Strategies for Training teachers to integrate ICT in the classroom:
A systematic review

A proposal by
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CONTENTS

1 BACKGROUND

1.1 DESCRIPTION OF THE PROBLEM

Promise of ICT for basic education[1] is of much interest from a development perspective since basic education completion is widely accepted as a necessary condition for development (UNESCO[2]). Successful integration of ICT into the teaching-learning process is largely viewed from student performance perspective.[3] Cheung and Slavin's work, for example represents the kind of comprehensive systematic reviews available from a student performance perspective.

However, parallel to the student performance approach, a teacher competency and performance perspective, where the teachers' efficacy and beliefs are seen as critical, too has developed.[4]

To our knowledge no systematic review has been done on the teacher dimension in integrating ICT in education. We propose a systematic review to examine the impacts of, or lack thereof, training of teachers for ICT integration in education in both developed and developing countries with the view of informing the policy process in developing countries.[5]

1.2 REVIEW QUESTIONS

- What strategies are used to train and/or support teachers to integrate ICT in the classroom?
- What are the measures of integration?
- How has each strategy impacted the success of teachers in integrating ICT in the teaching-learning process?

The third review question is dependent on the typology resulting from the answers to the first and second questions.

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[1]According to UNESCO's International Standard for Classification of Education (ISCED) basic education is primary education covering six years of full-time schooling (age of entrance normally being not younger than five years or older than seven) followed by 3 years of lower secondary schooling.

[2]http://www.unesco.org/new/en/unesco/themes/icts/

[3] SeeMeans, B.(1994); Durrant C. and B. Green (2000); Perraton, H. D. and C. Charlotte Creed (2000); Lagrange, J.B., M. Artigue, C. Laborde and L. Trouche (2001); Pelgrum, W.J. (2001); Tearle, P. (2003); Lai, K. (2008); Law, N., Pelgrum, W. J., & Plomp, T. (2008); Bingimlas, K.A. (2009); Tolani-Brown, Nikita, McCormac, M.A. & Zimmermann, Roy (2009); Strigel, C. and S. Pouezevara (2012); Berlinski and Busso (2013); Cheung and Slavin (2013); Tamim, R. M., M.B. Robert, E. Borokhovski, P. C. Abrami and R.F. Schmid (2013); Voogt, J., Knezek, G., Cox, M., Knezek, D. and ten Brummelhuis, A. (2013))

[4] See Kerr, S.T. (1991); Bandura, A. (1994); Ringstaff, C. and L. Kelley (2002); Hennessy, S., K. Ruthven and S. Brindley (2005); Baek, Y., J. Jong, and B. Kim (2008); Hermans R., J. Tondeur, J. van Braak and M. Valcke (2008); MacDonald, R.J. (2008); Richardson J. W. (2008); McCormick, J. and Ayres, P.L. (2009); Abuhmaid, A. (2011); Richardson J. W. (2011); Tømte, C., E. Hovdhaugen and N.H. Solum (2011); Khan, S.H., M. Hasan, C.K Clement (2012); Orr, D., J. Westbrook, J. Pryor, N. Durrani, J. Sebba and C. Adu-Yeboah (2013); Tondeur, J., J. van Braak, P.A. Ertmer and A. Ottenbreit-Leftwich (2013).

[5]Developing countries are low or low-middle income countries as defined by the World Bank. See Annex 7.1.

1.3 WHY THE REVIEW IS IMPORTANT

Positive impacts of ICT on learning are widely acknowledged in terms of general educational outcomes[6] or in regard to specific outcomes,[7] but, the evidence is not compelling.

In their comprehensive review of "effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms, Cheung and Slavin note that:

> Educational technology is making a modest difference in learning of mathematics. It is a help, but not a breakthrough. However, the evidence to date does not support complacency. New and better tools are needed to harness the power of technology to enhance mathematics achievement for all children."

Teachers' role in harnessing the power of technology

Harnessing the power of ICT for education is based on a new definition of "good teaching," that is, teaching that revolves around student-centred practices and leverages relevant ICT tools and resources as meaningful pedagogical tools. However, implementing a new definition of effective teaching requires 'teacher change' in their knowledge, skills and attitudes regarding the integration of technology into the teaching-learning process. One important attitude change is the belief that technology can make a difference.

> If technology is to be used in powerful ways — to support student collaboration, inquiry, and interactive learning — then teachers' beliefs about learning and teaching often must change. For those teachers who firmly believe that the lecture-recitation-seat work model of instruction is the best teaching method under all circumstances, even the best professional development on technology will have limited success. Integrating technology into instruction is a difficult, time-consuming process; only those teachers who believe that technology use will lead to significant benefits for their students will undertake the associated challenges. [Ringstaff, C. and L. Kelley, 2002]

The vast body of literature that examines the effects of ICT on student learning outcomes typically tries to correct for moderating effects of teacher characteristics by assigning teachers as randomly as possible (e.g. the systematic review by Leung and Slavin (2013) and references therein). Yet, the teacher dimension can be the determining factor in the successful integration of ICT for achieving learning outcomes. For example, in a recent RCT study Cost Rica by Inter-American Development Bank the authors note that:

> "The evidence suggests that teachers went through the motions as prescribed but did not master the innovation in a way that would have allowed students to get the most of it."

What would encourage teachers to truly embrace technology in the classroom? The obvious policy tool is training and support for teachers, but, what do we know about training teachers for technology integration in the classroom.

