of network-enabled community-building for the professional development of elementary math teachers. New models of practice are recommended based on research related to effective study in virtual learning environments. By the same token, school-wide (as distinct from "enclave") COP strategies are particularly recommended for Cypriot primary schools by Hadjithoma and Karagiorgi (2009). Hodgkinson-Williams, Slay, and Siebörger (2008) presents a persuasive case for multi-sector COP strategies in South African higher education.

Based on survey research and in-depth interviews, Goktas, Yildirim, and Yildirim (2009) identify enablers and barriers to effective ICT integration in teacher training. Their research reveals agreement among stakeholders that insufficient exposure to ICT and a paucity of software, materials, and hardware constitute important obstacles for integrating ICTs in the initial teacher education. In Sweden, Andersson (2006) reinforces the view that ICT is inadequately featured in pre-service teacher training, resulting in an entering teacher workforce unaware of ICT's potential and unskilled in the techniques to realize it.

Fleming, Motamedi, and May (2007) attribute positive teacher trainee attitudes toward the curricular integration of ICT to the role modeling and work assigned by their professional education professors. Absent the power of professional example, other factors seem relatively unimportant. Reinforcing this general sentiment from the UK, Hammond et al. (2009) present a study indicating that resource access and support, and strong role-modeling of ICT utilization particularly, contributed to strong subsequent classroom integration.

Several studies address the challenge of organizational coordination to support ICT sustenance in schools.  Aczel, Peake, and Hardy (2008), for example, have called for service-providing agencies to coordinate efforts in order to reduce developmental overlaps and redundant duplication of effort. They are concerned that organizational roles be appropriately matched to local needs and cultures, suggesting that such coordination is especially critical in developing countries.

Consonant with the strong sense presented in our P1 report that the local school principal plays a crucial leadership role in supporting ICT school implementation, Gokce (2009) supports this premise in an interview-based study of Turkish elementary school principals and teachers. In this study, 80 principals and 280 teachers were interviewed for their perceptions about leadership. Not surprisingly, opinions between teachers and principals differed somewhat, but they agreed on the importance of effective principal leadership.

Teo's (2009) correlation between teacher perception and classroom practice highlights the systemic association connecting perception, implementation, training, professional development, resources, and leadership. When any component within this system fails, the entire system may become dysfunctional. The P1 report highlighted several studies stressing the importance of effective leadership at the local school level. Literature from outside the field of ICT repeatedly makes this case. For example, Hess and Kelly (2007) present a sharp critique of contemporary higher education programs to prepare school leaders. In particular, less than 5% of instruction in graduate-level school leadership preparation focuses on the use of technology for data-driven administration. Educational leaders who ignore technology tools for management are hardly likely to advance their potential for teaching and learning.

Focusing on the role of school principals interviewed in west of Ireland, McGarr and Kearney (2009) describe a community of dedicated school leaders struggling to promote ICT implementation in the face of resource scarcity and poor coordination at higher levels

of national authority. Strong, collaborative, and coordinated leadership is needed at all levels of authority's food chain.

### How should resources be organized and deployed?

From the reports cited above, we might conclude that the organization and deployment of ICT resources concentrate on the following priorities:

1. Effective, continuing leadership training, especially for school principals and other personnel in leadership positions;
2. Research-backed ICT integration at all levels of teacher education, pre-service and in-service;
3. Establishment of "communities of practice (COP)" among practitioners, with effective role modeling and mentorship built in, preferably on a school-wide basis rather than in narrower, interest-specific enclaves;
4. On-going planning for ICT integration at local, regional and national levels;
5. Coordination of leadership among areas levels of educational authority;
6. Provision of adequate resources to support the aspirations of all legitimate stakeholders.

In many countries, educators struggle between curricular demands perceived from local schools and the guidelines or mandates communicated from more centralized sources of policymaking. This issue is addressed extensively in the P1 report, but it is also recognized here. A particularly useful book providing guidelines for reconciling local needs with centralized guidelines is John Duffty's (2007) *Extending Knowledge in Practice: Primary ICT.*

For the developing world, in this case Malawi, Nampota, Thompson, and Wikeley (2009) additionally call for strong university involvement to promote human resource development in the sciences. Several researchers (Huang, Kuo, Lin, & Cheng, 2008) describe new strategies and techniques to incorporate mobile technologies into contemporary education. In particular, Markett, Sánchez, Weber, and Tangney (2006) advocate for the incorporation of SMS tools, consonant with emerging communication habits of contemporary young people.

### What further research is needed to advance effective deployment and "best practice"?

As Clarke (2009) avers, further research is needed to examine best practice for virtual learning in teacher preparation, partly as a guide for instilling effective learning behaviors among the incoming corps of new teachers. In the British context, Davis, Preston, and Sahin (2009) offer research related to the continuing education of practicing teachers so that standards of practice, especially related to ICT integration in the curriculum, match those of teachers entering the workforce from initial preparation.

Some research literature presents descriptions of specific curricular techniques using ICT. A few of these accounts contain student outcome assessments to varying degrees of rigor.

These articles are important because they advance dialogue about technique, but they often ignore matters of educational transformation. For example, Baek, Jung, and Kim (2008) discuss the degree to which teaching experience influences the quality of teacher decisions about ICT integration in the classroom. They found that veteran teachers tend to incorporate technology from extrinsic motivation, whereas younger teachers were more prone to act as a consequence of their own intrinsic professional needs.

In the growing inquiry into ubiquitous computing, Gado, Ferguson, and van't Hooft (2006) have promoted the use of hand-held devices into pre-service education of science teachers. With burgeoning access to hand-held communications tools, Ng and Nicholas (2009) urge a refocusing of scholarly research toward the efficacy of educational application. They point out that the creation of a strong research foundation to support implementations of new technology trends requires more time and money than is typically available. Although their research points to the motivational potential of handheld devices on Australian pupils, especially in the English curriculum among weaker learners, they acknowledge the feeble status of current scholarship, urging pursuit of a deeper and broader research agenda.

In a major policy paper for Columbia University's *Teachers College Record*, Rothkopf (2009) calls for a major American initiative marshaling the resources of the national educational system to standardize and to "technologize" school instruction in the critical disciplines, most notably mathematics and science. He proposes a massive infusion of technology to support this initiative, backed by the full force of federal and state governments and the private sector. Rothkopf labels such an initiative "a pedagogic information support system (APIS)," claiming that it must be backed by the development of effective training, national databases, and information networks of practice and practitioners.

References

Aczel, J. C., Peake, S. R., & Hardy, P. (2008). Designing capacity-building in e-learning expertise: Challenges and strategies. *Computers & Education, 50*(2), 499-510. doi:10.1016/j.compedu.2007.07.005

Albirini, A. (2007). The crisis of educational technology, and the prospect of reinventing education. *Journal of Educational Technology and Society, 10*(1).  Retrieved from: http://www.ifets.info/

Andersson, S. B. (2006). Newly qualified teachers' learning related to their use of information and communication technology: A Swedish perspective. *British Journal of Educational Technology, 37*(5), 665-682. doi:10.1111/j.1467-8535.2006.00563.x

Baek, Y., Jung, J., & Kim, B. (2008). What makes teachers use technology in the classroom? Exploring the factors affecting facilitation of technology with a Korean sample. *Computers & Education, 50*(1), 224-234. doi: 10.1016/j.compedu.2006.05.002

Clarke, L. (2009). The POD model: Using communities of practice theory to conceptualise student teachers' professional learning online. *Computers & Education, 52*(3), 521-529. doi:10.1016/j.compedu.2008.10.006

Crow, G. M. (2006). Complexity and the beginning principal in the United States: Perspectives on socialization. *Journal of Educational Administration, 44*(4), 310-325. doi:10.1108/09578230610674930

Dalgarno, N., & Colgan, L. (2007). Supporting novice elementary mathematics teachers' induction in professional communities and providing innovative forms of pedagogical content knowledge development through information and communication technology. *Teaching and Teacher Education: An International Journal of Research and Studies, 23*(7), 1051-1065. doi:10.1016/j.tate.2006.04.037

Davis, N., Preston, C., & Sahin, I. (2009). ICT teacher training: Evidence for multilevel evaluation from a national initiative. *British Journal of Educational Technology, 40*(1), 135-148. doi:10.1111/j.1467-8535.2007.00808.x

Diamantopoulou, A. (2006). The European dimension in Greek education in the context of the European Union. *Comparative Education, 42*(1), 131-151. doi:10.1080/03050060500515819

Extending knowledge in practice: Primary ICT – by John Duffty.(2007). *British Journal of Educational Technology, 38*(3), 550-551. doi:10.1111/j.1467-8535.2007.00725_10.x

