EVOLVING LEARNING PARADIGMS
Re-setting the baselines and collection methods of ICT in education statistics post-2015

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1. Abstract

This paper proposes new indicators of *evolving learning paradigms* associated with the use of ICT in education. It focuses on what teachers and students are doing with ICT to teach and learn, which depends upon a level of ICT infrastructure, access to ICT and information within the curriculum, and teacher training and support for the implementation of ICT. In particular, the paper discusses the: i) evolving mission, methods and core principles of ICT in education; ii) nature of ICT in education in hastening the emergence of new learner-centred pedagogies; iii) types of learning activities and usage patterns associated with the use of ICT including those for leaders, teachers and students; and iv) deployment patterns. The paper also addresses the variety of teaching tasks and the frequency patterns of ICT usage in support of the evolving paradigms. School levels ranging from primary and secondary schools to higher education institutions are considered and included as part of a country or region's complete educational system. Indicators are included that are sex-disaggregated to facilitate tracking female access and participation.

2. The evolving mission and core principles of ICT in education

The potential to measure information and communication technology (ICT) in teaching and learning, both formally in an education system and informally outside the traditional institutions of education, is a challenge for any country. Two challenges arise in particular: the local relevance of the information and the focus of that information on improving the experience of teaching and learning with educational technology. For example, the problematic validity of data sources has been noted by a World Bank report from the Systems Approach for Better Education Results (Trucano, 2012), when a collection activity "comes from data sources outside of the education sector itself and does not appear to be gathered according to common methodologies and definitions." Large-scale efforts such as the International Computer Information Literacy Study or ICILS 2013 (Fraillon et. al., 2013) provide useful information for comparable systems views but often leave local educators without actionable information. The indicators recommended in this paper address these issues.

While information about the physical infrastructure available to educators has been more easily collected and accessible in extant surveys and research, understanding the impact of ICT on pedagogical processes and educational outcomes is paramount for the next stages of policy and implementation. Plomp and Akker noted as early as 1988 that hardly any research-based knowledge existed about the way, the frequency and intensity teachers are using computers and about changes in educational practice and in the school curricula as a consequence of the introduction of the new technology in education. Because these higher-level concerns of implementation depend on infrastructure, access, and teacher training, which are still lacking in many places, today there is still not much known about the implementation and impacts of ICT in education in many parts of the world. A 2011 report on policies and practices in Latin America and the Caribbean, for example, noted significant gaps and a clear lack of records concerning educational technology implementation (Hinostrosa and Labbe, 2011). Uma and Arulchelvan (2012) confirm that there is a dearth of information about student use of technologies; while students are using ICT extensively outside of school, they engage in limited usage for learning purposes and still rely primarily on classroom teaching and textbooks for academic progress. In Africa and the Middle East, Isaacs (2012) noted that for many years, the focus of investments was on making successive waves of new technologies work in resource-poor education environments – an emphasis that tended toward a techno-centric approach to ICT in education.

Addressing the gap in knowledge about the uses and impacts of ICT in education, the ICILS 2013 collected information from students, teachers, school technology coordinators and school principals. The study's constructs point to a shift away from collecting information about infrastructure and access toward the use of technology to achieve educational benefits, especially preparing students to participate fully in the digital age. Computer and information literacy in this context is defined as "an individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in society" (Fraillon, Schulz and Ainley, 2013, p.17).

New driving forces on the global stage are leading to the emergence of new learning paradigms since the fundamental unit of formal education, which is the interaction between the teacher and the learner, is being transformed and expanded by technology-enabled interactions and capabilities. The implications for teachers in terms of roles, pedagogy and approaches is well documented in the UNESCO ICT Competency Framework for Teachers (UNESCO, 2008). While many developed countries are grappling with advanced ICT and quickly emerging tools and practices such as open educational resources (OER), social networking and a flattened world of information and communication technologies, other countries are progressing more slowly due to a variety of financial and policy constraints.

The benefits of the transformation cannot be realised without all schools at all levels, including higher education, changing the way ICT is used to support educational outcomes, and until policymakers appropriately measure this complex interlinked system. As a recent Organization for Economic Co-operation and Development (OECD) analysis by the Centre for Educational Research and Innovation (CERI, 2008) notes…

> …it has long been apparent that much of the use of ICT in schools has been as an alternative way of doing the same thing as before rather than to do something different. If this is the case, for which aspects of learning does ICT permit things to be done which otherwise cannot be? What is its unique "value-added"?

To a large extent schools in some countries are still teaching a series of disconnected subjects using methods and structures that compromise motivation, engagement and deeper learning for superficial coverage of material expected on tests (Baker, 2007; Black, 2000; Koch and DeLuca, 2012). In contrast, the evolving paradigms of learning discussed in this paper, which have come from massive shifts caused by ICT practices in the global economy and culture, have already changed how people learn in informal and lifelong learning contexts, and are now emerging as best practices in formal educational systems. How quickly, how extensive and to what ends they are emerging depend on local education policy, funded commitments, access, schooling culture, the adoption of lessons from learning sciences and sufficient reflective experience in the integration of ICT in teaching and learning.

This paper aims to provide recommendations for new global indicators beyond basic infrastructure to focus on evolving learning paradigms for ICT in education. The primary focus is on what teachers and students are doing with ICT to enhance learning within a country, school-by-school, and classroom-by-classroom. The proposed dimensions for the indicators form a framework for baseline and annual progress monitoring using core ideas of what it means to be a successful global citizen with a high level of ICT literacy.

The foundation for this paper stems from a vision to build capacity in global youth to support the goals of a knowledge economy and increased levels of digital literacy in society.

> VISION: A student who graduates from secondary school ready for lifelong learning and using ICT for personal and professional productivity. Such a student is ready to use ICT to contribute to society, start a business, succeed in tertiary education, and work for a local or global company.

The paper will discuss the following: i) ICT in education and its evolving mission, methods and core principles; ii) evolving nature of ICT in education in supporting the emergence of new learner-centred pedagogies; iii) types of learning activities and usage patterns associated with the use of ICT; and iv) deployment patterns. Furthermore, in order to represent a holistic dataset of the education system globally, this paper highlights the growing need for inclusion of data at the post-secondary level, thereby including the higher (tertiary) education sector in all aspects of the new indicators, including the need for gender balance in providing access to ICT and educational opportunities in order to maximize all human potential.