Training and support for Teachers

The necessity of training of teachers to use the technology in question and follow-up support in the use of the technology is typically taken as a given in the literature. More attention seems to be paid to attributes that are more difficult to inculcate. For example, there is much evidence to show that

[6] For example, IAE 2006, MacDonald 2008, Ringstaff and Kelley 2002, Tamim *et al.* 2011, Tolani-Brown *et al.* (2011).

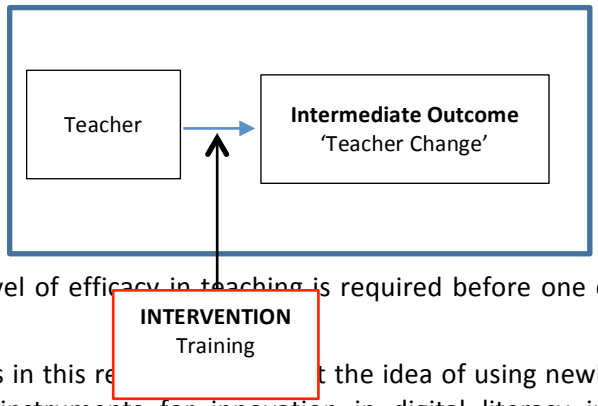
[7] Cheung and Slavin, 2013, for example, on a study of technology in mathematics education

teachers' beliefs, among other factors are critical in the integration of technology into the teaching and learning process. Two other often cited factors are self-efficacy about teaching in general and the teaching-learning culture within which the teacher operates(for example, Hermans *et al.* 2008,Lai 1993, Ringstaff and Kelley 2002,Voogt *et al.* 2011).

> Self-efficacy is a defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura 1994). Self-efficacy is an attribute which is developed over time and is not easily affected through one intervention. The teaching-learning culture too is a complex attribute which cannot be affected by training. The attribute which can be affected through training is a change in the attitude of the teachers that technology can make a difference in the teaching-learning process and they have the capacity to implement such.The literature has demonstrated that teachers are more likely to adopt ICT when they are convinced of its benefit for education (McCormick and Ayers 2009, Means 1994, Subhi 1999).

Teacher training and support for ICT integration may target any of these attributes and influence some of all of them. The expected outcome depends on each situation and is best described as 'Teacher Change' regarding ICT integration. We denote that as an intermediate outcome because it is difficult to capture a 'teacher change' in its entirety as a quantitative measure.

Figure 1. 'Teacher Change'



Generally, some level of efficacy in teaching is required before one can integrate technology into teaching:

> [The] findings in this re t the idea of using newly graduated teachers as instruments for innovation in digital literacy in schools is unrealistic. Bearing in mind the way use of digital tools is defined as a core competence in the Norwegian curriculum for the compulsory education, it's questionable if teacher training institutions are able to prepare their students adequately in this respect before entering the profession.(Tømte*et al.*2011: 32).

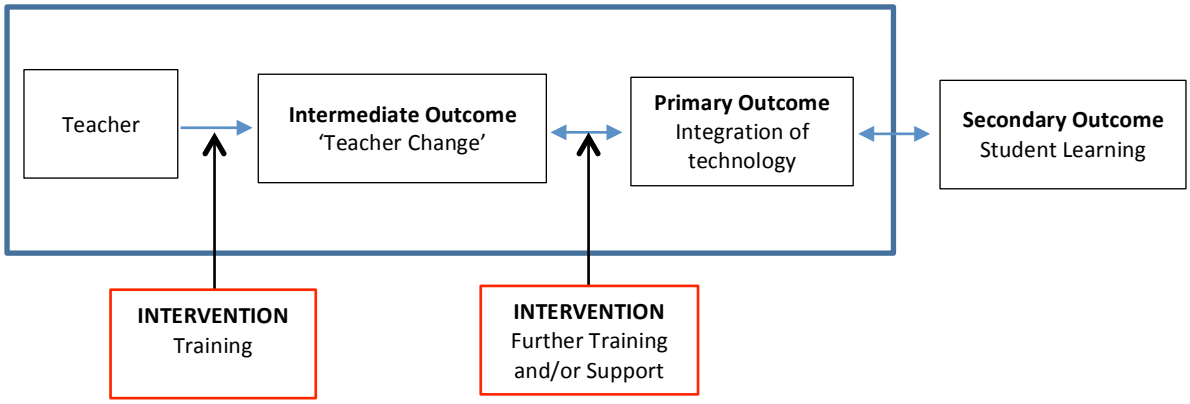
However, there is also evidence to show that teachers are more amenable to integrate technology in early stages of their career (Cheung and Slavin, 2013). Therefore, the review will include both pre-service and in-service training of teachers.

Success in technology integration as an indicator of 'teacher change'

The 'teacher change' variable is a complex one which includes changes in the teachers' knowledge, skills and attitudes with knowledge and skills often described as efficacy. Given the complexity, we

propose to use the teacher change in action- i.e. the success of actual integration of ICT in the teaching-learning process - as a proxy indicator. Therefore in our theory of change 'teacher change' is an outcome of which we may not have full information at any time, but, how well the teachers integrate technology in the classroom is more measurable. Therefore the former is labelled an 'intermediate outcome' and the latter a 'primary outcome'. Learning outcomes which are affected by student characteristics and other factors are secondary outcomes.