Fleming, L., Motamedi, V., & May, L. (2007). Predicting preservice teacher competence in computer technology: Modeling and application in training environments. *Journal of Technology and Teacher Education, 15*(2), 207-231. Retrieved from http://www.editlib.org/p/19848

Gado, I., Ferguson, R., & van't Hooft, M. (2006). Inquiry-based instruction through handheld-based science activities: Preservice teachers' attitudes and self-efficacy. *Journal of Technology and Teacher Education, 14*(3), 501-529. Retrieved from http://www.editlib.org/index.cfm?fuseaction=Reader.ViewAbstract&paper_id=5851

Gao, X. (2008). Teachers' professional vulnerability and cultural tradition: A Chinese paradox. *Teaching and Teacher Education: An International Journal of Research and Studies, 24*(1), 154-165. doi:10.1016/j.tate.2006.11.011

Gokce, F. (2009). Behaviour of Turkish elementary school principals in the change process: An analysis of the perceptions of both teachers and school principals. *Educational Management Administration & Leadership, 37*(2), 198-215. doi:10.1177/1741143208100298

Goktas, Y., Yildirim, S., & Yildirim, Z. (2009). Main barriers and possible enablers of ICTs integration into pre-service teacher education programs. *Education Technology and Society, 12*(1). Retrieved from http://www.ifets.info/main.php

Gulbahar, Y., & Guven, I. (2008). A survey on ICT usage and the perceptions of social studies teachers in Turkey. *Educational Technology & Society, 11*(3), 37-51. Retrieved from http://www.ifets.info/abstract.php?art_id=866

Hadjithoma, C., & Karagiorgi, Y. (2009). The use of ICT in primary schools within emerging communities of implementation. *Computers & Education, 52*(1), 83-91. doi:10.1016/j.compedu.2008.06.010

Hammond, M., Crosson, S., Fragkouli, E., Ingram, J., Johnston-Wilder, P., Johnston-Wilder, S., Kingston, Y., Pope, M., & Wray, D. (2009). Why do some student teachers make very good use of ICT? An exploratory case study. *Technology, Pedagogy and Education, 18*(1), 59-73. doi:10.1080/14759390802704097

Haydn, T. A., & Barton, R. (2007). Common needs and different agendas: How trainee teachers make progress in their ability to use ICT in subject teaching. Some lessons from the UK. *Computers & Education, 49*(4), 1018-1036. doi:10.1016/j.compedu.2005.12.006

Hayes, D. N. A. (2007). ICT and learning: Lessons from Australian classrooms. *Computers & Education, 49*(2), 385-395. doi:10.1016/j.compedu.2005.09.003

Hess, F. M., & Kelly, A. P. (2007). Learning to lead: What gets taught in principal-preparation programs? *Teachers College Record, 109*(1), 244-274. Retrieved from http://www.tcrecord.org/Content.asp?ContentId=12742

Hodgkinson-Williams, C., Slay, H., & Siebörger, I. (2008). Developing communities of practice within and outside higher education institutions. *British Journal of Educational Technology, 39*(3), 433-442. doi:10.1111/j.1467-8535.2008.00841.x

Huang, Y., Kuo, Y., Lin, Y., & Cheng, S. (2008). Toward interactive mobile synchronous learning environment with context-awareness service. *Computers & Education, 51*(3), 1205-1226. doi:10.1016/j.compedu.2007.11.009

Markett, C., Sánchez, I. A., Weber, S., & Tangney, B. (2006). Using short message service to encourage interactivity in the classroom. *Computers & Education, 46*(3), 280-293. doi:10.1016/j.compedu.2005.11.014

Martin, S., & Vallance, M. (2008). The impact of synchronous inter-networked teacher training in information and communication technology integration. *Computers & Education, 51*(1), 34-53. doi:10.1016/j.compedu.2007.04.001

Martínez Arbelaiz, A., & Correa Gorospe, J. M. (2009). Can the grammar of schooling be changed? *Computers & Education, 53*(1), 51-56. doi:10.1016/j.compedu.2008.12.016

McGarr, O., & Kearney, G. (2009). The role of the teaching principal in promoting ICT use in small primary schools in Ireland. *Technology, Pedagogy and Education, 18*(1), 87-102. doi:10.1080/14759390802704139

Mukama, E., & Andersson, S. B. (2008). Coping with change in ICT-based learning environments: Newly qualified Rwandan teachers' reflections. *Journal of Computer Assisted Learning, 24*(2), 156-166. doi:10.1111/j.1365-2729.2007.00249.x

Nampota, D., Thompson, J., & Wikeley, F. (2009). The development of human capacity in Malawi: The role of science and technology. *International Review of Education, 55*(1), 59-74. doi:10.1007/s11159-008-9113-0

Ng, W., & Nicholas, H. (2009). Introducing pocket PCs in schools: Attitudes and beliefs in the first year. *Computers & Education, 52*(2), 470-480. doi:10.1016/j.compedu.2008.10.001

Rothkopf, E. Z. (2009). An immodest proposal: Pedagogic information supports for teachers. *Teachers College Record, 111*(1), 164-179. Retrieved from http://www.tcrecord.org/Content.asp?ContentId=15218

So, W. W., Hung, V. H. & Yip, W. Y. (2008). The digital video database: A virtual learning community for teacher education. *Australasian Journal of Educational Technology, 24*(1), 73-90. Retrieved from http://www.ascilite.org.au/ajet/ajet24/so.pdf

Spring, J. (2008). Research on globalization and education. *Review of Educational Research, 78*(2), 330-363. doi:10.3102/0034654308317846

Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education, 52*(2), 302-312. doi:10.1016/j.compedu.2008.08.006

Thomson, P., Nixon, H., & Comber, B. (2006). A case of intention deficit disorder? ICT policy, disadvantaged schools, and leaders. *School Effectiveness and School Improvement, 17*(4), 465-482. doi:10.1080/09243450600743590

Tondeur, J., Valcke, M., & van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning, 24*(6), 494-506. doi:10.1111/j.1365-2729.2008.00285.x

Turvey, K. (2006). Towards deeper learning through creativity within online communities in primary education. *Computers & Education, 46*(3), 309-321. doi:10.1016/j.compedu.2005.11.004

Whalley, P. (2007). Modifying the metaphor in order to improve understanding of control languages—the little-person becomes a cast of actors. *British Journal of Educational Technology, 38*(4), 715-726. doi:10.1111/j.1467-8535.2006.00642.x

**Transformational Migration to a New Century**

**What are the major research trends?**

David Buckingham's book, *Beyond Technology: Children's Learning in the Age of Digital Culture* (Hedberg, 2008) presents a critique of technological implementation in schools and calls for transformational innovation to shake education beyond conventional practice for an outmoded world. He suggests that children cannot become digitally literate if they use technology to learn conventionally. He suggests that much contemporary application, driven by commercial objectives, is "uninspiring and mundane." He views the technology as potentially transformational and draws upon contemporary research and innovation to illustrate his points. Richards (2006) re-focuses the discussion back to effective pedagogy; without it, the transformative application of ICT is unlikely to occur. Teo (2008) and Teo, Chai, Hung, and Lee (2008) correlate the beliefs that teachers bring to the classroom with the quality of their technology use. Teachers with a constructivist predisposition to teaching in general are more likely to integrate ICT creatively.

As noted earlier, Martínez Arbelaiz and Correa Gorospe (2009) raise the intriguing term "the grammar of schooling," suggesting that its rules constrain transformational curricular innovation especially ICT integration. Schools seem to be quite unique among types of organization in constraining the transformational effects of technology. Marsh (2007) suggests that out-of-school literacy habits of children are leading school practice by a significant and widening margin, with negative consequences for the curricular relevance of literacy education. Martínez Arbelaiz and Correa Gorospe (2009) suggest that if technology deployment fails to disrupt the comfortable assumptions of traditional practice, then the resources spent on it will fail to produce meaningful improvement. Through a case study of two out-of-school projects, this research depicts models that might breach the grammatical orthodoxy of change-resistant school practice. This perspective is supported by research in Turkish schools (Demiraslan & Usluel, 2008) reporting that the typical organizational culture of schools is characterized by rigid hierarchies and inflexible curricular timetables that inhibit the transformational effect of ICT.

How does a new "grammar of schooling" reflect itself in transformational practice? Drawing upon young students' inherent fascination with ICT tools, Ching and Kafai (2008) urge integration driven by thematic and interdisciplinary curricular designs. Some theories presented as "new" actually seem to hearken back to earlier educational movements such as progressivism. Yelland, Cope, and Kalantzis (2008) present an approach that they call "knowing-in-action," which depends upon ICT for teacher-driven communication, problem-solving, and documentation for better teaching. Hennessey et al. (2007) and Lim (2007) declare success in using ICT tools to promote higher-order science learning in British and Singaporean secondary schools.