3. Analysis of the current data collection instrument

Meta-analysis of the literature in the field of ICT in education was undertaken by organising and evaluating previously published research, theories, policies and practice from around the world. The approach included analysing the existing indicators alongside the literature review and providing recommendations for strengthening the data collection post 2015, in line with evolving learning paradigms. A panel of experts then provided extensive feedback, which was used to further shape the framework.

The recommendations in this paper have been organised in sequence with the current Questionnaire on Statistics of Information and Communication Technologies (ICT) in Education (UIS, 2014). The recommendations are organized according to general areas addressed by the survey. In each section, a research-based rationale is presented for the recommendations. While there is a continued need to collect survey data from the national ministerial level, the recommendations also include items that will be best asked of teachers at the classroom level (e.g. their reported use of ICT in teaching, their participation in professional learning) and items that will be best if asked of the school administrator (e.g. resources available and school approaches to training and incorporating ICT in teaching); the recommended respondent is noted at the beginning of each section.

4. General Information

It is recommended that the survey collect information on the total number of schools, by public and private sector, and compare the response rate in both categories in order to gauge the level of participation and to add validity to the results.

The field labelled ‘main data source’ is recommended to be moved onto the top of each section of the survey, so that each item can track its data source rather than assuming that one data source adheres to a complete page of data. Items with no need for a data source or which aggregate from other sources do not need the field.

5. Policy and curriculum

The current UIS survey has a section on policy and curriculum, with questions for Ministers. The section asks if there are laws or regulatory mechanisms to promote the use of ICT in education; if there are laws that address equity in favour of a number of disadvantaged groups, including females, minorities and rural peoples. The section also asks if there is a basic course on computer skills or computing, and which subjects (Mathematics, Natural Sciences, Social Sciences, etc.) have recommendations to use ICT to support teaching and learning. Finally the section asks about the intended instructional time in basic computer skills and using ICT across the curriculum, and if there are accredited teacher education programmes that include ICT-enabled distance education components.

The current survey has a lack of questions concerning the development of leadership in ICT and in a number of emerging themes of professional development beyond basic computing and using computers across the curriculum. Therefore new indicators in leadership and training themes are recommended.

5.1 Recommended policies for leadership and training themes

Several authors and international organizations have stressed the importance of access to computers, training for teachers, and basic conditions needed to maintain ICT in education; for example having an adequate infrastructure, technical support, and policies that encourage infrastructure usage by all students (International Society for Technology in Education, 2008; Kozma, 2003; Voogt and Knezek, 2011). In these basic dimensions, many countries need continued development. For example, in their study of policies in Latin America and the Caribbean Hinostrosa and Labbe (2011) note that relatively few countries incorporated systems for evaluating policy implementation, half of the countries did not include enhanced student learning in policy, and twenty percent had not yet incorporated basic ICT competency into their curricula.

Going beyond the basics of infrastructure, access and training, educational systems must also take account of the global drivers of change in ICT in education, including game changing knowledge, tools and practices of ICT that have impacted economics, science and culture across the world, thus demanding a change in the way ICT is used in education. The implications of the global drivers span from the science of learning, to the expectations of learners, to new horizons for curriculum and pedagogy (New Media Consortium, 2014). For example, the global shift toward the knowledge economy has created an acute need for *deeper learning* by larger and larger numbers of people, and so it is necessary to create and sustain ICT practices in education that support personalization, social community learning, acquisition of knowledge and expertise, and timely, effective formative performance feedback (Gibson and Webb, 2013).

Researchers, practitioners and policymakers in the EDUsummIT community (Voogt and Knezek, 2013) have collaborated on the current status and research-based practices of ICT in education in nine theme areas since the program was established in partnership with UNESCO in 2006. The theme areas, which build on and extend the science of learning and global best practices in ICT in education into a *systems view of education* have been studied and validated by over 200 researchers from around the world since the early 2000's (Voogt and Knezek, 2008) and are reviewed every two years. Results from this research and reporting are available on www.curtin.edu.au/edusummit and are summarized by the items under 'Leadership training and development' in Table 1. Here, the narrative briefly defines the items with edited texts from the international EDUsummIT reports.

School-Community Partnerships:

> New forms of partnerships are critical to new forms of schooling. The international dialog has evolved from a definition of public-private and informal-formal partnerships to a complex and evolving ecosystem of relationships of schools and society. Ministers and school leaders need to understand how this ecosystem responds to policy and funding as well as the progress of the science of learning and research on education.
>
> Davis, Eickelmann and Zaka (2013) for example, indicate the relevance of considering the co-evolution of pedagogy and technology. Because both education and digital technologies are evolving rapidly, the term co-evolution is adopted to describe the changing ICT applications and services as well as the changing scenarios leading to new systems and forms of schooling. In this context, co-evolution is defined by the interaction between the evolution of education and the evolution of digital technologies applied within education. Both education and digital technologies are evolving, and therefore changes in one have the potential to stimulate changes in the other.

Furthermore, a need has been identified to move beyond traditional conceptions of formal vs. informal learning, online vs. offline activities, and to develop new conceptions of what defines learning spaces across different locations and contexts (Erstad et. al., 2009; Fullan, 2012).

Mobile Learning:

There has been a gradual shift of understanding in the theory and practice of mobile learning in the last ten years, from a techno-centric perspective focusing on the attributes and affordances of the technology, to a learner-centred perspective focusing on the mobility of the learner (not just space and time, but also access to people and resources) and contexts (Kukulska-Hulme et. al., 2009). One example of such a perspective is provided by Sharples, Taylor and Vavoula (2007), who define mobile learning as "the process of coming to know through conversations across multiple contexts among people and personal interactive technologies" (p. 225).

Mobile learning is also closely linked to informal learning, which is characterised by "personal ownership of codified knowledge, user-generated ideas, user-constructed contexts...personal and contextualised, and controlled by the learner" (Laurillard, 2009). Learner control and agency is thus at the heart of mobile learning and both personalised and collaborative learning opportunities can be afforded by mobile technologies. The field has thus begun to see development of theories of mobile learning (e.g. Sharples, Taylor and Vavoula, 2007; Laurillard, 2007).

Educational Equity:

Digital divides exist between countries, including between girls and boys, women and men, rural and urban areas (McConnaughey & Sloan, 1995), young and old people (Becker, 2000; Fox & Madden, 2006), poor and rich people (Eamon, 2004), persons with or without disabilities, indigenous and "foreign" people, and 'haves' and 'have nots' (Resta, 2011). As stressed by van Dijk & Hacker (2003), the digital divide is a complex and dynamic phenomenon, one that is multifaceted. DiMaggio & Hargittai, (2001) suggested five dimensions along which the gender, age and socioeconomic inequalities may exist: 1) inequality in technical apparatus; 2) inequality in autonomy of use; 3) inequality in skill; 4) inequality in the availability of social support; and 5) variation in the purposes for which people use the technology.