Figure 2. Interventions and Outcomes



There is much evidence to show that Learning outcomes indeed depend on how well teachers integrate technology in the classroom. Commenting on a study on the use of a particular ICT-based teaching tool called ILS in a classroom, Cheung and Levin observe that:

> [A] Statistically significant difference was found among the three categories of program intensity. Applications that required computer use of more than 30 min or more had a larger effect than those that required less than 30 min a week. Some researchers argued that the small effect produced by these supplemental programs could be due to low implementation. For instance, in their study of Integrated Learning Systems (ILS), Van Dusen and Worthen (1995) found that few teachers followed the actual ILS usage guidelines. Thus, students typically only ended up spending between 15% and 30% of their commended time on the computer. Some used less than 10 min per week. Teachers, who often saw ILS as supplemental technology, rarely integrated ILS instruction into regular classroom instruction. Reviewers and researchers often treat the limited time devoted to technology as an implementation problem, but perhaps it speaks to a fundamental problem that separate CAI programs are not well accepted or seen as central to instruction by teachers, so teachers may not make sure that students get the full amount of time on technology recommended by vendors. Future studies should investigate more closely the impact of the time and integration factors for various grade levels (Leung & Slavin, 2013).

In the proposed systematic review we will do exactly as suggested above by focusing on technology use or technology integration as our outcome of interest.

1.4 OBJECTIVE OF THE REVIEW

The objective of the review is to identify a methodologically sound set of studies on types of teacher training and support used in the integration of technology and the effects of such training and support on technology integration, distinguishing between studies as to the developing

/developed nature of the country or the context in order to inform policymakers in developing countries to select interventions to suit their context.

1.5 DESCRIPTION OF THE INTERVENTION AND OUTCOMES

The intervention of interest is the training and support for teachers for ICT integration into the teaching–learning process (Training for technology integration, for short). We include the term 'support' because a study conducted as early as 1990 shows that ICT integration is a long term process that requires continuous support not just one time training (Sheingold, 1990). More recent literature also shows training for technology includes varying levels of follow-up support (e.g. regular/sporadic/none). The support can come from multiple sources (Trainer/School Administrators/ Peers/Others). The types of interventions for focus will be determined after the evaluating the types of interventions available in the literature. The evaluation will be done after the second screening by dog a preliminary data extraction using a representative sample of the yield of studies. Nine coding variables are proposed as a working list for the preliminary data extraction step. (See Table 3).

The outcome of interest is the integration of ICT into the teaching-learning process with the success of integration defined in terms of the frequency of use or other measures.[8] As discussed earlier, for the purposes of the present systematic review, 'Teacher Change' is considered an intermediate outcome and learning outcomes as a secondary outcome. We feel this focus on technology integration is timely because the literature on ICT in education overlooks this primary outcome. Besides, and there are already many systematic reviews on effects of ICT on student learning (See Levin (2013) and references therein).

1.6 HOW THE INTERVENTION MIGHT WORK

A visual representation is given in Figures 1 and 2. The more descriptive theory of change is given in Annex 7.4

2 METHOD

Campbell Collaboration's approach to systematic reviewing[9] was used to develop the protocol. For risk of bias analysis, calculation of effect size and meta-analysis methods are based on a methods workshop organized by LIRNEasia in Colombo during April 25-27, 2014.[10]The theory of change in

[8]Van Braak et al (2004) identified two types of integration –supporting computer use and computer use in the classroom and use a scale such as -- 0 (never), 1 (once a term), 2 (monthly), 3 (weekly) and 4 (daily). - to quantify computer use in the classroom. Tweed (2013) also used a similar scale.

[9]International Development Coordinating Group (IDCG): Protocol and review methods guidance (http://www.campbellcollaboration.org/artman2/uploads/1/Campbell_International_Development_Coordinating_Group_Protocol_and_Review_Guidelines_2.0_Final.pdf)

[10]Based on the quantitative methodological research that Hugh Waddington is leading in the 3ie London office and presented by Jorge Garcia Hombrados.

Annexe 8.3 will be used as the framework for the review and for informing the inclusion criteria, data extraction and coding.

2.1 CRITERIA FOR INCLUDING STUDIES IN THE REVIEW [PICOS]

Inclusion exclusion criteria are summarized in Tables 1-2. A summary is given here using the PICOS labeling.

2.1.1 Population

The study population includes teachers serving in primary or secondary schools in both developing and developed countries. For informing policy purposes we will look in detail at the developing country sub group (or countries classified as low or lower middle income by the World Bank in 2013 (Section 7.1).

2.1.2 Interventions

The intervention is the training and support for teachers for ICT integration of teachers. The intervention may vary by training technique, setting and media (Cordingley *et al.*2007). A working typology is given in Rows 1-4 in Table 3.

2.1.3 Types of Comparisons

The differences in effect between the selected set of interventions will be compared.

2.1.4 Types of outcome measures

Following our theory of change, technology integration in the classroom is necessary for achieving student learning outcomes through technology. Therefore the outcome of interest in the proposed systematic review is the teachers' success in technology integration in the classroom.[11]

2.2 SCREENING OF STUDIES AND DATA EXCTRACTION

2.2.1 First screening and relevant inclusion/exclusion criteria

At the first stage, application of the inclusion and exclusion criteria will be conducted by pairs of review group members working independently and then comparing their decisions and coming to a consensus.

The inclusion/exclusion criteria are given in Table 1. The titles of the studies and year of publication will be used for the purpose. Abstracts will be used as needed.

