Main title	Strategies for training or supporting teachers to integrate technology in the classroom
Sub title	A systematic review
Review group	
Section	TECHNICAL REPORT
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EPPI-Centre reference number	[To be completed by EPPI-Centre]
Month/year of publication	[To be completed by EPPI-Centre]
This report should be cited as…	[To be completed by EPPI-Centre]
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Conflicts of interest (if any)	-
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Strategies for training or supporting teachers to integrate technology in the classroom: A systemtic review

Technical report written by Sujata N. Gamage and Tushar Tanwar

EPPI-Centre

Social Science Research Unit

Institute of Education

University of London

EPPI-Centre report no. [# … DATE]

TECHNICAL REPORT

Contents

List of abbreviations

ICT	Information and Communication Technology
E-Book	Electronic Book
DLE	Digital Learning Environment
K-12	Primary and secondary education, typically 12 years of school education from kindergarten
LMS	Learning management system
GIS	Geographic Information System
OCU	Observations of Computer Use
RoB	Risk of Bias
RSCA	Rubric for Student-Centered Activities
SOARS	Student Online Assessment Reporting System
SOM	School Observation Measure
TAM	Technology Acceptance Model
UTTAU	Unified Theory of Technology Acceptance and Use
TAM	Technology Acceptance Model

Abstract

The review question

ICT for education holds much promise for improving student learning outcomes but the results to date have been less than spectacular. Perhaps in response, more attention is now paid to teachers' role as intermediaries in the use of ICT in education. Through our systematic review we want to know what has worked in terms of strategies for training and/or supporting teachers to what effect.

Who wants to know and why?

Teacher training colleges wishing to train teachers for technology use; school administrators wishing to introduce specific technologies into their schools or school systems; corporate donors, other well-wishers who are stakeholders in education; and policymakers at the international, national or regional level.

Methods of the review

We used a systematic review protocol approved by the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) at the University College London (UCL) Institute of Education. The method includes the six basic steps of Search, Screen, Map, Appraise, Extract and Synthesize. We searched the ERIC, EBSCO, SCOPUS, SSCI and Proquest databases electronically and hand searched a selected set of other sources to get a set of all possible citations. In the title and abstract screening step we included all citations contianing “empirical studies that measure technology use in primary or secondary education and published in 1990 or after" and excluded “studies that consisted of an entirely secondary source only (i.e. book review or textbook), deals with theoretical issues only or technology use by pre-service teachers or technology use in special education".

After the screening, we mapped the all the included citations according to the type of study (experimental studies to assess outcomes; observational studies to assess factors affecting outcomes; and other studies). All observational studies were further mapped according to the specificity of the technology and the theory of change used. After the mapping exercise, a second set of inclusion/exclusion criteria were developed and applied to the observational studies to include those that specified the technology and used a TAM-based theory of change and excluded all other observational studies.

We used the Risk of Bias assessment tool by Waddington and Homrados (2014) to assess the internal validity of both experimental and observational studies. The effect size of the interventions and the effect of miscellaneous other factors on the outcome were both calculated using the standardized mean difference (SMD) method.

Results

A search for reports relating to technology use in K-12 classrooms and published between 1990 and July 2014 yielded 11,419 citations. Initial screening led to 64 citations for all which we were able to obtain full reports or extended abstracts. After a follow-up screening and quality appraisal steps, 3 experimental studies (from 2 reports) and 8 observational studies (from 7 reports) were identified as of sufficient internal and external validity for statistical synthesis.

The experimental studies show that teacher training along with facilitating conditions, in the form of (1) one laptop per child or (2) on-site coaches, increase technology integration by effect sizes of +0.49 to +1.31 as compared to the control situations with no such facilitation. An effect size of 0.2 to 0.3 is considered a "small" effect; 0.5 a "medium" effect and 0.8 to infinity, a "large" effect, under certain conditions (e.g. Sullivan & Feinn, 2014). The effect sizes found in the present review can be considered medium to large. The costs of the interventions were not reported.

The observational studies exploring the various factors affecting the use of technology by teachers showed that the perception of teachers regarding the usefulness of a particular technology is twice as important as their perception of the ease of use of that technology in the classroom, if the technology is specified and related to a specific teaching or learning use. It is difficult to make generalizations when the technology intervention is not specified and not related to a specific use.

Implications

Studies on the effect of ICT use in the classroom on student learning are often conducted without exploring the logical requirement of acceptance and use of ICT by teachers in the classroom.

Eight observational studies from Belgium (4), Netherlands (1), Singapore (1), South Korea (1) and Taiwan point to the importance of the perceptions of teachers regarding the usefulness and the ease of use of a technology, with perceptions usefulness being as twice as important as perceptions of ease of use, underscoring the importance understanding and responding to 'teacher factors' in the effective use of ICT in improving student learning outcomes.

Three experimental studies, all from the US, are seemingly more concerned with the ease of use aspects. They show that teachers use ICT in increased if professional development on ICT use is accompanied by adequate follow-up support for the teachers or provision of one laptop per child in the classroom. While more attention should be paid to teachers' perceptions of usefulness in introducing ICTs in system-wide initiatives, such initiatives should be planned and executed as experiments to evaluate the effect of ICT on teacher perceptions and effect of perceptions and/or use on student learning outcomes.

CHAPTER ONE

Background

Outline of chapter

1.1 Aims and rationale for current review

ICT for education holds much promise for improving student learning outcomes but the results to date have been less than spectacular (See Bingimalas, K.A. , 2009; Cheung and Slavin , 2013; Lagrange et al., 2001; Means, B., 2010; Tamim et al., 2013; Tolani-Brown et al., 2009 and also OECD, 2015).