Assessment:

There is a strong recognition that assessments serve a range of formative and summative purposes. It is also clear that there are opportunities for IT-based assessments to serve 21st century learning goals including higher order thinking skills and deep knowledge (Gibson & Webb, 2013). The importance of assessment as a learning context has come to the fore and is particularly evident and arising in virtual performance assessment (Clarke-Midura, Code, Dede, Mayrath, & Zap, 2012; Pirnay-Dummer, Ifenthaler, & Spector, 2010; Webb & Gibson, 2015) where the experience of the assessment can be a learning engagement (Mislevy, Steinberg, & Almond, 2003).

Some challenges include whether the following four perspectives on assessment – 1. feedback information, 2. improvement decisions, 3. degree of engagement and understanding, and 4. value judgments - can co-exist to the benefit of learners (Webb et al. 2013). Even with the increased possibilities that ICT provides, educators have not yet found

a way to say confidently that the multiple purposes for which some assessments have been used (Mansell et al. 2009) can or should be supported through the same assessment systems. This is because the impacts of some purposes interfere with the validation processes of others.

For example, the purpose of sorting students into those who can and cannot move forward with their formal education, which is validated by experts, interferes with the purpose of giving feedback information to improve performance, which is validated by the individual. To make this clearer, suppose a student named Sarah is told she has scored low on a test. Consider the case when she can use that information to find out which concepts she needs to master and that she can study and re-take the test. Compare that to being told that as a result of her score, she cannot get into the next class she wishes to take. In the second case, there is nothing she can do about the score nor the next step, but the first case, she can study and attempt the test again. These two purposes are in perpetual conflict with each other because the purpose of the second test result interferes with the validation process of the first test result – even if the result is the same score for the same assessment process.

Therefore in considering assessment design for multiple purposes, users need to examine impact factors carefully in order to minimize negative impacts on learning and learners. Significant challenges remain for developing validation approaches that can take account of the complexity of learning experiences especially for group tasks in simulations, games and other problem solving environments. Furthermore, with the emergence of “big data” the need to develop assessment literacy (Stiggins 1995) in teachers and other users has become even more important. Teachers need to understand the advantages and limitations of assessment types and processes and become confident in developing and analysing valid arguments from evidence (Black et al. 2010).

Creativity in the Curriculum:

This emerging research item refers to many forms of creativity, entrepreneurship, innovation, and non-verbal problem-solving, particularly when using ICT, that lead to new ideas and enhanced thinking skills (Mishra, Cain, Sawaya and Henriksen, 2013; Mishra, 2012).

Indicators of ICT-enhanced Teaching and Learning:

How teaching and learning is enhanced by ICT includes measures of several relevant domains; e.g. learning affordances for critical thinking, communications, creativity and collaboration (Kay and Greenhill, 2011), student characteristics, task and student performance characteristics, and evidence models (Mislevy, Steinberg and Almond, 1999) to ascertain the extent, costs and benefits of ICT in teaching and learning.

Digital Citizenship and Cyberwellness:

Parekh has written extensively on the topic of global citizenship (Parekh, 2008, 2003, and 2002). Rather than arguing for absolute global citizenship, he suggests that “...citizens should be globally orientated, and able to discharge their duties to global others by exercising their responsibilities as democratic citizens and where necessary challenging nationalistic policies which are against the interests of mankind” (Parekh, 2003). This framework would allow the world’s citizens to move toward a global orientation; yet, within their region and nation-state contexts.

Cyberwellness and keeping safe on the Internet is part of a larger conception of media and information literacy (UNESCO, 2013) which emphasizes the importance of accessing, evaluating and creating knowledge. Information literacy according to Catts and Lau (2008) includes capacities to 1) recognise information needs; 2) locate and evaluate the quality of information; 3) store and retrieve information; 4) make effective and ethical use of information; and 5) apply information to create and communicate knowledge.

Computer Science and Informatics in the Curriculum:

To what extent do schools give students learning opportunities in computer science and informatics? Computer science is the study of computation, coding, algorithms and related areas. Informatics is the use of information to solve problems (van Veen, Mulder and Lemmen, 2004).

These rationales lead to items in **Table 1**, which maps these education policy domains across the systems in the formal education sector.

Table 1. Existing ICT in education policies and/or laws
(to be answered by Ministers)

Do any of the existing ICT in education policies and/or laws address:	ISCED1	ISCED2	ISCED3	Higher Education
Equity in favor of the following (yes or no)				
Gender				
Poor groups				
Rural areas				
Persons with special needs				
Minorities				
Other (specify)				
Leadership training and development in the following (yes or no)				
School-Community Partnerships				
Mobile Learning				
Educational Equity				
Assessment				
Creativity in the Curriculum				
Indicators of ICT-enhanced Teaching and Learning				
Digital Citizenship and Cyberwellness				
Computer Science & Informatics in the Curriculum				
Other (specify)				

5.2 Learner-centred engagement in the curriculum

Students need access and support in order to learn with ICT. A Nigerian study by Adomi and Kpangban (2010) noted that the New Partnership for Africa's Development (NEPAD) found that 55% of students reported no experience whatsoever with computers and most schools provided neither learning opportunities nor teacher training. A study of the implementation of a learning management system in Qatar illustrates the connection between teacher expectations and students (Nasser, Cherif and Romanowski, 2011) finding that a lack of formal expectations by teachers contributed to low student use of the technology. But access and attitudes toward including ICT in education provide only a floor upon which to stand. As important are the types

of usage, for example to replace or extend traditional methods of teaching. In Latin America and the Caribbean Hinostrosa and Labbe (2011) point out that the school and teacher's perspective contributed significantly to the variation in learning opportunities from simple operations to creative uses of ICT. While it is therefore important to continue tracking the progress of countries on infrastructure, access and teacher training, a shift toward learner-centred usage is of critical importance for evaluating and comparing how students are being prepared for participating in the digital age

The shift toward learner-centred engagement has occurred at the policy level in developing countries for some years; however, it is evident that the implementation of such pedagogies has been fraught with inconsistency. For example, a case study in Namibia attempted to investigate the extent to which teachers (n=145) were implementing learner centred approaches as outlined in reform policy documents. While teacher interviews suggested an understanding of the approach and most teachers reported to be implementing the policy in the classroom, the researcher reported that rote teaching was in fact the main method of instruction (O'Sullivan, 1999). Hinostrosa and Labbe (2011) make almost no comment on the types of pedagogical usage by teachers and the resulting learning opportunities for students in Latin America and the Caribbean, highlighting the need for new data collection measures and methods.