Based on research conducted in the two American states of California and Maine, Warschauer (2007) reports mixed efficacy results on the one-on-one school infusion of laptop computers. It appears that other factors of school quality determine the effects of computer distribution. McGrail (2006) reports ambivalence among American high school

English teachers regarding a one-on-one laptop initiatives. In her opinion, successful undertakings of this nature require sufficient autonomy, resources, and professional development. Thus, massive laptop distribution to pupils throughout schools is not a solution to the problem of educational transformation; it is a tactic to be deployed as part of a systemic commitment to institutional change. (One-on-one laptop projects are discussed more fully in the P1 report.)

Outlining the substantial cultural and political differences between India and Western countries, Mohanty and Vohra (ICT strategies for schools, 2008) explain why national implementation models that work for one culture might fail in other cultures. They point out, for example, the absurdity for a country that typically spends less than $100 annually on the public schooling for each child, of investing $200 per head to finance individual laptop computers for all. Many developing countries are substantially poorer than India. In this regard, the viewpoints of Mohanty and Vohra are reinforced by Aczel (2008). Jules (2008) suggests that successful ICT integration in the post-colonial, English-speaking Caribbean area is impossible in the absence of systemic educational restructuring. Without such transformation, small developing nations will continue to be marginalized.

Writing from an Asian perspective, Bigum and Rowan (2008) describe what they call the "landscape" of teacher education, suggesting that the massive shifts of society and commerce occasioned by the rapid contemporary pace of technological development fail to reflect in teacher education organization and practice. These researchers suggest that teacher education has stressed developmental window-dressing at the expense of substantive transformation. As long as teacher education resists transformation from the strictures of bygone practice, meaningful change in teaching practice and school structure cannot be expected. Leach (2008) presents a similar case in the face of resistance to ICT for educational transformation in sub-Saharan Africa.

In addition to the issues discussed in other sections of this report, challenges in ICT research and development for educational transformation include ethical use (Beycioglu, 2009), information literacy (Probert, 2009), and school interaction with non-school entities (Sloan, 2008).

### What works; what does not?

From the relatively advanced settings of Hong Kong and Singapore, ICT-intensive teaching transformation is typically anchored in teachers' mindful migration away from a teacher-centered strategy of instruction toward student-centeredness (Wong & Li, 2008; Wong, Li, Choi, & Lee, 2008). These studies propose that effective leadership and collaborative school climate are essential to the kinds of transformation that optimize investments in ICT. In the upper grades of an American elementary school, Ching and Kafai (2008) report that learning outcomes in a technology-rich marine biology curriculum are advanced through explicit strategies anchored in student collaboration and peer scaffolding.

Reflecting the landscape of educational technology in American schools described by Cuban (2001), in a large-scale study of Cypriot elementary schools by Eteokleous (2008), ICT integration was found to be perfunctory and non-transformative. Gülbahar (2007) reports similar findings for Turkey. In the studied schools, technology was used sporadically, and when it was implemented, tended to reinforce traditional classroom practice. In significant measure, Eteokleous (2008) attributes these circumstances to poor training and support. Cypriot teachers, in his opinion, simply do not know how to use technology in transformative ways. Clearly, this puts pressure on leadership across borders and at all levels of the educational enterprise.

Watson and Hempenstall (2008) bridge the gap between educational tradition and the needs of the 21st century. Describing the implementation of a technology-rich program to support literacy acquisition in the early Australian school grades, positive effects were revealed for phonemic awareness, letter-sound fluency, non-word decoding skills, and oral reading fluency when compared to a non-treatment control group. This research concludes that at-risk students may particularly benefit from the strategies described. Young (2008) addresses the question of ICT program development and culture, suggesting that designers have not yet effectively accounted for the cultural needs of diverse learning populations in the development of products and curriculum.

Increasingly, multi-user virtual reality (MUVE), virtual learning environments (VLE), and Web 3-D technologies are being proposed and described as 21st-Century ICT innovations (Chittaro & Ranon, 2007; Colomar & Guzmán, 2009).  Although learning results are mixed, tools such as *Second Life* seem to have facilitated students in Singapore to work constructively in groups and to monitor their social behaviors in a purposeful context (Rappa, Yip, & Baey, 2009).

Bottino, Ferlino, Ott, and Tavella (2007) report success in the elementary school grades with computer-based gaming strategies. From a Turkish primary school setting,  Tüzün, Yılmaz-Soylu, Karakuş, İnal, and Kızılkaya (2009) report positive results of gaming tactics for learning outcomes and intrinsic motivation. Lin and Zini (2008) opine that the low-cost and local adaptability of open-source software solutions will ultimately trump costly commercial products for educational adaptation, especially in lesser developed regions of the world. Kuiper, Volman, and Terwel (2009) describe a Dutch project where fifth-graders develop Web literacy skills through the use of cooperative learning techniques that employed, among other things, networking tools available on the Web.

Networked technology shows potential for authentic collaboration across cultures and national boundaries. In this respect, Simovska and Jensen (2008) describe an initiative concerning health awareness among students in the Czech Republic, Denmark, Macedonia, and Sweden in connection with the WHO-supported Schools for Health in Europe initiative. The technology used was supported by explicit strategies to promote student collaboration. Evaluation results demonstrated strong motivation among the learners, in addition to an enhanced sensitivity to the perspectives of other cultures. Vavoula, Sharples, Rudman, Meek, and Lonsdale (2009) describe concrete strategies through which students may use a

dedicated tool designed for mobile devices to record and transmit museum field trip experiences back to their classrooms and homes. This tool is called "myartspace."

What does not work? Clearly, classroom practices that simply embellish traditional modes of direct instruction with ICT tools have been repeatedly labeled as ineffective. Lin (2008) argues against separating instruction for technology literacy from the overall curricular mainstream of schooling. She describes the integration of ICT across the curriculum as critical to learning how technology is productively applied in real-life situations. Hassett (2006) suggests that traditional theoretical constructs for early-literacy education fail to reflect the new communicative realities emerging from the affordances of networked technology.

As  Huang, Kuo, Lin, and Cheng (2008) point out, resource deployment needs to reflect student migration toward mobile technologies and Web 2.0 applications. From a Norwegian case study, Elstad (2006) affirms that the dynamics of the technology-infused classroom reduces teacher control thereby creating a threat that students will carry out non-educational activity with the available technology devices. Teacher control, however, seems hardly to be the point of ICT transformation in the curriculum.  Teacher roles must change, not toward tighter control but toward the more effective orchestration of independent learning.

### How should resources be organized and deployed?

Writing from outside the ICT field in the *American Educational Research Journal*, Cilesiz (2009) suggests that educators examine leisure-related computer habits of young people and design relevant curriculum with these habits in mind. Clearly, this recommendation has implications for the infusion of mobile devices. By formal research and by informed anecdote, it is well-known that young people use mobile devices voraciously for networked communication.

Dangwal and Kapur (2008) describe a fascinating experiment with the distribution of networked computers in open, public locations across Indian urban slums. Equipped with easy to use GUI interfaces, these "hole in the wall" installations promoted a rich variety of informal learning activity, representing not only an innovation for the deployment of educational resources but also a means to reduce equity disparities across demographically unequal groups.

As for teacher education, Clarke's (2009) call for the development of networked communities of practice (COP) has already been mentioned, as have the community-building recommendations of Hadjithoma and Karagiorgi (2009). Gulsecen and Kubat (2006) report positive results from Turkish teacher education initiatives that incorporate technology-supported project-based learning (PBL) activities into curricular programs. Although such a strategy does not appear to influence incipient teacher attitudes, students undergoing such a curriculum emerged more competent than their control-group peers who experienced a teacher-centered approach. Morgan and Kennewell (2006) stress the importance of play in effective initial teacher education (ITE). Unfortunately, according to

these researchers, ITE students' own traditional schooling seems to erect psychological barriers to the effective pursuit of play-centered study and action. Leadership is required to create safe environments for exploring such methodologies.

Can ICT resources be deployed constructively at the earlier grade levels? According to O'Hara (2008), indeed they may. Although pedagogical innovation at these levels does not always keep pace with the provision of resources, based on observations and interviews of young children and their teachers, technology has been shown to promote academic learning and social skill development. Barton and Hayden (2006) found that massive ICT investments in specialized training and time for beginning teacher educators do not translate into improved attitudes or efficacy, suggesting that the better strategy is to infuse technology seamlessly throughout the teacher education program.

Ashton and Newman (2006) perceive networked technology as an ideal vehicle for heutagogy (defined as the principle of teaching and learning created on a foundation of authentic self-determination), independent of credentialing institutions. They suggest that education is moving in this direction in any case, that such transformation is enabled by ICT, and that formal education at all levels needs to recognize and adjust to this socially-embedded, technology-driven change. According to this vision, there will be no future "heutagogues" in the sense that "pedagogues" currently exist in the educational workplace. Learners will determine their own educational path, availing themselves of a growing quiver of electronic learning tools.

