TEACHER TRAINING AND USAGE OF ICT IN EDUCATION

New directions for the UIS global data collection in the post-2015 context

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1. Executive summary

Information and communication technology (ICT) has the potential to transform teaching and learning processes. However, most countries face challenges in measuring the impact of investments in infrastructure, massive roll-outs of teacher training initiatives, and usage in the classroom. The lack of a comprehensive set of indicators can partly explain current challenges. Moreover, there is a growing recognition that added focus is needed to measure teacher training and usage holistically within a systems perspective whereby indicators are not viewed in isolation but reflect a complex pattern of how teachers are prepared and how teaching activities with pupils, in and out schools and the classroom are executed (Partnership on Measuring ICT for Development, 2010).

Following a technical advisory panel (TAP) meeting that brought together a diverse group of statisticians and subject matter experts in the area of ICT in education from 9 to 10 December 2014 in Paris (France), this paper has been developed to help strengthen the conceptual framework of ICT in education with specific reference to the importance of collecting data relevant to teacher training in relation to ICT and its usage in the classroom. This paper is complementary to a paper authored by Broadley et al. (2015) on 'Evolving Learning Paradigms' as well as another by Twining et al. (2015) on 'Developing new indicators to describe digital technology infrastructure in primary and secondary education'. These three papers were commissioned by UIS to inform the planning of new ICT in education data collections and identifying core indicators for the post-2015 developmental agenda.

The UNESCO-UIS Guide to Measuring Information and Communication Technologies (ICT) in Education, Technical Paper No. 2 (UIS, 2009), put in place a common set of standardized internationally agreed indicators on ICT in education including a number related to teachers' professional development and usage, which are drawn from administrative sources. This paper however argues that a more holistic approach, as per example the ICT Education 2013 Survey (CETIC.br, 2013) on the use of ICT in Brazilian schools, may be useful for shedding additional light on teacher dimensions of ICT in education.

More specifically, this paper attempts to asses current indicator gaps in teacher professional development and training by asking basic questions, including who is being trained in the use of ICTs, where and how are teachers trained, what kind of ICT training is provided and based on which certification standards, and finally, when and for how long are teachers trained? Based on an analysis of these issues, additional indicators are suggested. This paper also examines teacher usage of ICT in delivering instruction and makes a case for including cross-cutting elements that point to teachers' usage of ICT-enhanced pedagogy, digital curriculum and assessment, ICT in education policy, ICT infrastructure, and ICT used for for administrative and organizational purposes. The teaching of basic computer skills and computing is also addressed.

Finally, the importance of obtaining better gender-related data regarding teacher training and usage of ICT in education, including indicators disaggregated by sex, is highlighted.

2. Introduction

As information and communication technology (ICT) plays a greater role across society including public and private education, countries around the world are more than ever in need of high quality internationally comparable statistics on ICT in education. In particular, indicators are essential for measuring and tracking the integration of ICT and its impact given investment can constitute a significant portion of national education budgets, for many, if not most countries. In the United Kingdom (UK) alone, an estimated £567.8 million was spent on ICT in schools, excluding software (Twining and Henry, 2014). This particular investment takes into account special attention given to teachers in providing them with the necessary policy environment, digital curriculum, skills, infrastructure, and professional development to make effective use of ICT in the classroom. Given the substantial size of investment in many countries, other literature sets targets for spending on teacher training suggesting that 30% of funding for ICT integration into schools should be devoted to professional development to ensure that ICT is used effectively (Twining and Henry, 2014). This target is based on the firmly held belief that teacher training and ongoing relevant professional development are essential if benefits from investment in ICT are to be maximized (Infodev, 2015).

Meeting international goals (e.g. Millennium Development Goals (MDGs], Education for All (EFA], World Summit on the Information Society (WSIS)) by 2015 and beyond requires substantial investment in teacher training institutions so that adequate pre-service and in-service training can be delivered (UNESCO-UIS, 2006). The Education for All Global Monitoring Report (2013/ 2014) states that an education system is only as good as its teachers. While the introduction of ICT in education plays a role in shifting responsibility for learning from teacher to student, ICT does not however remove the need for classroom leadership, nor does it invalidate related traditional teacher skills and practices (Infodev, 2015). Developing teachers' capacity to enhance the quality of learning remains essential and evidence shows that education quality improves when teachers are supported and deteriorates if they are not (UNESCO, 2014a). While ICT has been used in various ways to support teachers, some of the literature points to the fact that little evidence exists supporting the claim that digital technology has transformed education (Twining and Henry, 2014). It is thus only by capturing better data on the integration, usage and impact of ICT in education that improvements to data collection processes can occur and best practices be scaled-up and rolled-out more effectively in countries.

International ICT in education assessments recognise the importance of measuring teacher training and usage in regards to ICT. However from a policymaking perspective, it is widely recognised that information needs differ amongst countries depending on the level of ICT penetration in the education system. For example in countries where ICT penetration levels are higher, there may be significantly more need for renewed training cyclically given the high turnover in digital technology. In contrast in countries where ICT penetration is less whereby fewer schools have ICT in place, training demands will also be significantly less (UNESCO-UIS, 2009). Data collection efforts should therefore aim to reflect relative needs.