The shift to learner-centred teaching requires more than a working knowledge and shift in attitudes concerning the potential benefits of ICT; it requires a practice-based change of teaching habits across a systems view of how people learn that includes changes in the teacher's understanding of the nature and contexts of acquiring knowledge, how to form a classroom community of learners, and how to provide ongoing formative feedback that promotes metacognition by the individual. The change of practice in all these areas then can lead to deeper learning.

In their review of cognitive science, Bransford, Brown and Cocking (2000) provide research evidence that learners retain and generalise knowledge to a broader range of contexts when they experience deeper rather than surface knowledge, and when they learn how to use that knowledge in real-world settings. Their message concerning the science of learning is fourfold: educators need to more fully understand and make use of:

1. Learner characteristics (e.g. Personalization depends on the educational system knowing about and adapting to the individual)

2. Community of practice within each field of knowledge (e.g. Social networks and collective intelligence are required elements of expertise)

3. The nature of knowing, learning and communicating in that field of knowledge (e.g. Development of flexible expertise within a field of knowledge can only be exhibited with the tools and practices of that field)

4. Timely constructive formative feedback (e.g. Just-in-time performance support and coaching are needed to guide the development of flexible expertise).

The 'global flatteners' defined by the rise of the Internet and hypermedia, have led to changed expectancies by a new and much larger generation of learners worldwide, who have newly acquired access to knowledge as well as unfettered access to the primary means of economic production in the knowledge society (Friedman, 2005).

The new global learners, at all levels of literacy, are increasingly adept at using technologies as active participants in informal knowledge communities and making use of the emerging paradigms of digital media learning and communication practices. While they may have wide gaps in knowledge and experience and a pressing need for basic education, their informal skills and practices include conducting global searches, sharing images on social media, storing information in the cloud, marshalling computing resources to make videos, record audio and create interactive graphics, remixing any available sources of knowledge, recruiting and combining talents with others, and working smarter with personalized mobile technologies. The ICILS study found for example, that across all countries, students reported using computers more frequently at home to search for information and to communicate than when at school (Fraillon, Ainley, et al., 2013, p. 22). These practices of informal technology-enabled learning have been called 'new media literacies' of an emerging 'participatory culture' (Jenkins et. al., 2006) and as a cultural phenomenon driven by the flattening forces, are occurring parallel to but sometimes out of step with bureaucratic and institutionalized formal education theory and practice (Gibson, 2012).

These rationales lead to items in **Table 2**, which asks teachers to report on the number of hours per week that students experience ICT-based learning opportunities related to these dimensions.

5.3 Teacher use patterns

Since the 1980's learning scientists have argued that standard model schools are not aligned with the knowledge economy (Sawyer, 2006) because deep learning requires i) specific conditions that enable real-world practice in a community, ii) emotional and motivational buy-in by the learner, and iii) ample timely feedback. In their review of cognitive science, Bransford et al. (2000) in their review of learning sciences frameworks in "How People Learn" (HPL) provide research evidence that learners retain and generalise knowledge to a broader range of contexts when they experience deeper rather than surface knowledge, and when they learn how to use that knowledge in real-world settings. Investigating what students are doing with ICT and which learning activities teachers plan for students when using ICT helps measure how ICT is being used in education. That information about the contexts of use can then be used to better understand the impacts of ICT in education, by increasing the available information for comparison and increasing the information about various contexts.

Beetham and Sharpe (2013) emphasise the importance of teachers in guiding the learner's journey given that even though digital native students may be able to use technologies, they may not be able to necessarily learn from them. Designing learning activities for 21st century learning goes beyond teachers attempting to incorporate new technologies into old teaching practices. For instance, Hayes' (2007) observation of thirty classrooms in Australia indicated ICTs were mainly being substituted for other traditional technologies, including textbooks, pens, and blackboards and were not supporting the development of new pedagogies to foster higher order thinking skills.

Seminal work in seven countries by Stanford Research Institute (SRI) International (Shear, Gallagher and Patel, 2011) demonstrated "while ICT use in teaching is becoming more common, ICT use by students in their learning is still an exception in many of these schools." The countries included Finland, Indonesia, Russia, Senegal, England, Mexico and Australia and the methods included teacher and school leader surveys in a sample of schools from each country, site visits to three to six of the sampled schools, and analysis of learning activities and student work. All the instruments of the study are available at http://www.itlresearch.com along with a technical supplement that describes the project methods.

Table 2. Learner-centred use of ICT
(to be answered by teachers)

How many minutes per week do students use ICT in your class to:	Primary (ISCED1)	Lower Secondary (ISCED2)	Upper Secondary (ISCED3)	Post-secondary (ISCED 4-8)
Support their learning in the following subjects				
Mathematics				
Natural Sciences				
Social Sciences				
Reading, writing and literature				
Fine arts				
Language learning				
Other (specify)				
Engage in the following learner-centred activities				
Learner Characteristics				
Make decisions about what to learn				
Interact with multimedia materials				
Do a self-assessment				
Other (specify)				
Classroom Community of Practice				
Work with remote partners				
Get feedback from peers				
Work independently				
Work from anywhere on campus				
Have unrestricted access to the Internet to do their work				
Other (specify)				
Knowing and Doing				
Use diverse knowledge sources to create a product or participate in global communications				
Undertake an open-ended challenge or problem				
Learn with games and simulations				
Create or construct something				
Search for information on the Internet				
Integrate new understandings into pre-existing knowledge to expand overall comprehension				
Test hypotheses using available tools and based on findings construct new models.				
Practice skills using various tools to improve performance.				
Other (specify)				
Feedback				
Take or do a digital or online assessment				
Communicate with the teacher (e.g. via personal email, chat, discussion board)				
Give feedback to a peer				
Other (specify)				

Across all the countries in the study, there were national documents supporting the use of innovative teaching and learning; however, researchers in all countries also reported a gap between the vision expressed in policy documents and what happens in classrooms. Tensions between innovation and accountability existed in all countries that practiced extensive national student testing. Innovative teaching happens in schools with classroom-level access to computers and where there is a school-wide culture of innovation. The local ecosystem within which teaching occurs greatly influences whether or not innovative teaching takes place, lending support to this call for school-based measures to assist Ministers and school leaders in establishing those cultures of support. Findings concerning the student experience indicate that variance across scores is explained by the associated learning activity rather than by difference in students. This implies that focuses on the extent of learning opportunities (Table 4) as well as on the details of task design (Table 5) with ICT are critical to improving the student learning.