**What further research is needed to advance effective deployment and "best practice"?**

As we discuss teacher education in the context of 21st-century transformation, we find extensive literature touching upon techniques that might or might not benefit subsequent teacher practice. For example, Bai and Ertmer (2008) proclaim the efficacy of an introductory teacher preparation course to improve teachers' technology attitudes. We have already discussed Edmunds' (2008) call for technology applications research to focus on teaching rather than technology, especially related to low-performing students. Hermans, Tondeur, van Braak, and Valcke (2008) make a similar case for all learner populations.  Lim, Lee, and Hung (2008) take their research methodology one step further, focusing qualitatively in great depth to study an individual teacher's evolution toward technology competence. Chen (2008) finds that technology specific prior training and continuous professional development are essential to successful ICT integration in second language school instruction. These truths have previously been established.

Research by Owston, Sinclair, and Wideman (2008) on Canadian professional development for middle school math teachers highlights the complexity of variables involved in assessing the impact of technological application. Even when certain treatments are correlated with the putative results, specific variables are often difficult to isolate. Therefore, claims that particular variables are solely responsible for the co-related results are typically suspect. For this reason, a blend of naturalistic inquiry with quantitative methodologies tends better to describe real phenomena as they occur in the field.

Drent and Meelissen (2008) conducted a case study of teacher educators in the Netherlands. Although they expected school-level factors to influence ICT innovation, they found that personal attributes (such as a spirit of entrepreneurship) were more influential. Of course, such entrepreneurship can be stimulated and promoted by effective leadership and organization, but this research suggests that the impact of top-down change strategies will be blunted without the benefit of bottom-up risk-taking. This speaks to the importance of effective teacher recruitment and preparation supported by incentives to attract top talent to the teaching profession. It also addresses the need for leadership that treats failed experimentation as opportunity for learning, growth, and professional improvement.

Angeli and Valanides (2009) affirm that the transformational impact of ICT requires a clear, commonly understood epistemological framework. Without such clarity, it is very difficult for teachers to understand ICT's transformational potential or for educational decision-makers to assess whether or not high standards are being met. In the context of the extensive discussion about ICT as a potentially "disruptive" force in schooling,  Conole, de Laat, Dillon, and Darby (2008) lament that much contemporary research has focused on quantitatively measured learning outcomes instead of strategies that disrupt curriculum in transformative ways. About best practice, they write, "Technology is not simply seen as an 'add on' for these students, it is central to how they organize and orientate their learning" (p. 522).

In Australia, Donnison and Haynes (2007) describe a conflicted generation of pre-service school teachers simultaneously carrying conservative and progressive mindsets about the prospect of ICT integration. Yuen and Ma (2008) report from Hong Kong that perceived ease-of-use is a superior predictor of subsequent teacher ICT curricular integration than perceived usefulness. These questions demand further research. Finnish researchers Ryymin, Palonen & Hakkarainen (2008) compared leadership characteristics among teachers operating simultaneously in computer networked and informal non-technological environments. They found that effective leadership in one setting did not necessarily translate into other environments, suggesting that a methodological blend best suits a broad base of professional development needs.

References

Aczel, J. C., Peake, S. R., & Hardy, P. (2008). Designing capacity-building in e-learning expertise: Challenges and strategies. *Computers & Education, 50*(2), 499-510. doi:10.1016/j.compedu.2007.07.005

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education, 52*(1), 154-168. doi:10.1016/j.compedu.2008.07.006

Ashton, J., & Newman, L. (2006). An unfinished symphony: 21st century teacher education using knowledge creating heutagogies. *British Journal of Educational Technology, 37*(6), 825-840. doi:10.1111/j.1467-8535.2006.00662.x

Bai, H., & Ertmer, P. (2008). Teacher educators' beliefs and technology uses as predictors of preservice teachers' beliefs and technology attitudes. *Journal of Technology and Teacher Education, 16*(1), 93-112.  Retrieved from http://www.editlib.org/index.cfm?fuseaction=Reader.ViewAbstract&paper_id=228 51

Barton, R., & Haydn, T. (2006). Trainee teachers' views on what helps them to use information and communication technology effectively in their subject teaching. *Journal of Computer Assisted Learning, 2*2(4), 257-272. doi:10.1111/j.1365-2729.2006.00175.x

Beycioglu, K. (2009). A cyberphilosophical issue in education: Unethical computer using behavior--the case of prospective teachers. *Computers & Education, 53*(2), 201-208. doi:10.1016/j.compedu.2009.01.009

Bigum, C., & Rowan, L. (2008). Landscaping on shifting ground: Teacher education in a digitally transforming world. *Asia-Pacific Journal of Teacher Education, 36*(3), 245-255. doi:10.1080/13598660802232787

Bottino, R. M., Ferlino, L., Ott, M., & Tavella, M. (2007). Developing strategic and reasoning abilities with computer games at primary school level. *Computers & Education, 49*(4), 1272-1286. doi:10.1016/j.compedu.2006.02.003

Chen, Y. (2008). A mixed-method study of EFL teachers' Internet use in language instruction. *Teaching and Teacher Education: An International Journal of Research and Studies, 2*4(4), 1015-1028. doi:10.1016/j.tate.2007.07.002

Ching, C. C., & Kafai, Y. B. (2008). Peer pedagogy: Student collaboration and reflection in a learning-through-design project. *Teachers College Record, 11*0(12), 2601-2632. Retrieved from http://www.tcrecord.org/Content.asp?ContentId=15198

Chittaro, L., & Ranon, R. (2007). Web3D technologies in learning, education and training: Motivations, issues, opportunities. *Computers & Education, 4*9(1), 3-18. doi:10.1016/j.compedu.2005.06.002

Cilesiz, S. (2009). Educational computer use in leisure contexts: A phenomenological study of adolescents' experiences at Internet cafes. *American Educational Research Journal, 4*6(1), 232-274. doi:10.3102/0002831208323938

Clarke, L. (2009). The POD model: Using communities of practice theory to conceptualize student teachers' professional learning online. *Computers & Education, 5*2(3), 521-529. doi:10.1016/j.compedu.2008.10.006

Colomar, M. P. A., & Guzmán, E. G. (2009). ICT-SUSTOUR and MARKETOUR: Two second language acquisition projects through a virtual learning environment. *Computers & Education, 5*2(3), 581-587. doi:10.1016/j.compedu.2008.11.008

Conole, G., de Laat, M., Dillon, T., & Darby, J. (2008). 'Disruptive technologies', 'pedagogical innovation': What's new: Findings from an in-depth study of students' use and perception of technology? *Computers & Education, 5*0(2), 511-524. doi:10.1016/j.compedu.2007.09.009

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge, MA: Harvard University Press.

Dangwal, R., & Kapur, P. (2008). Children's learning processes using unsupervised "hole in the wall" computers in shared public spaces. *Australasian Journal of Educational Technology, 2*4(3), 339-354.  Retrieved from http://www.ascilite.org.au/ajet/ajet24/dangwal.pdf

Demiraslan, Y., & Usluel, Y. K. (2008). ICT integration processes in Turkish schools: Using activity theory to study issues and contradictions. *Australasian Journal of Educational Technology, 2*4(4), 458-474.  Retrieved from http://www.ascilite.org.au/ajet/ajet24/demiraslan.pdf

Donnison, S., & Haynes, B. (2007). Digital generation pre-service teachers as change agents: A paradox. *Australian Journal of Teacher Education, 3*2(4), Retrieved from http://ajte.education.ecu.edu.au/issues/PDF/324/Donnison.pdf

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively*? Computers & Education, 5*1(1), 187-199. doi:10.1016/j.compedu.2007.05.001

Edmunds, J. A. (2008). Using alternative lenses to examine effective teachers' use of technology with low-performing students. *Teachers College Record, 11*0(1), 195-217.  Retrieved from http://www.tcrecord.org/Content.asp?ContentId=14568

Elstad, E. (2006). Understanding the nature of accountability failure in a technology-filled, laissez-faire classroom: Disaffected students and teachers who give in. *Journal of Curriculum Studies, 3*8(4), 459-481.  doi:10.1080/00220270500508901

Eteokleous, N. (2008). Evaluating computer technology integration in a centralized school system. *Computers & Education, 5*1(2), 669-686. doi:10.1016/j.compedu.2007.07.004

Gülbahar, Y. (2007). Technology planning: A roadmap to successful technology integration in schools. *Computers & Education, 4*9(4), 943-956. doi:10.1016/j.compedu.2005.12.002