Table 1. Inclusion/Exclusion Criteria for the First Screening

[11] Van Braak et al (2004) identified two types of integration –supporting computer use and computer use in the classroom and use a scale such as --0 (never), 1 (once a term), 2 (monthly), 3 (weekly) and 4 (daily). - to quantify computer use in the classroom. Tweed (2013) also used a similar scale.

Authors, Year, Title (abstracts will be used as needed):	
Is the study published in 1990 or after?[12]	Yes or maybe: Continue No: Terminate
Does the study focus on primary, secondary education	Yes or maybe: Continue No: Terminate
Does the study consist of an entirely secondary source only (i.e. book review or textbook which adds nothing to	Yes or maybe: Terminate No: Continue
Does the study concern a use/uses/integration of technology in the classroom	Yes or maybe: Continue No: Terminate

2.2.2 Second screening and relevant inclusion/exclusion criteria

The second screening will be based on title and abstract and full text as needed and will use additional inclusion exclusion criteria as listed in Table 2.

Table 2 Inclusion/Exclusion Criteria for the Second Screening

Author/s, year, Title and Abstract and full text as needed[13]	
Is the study design experimental or quasi-experimental design?	Yes or maybe: Continue No: Terminate
Does the study measure the extent of technology integration	Yes or maybe: Continue No: Terminate
Does the study describe the teacher training or support	Yes or maybe: Continue on to data extraction No: Terminate

Data extraction will be carried out as detailed in Sec 2.2.3. The quality of studies will be assessed using the risk of bias assessment criteria (Section 2.4) prior to the synthesis of data as detailed in Section 2.5. (.

[12] We use the seminal work by Sheingold et al (1990), a first comprehensive effort at understanding computer use in the classrooms in the USA, to safely assume that studies on computers use in classrooms in the developing world would hardly exist prior to 1990..

[13] Prior to the second screening, references from systematic reviews on ICT in education learning outcomes (e.g. Cheug & Slavin, 2013) will be added to the list of publications to be screened.

2.2.3 Data extraction

Data extraction will be conducted on the final set of included studies and will be carried out in two steps.

(1) Pilot data extraction for refining the data extraction variables.

The research team of five will code the studies using the following data extract variables for a random sample which contains at least 10% of the selected studies. After coding, the team will convene to decide which variables should be removed for paucity of studies and which should be added. An additional sample will be drawn, if needed.

Table 3. A Working set of data extraction variables

Category	**Variable**
Training (Intervention)	Teaching IT as a subject/Other subject-specific/General
	Technology specific/multiple technologies
	With follow-up support/no follow up support
	Other
Support (Intervention)	None/Sporadic/Regular
	Early stage/middle stages/Throughout implementation
	Provided by Trainer/Mentor/Supervisor/Peer
	Technical/Pedagogical/blended/inspirational
	Other
Technology Integration (outcome)	Once a day/once a week/once a semester
	Used only once/twice/more than twice by the teacher
	Subject-specific/General
	Technology specific/multiple technologies
	Other
Type of ICT	Computers/Laptops/Tablet; Standard software /Custom software; with Internet/without Internet
Aim of training	Technology integration efficacy/Attitude change about technology/Other
Country	Developed/Developing (Middle Income/Low income)
Grade	Primary/Secondary
School characteristics	Rural./Urban; Affluent/Not Affluent
Year of publication	1990-2013

(2) Final extraction

The refined set of data extraction variables resulting from the pilot will be used to extract the variables from the publications as they selected through the second screening.

2.3 SEARCH METHODS

Searches will be conducted using online research databases with the assistance of an information scientist. Other sources will be searched by the SR team. A list is given below.

2.3.1 Search terms

We will be using the services of an information scientist to define the search terms. The Terms Teacher AND ICT OR Technology] AND (Integration OR Adoption) AND Training OR Development will be used in the grey literature search process.

2.3.2 Electronic Databases (research)

We suggest searching on the following two types of databases:
Education relevant databases:

- ERIC
- Australian Education Index,
- British Education Index
- Canadian Business and Current Affairs (CBCA)- Education
- Education Abstracts (Wilson),

Social Science databases

- EBSCO
- Psych INFO
- Social Science Citation Index (SSCI)
- JSTOR
- Sociological Abstracts
- BLDS – British Library of Development Studies
- Dissertation and Theses (UK, USA/Canada and Australia)

We will choose additional databases that index the journals in the journals check list in Sec 2.2.1.1 below.

2.3.2.1 Journals checklist

The databases will be checked to see if the following journals are included in those. . If they do not, those excluded journals, or a selected set of those will be searched manually.

American Educational Research Journal; British Educational Research Journal; Canadian Journal of Learning and Technology; Comparative Education; Comparative Education Review; Computers and Education; Distance Education; Distance Education (Australia); Education Action Research Journal 1993–2003; Educational Technology and Society; European Journal of Teacher Education; Harvard Educational Review; International Journal of Educational Development; International Journal of Instructional Technology & Distance Learning; International Review of Research in Distance and Open Education; International Review of Research in Open and Distance Learning; Journal of Asynchronous Learning Networks; Journal of Comparative and International Education; Journal of Distance Education; Journal of Distance Education (Canada) ; Journal of Education for Teaching; Journal of Educational Research: International Research and Pedagogy; Journal of Educational Psychology; Journal of In–Service Education; Journal of Interactive Media in Education; Journal of Interactive Online Learning; Journal of Learning Design; Journal of Teacher Education; Journal of