Further research by SRI International in collaboration with Curtin University offers a framework for thinking about classroom-level ICT implementation with six factors that are mapped onto the science of deeper learning. **Table 3** compares the alignment of the HPL and SRI frameworks. The comparison is important for understanding the alignment of best practices found in global studies with what the learning sciences indicate are the necessary contexts needed in order for people to learn.

For example, how a student best approaches and utilizes new information as well as how well they are able to monitor and adapt their self-regulation skills while learning impacts their ability to construct a bridge from what they already know to new knowledge. This implies that teachers who know about and use their pupil's learning characteristics and in particular, to improve the student's self-regulation and knowledge construction skills, are in a better position to utilize ICT for learning and to create more significant impacts when using ICT in teaching and learning.

Table 3. Comparison of ICT learning frameworks

Learner Characteristics	Self-regulation Knowledge construction
Community of Practice	Collaboration Skilled communication
Nature of knowledge	Real-world problem-solving and innovation Use of ICT for learning
Feedback	

In addition to these foundations, the New Media Consortium uses a Delphi method to uncover trends and ascertain a priority ordering of those trends in ICT in education (New Media Consortium, 2014). The Delphi method facilitates an expert group reaching a consensus by two or more rounds of repeated polling and prioritizing lists of positions and potential actions, and is an appropriate method for summarizing how experts in the field are planning for the immediate, medium term and distant future. Several of the items in this paper's recommendations relate to those trends, including:

- Shift to real-world learning;
- Focus on open content;
- Use of hybrid learning designs;
- Redesign of the traditional school day; and
- Complex thinking and communication.

The impact of future teachers who have often grown up highly connected has been investigated. For instance, a study of 225 teacher education students in Korea and Singapore, who were the recipients of recent ICT policy implementations in schools, were invited to participate in a study measuring past experiences with ICT, pedagogical beliefs and ICT integration. Findings indicated that student teachers who held constructivist beliefs had strong computer efficacy, showed positive attitudes toward ICT in education, and were more interested in using ICT in future teaching practices (So, Choi, Lim, et al 2012). The more recent ICILS study also confirms that teachers with greatest use are those who are more confident in their abilities, and those who develop higher levels of confidence in using ICT in teaching tend to work in school environments where staff learn together, collaborate in institutional planning, and where there are fewer resource limitations concerning the use of ICT in teaching and learning (Fraillon, Ainley, et al., 2013, p. 23).

The items in Table 3 are embedded into the recommendations in **Tables 4** and **5** for new indicators of the impact of ICT in education on the strength of the best scientific and practice field research information available today.

In Table 5, teacher ICT use patterns are measured concerning the design of educative tasks for students. Table 5 offers a deeper dive into task design to provide additional detail not addressed in Table 4.

6. Government expenditure

6.1 Expenditure on professional development

Professional development measures included in sections of the survey can help drive and support progress on suggested indicators and make progress on barriers to implementation. Barriers identified in the literature have been outlined in an article by Bingimlas (2009) and include teacher confidence, competence and accessibility which are developed through effective professional development on a basic foundation of ICT resources, sufficient time, and technical support. To support teachers in the *ICT Competencies* listed in the tables above, it is recommended that current expenditures be measured that broadly align with the above recommendations. Table 6 below outlines current expenditures on teacher professional development disaggregated by some key policy areas.

Table 4. Teacher use of ICT to administer, teach, learn and share materials
(to be answered by teachers)

How many minutes per week did you use ICT in your class to:	Primary (ISCED1)	Lower secondary (ISCED2)	Upper secondary (ISCED3)	Post-secondary (ISCED4-8)
Administer				
Prepare for class (e.g. create unit outline or classroom materials, lesson planning?)				
Send e-mail for professional communications				
Other (specify)				
Teach				
Direct and guide student learning decisions				
Talk aloud while problem-solving, showing students how you think				
Show students how you create something				
Provide tasks that are designed to ensure that all students have equal access to learning (learning accommodations)				
Provide a variety of ways to learn so that students can make choices that best fit their preferences (learning alternatives)				
Provide opportunities for student-created ICT tasks or products				
Use free online educational materials in teaching				
Grade/ evaluate student work				
Other (specify)				
Learn				
Take an in-school refresher course or unit on some aspect of ICT for yourself				
Develop a new understanding of ICT integration in teaching by planning with colleagues				
Collaborate with colleagues about your teaching				
Make a change in teaching based on feedback from parents				
Other (specify)				
Sharing Materials				
Create free online educational materials for others to use in teaching				
Help a colleague with ICT issues				
Other (specify)				

Note: Table 4 collects total minutes per week teachers engage in relevant ICT-based activities to teach, learn for themselves, and create and share materials.

Table 5. Teacher use patterns related to ICT task design
(to be answered by teachers)

What kinds of ICT tasks do you provide for students?				
Provide different LEVELS of tasks (items should total to 100%)	Primary (ISCED1)	Lower secondary (ISCED2)	Upper secondary (ISCED3)	Post-secondary (ISCED4-8)
1. Support: ICT supports learning as a substitute for a traditional tool (e.g. to read, write, or listen)				
2. Extend: ICT allows significant task redesign (e.g. communicating with others during class, doing online research, using digital tools)				
3. Transform: ICT allows for the creation of new tasks that that are impossible without ICT (e.g. global communications, data-rich visualizations, multimedia using Internet resources)				
TOTAL of LEVELS	100%	100%	100%	100%
Provide different KINDS of tasks (items should total to 100%)	Primary (ISCED1)	Lower secondary (ISCED2)	Upper secondary (ISCED3)	Post-secondary (ISCED4-8)
TASK CHOICE				
Teacher-directed				
Self-directed				
Group-directed				
Other (specify)				
TOTAL	100%	100%	100%	100%
PROBLEM TYPE				
Structured problems				
Open-ended problem solving				
Other (specify)				
TOTAL	100%	100%	100%	100%
WORK SETTING				
Individual work				
Collaborative work				
Other (specify)				
TOTAL	100%	100%	100%	100%

Table 6. Professional development expenditures
(to be answered by Ministers)

Total government expenditures on ICT in education	Primary (ISCED1)	Lower secondary (ISCED2)	Upper secondary (ISCED3)	Post-secondary (ISCED4-8)
Total expenditure on ICT in education				
Of which:				
Current expenditure on ICT in education				
Professional development on ICT				
Learner-centred use (Table 2)				
Administrative functions (Table 4)				
Teaching (Table 4)				
Learning (Table 4)				
Sharing materials (Table 4)				
Task design (Table 5)				
All other current expenditure on ICT (Table 1)				
Capital expenditure				
Etc.				