3. Teacher training for ICT in education

The UNESCO-UIS Guide to Measuring Information and Communication Technologies (ICT) in Education currently (2009) explores the conceptual domain of teacher professional training and staff development with these three main indicators:

- **ED8 Proportion of ICT-qualified teachers in primary and secondary schools (ISCED levels 1-3)**[1] Total number of teachers trained to teach basic computer skills (or computing) in primary and secondary schools based on national standards, expressed as a percentage of the total number of teachers at these levels of education;
- **ED35 Proportion of primary and secondary-school teachers trained via ICT-enabled distance education programmes (ISCED levels 1-3)**: Total number of primary and secondary school teachers who were trained via ICT-enabled distance education programmes, expressed as a percentage of the total number of teachers;
- **ED38 Proportion of primary and secondary-school teachers trained to teach subject(s) using ICT facilities (ISCED levels 1-3)** Total number of teachers trained to use ICT to teach subject(s) in primary and secondary schools, expressed as a percentage of all teachers for ISCED levels 1-3 (UNESCO-UIS, 2009).

These three indicators do not however capture the full scope of teacher training in relation to ICT in education. The following section will explore additional indicators that can shed light on teacher training for ICT in education.

3.1 Expanding basic concepts and dimensions of teacher training related to ICT

Definitions of training

In some developing countries, ICT training for teachers is based on developing computer literacy, which is an important component for integrating ICT in education; however it is noteworthy that effective training should not stop at computer literacy but should model effective teaching practices (Infodev, 2015). Nevertheless, there are many other countries that provide little or negligible teacher training related to ICT in education. For example evidence from Europe shows that 70% and 65% of students in Lithuania and Romania, respectively, are taught by teachers for whom it is compulsory to participate in ICT training, compared to just 13% or fewer of students in Luxembourg, Austria and Italy (European Commission, 2013).

ED8 measures the proportion of teachers that are “ICT-qualified”; in other words it measures those teachers trained and thus best equipped to teach courses specifically on basic computer skills in primary or basic education and/ or computing in secondary education. In contrast UIS indicator ED38 measures the proportion of primary and secondary-school teachers trained to teach other subject(s) using ICT facilities (for ISCED levels 1-3). For both indicators, “trained” refers to national standards. In several countries across Latin America and the Caribbean (UNESCO-UIS, 2012), some Arab States (UNESCO-UIS, 2013), and some countries in Asia and the Pacific (UNESCO-UIS, 2014) varying proportions of teachers have received each type of training. Typically lower proportions of teachers have been trained to teach basic computer skills or computing (i.e. 10% or fewer), while the proportions of teachers trained to teach

[1] ISCED is an acronym for the International Standard Classification of Education published by UIS at http://www.uis.unesco.org/Education/Documents/isced-2011-en.pdf. ISCED levels 1, 2 and 3 represent primary, lower secondary and upper secondary education levels, respectively.

subjects using ICT varies more widely ranging from few in low income countries to the majority in some developed countries (Partnership on Measuring ICT for Development, 2014b).

In Asia and the Pacific it is suggested that countries such as Hong Kong Special Administrative Region of China, Malaysia and Singapore, where ICT is well integrated into curricula and nearly universally available across schools, all teachers are trained to teach using ICT in their classroom. Moreover, other data suggest that all teachers in these three countries are using ICT in their teaching. In contrast data suggest that few teachers are trained in countries where ICT is scarce including Philippines, Myanmar and Kyrgyzstan (UNESCO-UIS, 2014). Teacher training related to ICT in education is thus also related to existing infrastructure, as also highlighted by Twining et al. (2015). In other words, one anticipates a directly proportional relationship between ICT infrastructure and teacher training whereby as there is more and new infrastructure, training should increase. While training initiatives on ICT are far from covering all teachers in Africa, InfoDev reported that as far back as 2007 an estimated 61 different ICT-related teacher training and professional development programmes, projects, and courses were under way in Africa (Farrell and Isaacs, 2017).

Understanding the complex evolving nature of ICT in general, additional clarity regarding the concepts "ICT-qualified" and "trained to teach subjects using ICT facilities" is needed. Consistent with this need for further reflection, Twining and Henry (2014) in an article entitled "Enhancing ICT Teaching in English Schools: Vital Lessons" argue that the term ICT has changed its focus over time and refers to several specific aspects of the use of technology within schools, encompassing the specialist subjects, the use of technology to support learning across the curriculum, as well as digital technology itself.

Acknowledging the many dimensions to being "ICT-qualified" and "trained to use ICT to support teaching other subjects", the UNESCO ICT Competency Framework for teachers provides a helpful guide to codify ICT competencies and therefore can inform the development of new indicators to measure teacher training and preparedness. The UNESCO ICT Competency Framework for Teachers outlines the competencies that teachers need to integrate ICT into their professional practice. It emphasizes the role that ICT can play in supporting six major education focus areas across three growth phases of knowledge acquisition (UNESCO, 2011). Currently some international teacher training programmes are based on this framework, such as *Partners in Learning* from Microsoft or INTEL Teach to name only a few (UNESCO, 2011b).

Table 1. UNESCO ICT competency framework for teachers

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: UNESCO ICT Competency Framework for Teachers Retrieved from: http://unesdoc.unesco.org/images/0021/002134/213475e.pdf

Content of training

Indicators 8 and 38 indicate proportions of trained teachers; however they do not shed light on the content of teacher training and how it is delivered.