Perhaps in response, more attention is now paid to teachers' role as intermediaries in the use of ICT in education. More recent studies include a series of in-depth studies originating from Europe (e.g. Van der Linde, 2014) and many unpublished PhD theses from faculties of education in USA (e.g. Tweed, 2013).

Through our systematic review we want to know what has worked in regard to strategies for training and/or supporting teachers to what effect. Strategies of interest include various modes of professional development and other facilitating conditions to influence technology acceptance and use by teachers.

1.2 Definitional and conceptual issues

1.2.1 Theories of technology use

In a paper introducing a Unified Theory of Technology Acceptance and Use (UTTAU), Venkatesh et al. (2013) identified three major theories prevalent at that time, namely - Technology acceptance model, Social cognition theory and Innovation diffusion theory. Other theories found in the literature are the Expectancy value theory and the Technology, Pedagogy, Content Knowledge (TPCK) framework. In describing and coding reports included in the review we will be noting which of these theories, their variations or other theories are used in those reports.

1.2.1.1 TPACK framework

The Technology, Pedagogy, Content Knowledge (TPCK) framework (Koehler & Mishra, 2007) is found in many PhD theses emerging from Colleges of Education (Fordham, 2004; Hastings, 2009; Hong, 2009 & Johnson, 2006). The TPACK framework seems to stand on its own. The other theories discussed in this section are related to each other and addressed in the paper by Venkatesh et al to develop the UTTAU framework.

1.2.1.2 Social cognition theory

Social Cognitive Theory is a learning theory based on the idea that people learn by observing others. The observed behavior of an individual is influenced by the interaction of the following three determinants: (1) Personal: Whether the individual has high or low self-efficacy toward the behavior, (2) Behavioral: The response an individual receives after they perform a behavior) and (3) Environmental: Aspects of the environment or setting that influence the individual’s ability to successfully complete a behavior (Bandura, 1986).

Many variations of the social cognition theory are used in the 'ICT for education' literature, with self-efficacy used as key a determinant of ICT use (e.g. Tweed, 2013). Self-efficacy is 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). The technology, pedagogy and content knowledge (TPCK) model, or the idea that the technological, pedagogical, and content knowledge of the teachers are determinants of technology acceptance, is one variation of self-efficacy based theory (Koehler and Mishra, 2007).

1.2.1.3 Innovation diffusion theory (IDT)

According to Rogers (2003), the characteristics of an innovation as perceived by the members of a social system determine its rate of adoption. These characteristics are relative advantage, compatibility, complexity, trialability, and observability. When an innovation is perceived by users as having these attributes the innovation is more likely to be adopted.

In a review of different models of technology acceptance, Venkatesh et al (2003) found that the complexity attribute in IDT overlaps with "PEoU" or Perceived ease of use attribute in their model, and in fact, the all the IDT attributes can be captured by the UTAUT model.

1.2.1.4 Expectancy-value theory

According to Wozney et al (2003), models of expectancy-value have been largely applied to industrial and occupational settings and have been found to be an accurate predictor of productivity. They applied the theory to technology use by teachers and rationalized their choice as follows:

"Innovations are more likely to be adopted if the perceived value of the innovation and the likelihood (or expectancy) of success are high, as well as if these benefits outweigh the perceived costs of implementation. That is to say, teachers' decisions to use an innovation, such as computer technology, in the classroom relate to (a) how highly they value the innovation; (b) how successful they expect their application of the innovation to be; and (c) how highly they perceive the costs of implementation and use to be."

1.2.1.5 Technology acceptance models

The Technology Acceptance Model (TAM) by Davis (1989) is essentially an application of the theory reasoned action (TRA) by Fishbein and Ajzen (1975) to the acceptance of technology. According the 1975 version of TRA, intention towards a behavior is the strongest predictor of a particular behavior and the intention in turn is determined by attitude towards the behavior. In the case of technology acceptance by a teacher, the two attitude determinants are perceived usefulness and perceived ease of use of the technology by the teacher.

Subjective norms such as the person's perception that most people who are important to him think he should or should not perform the behavior in question and other external conditions would indirectly affect the attitude, and Davis has included subjective norm and other variables under the general category of external variations.

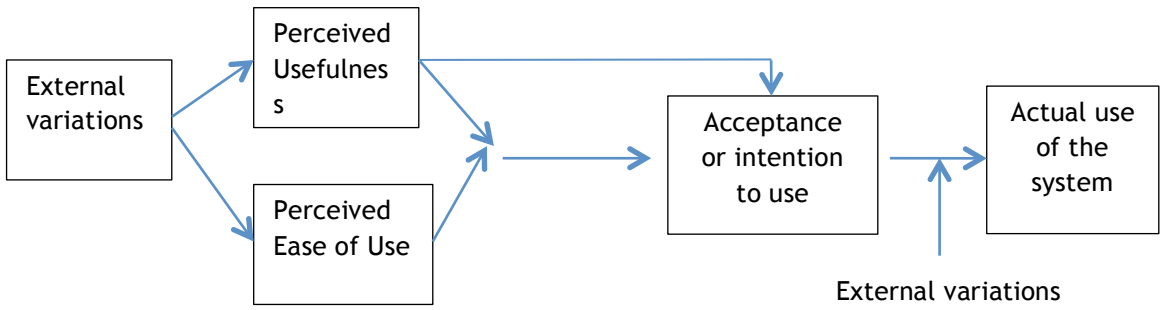

Figure 1-1 Technology Acceptance Model (Davis et al., 1989)

To improve the explanatory power of the TAM model, Venkatesh, Davis and others (2003), evaluated twelve other models used in the literature to come up with what they called the Unified Theory of the Acceptance and Use of Technology (UTAUT).