Note: In Table 6 it is expected that the Minister may aggregate information from School Administrators. For example, primary school administrators may answer a survey from the Minister that asks about their local level of expenditures in professional development, which the Minister then aggregates.

7. ICT Infrastructure

The ICILS study found that students from countries with greater access to computers in schools tended to have stronger computer and information literacy skills (Fraillon et al., 2013, p.23). The ICT infrastructure paper by Twining and Davis (2015) commissioned by UNESCO-UIS addresses infrastructure issues in more depth.

7.1 Deployment patterns by space and type of access

However, collecting a 'minutes per week' estimate by the teacher is recommended (and perhaps by students as well for corroboration) that focuses on deployment patterns inside and outside the classroom to help triangulate and validate deployment patterns. Also recommended is documenting the access mode type (e.g. mobile, wireless or wired connections). By collecting information on where and via what modes students are accessing ICT, comparability among schools will be improved and impacts can be better understood (Table 7).

Table 7. ICT deployment patterns by space and type of access
(to be answered by teachers)

How many minutes per week do your students use ICT within the school environment?	Primary ISCED1	Lower secondary ISCED2	Upper secondary ISCED3	Post-secondary ISCE4-8
Deployment on campus				
In computer lab(s)				
In classrooms				
In the library				
Other locations (not including at home)				
TOTAL minutes per week deployment by space				
On campus using campus wireless system				
On campus using wired-only connections (no wireless system)				
TOTAL Minutes p. week deployment by access type				

Note: The total minutes per week will normally be less than 5 days * 8 hours * 60 minutes = 2,400 minutes. In 24-7 access (24 hours 7 days a week access), such as in mobile for a community, the total minutes per week cannot exceed 7 days * 24 hours * 60 minutes = 10,800. Normally when UIS collects data on instructional time, breaks are excluded. UIS considers numbers of periods in a day and the length of periods in measuring instructional time.

Unique student data records

To support analyses and better understand the impacts of ICT on students, schools and systems, the creation of a unique student identifier is recommended, ideally that is unique within the largest system of data collection envisioned (e.g. unique in the country).

The unique student identifier (an integer or integer plus alphanumeric student ID code) is recommended to allow in-depth analytics at the most granular level possible (i.e. individual student) and to prevent duplication of data. If these fields exist, then fine-grained analyses of gender equality issues are supported, otherwise gender and other issues are difficult to detect and validate. In **Table 8**, the Minister answers with the percentage of schools at each level that can truthfully answer 'yes'

Table 8. Unique data records
(to be answered by the Minister)

Unique student identifier, demographics and basic impacts	Primary ISCED1	Lower secondary ISCED2	Upper secondary ISCED3	Post-secondary ISCE4-8
Number of school with a unique student identifier				
For all students				
For some but not all students				
For no students				
Number of schools with a data file for each student with the following fields:				
Gender				
Grade level in current year				
Satisfaction in current year				
Year graduated				

Data elements for tracking specific impacts of ICT policies

ICT infrastructure includes data system structures for documenting how key policies drive the impact of using ICT in teaching and learning. Thus, a series of policy level estimations is recommended concerning the movement of schools on three measures that relate to the impact of ICT on teaching and learning: Retention, Student satisfaction and Learning analytics. The survey will not ask for the numbers in these categories until each policy (e.g. retention, student satisfaction, learning analytics) is being implemented in more than 75% (or some other benchmark %) of the country or region's schools.

The survey will ask what percentages of schools are in these categories: 1. No policy, 2. Policy developed, 3. Implementation planned or piloted, 4. System fully implemented. The fields are mutually exclusive by definition. 'Policy developed' means that its implementation has not yet been planned or piloted. 'Implementation planned or piloted' moves a school out of the "Policy developed' category. 'System fully implemented' moves a school out of the category 'Implementation planned or piloted.' Each line adds to 100% of the country's schools.

Retention in school as a result of ICT tests the idea that the use of ICT increases engagement and improves academic success. But to measure retention, there needs to be a common definition about how to count cases and since retention can be interpreted in different ways, multiple-measure approach is recommended, which will cause people to think carefully about the numbers they are using and considering. Recent research at Curtin University (Deloitte, 2010) has found it best to measure retention with three cases highlighted:

1. **Year-on retention rate** (a count of students from start to end of a school year)
2. **Lifetime dropout rate** (a count of students who do NOT graduate a school level)
3. **Grade repetition rate** (a count of students who are at the same grade level as the last data collection event).

Student satisfaction policy status indicates the extent to which schools ask their students about their satisfaction with the school organization, their teachers, and their learning. Sentiment analysis on this data (analysis of how students feel about their learning, their teachers and their school) helps schools to self-reflect on the impact they are having on their students.

Learning analytics policy status indicates the extent to which schools are using data about student learning to make decisions. Analyses can be performed at several levels (e.g. individual student, classroom, grade level or department, school, and aggregations of schools) and the sources of data can be any combination of information about the system (e.g. grades, attendance, test success, grade completion, teacher effectiveness, school effectiveness).

These rationales lead to **Table 9**, to be best answered by the Minister.

Table 9. Policies concerning impacts of ICT
(to be answered the Minister)

Policy status concerning retention, student satisfaction and learning analytics	No policy	Policy in place	Implementation planned or piloted	System fully implemented	Total
(for each level of ISCED)	1	2	3	4	
Year-On Retention Rate					100
Lifetime Dropout Rate					100
Grade Repetition Rate					100
Student Satisfaction					100
Learning Analytics					100

Note: The data to be recorded in Table 9 are percentages. For example, concerning 'Year-On Retention',

1. What percentage of ISCED 1 schools have no policy (either local or from the government)?
2. What percentage have a policy in place but have no implementation either planned, piloted or fully underway?
3. What percentage have a policy in place and are either planning or piloting implementation?
4. What percentage have a policy in place and are fully implementing the policy?

The total percentage of schools on each line should equal 100% as the categories are mutually exclusive.