Gulsecen, S., & Kubat, A. (2006). Teaching ICT to teacher candidates using PBL: A qualitative and quantitative evaluation. *Educational Technology & Society,* 9(2), 96-106.  Retrieved from http://www.ifets.info/journals/9_2/8.pdf

Hadjithoma, C., & Karagiorgi, Y. (2009). The use of ICT in primary schools within emerging communities of implementation. *Computers & Education, 52*(1), 83-91. doi:10.1016/j.compedu.2008.06.010

Hassett, D. D. (2006). Technological difficulties: A theoretical frame for understanding the non-relativistic permanence of traditional print literacy in elementary education. *Journal of Curriculum Studies, 3*8(2), 135-159. doi:10.1080/00220270500363703

Hedberg, J. G. (2008). Beyond technology: Children's learning in the age of digital culture – by Buckingham, David. *British Journal of Educational Technology, 3*9(4), 751-752. doi:10.1111/j.1467-8535.2008.00870_4.x

Hennessy, S., Wishart, J., Whitelock, D., Deaney, R., Brawn, R., Velle, L. l., McFarlane, A., Ruthven, K., & Winterbottom, M. (2007). Pedagogical approaches for technology-integrated science teaching. *Computers & Education, 4*8(1), 137-152. doi:10.1016/j.compedu.2006.02.004

Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers & Education, 5*1(4), 1499-1509. doi:10.1016/j.compedu.2008.02.001

Huang, Y., Kuo, Y., Lin, Y., & Cheng, S. (2008). Toward interactive mobile synchronous learning environment with context-awareness service. *Computers & Education, 5*1(3), 1205-1226. doi:10.1016/j.compedu.2007.11.009

ICT strategies for schools – by Laxman Mohanty & Vohra Neharika.(2008). *British Journal of Educational Technology, 3*9(3), 574-574. doi:10.1111/j.1467-8535.2008.00855_20.x

Jules, D. (2008). Rethinking education for the Caribbean: A radical approach. *Comparative Education, 4*4(2), 203-214. doi:10.1080/03050060802041142

Kuiper, E., Volman, M., & Terwel, J. (2009). Developing web literacy in collaborative inquiry activities. *Computers & Education, 5*2(3), 668-680. doi:10.1016/j.compedu.2008.11.010

Leach, J. (2008). Do new information and communications technologies have a role to play in the achievement of education for all? *British Educational Research Journal, 3*4(6), 783-805. doi:10.1080/01411920802041392

Lim, C. (2007). Effective integration of ICT in Singapore schools: Pedagogical and policy implications. *Educational Technology Research & Development, 5*5(1), 83-116. doi:10.1007/s11423-006-9025-2

Lim, W., Lee, Y., & Hung, D. (2008). "A prophet never accepted by their own town": A teacher's learning trajectory when using technology. *Asia-Pacific Journal of Teacher Education, 3*6(3), 215-227. doi:10.1080/13598660802232605

Lin, J. M. (2008). ICT education: To integrate or not to integrate*? British Journal of Educational Technology, 3*9(6), 1121-1123. doi:10.1111/j.1467-8535.2008.00825.x

Lin, Y., & Zini, E. (2008). Free/libre open source software implementation in schools: Evidence from the field and implications for the future. *Computers & Education, 5*0(3), 1092-1102. doi:10.1016/j.compedu.2006.11.001

Marsh, J. (2007). New literacies and old pedagogies: Recontextualizing rules and practices. *International Journal of Inclusive Education, 1*1(3), 267-281. doi:10.1080/13603110701237522

Martínez Arbelaiz, A., & Correa Gorospe, J. M. (2009). Can the grammar of schooling be changed*? Computers & Education, 5*3(1), 51-56. doi:10.1016/j.compedu.2008.12.016

McGrail, E. (2006). "It's a double-edged sword, this technology business": Secondary English teachers' perspectives on a schoolwide laptop technology initiative. *Teachers College Record, 10*8(6), 1055-1079. doi:10.1111/j.1467-9620.2006.00685.x

Morgan, A. E., & Kennewell, S. E. (2006). Initial teacher education students' views on play as a medium for learning--A divergence of personal philosophy and practice. *Technology, Pedagogy and Education, 1*5(3), 307-320. doi:10.1080/14759390600923691

O'Hara, M. (2008). Young children, learning and ICT: A case study in the UK maintained sector. *Technology, Pedagogy and Education, 1*7(1), 29-40. doi:10.1080/14759390701847443

Owston, R. D., Sinclair, M., & Wideman, H. (2008). Blended learning for professional development: An evaluation of a program for middle school mathematics and science teachers. *Teachers College Record, 11*0(5), 1033-1064. Retrieved from http://www.tcrecord.org/Content.asp?ContentId=14668

Probert, E. (2009). Information literacy skills: Teacher understandings and practice. *Computers & Education, 5*3(1), 24-33. doi:10.1016/j.compedu.2008.12.018

Rappa, N. A., Yip, D. K. H., & Baey, S. C. (2009). The role of teacher, student and ICT in enhancing student engagement in multiuser virtual environments. *British Journal of Educational Technology, 40*(1), 61-69. doi:10.1111/j.1467-8535.2007.00798.x

Richards, C. (2006). Towards an integrated framework for designing effective ICT-supported learning environments: The challenge to better link technology and pedagogy. *Technology, Pedagogy and Education, 15*(2), 239-255. doi:10.1080/14759390600769771

Ryymin, E., Palonen, T., & Hakkarainen, K. (2008). Networking relations of using ICT within a teacher community. *Computers & Education, 51*(3), 1264-1282. doi:10.1016/j.compedu.2007.12.001

Simovska, V., & Jensen, B. B. (2008). On-line learning environments and participatory health education: Teachers' reflections. *Journal of Curriculum Studies, 40*(5), 651-669. doi:10.1080/00220270701648092

Sloan, K. (2008). The expanding educational services sector: Neoliberalism and the corporatization of curriculum at the local level in the US. *Journal of Curriculum Studies, 40*(5), 555-578. doi:10.1080/00220270701784673

Teo, T. (2008). Pre-service teachers' attitudes towards computer use: A Singapore survey. *Australasian Journal of Educational Technology, 24*(4), 413-424. Retrieved from http://www.ascilite.org.au/ajet/ajet24/teo.pdf

Teo, T., Chai, C. S., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia-Pacific Journal of Teacher Education, 36*(2), 163-174. doi:10.1080/13598660801971641

Tüzün, H., Yılmaz-Soylu, M., Karakuş, T., İnal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education, 52*(1), 68-77. doi:10.1016/j.compedu.2008.06.008

Vavoula, G., Sharples, M., Rudman, P., Meek, J., & Lonsdale, P. (2009). Myartspace: Design and evaluation of support for learning with multimedia phones between classrooms and museums. *Computers & Education, 53*(2), 286-299. doi:10.1016/j.compedu.2009.02.007

Warschauer, M. (2007). Information literacy in the laptop classroom. *Teachers College Record, 109*(11), 2511-2540. Retrieved from http://www.tcrecord.org/Content.asp?ContentId=14534

Watson, T., & Hempenstall, K. (2008). Effects of a computer based beginning reading program on young children. *Australasian Journal of Educational Technology, 24*(3), 258-274. Retrieved from http://www.ascilite.org.au/ajet/ajet24/watson.pdf

Wong, E., & Li, S. (2008). Framing ICT implementation in a context of educational change: A multilevel analysis. *School Effectiveness and School Improvement, 19*(1), 99-120. doi:10.1080/09243450801896809

Wong, E. , Li, S., Choi, T., & Lee, T. (2008). Insights into innovative classroom practices with ICT: Identifying the impetus for change. *Educational Technology & Society, 1*1(1), 248-265.  Available from http://www.ifets.info/

Yelland, N., Cope, B., & Kalantzis, M. (2008). Learning by design: Creating pedagogical frameworks for knowledge building in the twenty-first century. *Asia-Pacific Journal of Teacher Education, 3*6(3), 197-213. doi:10.1080/13598660802232597

Young, P. A. (2008). Integrating culture in the design of ICTs. *British Journal of Educational Technology, 3*9(1), 6-17. doi:10.1111/j.1467-8535.2007.00699.x

Yuen, A. H. K., & Ma, W. W. K. (2008). Exploring teacher acceptance of E-learning technology. *Asia-Pacific Journal of Teacher Education, 3*6(3), 229-243. doi:10.1080/13598660802232779

**Equity of Access to ICT Resources**

**What are the major research trends?**

***Equity related to gender, race, ethnicity and nationality.***

The question of equity may be viewed from a variety of perspectives. We examine this question from the perspectives of personal identity (e.g., gender, ethnicity, national origin, disability/special need and socioeconomic status (SES). Although we make no particular effort to identify equity issues pertaining specifically to developing countries, research dealing with this challenge will be evident from the following discussion.