The behavioral psychological basis for this improved version is the Theory of Planned Behavior (TPR) introduced by Fishbein and Ajzen in 2006. TPR is an improvement to the Theory of reasoned action (TRA) by the same duo.

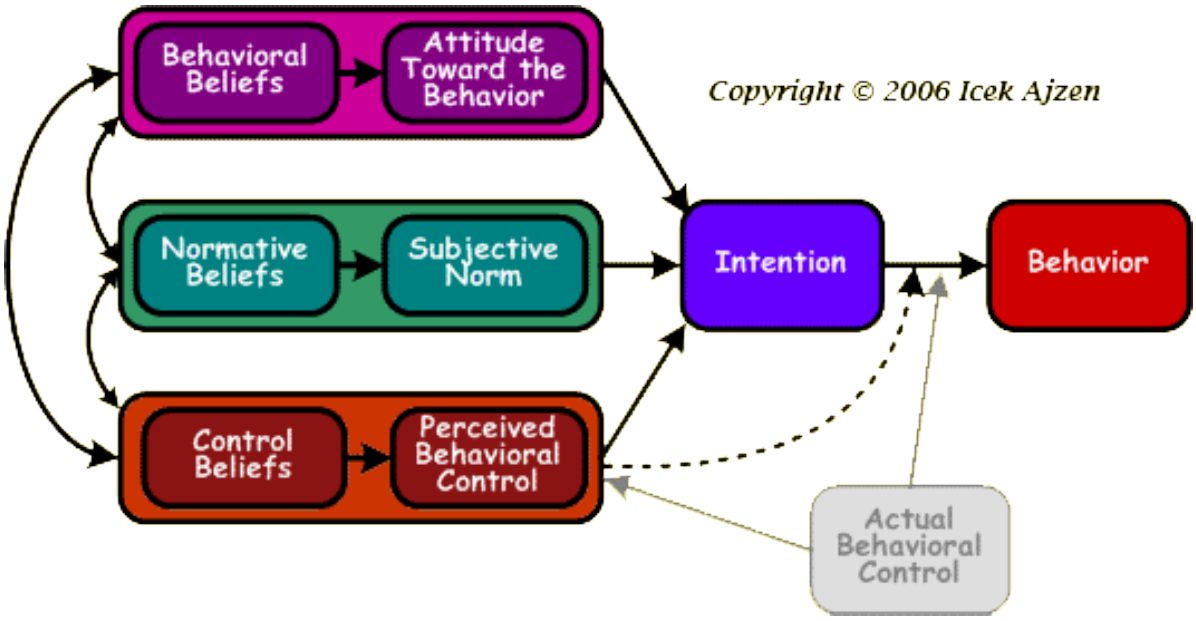

Figure 1-2. Theory of Planned Behavior

The UTAUT, the behavioral beliefs are distinguished as “Performance expectancy” and the “Effort expectancy, respectively. Normative beliefs are more explicitly stated as Social Influence and Control beliefs too more explicitly stated as perceptions of user about Facilitating Conditions. This model also emphasizes the importance of the attributes of the user such as gender, age, experience and voluntariness of use as other conditions affecting acceptance and use.

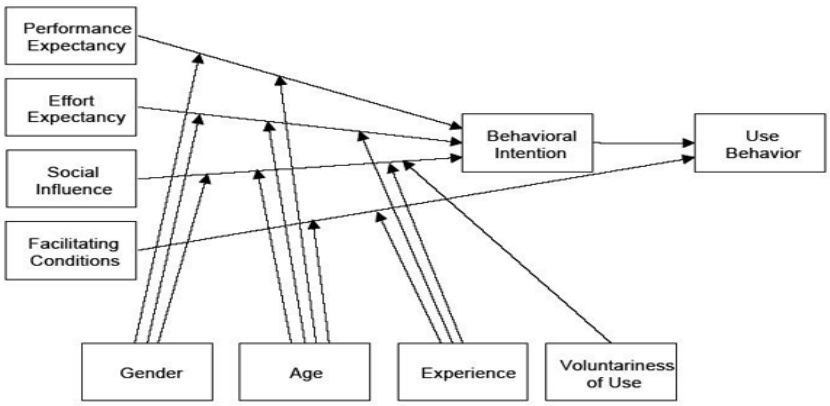

Figure 1-3 Unified Theory of Acceptance and Use of Technology (UTAUT), Venkatesh, 2003

Specifically, Effort expectancy or Perceived ease of use is the degree of ease associated with the use of the a technology; Performance expectancy the degree to which an individual believes that using the system will help him or her to attain gains in job; Social influence is the degree to which an individual perceives that important others believe he or she should use the technology; and Facilitating conditions is the degree to which an individual believes that an organizational and technical infrastructure exists to support his/her use of the technology. Facilitating conditions also affect determine the intention to actual use process. Gender, age, experience and voluntariness of use are other conditions determining the outcome of technology acceptance and use.

1.2.2 Theory of change for the review

Lawless and Pellegrino (2007) in their paper titled "Professional development in integrating technology into teaching and learning: Knowns, unknowns and way to pursue better questions and answers" layout a plan for evaluating professional development programs and identify the need for linking professional development strategies to how teachers adopt and use new technologies in the classroom.