Technology; Journal of Technology and Teacher Education and Career and Technical Education Research (formerly known as Journal of Vocational Education Research) ; Language Learning and Technology; Learning and Assessment; Open Learning; Prospects; Teacher College Record; Teacher Development: An International Journal of Teachers' Professional Development; Teachers and Teaching: Theory and Practice; Teaching and Teacher Education; Teaching and Teacher Education; Turkish Online Journal of Distance Education;

2.3.3 Conferences papers

AERA-American Education Research Association

2.3.4 Electronic Databases (institutional)

- World Bank
- DFID (www.dfid.gov.uk)
- IDRC, Digital library of the International Development Research Centres (IDRC)
- British Library of Development studies
- USAid
- UNICEF (http://www.unicef.org.uk)

2.3.5 ICT in Education Projects

Web sites for the following will be checked for relevant studies. All web sites were checked in May 2013 for availability.

Active learning with Technology- United states, Computers; Applying technology to Restructuring ; Learning- United states, Computers; Basic education Project- Turkey, Computers; Basic Education ; Support 2- Namibia, Computers; Conflict-prevention Project- Rwanda, Computers; Connect ED ; Project- Uganda, Computers; DEEP-South Africa, Handheld Computers; Discovery Channel Global ; Education Foundation- Namibia, Video; Discovery Schools Project- Namibia, Video; Educational Inclusion for Disabled Students, Save the children- Lesotho, Video; EFA Curriculum Project- Uganda, Nicaragua; Enlaces- Chile, Computers; G. S. *Soeurs de la assumption*- Rwanda, Computers; EdTech; Leaders Online- United states, Computers; Fundamental Quality and Equity Levels- Guinea, IRI; Initiative for Namibian Educational technology- Namibia, Computers; Intel Teach to the Future-South Africa, Turkey, Computers; Kids on the Block, SchoolNet- Namibia, Computers; Learn Link- Namibia, Computers; New School Program- Egypt, Computers; Mental Arithmetic: The Numbers Family- Honduras, Radio; Nota 10- Brazil, Television, *Programa de InfornaticaEducativa*- Costa Rica, Computers; Relief International- Schools Online- Tajikistan, Computers; *Salto para o Futuro*- Brazil, Television; SIEEQ Project- Congo, Video; Uganda VSAT Rural Connectivity Project – Uganda, Computers; Telesecundaria- Mexico, Television; WIDE World- Namibia, Computers.

2.3.6 Search engines

Scholar.google.com will serve as the main source of grey literature.

2.3.7 Unpublished studies

Unpublished studies will be sought out where possible through personal communications with experts some of whom will be invited to serve in an advisory panel.

2.4 ASSESSMENT OF RISK OF BIAS

We suggest to use of a Risk of Bias assessment tool we name the '3ie tool'. This tool is based on the quantitative methodological research that Hugh Waddington is leading in the 3ie London office and presented by Jorge Garcia Hombrados at a workshop on Quantitative methods in systematic reviews" held by LIRNEasia in Colombo during April 23-25 in Colombo, Sri Lanka. We suggest the use this tool due to following reasons:

- Captures the risk of bias concepts of existing tools including CEBP, EPOC and Cochrane's.
- Addresses the statistical and conceptual assumptions underpinning the validity of quasi-experimental designs which are likely to me the main output of the proposed search.

The 3ie Tool consists of seven categories of bias, namely -- s 1) Sample Selection bias; 2) Confounding variables bias 3) Motivation bias (or Hawthorne effect); 4) Spill-over bias 5) Reporting bias; 6) Other risk of Bias such as placebo effects, courtesy bias, survey effects, inadequate survey instruments etc. and 7) Bias due to misinterpretation of significance of effect.

For each of the criteria, the risk of bias will be rated: 1-High, 2-Medium and 3-Low. All studies included in the in-depth review will be data extracted and quality assessed independently by two members of the research team. Discrepancies will be resolved through discussion between all the team members until consensus is reached.

Table 4 3ie Risk of bias Tool

Evaluation criteria	Category of bias	Relevant questions
1. Mechanism of assignment / identification	Selection bias	For experimental designs: Is the allocation mechanism appropriate to generate equivalent groups? Does the model of participation capture all relevant observable and unobservable
2. Group equivalence in implementation of the method	Confounding	Is the method of analysis adequately executed? Are the observable results of the counterfactual identification process convincing? Are all likely relevant confounders taken into account in the analysis? Is the estimation method sensitive to non-random attrition?
3. Hawthorne effects	Motivation bias	Are differences in outcomes across groups influenced by participant motivation as a result of programme implementation and, or monitoring?

4. Spill-overs and Cross-overs	Performance bias	Is the programme influencing the outcome of the individuals in the control group (including compensating investments for control groups)?
5. Selective methods of analysis	Analysis reporting bias	Is the method of analysis or specification model used by the author selectively chosen? Is the analysis convincingly reported (and available for replication)?
6. Other sources of bias	Other biases	Are the results of the study subject to other threats to validity (e.g. placebo effects, courtesy bias, survey effects, inadequate survey instruments)
7. Confidence Intervals and significance of the effect	Type I and Type II error.	Is the study subject to a unit of analysis error not adequately accounted for? Is the study subject to heteroscedasticity not accounted for? Is the study not taking into account possible heterogeneity in effects? Is the lack of significant effects driven by a lack of power?