Teo (2008) points out that gender disparity related to ICT is trending downward from the differences observed in the late 1990s and early 2000s. Tondeur, Valcke, and van Braak (2008) report mild gender differences between male and female teachers in Belgium, with males more prone to using ICT as an information tool in primary schools. Similarly, Kuhlemeier and Hemker (2007) uncovered minor gender differences at various levels of Dutch education. Singh, Allen, Scheckler, and Darlington (2007) report to the American Educational Research Association (AERA) that relative US female participation in computer-related higher education programs has been declining over the past decade. From a British context, Kennewell and Morgan (2006) report little difference between genders in curricular ICT use but stress the importance of play to promote effective learning for boys and girls across a wide variety of age levels.

A recent empirical study from Greece (Barkatsas, Kasimatis, & Gialamas, 2009) raises troubling gender questions at the high school level. In this quantitative study, boys were found to possess significantly higher levels of confidence and affinity with computer-based technology than girls. Particularly troubling is the background relationship between positive attitudes and scholarly achievement. This research points out a pervasive performance gap between boys and girls in secondary mathematics, urging new research-backed policy and practice to improve the ICT attitudes and engagement of girls.

Vekiri and Chronaki (2008) surveyed more than 300 elementary school boys and girls, revealing that technological conditions in their homes influence their attitudes about ICT in school. They found that Greek boys use computers more frequently and with greater parental support than do girls, and that such support is related differentially to their respective perceptions of self-efficacy. In a different Greek study, on the other hand, high school girls and boys were found to benefit equally and to be similarly motivated by curricular gaming methods aimed at teaching concepts of computer memory, suggesting that strategies are available to help break down gender disparities (Papastergiou, 2009).

In a comprehensive quantitative/qualitative study comparing test results in level-10 science learning in Australia, differences were found among sub-groups undergoing traditional classroom teaching versus a blended classroom/e-learning setting (Chandra & Lloyd, 2008). Subject cohorts were divided between boys and girls and then further broken down into performance quartiles. Boys in the lowest quartile appeared to benefit the most from the blended setting; performance of the girls in the top quartile actually fell. The attitudes toward e-learning revealed in the qualitative facet of this study were positive

across the full range of subjects.  In survey research on secondary Australian schoolgirls pursuing subject matter via ICT, researchers found low rates of participation and dubious attitudes toward computers (Anderson, Lankshear, Timms, & Courtney, 2008). According to a study of cyber-bullying in Canadian and Chinese junior high schools, Li  (2007) reports that boys are more likely than girls to engage as bullies, but the girls are more likely to be victimized. This appears to be consistent with experience in other countries.

Teo (2008) uncovered no gender distinction in teacher perceptions of school ICT integration in Singapore but found significant distinctions based on length-of-teaching service and the quality teacher training experience. He points out the importance of teachers as change agents in schools because they are powerful role models for the kinds of attitudes and behaviors that students will exhibit during and after their formal studies. On the question of leadership, Gokce (2009) urges improved administrative preparation and a more equitable distribution of school leadership jobs for female educators in Turkey.

In a report on Tanzanian conditions, Stambach and Malekela (2006) opine that ICT development for schooling relies excessively on traditional practice and fails to capitalize on the systemic transformation needed to produce satisfactory results. They question, for example, the local deployment of equipment and material without sufficient investment in human resource development and infrastructure. These researchers ask whether the apparent isolation of lesser developed countries (LDCs) in adjusting to the knowledge-based society is not more attributable to the on-going prejudices of the developed world as it is to LDC shortcomings. ICT development may indeed be held hostage to the past; the question is, whose past is doing the holding?

### Equity related to special learner need and SES.

Digital divide concerns have been repeatedly described for schools within the United States. In an analysis of statewide data in Florida, researchers describe an improving situation in the equitable distribution of technological resources for schools, but they claim that continuing inequities persist between high and low SES districts in access to software, technological support, and teacher use – the  infrastructural foundation for systemic ICT integration (Hohlfeld, Ritzhaupt, Barron, & Kemker, 2008). In Chile, a summative account of the nationwide ICT infrastructure initiative, labeled "Enlaces," offered mixed results. Despite acknowledged gains in information access and the equitable distribution of resources nation-wide, there is no hard evidence of improved student learning (Sánchez & Salinas, 2008).

From a large survey study (1024 subjects), Iske, Klein, Kutscher, and Otto (2008) report significant inequalities in digital access and use-strategies among German youth aged 14 to 23. These researchers urge educational policymakers to implement strategies explicitly dedicated to reducing these inequities. According to Stevenson (2008), however, relative affluence in the UK does not necessarily translate into superior learning. Based on a qualitative case study of eight relatively affluent families, she found barriers to effective educational use of ICT. Schools, she suggests, will need to adopt improved policies and practices to address the needs of children in this seldom discussed facet of the digital divide.

A study from the Netherlands (Peltenburg, van den Heuvel-Panchuizen, & Doig, 2009) discusses the efficacy of ICT-based assessment devices for improving mathematics learning outcomes of 8-12-year-old children from two special-needs schools. Pupils were placed in experimental and control assessment groups. Members of the experimental group were given ICT-based assessment tools along with on-screen manipulatives to assist with problem-solving. Control group children were assessed traditionally. ICT-based assessment was found to be particularly useful to teachers for diagnosing individual problems and planning appropriate instructional remedies. Tan and Cheung (2008) conducted an in-depth study of a 7-year-old attention deficit hyperactive disorder (ADHD) school boy in a mainstream classroom setting and found that computer-enabled collaborative work resulted in increased peer acceptance. The setting for this study was unique, but it may provide a useful model for student collaboration and coaching elsewhere.

While much of the literature on technology and special needs promotes ICT integration with mildly or severely disabled children, Woodfine, Nunes, and Wright (2008) raise a serious question about the efficacy of text-based synchronous ICT tools. Their paper suggests that cognitively-impaired schoolchildren, particularly those with dyslexia, tend to be further marginalized, de-motivated, and disappointed by the integration of these tools into their classrooms. Rather than bridging distances, as claimed by advocates, e-learning appears to erect obstacles that impede learning progress. Technology product developers and educational policymakers need to take these dangers into account when building curriculum for this population of students. Young (2008) suggests that ICT designers, nationally and internationally, have a long way to go in order to achieve effectiveness in producing appropriate material for diverse cultures.

Wittwer and Senkbeil (2008) studied nearly 1500 mid-teen German school children in more than 200 schools, associating their math performance with their home computer use. Nearly all of the students enjoy access to computers at home and use a computer almost every day. The researchers found that levels of home computer use had no substantial influence on academic achievement. Of particular interest is the finding that leisure activities such as watching televised action, horror, or pornographic material was negatively associated with mathematics performance.

Dwyer (2007) describes a different kind of inequity in Australia. She reports that in New South Wales, the early primary school grades are shortchanged in ICT resources distributed across the grade levels. Among other things, she attributes this to uninformed, entrenched attitudes about curricular needs in the early grades, and she makes a variety of policy recommendations to remedy this inequity. In their book, *ICT in the Early Years*, Hayes and Whitebread (2007) make a persuasive case for efficacious ICT integration in the curricula of early years schooling.

### What works; what does not?

A study on Australian secondary school girls suggests that negative attitudes toward technology stem partly from the cultural perception that ICT activity is inherently "male-gendered" and that it reflects aspects of masculine culture sometimes deemed negative by

girls (Anderson et al., 2008). This would seem to call for deliberate attempts to stress female career visibility in ICT policy, commerce, and public service.

Aderinoye (2008) addresses the issue of equity in developing countries by advocating the use of more traditional technological tools such as radio and television to support literacy education. Similarly, from outside the educational technology research base, Atchoarena, Da Grace, and Marquez (2008) opine that ICT investment and distance learning are essential to the developmental sustainability of lesser-developed and middle-income countries, in this case, Cape Verde.

As reported in the Hohfeld et al. (2008) study from Florida, SES-based equity issues stem not so much from a disparity in the resources owned by poor versus affluent schools as much as from the infrastructural policy support behind hard, material investments. Over the years this has been a recurring theme in ICT literature. The theme speaks to the need for enforceable centralized standards and support at national or regional jurisdictions to reinforce the practical initiative that depends so much on local creativity. This observation comports with Dwyer's (2007) observation that the effective integration of ICT, especially in Australian primary schools, depends upon the environmental conditions that effective leadership alone can provide (e.g., excellent teacher support, superior software resources, thoughtfully-designed technology facilities, and participatory decision-making).

Barbour and Reeves (2009) present an international (predominantly Canadian and American) literature review on the efficacy of accredited virtual schooling. They posit that virtual schooling is typically provided primarily in an asynchronous mode via computer networks. Their analysis reflects the concern that virtual school programs have been designed according to assumptions about adult rather than younger learners. They suggest that such schooling is typically targeted at literate students performing at relatively high levels with strong intrinsic motivation and the ability to work independently. Students with steeper academic needs are less appropriately served.