Orr (2013) et al. in their EPPI systematic review titled "What are the impacts and cost-effectiveness of strategies to improve performance of untrained and under-trained teachers in the classroom in developing countries?" identified five main strategies: (1) Training workshops - i.e. long or short face-to-face meetings, tutorials, workshops or lectures, often in teacher resource centers or a central school within a geographical cluster (2) independent study - i.e. structured distance learning self-study materials to enhance subject knowledge or prepare for written assignments or examinations; (3) in-class support-provided by a trainer or mentor who visits a trainee in their classroom, and observes and discusses their teaching; (4) in-school support (groups or pairs of trainees meet to discuss or share their learning, sometimes facilitated by a tutor or more experienced colleague; (5) school clusters (group activities and peer learning in school clusters through study circle meetings or pairings of teachers or groups, sometimes facilitated by a tutor to work on specific modules or to discuss practice. Since the desired outcome in their review is broadly defined as performance, the strategies identified are equally broad. Missing is a theory or theories of change as to how the professional development interventions may lead to behavior change in teachers.

In the approved protocol for the present systematic review we left the theory of change loosely defined as "A training of a support intervention would lead to teacher change, where teacher change is a change in the teacher's behavior and the desired behavior is the integration of technology in the classroom.

It was necessary to leave the theory of change undefined because each study may involve its own theory of change as to how the intervention may bring about change. A mapping of included reports was used pick one or more prevalent theories of change for the review.

1.3 Policy and practice background

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]). The objective of using ICT in education is to improve student learning outcomes, but, according to the large body of reviews on the success or otherwise of various technology interventions (for example, Lagrange et al. (2001); Means, B.(2010); Tolani-Brown et al. (2009)) the promise of ICT has not been borne out. Studies on governmental interventions in USA, Canada, UK and Europe corroborate these academic studies. In spite

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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/

of massive efforts by these governments to provide technology to schools the results have been disappointing (European Commission, 2013; Means, 2002 and 2010; Ringstaff and Kelley, 2002; Robertson, 2002 and; Ungeleider, 2002; OECD (2015)).

1.4 Research background

Tamim et al. (2013) in their review of the impact of ICT on education noted that since early 1980s thousands of studies have compared computing and non-computing classrooms to see what impact technology had in a face-to-face setting. To make sense of these disparate investigations, many researchers performed meta-analyses on these studies. Eventually, the number of meta-analyses themselves rose to over 60. Tamim and her collaborators review include a second-order meta-analysis of a selected set of 25 meta-analyses to capture the combined effect of 1,055 primary studies. They find the average effect size associated with direct instruction utilization of technology at +0.35, a moderate effect size.[3] In a more conventional systematic review of the literature on the impact of tablets on learning by Tamim et al. (2015) found higher effect sizes:

"A significant average effect size was found for studies comparing tablet use contexts with no tablet use contexts (g+ = 0.23, k = 28). For studies comparing two different uses of tablets by students, the average effect size (g+ = 0.68, k = 12) showed a significant favoring of more student-centered pedagogical use of technology (Tamim et al., 2015, Abstract]"

In contrast, systematic reviews of technology interventions targeting specific outcomes such as learning of mathematics, results are disappointing (Cheung and Slavin, 2013).

Perhaps in response to the conflicting reports on technology and learning outcome gains, there is an emerging recognition that learning outcomes indeed depend on how well teachers integrate technology in the classroom.

"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 (Cheung & Slavin, 2013)."

Lack of attention paid to acceptance of technology by teachers seems to be an old problem. 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 the recommended 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.

There is indeed a large body of literature on technology acceptance or non-acceptance by teachers and the factors affecting their behavior. Unfortunately that literature seems to exist independent of the literature on computer use and learning outcomes.

In 1990, Sheingold and Hadley surveyed teachers who were considered exemplars in the application of ICT to identify good practices and learn about obstacles faced by them. More recent studies include a series of in-depth studies originating from Europe (e.g. Van der Linde, 2014) and many unpublished PhD theses from faculties of education in USA (e.g. Tweed, 2013).

In an effort to develop a typology of studies Lagrange et al. (2000) analyzed 671 studies on technology use published during 1990-1994 period. They found that two third of the studies deal with descriptions of innovations and only one third to be research-based. They note that “innovations present a wealth of ideas

[3] Low:0.0-0.2; Med:0.3-0.5; High: 0.6-2.0. Source: http://www.uccs.edu/lbecker/effect-size.html.

and propositions whose diffusion is problematic; research struggles to tackle the complexity of the integration of evolving technologies."

Since then there have been attempts to summarize the literature on teacher dimension in the use of technology in the classroom (e.g. Bingimalas, 2009; Tondeur et al., 2013), but, to our knowledge, no systematic review has been done.

1.5 Authors, funders, and other users of the review

Institution:

LIRNEasia is a pro-poor, pro-market think tank with the mission of catalyzing policy change through research to improve people's lives in the emerging Asia Pacific by facilitating their use of hard and soft infrastructures through the use of knowledge, information and technology

Authors:

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Funders:

This work was carried out with aid of grant from International Center for Development Research (IDRC) of Canada and the Department for International Development (DfID) of UK.

Users:

Some of the users are included Appendix 1.3.

1.6 Review questions

Two review questions follow from the title of systematic review:

1. What strategies are used to train and/or support teachers to integrate ICT in the classroom?

3. How has each strategy impacted the success of teachers in integrating ICT in the teaching-learning process?

CHAPTER TWO

Methods used in the review

Outline of Chapter

We used a systematic review protocol approved by the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) at UCL Institute of Education..

2.1 User involvement

There was no direct involvement of users in the review process, except at a dissemination event held November 26, 2015 at Committee room D of the Bandaranaike Memorial International Conference Hall, attended by stakeholders in ICT for education in Sri Lanka, Bangladesh and Singapore (APPENDIX 1.2). Presentation of his report of was improved as a result of input from that meeting.