In order to shed more light on what kind of ICT training is provided, UIS might consider the inclusion of indicators that capture the content of teacher training. The ICT Education 2013 Survey on the use of ICT in Brazilian schools, proposes the following elements to be captured under teacher training content:

- Steps towards ICT integration;
- Instructional practice;
- Content knowledge and curriculum support;
- Continuous lifelong learning;
- Introduction to the 21st century skills;
- Collaboration;
- Problem solving;
- Communication;
- Creativity and innovation;
- Self-regulation and initiative (Seo, 2013; Brazilian Internet Steering Committee, 2013: Survey D2, page 373).

Training on assistive technologies

Enhancing pedagogy through ICT can also be a powerful means to improve equity in education and thus can be an important mechanism for inclusive education (UNESCO, 2014a). Once again the use of assistive technologies can be highlighted, but teachers need to know how to use it in addressing the needs of people living with disabilities. Inclusive education and the use of assistive technologies, however, are rarely covered in teacher training programmes so teachers typically do not have the skills to support children with a number of disabilities (UNESCO, 2014a) and this is especially so in developing countries. Nevertheless, some developing countries are establishing courses as part of teacher training. Grönlund et al. (2010), for example, provides an example from the United Republic of Tanzania whereby courses are on offer at the tertiary level to train secondary education teachers on inclusive education. Meanwhile Bangladesh also offers courses on inclusive education but there is no regulation that requires teachers to take these courses, which are considered elective (Grönlund et al., 2010 The training of teachers to effectively use assistive technologies also needs to be captured in new indicators.

Financing ICT training

The responsibility to finance ICT trainings also varies. Thus the UIS survey might consider data that answers questions regarding who is paying for the training courses outside of pre-service training including teachers themselves, governments, or the school. (see Brazilian Internet Steering Committee, 2013. ICT Education 2013 Survey on the use of ICT in Brazilian schools (See Appendix, Survey D2).

3.2 Who is being trained in ICT?

In addition to the competencies related to "ICT-qualified" or those needed to support the teaching of various elements of the curriculum, indicators shedding light on which teachers are targeted for training are also lacking. For example:

- Are teachers in all grades targeted? Some countries including Kenya are rolling out ICTs in primary grades only, while ICT is heavily concentrated in secondary education in Djibouti (UIS, 2015).
- Are teachers in all subjects targeted? It is important to note that in many contexts specific subject areas such as mathematics and sciences are emphasised in using ICT facilities for teaching. Just in Africa there is the OER[2]4schools initiative that is investing in applied pedagogy, including ICTs, in mathematics and sciences (Hennesy et al., 2015)). While indicator ED38, Proportion of primary and secondary-school teachers trained to teach subject(s) using ICT facilities (for ISCED levels 1-3), mentions subjects, it does not provide a break down by subject area.
- Are only teachers trained or are administrators, online facilitators and principals also trained? Some literature suggests that not only teachers need to be trained but also school administrators since they play a critical role to ensure ICTs are to be used in schools (Infodev, 2015).

3.3 Where and how are teachers trained?

The current set of indicators is further limited in that they do not provide in-depth analysis of where and how teachers are trained. Within its professional development model, InfoDev distinguishes three phases of succesive on-going training and preparation:

- Pre-service, focusing on initial preparation on pedagogy, subject mastery, management skills and use of various teaching tools (including ICTs). It serves 3 main purposes:
  - preparing teachers to use ICTs in pedagogically effective ways with respect to standards or competencies;
  - preparing teachers to teach ICT-related content;
  - applying ICTs to serve teacher education (Davis, 1995).
- In-service, including face-to-face and distance learning opportunities building upon pre-service formal (accredited) training and directly relevant to teacher needs; and
- On-going formal and informal pedagogical and technical support, enabled by ICTs, for teachers, targeting daily needs and challenges (Farrell and Isaacs, 2007).

When reviewing the evidence of when teachers are trained to use ICT in education, most teachers seem to be trained in-service. In Africa teacher professional development and training programmess for ICT focus on in-service teachers, but increasingly so there is a shift towards the inclusion ICT related training within pre-service teacher training programmes (Farrell and Isaacs, 2007). The proposed UIS indicators need to capture both pre-service and in-service professional development initiatives that are flourishing in different parts of the world. By expanding current indicators the shift from in-service teacher professional development and

[2] Open educational resources (OER) are materials used to support education that may be freely accessed, reused, modified, and shared, see http://www.unesco.org/new/en/communication-and-information/resources/publications-and-communication-materials/publications/full-list/guidelines-for-open-educational-resources-oer-in-higher-education/

training programmes towards the inclusion of pre-service teacher development on ICTs in education can be monitored. For example, one could opt for an indicator that determines the proportion of teachers whose teacher training programmes included a specific subject on how to use computers and the Internet to teach general curriculum.

Moreover within teacher training, there are several methods used to incorporate ICTs including:

- Stand-alone technology courses;
- Resource-based learning including workshops;
- Infusion of technology into methods and foundation courses;
- Application during field experience including mentoring;
- A combination of the above (Davis, 1995).