2.5 SYNTHESIS

2.5.1 Measures of treatment effect

Comparable effect size estimates and their 95 percent confidence intervals will be extracted from the studies. For binary outcomes, we will calculate odds ratio (OR) or relative risk (RR) as the effect measure. For continuous outcomes, we will calculate standardized effect sizes (SMDs).The effect size scales the treatment effect in units which tell us the magnitude of the difference between the treatment group and the control group and is comparable across studies.

A Positive SMD (or RR > 1) indicates increase in the outcome under the intervention as compared to the control. A negative SMD (RR < 1) indicates decrease in outcome under the intervention as compared to the control. A SMD equal to zero (RR = 1) means no change in outcome over the comparison. Whether these relative changes represent positive or negative impacts will depend on meaning of the outcome in the context of the programme being evaluated

2.5.2 Dealing with missing data

Most quasi-experimental studies used in impact evaluation in economics do not report the information required to calculate standardized mean differences. Where sufficient data are not available to calculate effect sizes, we will contact primary authors to obtain this. Where primary authors are unable to provide relevant information, we will calculate response ratios which offer greater possibilities for estimation. Response ratios measure the proportional change in an outcome in the situation in the intervention group relative to that in the comparison group, giving a similar interpretation to a risk ratio. Borenstein et al. (2009) define risk ration R as:

$$R = Xt / Xc$$

where R is the response ratio effect size, Xt is the mean outcome in the treatment group and Xc is the mean outcome in the comparison group. The response ratio provides a measure of the relative change in an outcome caused by an intervention. In other words, the response ratio quantifies the proportionate change that results from an intervention (Hedges et al. 1999). This systematic review may include different study designs that assess the impact on different measures of the same outcome. For example, studies using a difference-in-differences approach would provide the impact of the program on the growth rate of the outcome. Other studies that use a propensity score matching approach would provide the impact of the program on the level of the outcome. Since the response ratio measures the proportional change in an outcome of an intervention, it does not seem unreasonable to combine the response ratios of studies measuring impacts of an intervention on levels with studies assessing impacts on growth rates of outcomes.14

2.5.3 Assessment of heterogeneity

Heterogeneity of effects across studies will be reported using the I-squared statistic, which measures consistency in findings. I^2 represent the percentage of the total variation across studies due to heterogeneity rather than sampling error or chance. . I-squared value<40% are generally considered low (Abuabara et. al., 2012)

2.5.4 Subgroup analysis

If there is significant heterogeneity (I^2 statistic is greater than 75%), we will do subgroup analyses using random effects meta- regression to investigate whether findings differ according to key contextual factors such as location in a developing country v. a developed country.

2.5.5 Assessment of publication bias

Publication bias refers to bias that occurs when research found in the published literature is **systematically unrepresentative** of the population of studies (Rothstein et al., 2005). In general, studies with statistically significant results are more likely to be published than studies without statistically significant results (''negative studies'') (Guyatt et al. 2011e).

To minimize the effects of publication bias, we will perform a thorough search for unpublished studies and will use analytical tools such as Funnel plots, Egger's plot to detect publication bias and Trim and Fill Analysis to re estimate mean effect size.

2.5.6 Quantitative data synthesis

We propose use a meta-analysis method to synthesize the effect sizes using statistical software STATA (STATA Corporation, College Station, TX, USA). As we believe that the treatment effect will not be same across studies, random effects model for meta-analysis would be more appropriate. By accounting for the possibility of different effect sizes across studies in this way, random effects

[14]On the other hand it would not be meaningful to combine standardized mean differences or mean differences of studies measuring impact in yields levels with studies measuring impact on growth rate of yields. Indeed, the mean differences approaches might require included studies to use not only the same outcome but also the same measure of outcome, preventing the aggregation of results of studies that use study designs based on panel data (cross-sectional before versus after) and those based on cross-sectional data only.

meta-analysis produces a pooled effect size with greater uncertainty attached to it, in terms of wider confidence intervals than a fixed effect model. [15]

If meta-analysis is not possible, we will present effect sizes graphically using forest plots, together with statistical power analysis for included studies, accompanied by a narrative synthesis.

2.5.7 Qualitative Syntheses

Any studies that do not meet the risk of bias criteria for quantitative meta-analysis (and those that do) may be used in a qualitative meta-analysis to answer research questions 1 and 2. A guideline cited by the Cochrane Qualitative and Implementation Methods Group will be used for the purpose.[16]

3 REFERENCES

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[15] An important benefit of meta-analysis is that it aims to account for the statistical power of studies. The alternative to meta-analysis would be vote counting, which simply reports the numbers of positive, negative and insignificant findings. However, using this approach, one is more likely to come to incorrect conclusions about studies that find insignificant effects on outcomes, when this maybe the result of low statistical power (small sample size) (Borenstein et al., 2009). One of the main benefits of meta-analysis is that by pooling across a larger sample, it takes into account both magnitude and precision of effects, allowing the review team to correct for possibly under-powered studies

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4 TIME-TABLE

Tasks	Proposed Start Date	Proposed End Date
Submission of protocol	May 02, 2014	May 15, 2014
Refinement of search strategy	May 16, 2014	May 31, 2014
Conducting searches& first screening	Jun, 2014	Jun 30, 2014
Second Screening	Jul 01, 2014	Jul 15, 2014

Critical appraisal &Extraction of data	Jul 16, 2014	Jul 31, 2014
Effect-size calculation and meta-analysis	Aug 01, 2014	Aug 15,2014
Report Writing	Aug 16, 2014	Aug 31, 2014
Peer review	Sep 01, 2014	Sep 30, 2014

5 ACKNOWLEDGEMENTS

The reviewers wish to thank Hilary for providing the training for the review team members and Mukdarut Bangapan for her guidance throughout the proposal preparation process.