2.2 Identifying and describing studies

2.2.1 Inclusion/Exclusion criteria

The inclusion and exclusion criteria for the study were derived from the research question of interest and presented in Appendix 1.1. The criteria for title and abstract screening were applied in two different stages. First, we included any citations that (1) concern integration of technology in a classroom, school or school system (2) published in 1990 or after and (3) focus on primary, secondary education. We excluded any citations that consist of an entirely secondary source only (i.e. book review or textbook) or deals with theoretical issues only and studies concerning technology use in tertiary institutions including the technology use by pre-service teachers or technology use in special education.

A second set of Inclusion/Exclusion criteria was applied in a second round of title and abstract screening (with full-text screening as needed) where we included only experimental or observational reports that measured technology use in the classroom.

A third set of Inclusion/Exclusion criteria were developed after a mapping exercise. Here, all included citations were downloaded as full texts and the reports were coded and mapped according to the study design, specificity of the technology and the theory of change used in one or more studies in each report. Noting the need for a third screening step, we included all Experimental or Quasi-Experimental studies, but excluded Observational studies that did not specify the technology or used TAM or related theory of change (See Appendix 1.3 for definitions of types of studies). This last focus was necessary since the theories of change used in observational studies were wide and varied and only those that used TAM were comparable in regard to the relationships explored.

2.2.2 Search strategy

Searches were carried out using established research databases (Appendix 2.2) as well as the grey literature from the three additional sources of (1) scholar.google.com, (2) selected institutional databases and (3) ICT4D development projects (Appendix 2.3).

The research database search was carried out with the assistance of an information scientist. The databases used include ERIC, SCOPUS and SSCI and ProQuest. The instructions to the data scientist was to capture as many records as possible under the criteria "Teacher AND [ICT OR Technology] AND [Integration OR Adoption] AND [Training OR Development]" published between 1990 and the day of the search in 2014. Details of search terms are given in APPENDIX 2.2.

The grey literature search was carried out using same ""Teacher AND [ICT OR Technology] AND [Integration OR Adoption] AND [Training OR Development]" search terms.

2.2.3 Title and abstract screenings I & II

Three sets of inclusion and Exclusion (I/E) criteria were used in the screening. The first two sets of Inclusion/Exclusion criteria were applied to the titles and abstracts in consecutive steps. Where we had insufficient information to confirm inclusion or exclusion full reports were obtained. An electronic review system provided by EPPI Center was used to keep track of reports during the screening.

2.2.4 Full report acquisition & mapping

Here full reports were obtained for the citations identified after the first two screening steps and the reports were mapped according to the attributes relevant to the present systematic review. EPPI-Centre (2003) Core Keywording Strategy: version 0.9.7 was used where applicable. A systematic map of the reports was derived. Coding and mapping results from full-document screening were recorded on Microsoft Excel software.

2.2.5 Full text screening

A third set of Inclusion/Exclusion criteria based on the specificity of the technology and theory of change was derived after reviewing the map of the included reports. This third set of inclusion/exclusion criteria were applied to each of the studies in the included reports for a full-text screening and generating the final a list of studies to be included for the in-depth review.

2.2.6 Quality assurance

Application of the inclusion and exclusion criteria and the keywording were conducted by pairs of review group members working independently and then comparing their decisions and coming to a consensus. In-depth review was carried by the two co-authors in consultation with each other.

2.3 In-depth review

In the in-depth review step, the included studies from the third screening were evaluated for internal and external validity followed by data extraction and synthesis. The in-depth review including data extraction and synthesis of data reported on effects was also carried out using Microsoft Excel software. The Forest plots were produced using Stata software.

2.3.1 Assessing quality and relevance

We used 3ie Risk of Bias assessment tool by Waddington and Homrados (2014) to assess the internal validity of the studies. The 3ie Tool consists of seven categories of bias, namely, (1) Sample Selection bias; (2)

Confounding variables bias (3) Motivation bias or Hawthorne effect; (4) Spill-over bias (5) Reporting bias and (6) Other risks of bias such as placebo effects, courtesy bias, survey effects, inadequate survey instruments etc. and (7) Bias due to misinterpretation of significance of effects (See Appendix 2.4 for details).

For the first two criteria, the risk of bias was rated: 1-High, 2-Medium and 3-Low and all other biases were rated together as 'Other' biases. If any of the three biases received a 'high' rating, such studies were excluded. All studies included in the in-depth review were extracted and quality assessed independently by two authors of this review. Discrepancies were resolved through discussion. External validity in regard to review questions was evaluated and noted if negative. All studies selected for data extraction and synthesis

2.3.2 Data extraction

The data extraction step included the following variables:

Experimental studies: Population, Intervention, Comparisons and Outcomes including effect sizes and standard errors.

Observational studies: The variables of Perceived ease-of-use; Perceived usefulness; Social influence; Facilitating conditions; Gender; Age; Experience; Voluntariness and other variables as indicated in the studies contained in the reports and statistical results associated with those variables.

2.3.3 Synthesis of evidence

In development research there are two major methods of calculating effect size – (1) response ratio and (2) standardized mean difference (SMD). Effect sizes where not reported were calculated using the SMD method as given in the APPENDIX 2.5:

2.3.4 Quality assurance

The data extraction and synthesis steps carried out jointly by the two authors in consultation with each other.

2.3.5 Deriving conclusions and implications

The conclusions and implications were modified upon review received from EPPI for a first draft of this report. The results were also presented LIRNEAsia researchers at an internal colloquium to receive their inputs regarding the conclusions made. A stakeholder consultation was held on November 26th, 2015, to receive further inputs before finalizing the conclusions and implications.