ICT training as a compulsory element of teacher training

In Europe only 25% of students in Grade 8 and 11 and 30% in Grade 4, respectively, are taught by teachers for whom ICT training is compulsory (European Commission, 2013). However, while many ICT skills are acquired outside of the formal teacher training system, additional effort needs to be made to make ICT a mandatory rather than optional part of the curriculum. Many national curricula in Europe include ICTs and it is increasingly becoming an examined subject in Africa and Asia as national strategic development documents recognise the importance of ICTs in teacher capacity-building and professional development. Despite the increased emphasis on training teachers on the use of ICT, decisions to make such training compulsory are not always certain. In the case of Rwanda, such courses in teacher training programmes have not always been a prerequisite for teaching where it was officially considered an optional subject within its national curriculum (Davis, 1995). Rwanda is currently in the process of reviewing its ICT in Education Policy and UNESCO is supporting the Rwanda Board of Education in updating its ICT Essentials for Teachers Curriculum, based on the UNESCO ICT Competency Framework for Teachers (ICT CFT) (UNESCO, 2014b).

The current UIS questionnaire collects data on proportions of teachers that are trained to use ICT in their teaching. However, where teacher training on ICT is compulsory, tracking proportions of trained teachers takes on an added dimension and helps countries track their own progress in meeting national standards. Moreover, countries may have different training requirements specific to various target audiences for instance according to educational level, by subject taught, etc. While the UIS survey currently includes questions on training disaggregated by educational level, it might consider additional data that answers questions regarding whether or not ICT training is compulsory in the country and if so at which levels and subjects.

ICT-enabled distance education

UIS indicator (ED35) aims to capture data on the proportion of primary and secondary teachers that are trained via ICT-enabled distance education programmes. Unfortunately little data currently exists; moreover the UIS indicator only covers current teachers and therefore does not measure the use of ICT-enabled distance education in pre-service training. It would be important to capture these different stages of professional development in the proposed indicators on teacher training of ICT in education. Additionally, the survey does not specify whether training is formal or informal in nature.

Beyond collecting data on proportions of teachers trained via ICT-enabled distance education programmes, UIS should also elaborate an indicator that captures the extent of the training provided via ICT-enabled distance education compared to on-site training. The ICT Education

2013 Survey on the use of ICT in Brazilian schools, proposes the following elements to be captured under teacher training:

Proportion of teachers enrolled in continuous professional development using ICT including:

- those attending ICT-enabled continuous professional development on-site;
- those attending ICT-enabled continuous professional development in person and via ICT-enabled distance education programmes; and
- those attending only via ICT-enabled distance education programmes (Brazilian Steering Committee, 2013, Survey A4).

Type of technology used in ICT-enabled distance education

Radio, television and the Internet among others can be used to provide distance education opportunities, but some of these types are to be used in specific contexts. In particular, regional and or cultural differences have also been shown to be a factor in the use of ICT-enabled distance education in Africa. For example, a 2003 survey by the *Association for the Development of Education in Africa (ADEA) Working Group on Distance Education and Open Learning* found that while the Internet and CD-ROMs were used in 35% of francophone institutions providing teacher training services, only 5% of anglophone and 0% of lusophone institutions, respectively, were also using them (Farrell and Isaacs, 2007). While many types of ICTs can be used to provide distance education opportunities and some are better suited to different contexts, the UIS survey does not capture this information but rather groups all ICTs toegether.

Television has been shown to be effective delivery mechanism for ICT in a number of developing countries. In the Arab States, the GENIE programme (2006) in Morocco trains teachers on using ICTs in education through distance education modes using television (MathémaTICE, 2009). Meanwhile, Interactive Television has also been used to further the integration of ICTs in education in Morocco by providing teacher training possibilities through interactive television (MathémaTICE, 2012).

The Internet, while not always available in all regions in developing countries, is another form of ICT that can deliver ICT-enabled distance education. An Internet based Open and Distance Learning (ODL) programme for Teachers on ICTs can be found in Lesotho, where the *Commonwealth of Learning (COL)* and the *Lesotho College of Education* worked together to train academics on instructional design using ODL in 2002 (Daniel & Menon, 2007). In the Arab States, The *National Centre for Educational Innovation and Experimentation (CNIPE)*, which is another Internet-based project as part of a partnership with the *Advancing Learning and Employability for a better Future (ALEF)*, (a *USAID* funded project), provides teachers an online learning environment on how to create multimedia educational content. Meanwhile in Latin America both primary and secondary school teachers are trained via ICT-enabled distance portals, grouped together under the *Latin American Education Portals Network (RELPE)*. Countries in the region manage educational portals that offer local educational content to students and teachers (Gutterman, et al., 2009).

Teacher resistance to ICT-enabled distance education

Teachers frequently resist ICT-enabled distance education for several reasons. Where surveys have been carried out on ICT-enabled distance education, evidence exists that teachers frequently view online courses as of poor quality, for example teachers from the United Kingdom in preparation to the '*Vital courses'* (Twining and Henry, 2014). Contrasting evidence however

also exists that specific service providers such as the Open University are seen as delivering high quality distance education (Twining and Henry, 2014). In Africa, the number of primary and secondary-school teachers trained via ICT-enabled distance education programmes other than radio and television seems to be hampered by a lack of ICT infrastructure and affordable connectivity; yet several initiatives do exist. For example UNESCO has launched an initiative in Kenya to train teachers on ICT integration in education, but the pilot phase of the project has not yet been evaluated (UNESCO, 2015a).

Uruguay provides another interesting example of how teachers can be less than universally accepting of ICT-enabled distance education, even though it may also be somewhat attributable to the lack of access to infrastructure, incentives, or convenience. For example, when trained on a voluntarily basis, secondary school teachers showed a low participation rate (less than 10%), while primary teachers, which had ICT-enabled distance education imposed as the only means to take the course showed a significant increase with participation increasing up to 87% (UNESCO, 2011a).