8. ICT tools

8.1 ICT tool allocation by pedagogical use

The types of uses of ICT in a school have much to do with the expected outcomes in that context (Dede, 2008; Vanderlinde, Braak and Dexter, 2012). Key uses of ICT in schools can be divided into four types: ICT used for learning, ICT used for content or skills assessment, and ICT available for use during non-class time. One way to measure the amount of use in these categories is to count the number of available devices or the student-to-device ratio for these purposes.

It is therefore recommended that ICT device allocation numbers be subdivided to provide data on learning, content assessments, ICT skills assessments and devices allocated for free time use. The numbers are not mutually exclusive, but give an approximate student-to-computer ratio for each of the four types of use. An alternative measure might be to ask the school administrator to state the student-to-computer ratio available for each activity type.

Table 10. ICT devices
(to be aggregated by Ministers from School Administrators)

ICT allocated to educational programmes by level of education	Primary ISCED1	Lower secondary ISCED2	Upper secondary ISCED3	Post-secondary ISCED 4-8
Total number of ICT devices *Of which:*				
ICT for pedagogical use:				
Students use ICT during learning in order to solve problems, communicate, think critically or be creative.				
Content assessments are delivered via ICT (i.e. students use technology while being tested on core subjects, but are not tested on their ICT skills-in-use)				
ICT skills are assessed (i.e. ICT is used to collect evidence of student ability to use ICT to solve problems, communicate, think critically or be creative.)				
Students use ICT during free time at school				

Note: In Table 10 it is expected that the Minister will aggregate information from School Administrators. For example, the primary school administrators could answer a survey from the Minister that asks about the number of ICT devices used for pedagogical purposes.

8.2 Emerging paradigms of tool use in ICT in education

The Horizon Reports of the New Media Consortium (e.g. New Media Consortium, 2013, 2014) provide a source for comparing ICT uses being contemplated by ICT leaders in education. For over a decade these yearly reports detail the six technologies that will soon impact colleges and universities. Since 2006, NMC has partnered with Educause on additional versions, including K–12 trends in 2009, and tech trends in museums and libraries. The method of the report is based on a survey of current ICT leaders, who provide information about what is on their immediate timeline for adoption and implementation. Thus the reports give a field-based prediction about worldwide directions being taken in ICT in education.

It is recommended that several emerging paradigms in the use of ICT tool-based approaches to delivery and learning be tracked for comparison and change over time. The list has been generated from the Horizon Reports of the last several years (New Media Consortium, 2013, 2014). It is recommended that ministers be asked to estimate the number of years until a policy will be in place and until implementation will begin. Brief definitions of emerging policies are provided below.

Bring Your Own Device

Use of privately owned devices (e.g. computers, iPads, smart phones) in the classroom.

Cloud Computing

Use of distributed databases and Internet-based communications and file exchanges that remotely store and retrieve information, and which might include remote data processing such as for learning analytics and automated essay scoring.

Flipped Classroom

Teacher and student use of ICT devices prior to and after classroom learning experiences and supports increased student responsibility for learning outside of school. As an 'active learning' model of ICT, it differs from 'Blended Learning' which focuses on the use of face-to-face as well as online learning in any pedagogical model.

Game-based Learning

The use of interactive digital learning experiences that have characteristics such as clear goals for self-directed exploration and performance, transparent signals that track progress toward the goals and supports mastery learning, competition with self or others, resolution of a relevant conflict or challenge, and may involve some aspects of formal mathematical game theory.

Learning Analytics

Use of data-driven decision making which utilizes all sources of data available to the user and that recognizes the need for capacity building in students, teachers, parents and others to make best use of the system data.

Internet of Things

The encouragement of exploration and innovation in the digital-to-real transformation of ideas into real objects, including 3D printing, workshop or laboratory spaces for creating real-world objects, and problem-solving via digital engineering processes.

These rationales lead to **Table 11**, to be answered by the Minister.

8.3 Policies addressing tool-based approaches

Table 11. Policies addressing tool-based approaches
(to be answered by Ministers)

Modern ICT tools and approaches: Official policy and implementation	Primary ISCED1	Lower secondary ISCED2	Upper secondary ISCED3	Post-secondary ISCED 4-8
Estimated number of years (1, 2, 3, 4, 5) until:				
Bring Your Own Device				
Policy				
Funded implementation				
Cloud Computing				
Policy				
Funded implementation				
Flipped Classroom				
Policy				
Funded implementation				
Game-based learning				
Policy				
Funded implementation				
Learning Analytics				
Policy				
Funded implementation				
Internet of Things				
Policy				
Funded implementation				

9. Enrolment

9.1 Gender and cultural access to ICT

Enrolment statistics play an important role in promoting equal access to knowledge by all sectors of a society including equal opportunities for females and children from all different cultures, regions (urban versus rural), and socio-economic levels. Gender-sensitive indicators and analysis are valued in national policies to provide evidence-based information for concrete gender-specific measures such as projects and programmes (UNESCO, 2013). Items are recommended that use robust methods to identify and eliminate gender, cultural and other biases.

It is also recommended to include gender and socioeconomic or cultural analysis of participation in online learning recognizing that massively open online learning (MOOCs) can be valid forms of learning and need to be acknowledged (DeFreitas, Gibson and Morgan, 2015). MOOCs are scalable, free sources of information that are open and available to anyone with access to the Internet. Research on MOOCs is just beginning, so the approach bears watching. Any educational value or utility for workplace training is ultimately bounded by the efficacy with which the MOOC is designed and used by educators and students, so national policies are needed that review and make use of these unique Open Educational Resources to raise the level of education for all people. Schon and Conole (2014) provides a special issue journal on quality in MOOCs.

10. Teaching staff

10.1 ICT Competency Framework for Teachers

The commissioned paper "Teacher training and usage of ICT in education: New directions for the UNESCO Institute for Statistics global data collection in the post 2015 context" (Du Toit, 2015) presents the UNESCO ICT Competency Framework as a guide to professional development of teachers, which would suggest that six dimensions of training be provided at three levels. The six dimensions address policy, curriculum and assessment, pedagogy, ICT as tools, organization and administration, and professional learning and the levels are defined as technology literacy (awareness and basic knowledge), knowledge deepening (applying knowledge) and knowledge creation, including self-management and sharing knowledge as a model learner (Table 12).