McKenney and Voogt (2009) examine literacy learning in early-grade Dutch schools through an analysis of a computer-based tool called *PictoPal*. Software of this nature appears associated with improved learning outcomes pupils with special-needs but only when integrated with effective non-computer strategies. They also report that children are able to work independently and effectively with *PictoPal*.

### How should these resources be organized and deployed*?*

Mukama and Andersson (2008) suggest that properly-coordinated nationwide ICT deployment can be a force for generating gender inequity in developing countries, in this case Rwanda. Forlin and Lock (2006) propose investment in ICT as an effective means to serve the inclusion requirements of special needs students in remote areas of rural Western Australia.

Calculator (2009) argues for the systemic integration of augmentative and alternative communication (AAC) strategies and devices to support effective literacy education and successful inclusion of severely-disabled students throughout the school curriculum.  AACs, of course, may or may not be technologically intensive, but an increasing array of

technologically-driven devices is being tested and marketed. Further supporting inclusion, Causton-Theoharis, Theoharis, and Trezek (2008) stressed the importance of effective teacher preparation to meet the diverse needs of all students.

Writing from the field of curriculum studies, DeGennaro (2008) describes the beneficial effect of high school peer coaching, where suburban high school boys teach their less affluent African-American middle-school counterparts in after-school programs to promote Web page development. Using ICT, such a model might be scaled up to support such technology-intensive coaching from students in developed countries to their developing-world peers.

### What further research is needed to advance "best practice?"

Although their research reveals gender distinctions in the benefit that technology brings to learning, Chandra and Lloyd (2008) suggest that several imponderable variables remain that could influence future trends. As the authors declare, "There is not, and possibly will not ever be, a single unified metanarrative on the benefits of ICT in education" (p. 1098). Barbour and Reeves (2009) urge new research on the learning needs of all elementary and secondary students related to virtual schooling, not just the academically-talented. More comprehensive design research for all populations is also needed as distance education programs are developed. Edmunds (2008) believes that research on teacher practice with low performing students needs to begin from a perspective of teacher attributes and practice rather than from the viewpoint of technology.

Gaming techniques (Papastergiou, 2009; Tüzün, Yılmaz-Soylu, Karakuş, İnal, & Kızılkaya, 2009) show efficacy in Greek high schools and Turkish primary schools under certain environmental conditions. Practical studies of this nature need to be replicated under different conditions and in diverse cultures. As we consider questions of gender ICT equity in schools, Waite, Wheeler, and Bromfield, ( 2007) urge educators not to forget factors focused on individual learning attributes among children. This sentiment would comport with educational research outside the ICT field, notably Howard Gardner's writing about multiple intelligences.

Studies on the various aspects of ICT and gender equity tend to focus on particular geographies and cultures. A more robust meta-analysis is needed to compare and contrast phenomena cross-culturally. For example, gender equity may be deemed irrelevant or undesirable in some cultures whereas others would prize it as a normal and noble educational aim. Regarding the relationship between home computer use and scholarly achievement, Wittwer and Senkbeil (2008) suggest a refocus of research on the quality of home computer use rather than the degree.

### References

Aderinoye, R. (2008). Literacy and communication technologies: Distance education strategies for literacy delivery. *International Review of Education*, *54*, 605-626. doi:10.1007/s11159-008-9100-5

Anderson, N., Lankshear, C., Timms, C., & Courtney, L. (2008). "Because it's boring, irrelevant and I don't like computers": Why high school girls avoid professionally-oriented ICT subjects. *Computers & Education*, *50*(4), 1304-1318. doi:10.1016/j.compedu.2006.12.003

Atchoarena, D., Da Graca, P. D., & Marquez, J. M. (2008). Strategies for post-primary education in small island developing states (SIDS): Lessons from Cape Verde. *Comparative Education*, *44*(2), 167-185. doi:10.1080/0305006080204107

Barbour, M. K., & Reeves, T. C. (2009). The reality of virtual schools: A review of the literature. *Computers & Education*, *52*(2), 402-416. doi:10.1016/j.compedu.2008.09.009

Barkatsas, A., Kasimatis, K., & Gialamas, V. (2009). Learning secondary mathematics with technology: Exploring the complex interrelationship between students' attitudes, engagement, gender and achievement. *Computers & Education*, *52*(3), 562-570. doi:10.1016/j.compedu.2008.11.001

Calculator, S. N. (2009). Augmentative and alternative communication (AAC) and inclusive education for students with the most severe disabilities. *International Journal of Inclusive Education*, *13*(1), 93-113. doi:10.1080/13603110701284656

Causton-Theoharis, J., Theoharis, G. T., & Trezek, B. J. (2008). Teaching pre-service teachers to design inclusive instruction: A lesson planning template. *International Journal of Inclusive Education*, *12*(4), 381-399. doi:10.1080/13603110601156509

Chandra, V., & Lloyd, M. (2008). The methodological nettle: ICT and student achievement. *British Journal of Educational Technology*, *39*(6), 1087-1098. doi:10.1111/j.1467-8535.2007.00790.x

Degennaro, D. (2008). Sociotechnical cultural activity: Expanding an understanding of emergent technology practices. *Journal of Curriculum Studies*, *40*(3), 329-351. doi:10.1080/00220270801930655

Dwyer, J. (2007). Computer-based learning in a primary school: Differences between the early and later years of primary schooling. Asia-Pacific Journal of Teacher Education, *35*(1), 89-103. doi:10.1080/13598660601111307

Edmunds, J. A. (2008). Using alternative lenses to examine effective teachers' use of technology with low-performing students. *Teachers College Record*, *110*(1), 195-217. Retrieved from http://www.tcrecord.org/Content.asp?ContentId=14568.

Forlin, C., & Lock, G. (2006). Employing technologies to engage students with diverse needs in rural school communities. *Australian Journal of Teacher Education, 31*(1). Retrieved from http://ajte.education.ecu.edu.au/issues/PDF/311/Forlin.pdf.

Gokce, F. (2009). Behaviour of Turkish elementary school principals in the change process: An analysis of the perceptions of both teachers and school principals. *Educational Management Administration & Leadership*, *37*(2), 198-215. doi:10.1177/1741143208100298

Hohlfeld, T. N., Ritzhaupt, A. D., Barron, A. E., & Kemker, K. (2008). Examining the digital divide in K-12 public schools: Four-year trends for supporting ICT literacy in Florida. *Computers & Education*, *51*(4), 1648-1663. doi:10.1016/j.compedu.2008.04.002

ICT in the early years – edited by Mary Hayes & David Whitebread.(2007). *British Journal of Educational Technology*, *38*(6), 1146-1147. doi:10.1111/j.1467-8535.2007.00772_16.x

Iske, S., Klein, A., Kutscher, N., & Otto, H. (2008). Young people's internet use and its significance for informal education and social participation. *Technology, Pedagogy and Education*, *17*(2), 131-141. doi:10.1080/14759390802116672

Kennewell, S., & Morgan, A. (2006). Factors influencing learning through play in ICT settings. *Computers & Education, 46*(3), 265-279. doi:10.1016/j.compedu.2005.11.001

Kuhlemeier, H., & Hemker, B. (2007). The impact of computer use at home on students' internet skills. *Computers & Education*, *49*(2), 460-480. doi:10.1016/j.compedu.2005.10.004

Li, Q. (2007). Bullying in the new playground: Research into cyberbullying and cyber victimisation. *Australasian Journal of Educational Technology*, *23*(4), 435-454. Retrieved from http://www.ascilite.org.au/ajet/ajet23/li.html.