Given teachers' resistance to learning via ICT-enabled distance education, data beyond administrative sources that target teachers can be instrumental to shed light on teachers' deeper levels of enagagement with ICT-enabled distance education. Moreover in Europe it is reported that a large majority of teachers choose to develop their ICT-related skills during their own spare time which may include various means of professional development such as training provided by school staff and participation in online communities (European Commission, 2013).

The European Commission's survey of Schools: ICT in Education Benchmarking Access, Use and Attitudes to Technology in Europe's Schools proposes an indicator on means through which teachers have engaged in ICT related professional development during the past two years:

- Personal learning about ICT in your own time;
- ICT training provided by school staff;
- Participation in online communities (European Commission, 2013).

3.4 Duration: For how long are teachers trained?

It is also important to capture for how long teachers are trained on ICTs. Research shows that ICT training should not be too short in duration nor should it be delivered sporadically. Rather, best results are obtained when teachers are exposed to training over an extended period of time, or if mentorship programmes or focus group discussions among teachers to exchange best practices are held regularly (UNESCO-UIS, 2009). Teacher professional development is a process and not an event (Infodev, 2015). One could opt for an indicator that determines the percentage of short courses on ICT integration in education that are offered to teachers within the overall curriculum or training programme.

4. Teacher usage of ICT in education

While it is important to measure the training that teachers receive to engage with ICT, training programmes do not ensure that ICTs are used in the classroom to their potential. The evidence for teacher resistance to training for and/or using ICTs can carry over to implementation in the classroom for a number of reasons including a lack of training, and a lack of institutional support mechanisms. The UNESCO-UIS Guide to Measuring Information and Communication Technologies (ICT) in Education (2009) currently explores the conceptual domain of teacher usage with four indicators:

- **ED36 Proportion of primary and secondary-school teachers who teach basic computer skills (or computing) (ISCED levels 1-3)** Total number of teachers who teach basic computer skills (or computing) in primary and secondary schools expressed as a percentage of all teachers;
- **ED37 Proportion of primary and secondary-school teachers who currently teach subject(s) using ICT facilities (ISCED levels 1-3)** Total number of teachers who currently teach subject(s) using ICT facilities in primary and secondary schools expressed as a percentage of all teachers**;**
- **ED39 Ratio of learners-to-teachers of basic computer skills (or computing) (ISCED levels 1-3)** Number of learners enrolled in grades where basic computer skills (or computing) are currently taught divided by the number of teachers who teach basic computer skills (or computing);
- **ED40 Ratio of learners-to-teachers using ICT to teach (ISCED levels 1-3)** Number of learners enrolled in grades with ICT-assisted instruction divided by the number of teachers currently teaching subject(s) using ICT facilities).

However new indicators of teachers' usage of ICT in education should reflect a multitude of teaching and learning methods in an effort to relate usage patterns to impacts including learning achievement and other student outcomes. While the preceding list of indicators has been shown to be available based on data in administrative systems, new indicators demonstrating usage patterns will have to also rely on additioanl data sources including teacher level surveys in schools.

4.1 Expanding usage indicators using a framework of teacher competencies

One way to expand on the measurement of teachers' usage of ICT that is consistent with international policy standards for teacher training is to consider the depth and scope of the knowledge ladder, which is a set of complementary, alternative models or perspectives that together provides policymakers with an education reform trajectory in support development (UNESCO, 2011a) contained in the UNESCO ICT competency framework for teachers. Thus when looking at the usage of ICT it is important to capture the type of activities carried out by teachers with students including:

- Lectures;
- Reading comprehension;
- Customised support to specific students;
- Search for information in books, in magazines and/ or on the Internet;
- Organizing group and collaborative work between students;
- Production of materials by students;
- Debates and presentations made by students to the whole class;
- Development of spreadsheets and graphics with the students;
- Theme projects or assignments;

- Playing educational games;
- Contributing to the community through theme projects;
- Teaching to use computers and the Internet (Bazilian Internet Steering Committee, 2013: SurveyE2, page 377).

4.2 The use of ICT-enhanced pedagogy in teaching

ICTs are used by teachers for various purposes to enhance teaching and learning including general communication, playing games, doing homework, searching for information, and practicing and drilling such as foreign language learning or mathematics (OECD, 2014). At the same time ICTs have changed the instructional context requiring that teachers be able to effectively manage evolving teaching and learning paradigms and related processes[3].

It is believed that trained teachers can use ICT to extend and enrich learning across the curriculum through:

- 'Neoprogressives' that want learning communities and see computers as 'mind-tools' that can make this possible;
- Use of problem-solving software and tools to extend and enrich learning;
- As a major framework for learning in certain disciplines, notably languages;
- Computer Practice Framework that focuses on curriculum transformation (Twining and Henry, 2014).

Despite the belief that training prepares teachers for using ICT effectively in the classroom, a survey of ICT in Education in Europe recently reported that most teachers still use ICT first and foremost to prepare their teaching and only a few use it during lessons for enhancing pedagogy (European Commission, 2013). Moreover, the relationship between the use of ICT-enhanced pedagogy and performance is not clear. For example a study in Brazil found that the introduction of computer laboratories in schools had a negative impact on student performance, while teachers' use of the Internet as a pedagogical resource supported innovative classroom teaching and learning, resulting in improved test scores (UNESCO, 2014a). This contradiction suggests the importance of solid pedagogical principles and their application when introducing ICT-enhaned pedagogy.