CHAPTER THREE

Results: Identifying and describing studies

Outline of Chapter

A systematic search of the literature published during 1990-2014 July yielded 11,419 citations that concerned the use of ICT or technology by teachers or the training and development of teachers in the use of ICT of technology. A two-stage title and abstract screening of the citations using the primary set of inclusion/exclusion criteria (Appendix 2.1) yielded 64 reports containing studies that measured technology use. A full-text review of these reports showed the set to consist of 5 experimental study reports that measure effect size of outcomes and 59 observation study reports that explore other factors affecting outcomes.

All 5 experimental study reports were selected for in depth review. A mapping of the fifty nine observation study reports, revealed that fifty one either did not specify the technology or did not use TAM or related theory as the theory of change. Applying a secondary set of inclusion/exclusion criteria based on these factors (Appendix 2.1), we were able to select 8 observational study reports for in-depth analysis.

Thirteen reports in total were included in the in-depth analysis.

3.1 Included studies

3.1.1 Experimental studies

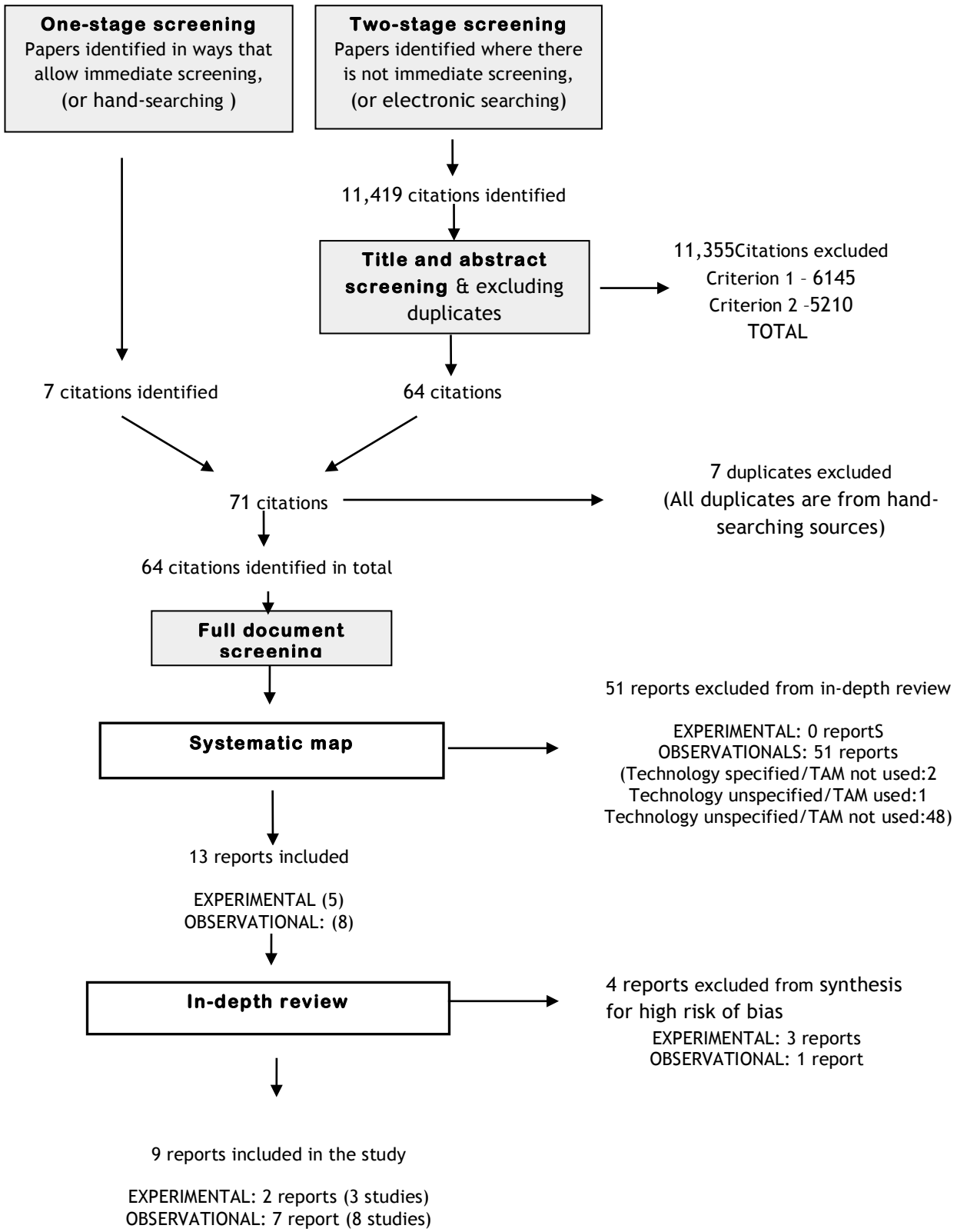
The five experimental study reports included five types of interventions in teacher professional development.

- Training for teachers and one lap top per students in classes taught by the teachers (Lowther, 2003)
- Training plus on-site technology coaches to support teachers (Lowther, 2008)
- Training plus web-based instructional resources (Pass, 2008)
- School-based, job-embedded professional development (Skoertz, 2001)
- Program designed to prepare Pre-k to Grade 12 teacher candidates (Mayo, 2005)

Reports by Lowther et al in 2003 and 2008 were based on RCT studies while the other three were quasi-experimental studies either based on natural experiments (Mayo, 2005) or using comparison groups (Pass, 2008 and Skoertz, 2001).

Trends over time show that there were no experimental study reports during the 2011 to 2014 period, a surprising finding which points to a need for further investigation.