McKenney, S., & Voogt, J. (2009). Designing technology for emergent literacy: The PictoPal initiative. *Computers & Education*, *52*(4), 719-729. doi:10.1016/j.compedu.2008.11.013

Mukama, E., & Andersson, S. B. (2008). Coping with change in ICT-based learning environments: Newly qualified Rwandan teachers' reflections. Journal of *Computer Assisted Learning*, *24*(2), 156-166. doi:10.1111/j.1365-2729.2007.00249.x

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers & Education*, *52*(1), 1-12. doi:10.1016/j.compedu.2008.06.004

Peltenburg, M., van, d. H., & Doig, B. (2009). Mathematical power of special-needs pupils: An ICT-based dynamic assessment format to reveal weak pupils' learning potential. *British Journal of Educational Technology*, *40*(2), 273-284. doi:10.1111/j.1467-8535.2008.00917.x

Sánchez, J., & Salinas, A. (2008). ICT & learning in chilean schools: Lessons learned. *Computers & Education*, *51*(4), 1621-1633. doi:10.1016/j.compedu.2008.04.001

Singh, K., Allen, K. R., Scheckler, R., & Darlington, L. (2007). Women in computer-related majors: A critical synthesis of research and theory from 1994 to 2005. *Review of Educational Research*, *77*(4), 500-533. doi:10.3102/0034654307309919

Stambach, A., & Malekela, G. A. (2006). Education, technology, and the "new" knowledge economy: Views from Bongoland. *Globalisation, Societies and Education*, *4*(3), 321-336. doi:10.1080/14767720600955329

Stevenson, O. (2008). Ubiquitous presence, partial use: The everyday interaction of children and their families with ICT. *Technology, Pedagogy and Education*, *17*(2), 115-130. doi:10.1080/14759390802098615

Tan, T. S., & Cheung, W. S. (2008). Effects of computer collaborative group work on peer acceptance of a junior pupil with attention deficit hyperactivity disorder (ADHD). *Computers & Education*, *50*(3), 725-741. doi:10.1016/j.compedu.2006.08.005

Teo, T. (2008). Pre-service teachers' attitudes towards computer use: A Singapore survey. *Australasian Journal of Educational Technology*, *24*(4), 413-424. Retrieved from http://www.ascilite.org.au/ajet/ajet24/teo.pdf

Teo, T., Chai, C. S., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia-Pacific Journal of Teacher Education*, *36*(2), 163-174.  doi:10.1080/13598660801971641

Tondeur, J., Valcke, M., & van Braak, J. (2008). A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of Computer Assisted Learning*, *24*(6), 494-506. doi:10.1111/j.1365-2729.2008.00285.x

Tüzün, H., Yılmaz-Soylu, M., Karakuş, T., İnal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education*, *52*(1), 68-77. doi:10.1016/j.compedu.2008.06.008

Vekiri, I., & Chronaki, A. (2008). Gender issues in technology use: Perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. *Computers & Education*, *51*(3), 1392-1404. doi:10.1016/j.compedu.2008.01.003

Waite, S. J., Wheeler, S., & Bromfield, C. (2007). Our flexible friend: The implications of individual differences for information technology teaching. *Computers & Education*, *48*(1), 80-99. doi:10.1016/j.compedu.2005.01.001

Wittwer, J., & Senkbeil, M. (2008). Is students' computer use at home related to their mathematical performance at school? *Computers & Education*, *50*(4), 1558-1571. doi:10.1016/j.compedu.2007.03.001

Woodfine, B. P., Nunes, M. B., & Wright, D. J. (2008). Text-based synchronous e-learning and dyslexia: Not necessarily the perfect match! *Computers & Education*, *50*(3), 703-717. doi:10.1016/j.compedu.2006.08.010

Young, P. A. (2008). Integrating culture in the design of ICTs. *British Journal of Educational Technology*, *39*(1), 6-17. doi:10.1111/j.1467-8535.2007.00699.x

# Concluding Discussion

## Leadership

This literature review has revealed a variety of broad themes. In the section discussing leadership and management, several studies address the unrealized transformational promise of ICT for change and the fundamental nature of schooling. Many contemporary schools throughout the world continue to be structured on a hierarchical industrial model. When technology is simply layered onto a traditional framework, its potential is severely constrained. Educational leaders are therefore challenged to examine the larger educational structure before considering the particulars of improvement through technology. Technology has been described as "disruptive." In this sense, disruption is positive and necessary. If curriculum is not disrupted, then technology will offer nothing more than superficial window dressing masquerading as innovation. Disruption is uncomfortable. Effective leadership accepts such discomfort and pushes beyond it in order to yield authentically beneficial change.

Since schools perform the double duty of curriculum and social supervision, the critical role of the local principal has been repeatedly stressed in the research, as has the necessity of deep, continuing communication among all levels of policy jurisdiction. Educational leadership is also urged to assure the provision of resources so that educators may pursue innovation in sensible and safe settings. This means that vision-driven professional development, persistent communication, material resources, and ongoing research are critical to the success of ICT-rich transformation.

Several studies stress the importance of initial teacher education, not only equipping prospective teachers with technological skills but also instilling confidence and habits that they will transport into their new professions. The research offers a broad variety of innovative techniques to improve teacher education and to make it relevant to a technologically networked world. As for the efficacy of ubiquitous computing, otherwise known as one-to-one laptop distribution, research stresses the importance of sound educational planning to realize the benefits of massive laptop infusion. Absent such planning, the computers might just as well remain on the vendors' shelves.

## Transformation

In the discussion of educational transformation and ICT, interesting metaphors appear. The "grammar of schooling" and "landscape of education" are terms that describe entrenched practice. Thus, it becomes incumbent upon educational leadership to create "disruption" in order to change the grammatical rules and to rearrange the landscape. In doing so, however, cross-border differences and regional cultures need to be understood and respected. Received truth in the West might be regarded as heresy in other parts of the world; priorities for resource distribution in rich countries could seem insane in regions where basic sustenance for survival is brutally scarce. The ubiquitous distribution of $200 laptops, for example, might make little sense where such a sum represents an average citizen's monthly -- or even annual -- income. This does not imply, however, that children in those countries should be denied access to the benefits of ICT and up-to-date

research on efficacious educational practice. It means that resources for accessibility and application are deployed in diverse ways.

The importance of research on how young people learn is stressed in the literature on transformation. The well-worn factory model of schooling lends itself to the tradition of instruction "delivered" to learners. Contemporary research, however, shows that lasting knowledge is "constructed" by learners based on their interactions with appropriate tools and materials and with other human beings. Although knowledge is constructed internally, it may or may not be reflected in externally observed behavior. Temporal exhibitions of behavior do not necessarily signify deep learning. ICT offers many affordances for the effective creation of constructivist learning environments. The research reported in the main body of this report points to specific strategies for doing so.

New technologies are transforming the way human beings fundamentally interact. Throughout the world, perpetual mobile connectivity is becoming commonplace. With 3-G telephony, young people are linked to a kaleidoscopic global universe everywhere and all the time. Already, their mobile gateway to the Internet is perceived quite differently than that of their elders, who were introduced to networked computing on fixed-location machines anchored to desks and connected only at predetermined times. New Web-based applications such as virtual cohabitation on mediated "campuses" (e.g., *Second Life*), shared workspaces, social networks, and round-the-clock bursts of public chatter constitute standard social practice for today's youth. Students are living parts of their lives virtually and are quite literally all a-twitter. If schooling fails to respond by taking its own transformational initiative, then the technological revolution occurring under our noses will continue altering the fundamental shape of education: inevitably, aimlessly, and negatively.

**Equity**

The question of equity in the distribution of ICT resources is complex. This question may be approached in countless ways. We have chosen to create two categories: equity related to gender, race, ethnicity and nationality; and equity related to special learner need and socioeconomic status (SES). In western European countries and North America, ICT resource disparities between the genders seem superficially to be in decline. Nevertheless, enabled by computer networks, cyber-bullying among schoolchildren seems to be spiraling out of control. Wherever cyber-bullying occurs, boys tend to be the perpetrators and girls, the victims.

In some cultures, gender disparities appear to be even starker. In Greece, for example, high school boys were found to be more facile with computers than their female peers. These disparate levels of technological confidence seemed to be associated with scholarly achievement. Some researchers found that inequities can be reduced through the application of creative ICT-embedded teaching strategies such as gaming, role-playing, peer coaching or adult mentoring. In some cases, strategies varied in their relative effectiveness for boys versus girls. Inequities across and within national boundaries are revealed on the basis of relative affluence and SES. Leadership for educational transformation is lacking.

Discussion about the equitable distribution of ICT resources has historically emphasized comparative machine counts. This, of course, fails to tell a more meaningful story. Rather than analyzing computer-to-student ratios, we ought to be looking at what actually happens in classrooms. The more important questions have to do with curriculum design and school structure. In the context of transformational vision for curriculum, we need to examine what is being accomplished with the machines we count; their condition, their software support, and professional development for teachers who are expected to implement ICT-based methods effectively. The massive infusion of computers in schools is of little use if they are not being used to their best possible advantage.

**A final word**

As negotiated with GeSci, this report offers an in-depth review of targeted literature on ICT and education. Valuable ancillary information, however, may be gleaned from public reports on policy and global development. One such report is the *2009 Prosperity Index* from the Legatum Institute. This index compares the relative prosperity of 104 nations based on a variety of factors such as education and social capital. Underlying narrative supporting these comparisons is provided on a country-by-country basis. In these narratives, information about such things as gender equity, educational investment, human capital offer context for the findings indexed in this report. The *2009 Prosperity Index* may be found at http://www.prosperity.com/rankings.aspx.  This resource was brought to our attention by Dr. Seppo Tella, Professor of Foreign Language and First Vice Dean of Education at Finland's University of Helsinki.

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