4.3 Teacher usage of digital curriculum and assessment in education

In the literature on ICT in education, and more specifically in the UNESCO Competency Framework for Teachers (UNESCO, 2011b) a distinction is made between pedagogy, and curriculum and assessment. Curriculum refers to what is taught and pedagogy on how teaching is carried out.

It has been argued that the use of digital resources by teachers in the classroom can play an important role in improving learning. Somewhat surprising then are survey results of ICT in Education in Europe showing that digital resources are still very rarely used. The highest frequencies (i.e. between 'several times a month' and 'at least once a week') of usage at all grades are found in Denmark, as well as in Norway at Grade 11 (also showing a high frequency

[3] This subject is treated in greater depth in Broadley, T., J. Downie and D. Gibson (2015). "Evolving Learning Paradigms: Re-setting the baselines and collection methods of ICT in education statistics post-2015". http://www.uis.unesco.org/StatisticalCapacityBuilding/Workshop%20Documents/Communication%20workshop%20dox/Paris%202014/ICT-learning-paradigms_EN.pdf

at Grade 8), and to a lesser extent and depending on the grade in Bulgaria, Lithuania and Sweden (European Commission, 2013).

UIS indicator ED37 Proportion of primary and secondary-school teachers who currently teach subject(s) using ICT facilities does not only refer to pedagogy but may also implicitly refer to the use of digital curriculum (resources) and assessment. However, one may also want to consider indicators that relate directly to the use of digital curriculum and establish the proportion of teachers by type of use among general activities:

- Searching for content to be used in the classroom;
- Researching or downloading pedagogical audio-visual content;
- Researching or downloading books and articles available on the internet;
- Searching for sample class plans;
- Accessing teacher web portals;
- Other purposes related to teaching activities (Brazilian Internet Steering Committee, 2013: Survey E10, page 410).

Even if digital curriculum and assessment seem to be mostly applicable in countries at more advanced stages of ICT development, various digital materials are increasingly available for use, while Open Education Resources (OER) are also increasingly available for re-use and adaptation within developing countries. Open Educational Resources (OERs) are any type of educational materials that are in the public domain or introduced with an open license. The nature of these open materials means that anyone can legally and freely copy, use, adapt and re-share them. OERs range from textbooks to curricula, syllabi, lecture notes, assignments, tests, projects, audio, video and animation (UNESCO, 2015b). The increasing availability of OERs do not necessarily translate into use by teachers. For example, in Europe it is reported that 15% of students in all grades are taught by teachers declaring that they create digital resources every or almost every day, and about an additional 15% at least once a week (European Commission, 2013).

The explicit mention of curriculum and assessment by teachers through ICTs is also largely absent from the proposed indicators to measure ICT in education. The ICT Education 2013 Survey on the use of ICT in Brazilian schools includes such an indicator (E7) which specifically measures the proportion of teachers by assessment methods used (Brazilian Internet Steering Committee, 2013: Survey E7, page 410). UIS might consider this indicator to ensure a more holistic perspective on teacher usage of ICT in education.

4.4 Teaching basic computer skills

Beyond using ICT to enhance other curriculum, several teachers use ICT in their teaching of basic computer skills and/or computing. Indicator ED36 determines the proportion of primary and secondary-school teachers who teach basic computer skills (or computing) (for ISCED levels 1-3). This indicator is important to understand the capacity of schools and the education system in general to provide instruction on basic computer skills and or computing; moreover it provides a benchmark by which to asses current qualifications of teachers and training needs. In Kenya, for example, primary and secondary-school teachers who teach basic computer skills (or computing) are in inadequate supply; however, this is in addition to the already existing lack of infrastructure such as electricity and computers thus hampering the uptake of computer skills in many countries (ICT Works, 2011).

As mentioned above, requisite infrastructure available to teach basic computer skills or computing or lack thereof is also relevant. In Nigeria, the National Policy on Education (Federal Republic of Nigeria, 2004), recognises the prominent role of ICTs in society and has integrated ICTs into education. To this end the government attempts to provide basic infrastructure and training for teachers at the primary school level whereas 'computer education' is offered as a core-vocational and vocational elective in junior and senior secondary school level schools, respectively. Although efforts are made to ensure that ICTs are available and used in secondary schools, the level of uptake is still low and most schools do not offer ICT training programmes (Adomi and Kpangban, 2010).

4.5 ICT policy and its normative influence on teachers' usage

Before the integration of ICT into national education systems can be effective, policy measures need to be established. Policy not only puts ICT in context but also motivates teachers to make adequate use of them and more generally to bring about change. This is illustrated in a study of 174 ICT-supported innovative classrooms in 28 countries (Kozma, 2003). In 127 cases, there was an explicit connection between the innovation and national policies that promoted the use of ICT (Jones, 2003). But while the introduction of ICT policy is necessary for change, it is not sufficient to result in its implementation or impact (Tyack and Cuban, 1995). Policies can, of course, fail to succeed and this happens when: i) they are viewed as mere symbolic gestures; ii) teachers actively resist policy-based change that they see as imposed from the outside without their input or participation (Tyack and Cuban, 1995); iii) they do not have explicit connections to instructional practice (e.g. focus on hardware rather than their relationship to pedagogy); iv) they do not provide teachers with an opportunity to learn the policies and their instructional implications; and v) there is a lack of programme and resource alignment to the policies' intentions (Cohen and Hill, 2001).