Figure 3-1 Filtering of papers from searching to map to synthesis.



3.1.2 Observational studies

The fifty nine observational study reports were mapped according to the specificity of the technology and theory of change used in each report.

Only ten reports concerned a specified technology and the acceptance of that particular technology by the teacher. The technologies studied ranged from learning management systems (LMS), e-books, GIS technology in Geography, Digital learning materials and Mathematics software, all mandated or made widely available by the relevant school or school system. The rest of the reports concerned technology acceptance in a generic sense in largely unspecified ICT environments.

Nine reports used Technology acceptance models (TAM) or related theories of change in their analysis. Almost all other reports except two were based on report-specific specific theories using some variation of the self-efficacy concept. The two exceptions used the innovation-diffusion theory and expectancy-value theory.

Eight reports in total specified the technology used AND used TAM or related theoretical framework. Since all TAM based reports used the perceived ease-of-use and perceived usefulness of a technology as predictors of acceptance and use of technology only these reports were amenable to the desired synthesis of findings. It was not possible to get predictors that are comparable across studies in the other fifty one studies included from the initial title and abstract screening prior to the mapping step.

3.2 Quality assurance

The coding of reports for (1) Specificity of technology /non-specificity and (2) TAM related or not criteira were determined through discussions principal researcher and second researcher.

3.3 Systematic map of included studies

The systematic map of the included studies is summarized in Table 3.1 according to the Publication year, Country, Population, Intervention, Comparison, Outcome and Study design.

Table 3.1 Map of included studies

	Experimental (5 reports)	Observational (59 reports)
Publication year	1990-2000 (0) 2001-2010 (5) 2011-2014 (0)	1990-2000 (5) 2001-2010 (34) 2011-2014 (20)
Countries	USA (all 5 reports)	Reports included in the in-depth review (8): Belgium (3); Netherlands (1); Singapore (1); South Africa (1); South Korea (1);Taiwan (1); Other reports (51): not examined
Intervention	In-service training followed by laptops to all students in class	• No intervention; Observation studies of following technology use in schools.

	In-service training followed by on-site technology coaches Pre-service training in ICT integrated lessons school-based, job-embedded professional development program participation in the development and use of a web-based instructional resource	Reports included in the in-depth review (8): Belgium (Learning Management System -LMS; Digital Learning Environment-DLR; Netherlands (Digital Learning Materials-DLM); Singapore (Algebra software); South Korea (Digital textbook); South Africa (Dynamic Mathematics software); Taiwan (GIS) (8 reports) Miscellaneous ICT resource (51 reports)
Comparison	Control group (2) Comparison group (2) No comparison, Natural experiment (1)	Not applicable
Outcome	Miscellaneous measure of technology use by K-12 students in class	Miscellaneous measure of technology use by K-12 students in class
Study design	RCTs (2) Equivalent group comparison (1) Non-equivalent group comparison (2)	Cross sectional surveys for data collection survey data and statistical regression methods for data analysis
Theoretical framework	Not Applicable	Technology Acceptance model (9) Other (50)

None of the 64 studies concerned a developing country. The five experimental studies in the set were all carried out and reported during the 2001-2010 period from locations in USA. The absence of studies from other developed countries or from more recent times is noteworthy. Four out of five interventions in the experimental studies involved some form of in-service professional development (PD) programs but using different approaches such as job-embedded PD, enhanced facilitating conditions such as OLPC or on-site technology coaches following PD, Provision and training in Web based teaching resources as PD. One report concerned pre-service training in the preparation of ICT-integrated lessons. Only the two studies on facilitating conditions were of sufficient quality to be used in the present systematic review.

All the observational studies were based on cross-sectional surveys of selected schools or school systems using a variety of ICT facilities. The eight studies that were used for in-depth review originated from Europe (Belgium and Netherlands) or Developed Asia (Singapore, South Korea and Taiwan) and concerned a variety of technologies summarized in and detailed in Appendix 1.3.

CHAPTER FOUR

Results: In-Depth Review

Outline of Chapter

The search, screen and mapping process yielded 5 experimental study reports (Lowther, 2003 and Lowther, 2008, Mayo-2005, Pass-2008 and Skoertz-2001)) and 8 observational study reports (DeSmet-2012, Kim-2009, Lay-2013, Pynoo-2011, Pynoo-2012, Stols-2011, Teo-2001, Van Acker-2013) as meeting inclusion/exclusion criteria.

Of the five experimental study reports, only Lowther, 2003 and Lowther, 2008 were found to be of low to medium risk of bias. Lowther (2008) contained two distinct studies to yield a total of three studies to be used for data extraction and synthesis. These three experimental studies show that teacher training along with facilitating conditions, in the form of (1) one laptop per child or (2) on-site coaches, increase technology integration by effect sizes of +0.49 to +1.31 as compared to the control situations with no such facilitation.

Of the eight observational study reports, all except the Stols-2011 report was found be of low to medium risk of bias and hence usable. Further, the report by DeSmet 2012) contained two distinct studies yielding 8 observational studies out of 7 usable reports. All eight studies used perception of teachers regarding the usefulness and ease of use of the technology used as a predictor of technology use. The standardized beta coefficient (or Effect size1 or ES1) for perceptions of usefulness of a particular technology (or Effect size 2 or ES2) were found to 2.43 times (with a confidence interval or 0.40) larger than the as the standardized beta coefficient) for the perception of the ease of use of that technology on average, in predicting the use of technology by teachers in five of the studies. The ratio was reduced to 1.23 when the three studies concerned with learning management systems (LMS) or digital learning environments (DLE) were added to the set. LMSs or DLEs are different from subject-specifics tools such e-books, Algebra software or GIS use in class that they involve more administrative and communication feature that go beyond the subject matter. The fact that measures of technology use varied across did not affect this finding since we are concerned only with the relative importance of two predictors in each of the eight exploratory studies in question.