6 DECLARATIONS OF INTEREST

The team consisting of Sujata Gamage, Chivoin Peou, Tushar Tanwar, Achala Abeykoon, Amritha Khakurel hereby do declare an interest in completing the systematic review titled "Strategies for Training teachers to integrate ICT in the classroom.

7 ANNEXES

7.1 LOW OR LOWER-MIDDLE INCOME COUNTRIES

World Bank listing as of April 1, 2014 was used to identify low or lower-middle income countries (http://data.worldbank.org/about/country-classifications)

Low-income economies ($1,035 or less)

Afghanistan	Gambia, The	Myanmar
Bangladesh	Guinea	Nepal
Benin	Guinea-Bisau	Niger
Burkina Faso	Haiti	Rwanda
Burundi	Kenya	Sierra Leone
Cambodia	Korea, Dem Rep.	Somalia
Central African Republic	Kyrgyz Republic	**South Sudan**
Chad	Liberia	Tajikistan
Comoros	Madagascar	Tanzania
Congo, Dem. Rep	Malawi	Togo
Eritrea	Mali	Uganda
Ethiopia	Mozambique	Zimbabwe

Lower-middle-income economies ($1,036 to $4,085)

Armenia	India	Samoa
Bhutan	Kiribati	São Tomé and Principe
Bolivia	Kosovo	Senegal
Cameroon	Lao PDR	Solomon Islands
Cabo Verde	Lesotho	Sri Lanka
Congo, Rep.	Mauritania	Sudan
Côte d'Ivoire	Micronesia, Fed. Sts.	Swaziland
Djibouti	Moldova	Syrian Arab Republic
Egypt, Arab Rep.	Mongolia	Timor-Leste
El Salvador	Morocco	Ukraine
Georgia	Nicaragua	Uzbekistan
Ghana	Nigeria	Vanuatu
Guatemala	Pakistan	Vietnam
Guyana	Papua New Guinea	West Bank and Gaza
Honduras	Paraguay	Yemen, Rep.
Indonesia	Philippines	Zambia