Several countries have embarked on formulating a policy on ICT in education that ideally captures a set of variables including objectives, the availability of ICT equipment, learning materials, and teacher capacities (UNESCO, 2011). In Africa, InfoDev found that back in 2007 there appeared to be a shift from experimentation pilot projects in ICT towards a more systematic integration of ICTs as per national government policies (Farrell and Isaacs, 2007). However, eight years later, in most countries in sub-Saharan Africa, most countries remain at the experimental phase, particularly in primary education (UNESCO-UIS, 2015).

It is important to examine the extent that policy captures the importance of teacher usage of ICTs and plans for its roll-out. The presence of national and/or education sector-specific policy, plan or regulatory framework for ICT implementation strategy has a direct influence on teachers' motivation but also the general environment in which ICTs are rolled-out. The policy can provide for motivation to make use of ICT in the classroom such as pay incentives, additional professional development opportunities and peer recognition. At the moment the UIS survey includes questions related to ICT in education policies, plans and regulatory frameworks, but not specifically in regards to the teacher component. Indicators that better capture the role of teachers and issues affecting them would also be an important consideration for the future.

For instance, governments often support or give incentives to teachers to purchase ICT devices, including for out of class use. It is reported across Europe that the most frequent incentives used to reward teachers for using ICT in teaching and learning are additional ICT equipment for use in the class with additional training hours to support pedagogy (European Commission, 2013). This support can even be extended, as in the case of Jordan, where the Ministry of Education has officially recognised all ICT in education training programmes as part of the

Teacher Ranking System, which can determine salary scales (UNESCO-UIS, 2013). Support or incentives can also take the form of dedicated government funding, tax brackets on ICT hardware, or even investment in or sponsoring of research in developing low-cost ICT devices (UNESCO-UIS, 2009), and are important political commitments for teachers to make use of ICTs. Additional indicators that measure the existence of such policies and/or that measure which and how many teachers these policies affect is also an area for possible exploration.

4.6 Teacher usage and ICT infrastructure

ICT equipment is quickly evolving technologically making it difficult for school administrators to make informed and sustainable choices regarding which devices to use. Moreover, this rapidly evolving digital landscape results in additional challenges to prepare teachers to integrate ICT into their teaching (Twining and Henry, 2014). The *UNESCO Competency Framework for Teachers* advocates that teachers know basic hardware and software operations, and to be flexible in order to use a variety of subject-specific tools and applications (UNESCO, 2011). If teachers are not exposed to this variety of ICT facilities and devices the confidence to make use of the devices may be compromised. In developing new indicators it might be important to go beyond those measuring usage of ICT in education in general, opting for indicators measuring the use of different types of ICT tools. Countries have a variety of combinations of ICT tools available to them in schools. However, given infrastructural difference between urban and rural areas in many developing countries, measuring types of ICTs used is relevant as the needs for countries with a high urban student population are different from those where more students reside in rural areas.

However, infrastructure in many countries is weak and this affects usage. According to UIS survey data in the Arab region (i.e. Egypt, Jordan, Oman, Palestine and Qatar), despite existing teacher training, many simply do not use computers during instruction due to a lack of experience, as well as the fact that many computers have become obsolete (UNESCO-UIS, 2013). In Europe it is also interesting to note that maintaining educational technology equipment is an in-school task often performed by teachers rather than by an external organization (European Commission, 2013). Teachers are thus ideally required to make informed decisions about which hardware and software to use and to ensure they have access to well functionning devices.

Given infrastructure's impact on teachers' motivation to use ICT, one may also want to measure obstacles that teachers encounter when ICTs are not used in the classroom and education in general. The ICT Education 2013 Survey on the use of ICT in Brazilian schools (Survey F1) looks specifically at:

- the proportion of teachers by their perception of potential obstacles, as well as
- the proportion of teachers by their perception of possible impact of ICT including:
    - gained access to more diverse/better quality materials,
    - using new teaching techniques,
    - carrying out administrative tasks more easily , etc. (Brazilian Internet Steering Committee, 2013: Survey F3, page 429).

4.7 Teacher usage of ICT in administration and organization

Increasingly, ICT tools are used to facilitate administrative, organizational and managerial processes by reducing burden, as well as effectively integrating official information channels about students, curricula, teachers, budgets and activities. UIS ICT in education indicators therefore also reflect key policy areas related to computers in educational administration and organization and their increased presence. This notion, however, can be broadened to capture ICT integration in a more holistic way, better encompassing teachers' roleincluding their contributions towards the smooth running of school-level administration.

Additionally, ICT also has evolved as a good means for informing community members (e.g. parents, politicians, and researchers) about educational news and policies (Hepp, et al., (2004). Going forward, additional indicators that capture this information is another possibility for the post-2015 context. Again usage and training form two sides of the same coin thus where additional skills of teachers are needed, additional indicators measuring relavant training should also be considered.

For example, UIS may want to determine the proportion of teachers that make use of ICT for carrying out administrative school tasks such as record keeping, communicating with parents, and preparing, administrating, compiling and analyzing students' test marks.