Table 12. UNESCO ICT Competency Framework

Area of educational focus	**'Modules' - Phases of knowledge acquisition**		
	Technology Literacy	**Knowledge Deepening**	**Knowledge Creation**
Understanding ICT in Education	Policy Awareness	Policy understanding	Policy Innovation
Curriculum and Assessment	Basic Knowledge	Knowledge Application	Knowledge Society Skills
Pedagogy	Integrate technology	Complex problem solving	Self management
ICT	Basic tools	Complex tools	Pervasive tools
Organization and Administration	Standard classroom	Collaborative groups	Learning Organizations
Teacher Professional Learning	Digital Literacy	Manage and guide	Teacher as model learner

Source: http://unesdoc.unesco.org/images/0021/002134/213475e.pdf

The proposed survey items recommended in this paper address all of these dimensions, but share the responsibility among the Minister, School Administration, Teachers with corroborating evidence from Students, as summarized in Table 13. Policy is led by and reported by the Minister, Access to tools is reported by the School Administrator, and the balance of items are reported by the Teacher, with a subset of classroom learning opportunity items corroborated by Students.

11. Summary of the recommended survey structure

Table 13. Survey summary

Data provider	Table No.	Table Title	Data type	Focus of data collection
Minister	Table 1	Existing ICT policies and/or laws	binary, text	Yes or no. Is there a policy or law concerning **equity issues** and **leadership training themes**
	Table 6	Professional development expenditures	integer	Total $ by expenditure type **to support ICT training** detailed in Tables 2, 4, 5
	Table 8	Unique data records	integer	Number of schools with **unique student identifier** and with fields for **gender, grade level in current year, satisfaction, year graduated**
	Table 9	Policies addressing ICT impacts	integer from 0 to 100	Percentage of schools with policies on **retention**, **drop-outs**, **grade repetition** and **student satisfaction**
	Table 11	Policies re: tool-based approaches	binary, text	Yes or no. Is there a policy on 'a,b,c…n' and has implementation been funded?
School Administrator	Table 10	Pedagogical Devices	decimal from .00 to 1.00	Ratio of students per computer device by four usage categories **learning, content assessments, ICT skill assessment, free time at school**
Teacher	Table 2	Learner-centred use patterns	integer from 0 to 2400	Minutes per week by **subject areas** and **pedagogical use**
	Table 4	Teacher Use patterns	integer from 0 to 2400	Minutes per week by **administrative** and ICT **competency levels**
	Table 5	ICT Task design	integer from 0 to 100	Percentage of total student tasks with specific **task design** features
	Table 7	Deployment patterns	integer from 0 to 2400	Minutes per week by **location** and **access type**
Student	Table 2	Learner-centred use patterns	integer from 0 to 2400	Minutes per week by **subject areas** and **pedagogical use**

12. Notes on discussions and feedback

12.1 Normative vs standards and benchmarks method

Some concern was expressed during the expert panel review about the normative or standards and benchmarks approach for countries that might have quite a distance to go in development. The authors acknowledge these issues but feel that the potential guidance of an international benchmark and the goal of assisting all students to become globally work-ready graduates outweigh the concerns. It is therefore recommended that a research-founded standards-based approach be used as suggested by the recommended items.

Alternative scales

Some alternative scales are noted here for further consideration. The scales offer a 'gap analysis' measure better at offering high levels of local relevance and for pointing to specific actionable next steps; so for example, scale 1 below might be useful for school administrators, while scale 2 might be useful at all levels, and scale 3 might be best as part of the teacher portion of the survey for its value in self-assessment.

Scale 1. Have each respondent enabled to indicate on each item: 1) How important the item is to them, and 2) Their level of current satisfaction with their current status.

Measuring the difference between importance and satisfaction is a gap analysis method that creates a metric for prioritizing items for action. If the perceived importance and satisfaction of some potential action is nearly on par, there is no urgency for action. But if the importance is rated high and satisfaction is rated low, it suggests a high priority for action. Scoring subtracts the satisfaction from the importance to create a range of values. For example, suppose the scale to be a Likert scale from 1 to 5 where 5 is highest (most important or highest satisfaction). A score of low importance (1) minus a high score of satisfaction (5) would produce a -4 or very low priority, while a score of 5 in importance and 1 in satisfaction would produce a 4 or high priority.

Scale 2. Have each respondent enabled to state: 1) Where on the scale they would like to see their classroom, school, or educational system, and 2) Where on the scale they would place their current state.

Measuring the difference between a desired state and a current state is a gap analysis method for identifying areas where a solution or implementation project is needed. Scored similarly to scale 1, a high score on the desired state and low score on the current state would indicate an area in need of attention. Aggregating the opinions of many stakeholders (e.g. teachers, community members, students, local educational leaders) concerning the desired state of the educational system would provide Ministers with a reading on the interests and focus of people on undertaking particular improvement projects or programmes.

Scale 3. Have each teacher indicate: 1) Their level of experience with each item, and 2) Their confidence in their capabilities regarding the item.

Measuring the difference between experience and confidence of teachers in using ICT in teaching and learning would provide a metric for prioritizing professional development offerings. Aggregating upward from individual teachers to a school system could guide the development of training programmes and help ensure effective use of available training funds.

The value of the recommended standards-based approach to a survey using scales such as the above ensures that the priorities emerging from the survey will be guided by research-based best practices.

Also of note is this method for the problem of mitigating the effect of subjectivity in survey estimates, from a research study in 2004:

> We ask respondents for self-assessments of the concept being measured along with assessments, on the same scale, of each of several hypothetical individuals described by short vignettes. We create interpersonally comparable measurements by using answers to the vignette assessments, which have actual (but not reported) levels of the variables that are the same for every respondent, to adjust the self-assessments. (King et. al., 2004)

Note the similarity of the method of asking for two perspectives on the same question, as is recommended above in the three 'gap analysis' scales just discussed. The essential idea is that by asking the respondent to give two measures on the same concept, with a relationship between the two, analysts can determine the reliability of answers by the consistency of twice as many points per concept and also make an estimate of the confidence of the respondent towards the primary measure.

13. Concluding remarks

The indicators of *evolving learning paradigms* associated with the use of ICT in education need to focus on what teachers and students are doing with ICT to teach and learn. Usage patterns will be affected by and can be correlated with ICT infrastructure, access to technology and information within the curriculum, and teacher training and support for the implementation of ICT. The recommendations contained herein are an attempt to address the evolving mission, methods and core principles of ICT in education; its role in hastening the emergence of learner-centred pedagogies; and the types of learning activities and usage patterns that best support full participation in the knowledge society.

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