7.2 SOURCES OF SUPPORT

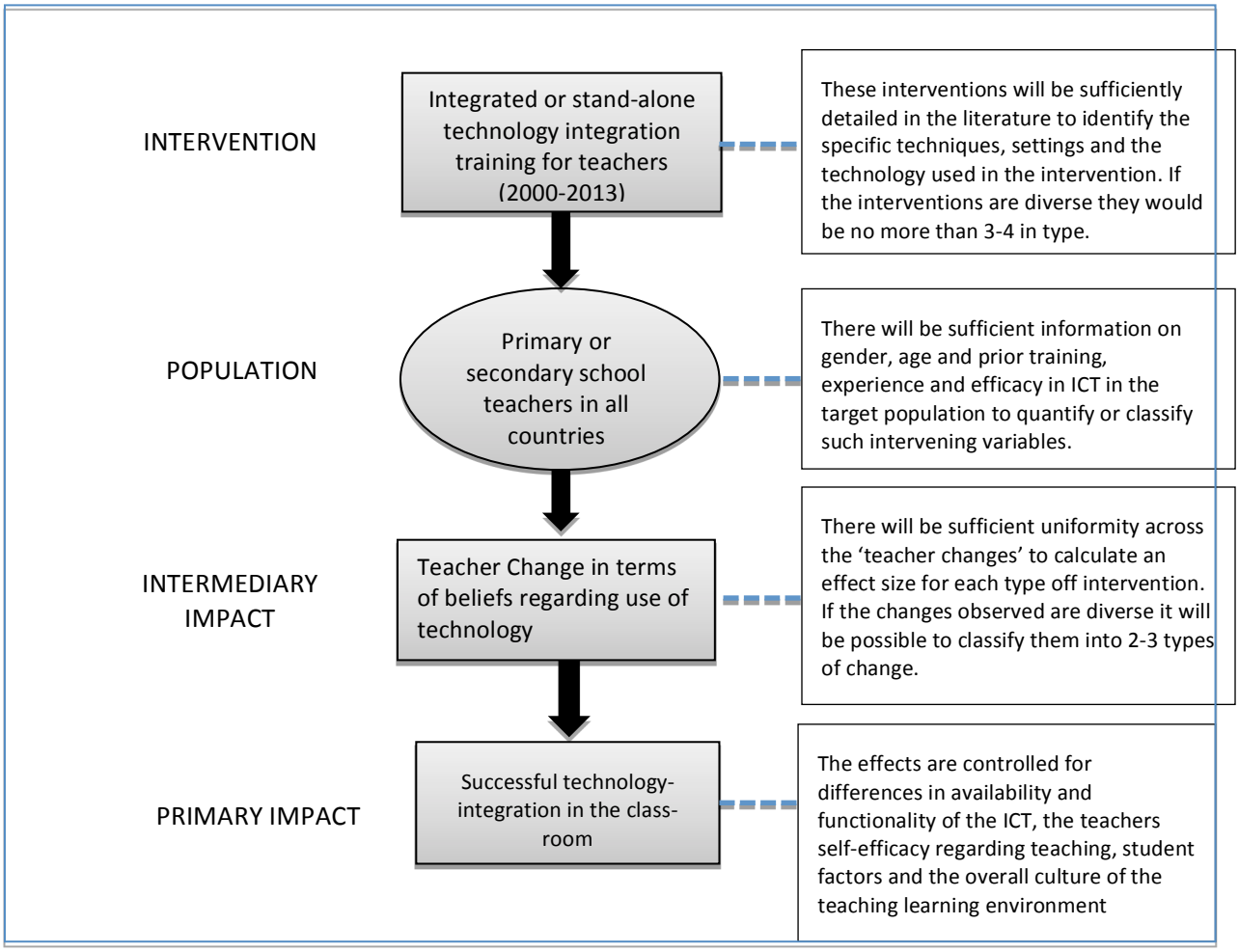
Provision of funding will be by IDRC

7.3 GLOSSARY OF TERMS

ICT — ICT includes all technologies, hard and soft, used for data processing and storage and communication. More familiar technologies are interactive software accessed using computers or computers with access to the internet. Can be (a) generic use of computers, Internet or ICT or (b) specific use of ICT tools, e.g., GeoGebra for teaching algebra.

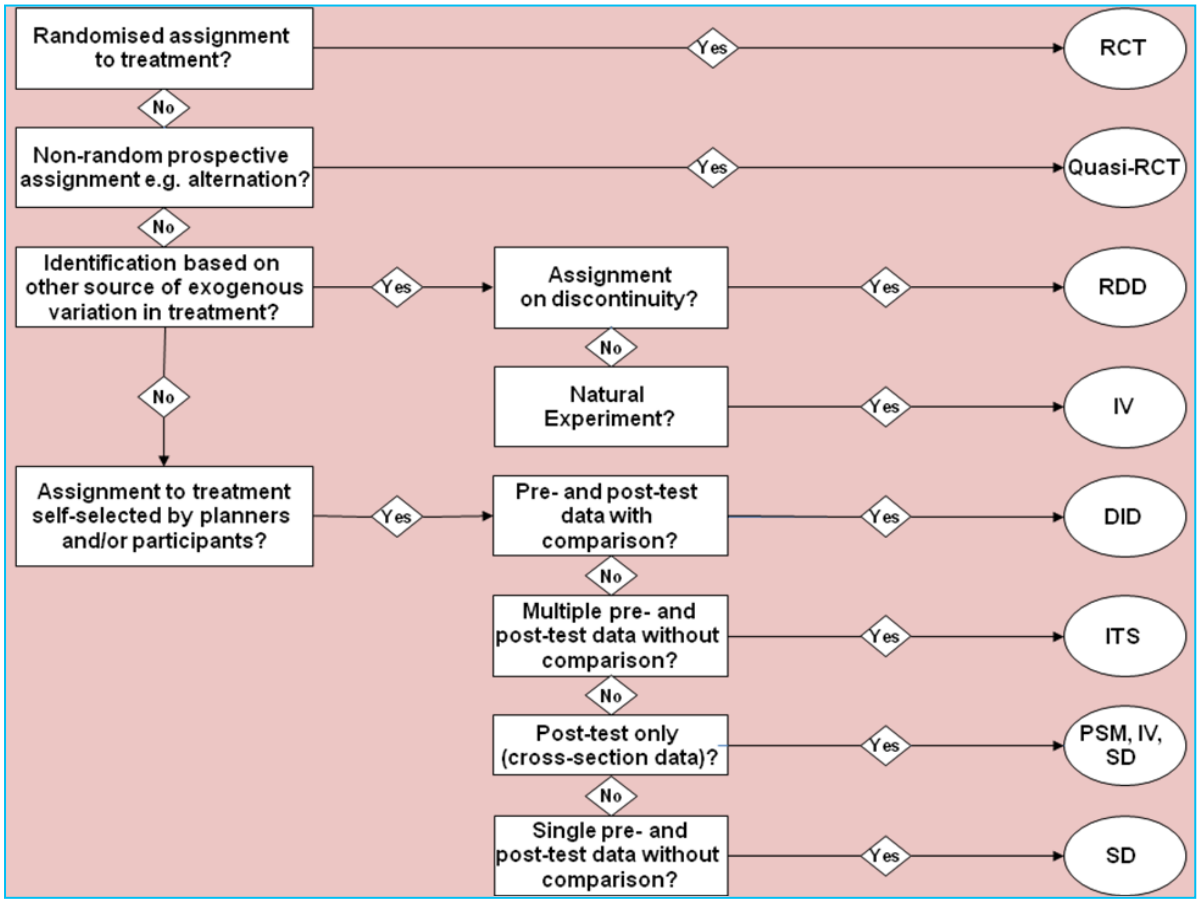
Technology integration: Use of technology in the classroom in the teaching-learning process in a regular manner with the regularity ranging from high to low. Definitionof high to low are yet to be determined. Use of technology in planning and reporting of the teaching learning process is not included.

7.4 THEORY OF CHANGE



7.5 STUDY DESIGN TYPOLOGY

(Source: Jorge Garcia Hombrados, Personal communication, April 2014)



Experimental

RCT	Randomized control trial

Quasi-experimental

Quasi-RCT	Quasi Randomized control trial
DID	Difference in difference design
ITS	Interrupted time series
IV	Instrumental variable design
PSM	Propensity score matching design
RDD	Regression discontinuity design
SD	Single differences design

Non-experimental

Case Studies

Other