5. Teacher training and usage of ICT in education and gender

Gender is an important cross-cutting theme that needs to be addressed in all teacher policy areas including training, teaching and usage. In Africa, the Research ICT Africa (RIA) *Household and Individual Access and Usage Survey* reveals that very little ICT data is disaggregated on gender lines (Gillwald et al., 2010). However, this statement is not only true of Africa as a UIS data scoping survey completed in 2007, showed that only 8% of Least Developed Countries (LDCs) and 11% of all African countries had sex-disaggregated data for the following indicators:

- **ED8 Proportion of ICT-qualified teachers in primary and secondary schools (ISCED levels 1 – 3);**
- **ED35 Proportion of primary and secondary-school teachers trained via ICT-enabled distance education programmes (ISCED levels 1 – 3);**
- **ED36 Proportion of primary and secondary-school teachers who teach basic computer skills (or computing) ISCED levels 1 – 3);**
- **ED37 Proportion of primary and secondary-school teachers who currently teach subject (s) using ICT facilities ISCED levels 1 – 3); and**
- **ED38 Proportion of primary and secondary-school teachers trained to teach subject(s) using ICT facilities ISCED levels 1 – 3).**

Indicators related to teacher training can demonstrate persistent inequalities. Based on analysis of twelve different countries in Africa, male and female teachers are not equally likely to be trained to use ICTs in classrooms; moreover male teachers are more likely to be trained to teach basic computer skills and computing (Mwebaze, 2011). Furthermore, Bowser-Brown argues that female students are more likely to enter programmes with few technology skills due to lack of access (Bowser-Brown, 2004). In a 2007 study carried out by Makerere University, the authors found that female students were less likely to use ICT compared to their male

counterparts. There is evidence to show that this disparity continues at the tertiary level in Africa. For example a study undertaken under the Pan African Research Agenda on the Pedagogical Integration of ICT in Africa showed that females had lower rates of ICT usage than males. As a reaction to this, Derbsvhere argues for policy initiatives that encourage recruiting female computer-related staff and technicians to ensure female staff have equitable access to computer-related training and support (Derbyshire, 2003).

Beyond sex-disaggregated data, it may be useful to examine a whole set of indicators to determine to what extent the indicators can take into account, where feasible, the meaningful participation of men and women. The gender equality marker, used as a mandatory requirement for all UN agencies under the United Nations System – Wide Action Plan (UN - SWAP), can be useful in this regard using a four-point scale:

- 0 - The indicator does not contribute to measuring gender equality: (i) it is either gender - unaware; i.e. it does not address existing gender inequalities; or (ii) it does not have any discernible effect on human activity;
- 1 - The indicator is gender-sensitive: it identifies and acknowledges the existing differences and inequalities between women and men, but does not address them;
- 2 - The indicator is gender-responsive: it identifies and acknowledges the existing differences and inequalities between women and men and articulates policies and initiatives which address the different needs, aspirations, capacities and contributions of women and men;
- 3 - The indicator is gender-transformative as it relates to discriminatory policies and practices and affects change for the betterment of life for all (UNESCO, 2013).

6. Conclusions

Effective training and usage of ICT in teaching is important since poor or improper usage and management of ICT in the classroom may result in underperformance in educational outcomes. The inefficient use of ICT-assisted instruction wastes time that could have been used for learning content and developing skills (UNESCO-UIS, 2014a). Effective usage requires quality teacher training; thus, it is important to identify clear indicators that shed light on how teachers are trained as well as how they use ICT in education.

More specifically, effective teacher training and appropriate linkage to ICT usage, which gives rise to sound pedagogy has different approaches based on different types of learning (i.e. basic education approach, knowledge acquisition approach, knowledge deepening approach and knowledge creation approach), as per the *knowledge ladder,* which is a set of complementary, alternative models or perspectives that together provides policymakers with an education reform trajectory in support development (UNESCO, 2011a). Indicators that help capture the level of application of ICT is therefore important.

This paper suggests that indicators measuring teacher training need to capture a wider range of professional development models, reflecting Ministries of Education expanding systems in order to maximise and evaluate their impact in schools (Twining and Henry, 2014). With the advanced use of ICT in the classroom it is necessary to go beyond the mere presence of ICT in the classroom, but also develop indicators to measure teachers' specific usage patterns, as well as linking the added value of ICT usage patterns to student outcomes. However when measuring the outcomes, the methodology of collecting data cannot focus solely on administrative data collected through ministries of Education. A more holistic approach which also collects data at

the teacher level, as per the ICT Education 2013 Survey on the use of ICT in Brazilian schools, may be necessary (Brazilian Internet Steering Committee, 2013).

ICT changes rapidly and affects both discipline knowledge and pedagogical possibilities in ways that influence teachers' perspectives for employing ICT as a constant part of the learning process (Twining et al., 2013). Teacher indicators that capture these evolving needs are also important to identify and develop.

Lastly, it is important to recognise that teacher training and usage of ICT do not take place in a vacuum, and therefore need to be viewed within a larger system where the teacher is central to several conceptual domains including ICT in education policy, curriculum development through the provision of digital content, ICT-enabled pedagogy, ICT infrastructure, and organization and administration at schools.

It is hoped that by expanding UIS ICT in education indicators on teachers that a more comprehensive view of the role of the teacher in influencing pupil outcomes, including achievement and school completion can be achieved. Furthermore, meaningful discussion must continue amongst stakeholders and consensus should be achieved in order to prioritise data needs as to not overburden countries during data collection activities, while still collecting the essential elements of what ICT in education needs to capture.

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