4.1 Experimental studies

4.1.1 Assessing quality and weight of evidence

The search, screen and mapping process yielded 5 Experimental study reports (Lowther, 2003 and Lowther, 2008, Mayo-2005, Pass-2008 and Skoertz-2001; details in Appendix 3.1). Of these only Lowther (2003) and Lowther (2008) were judged to be of low to medium risk in terms of bias (Appendix 3.2)

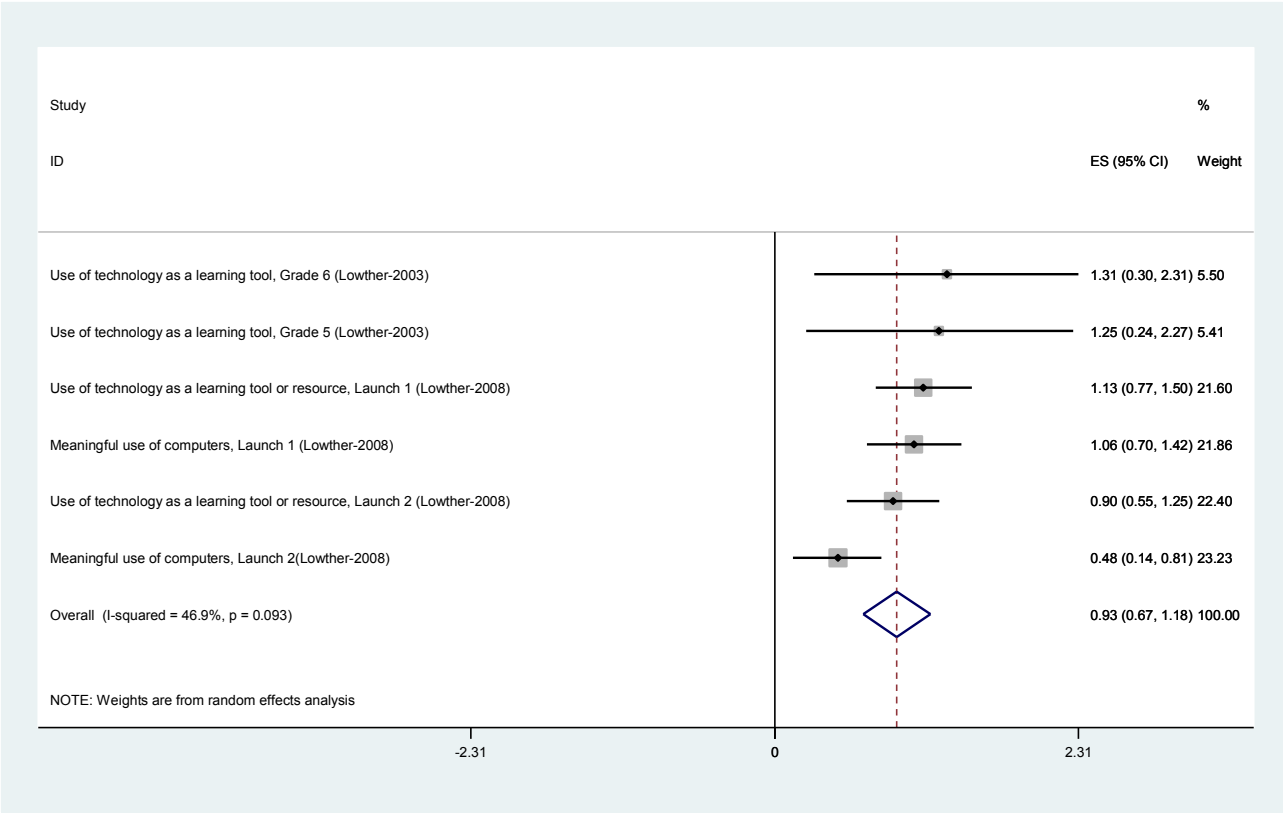
4.1.2 Data extraction and synthesis

Lowther (2008) contained two distinct studies to yield a total of three studies to be used for data extraction and synthesis. These three experimental studies show that teacher training along with facilitating conditions, in the form of (1) one laptop per child or (2) on-site coaches, increase technology integration by effect sizes of +0.49 to +1.31 as compared to the control situations with no such facilitation (Table 4-1).

Table 4-1 Effect sizes for three professional development interventions

Intervention	Outcome	Mean (Std. Error)	Range
Lowther-2003-Professional development with one laptop per child	Use of technology as a learning tool, Grade 5 (Lowther-2003, Table 5, SOM)	1.25 (0.52)	0.24-2.27
Lowther -2008 -Professional development with on-site technology coach (Launch 1)	Use of technology as a learning tool or resource, (Table 4, SOM)	1.13 (0.19)	0.77-1.50
	Meaningful use of computers (Table 7, OCU)	1.06 (0.19)	0.7-1.42
Lowther -2008 -Professional development with on-site technology coach (Launch 2)	Use of technology as a learning tool or resource (Table 4, SOM)	0.90 (0.18)	0.55 1.25
	Meaningful use of computers, Launch 2 (Lowther-2008, Table 7, OCU)	0.48 (0.17)	0.14-0.81

Figure 4-1 Forest plot for effect sizes for three professional development interventions



4.2 Observational studies

4.2.1 Assessing quality and weight of evidence

Of the eight observational study reports, all except the Stols-2011 report was found low to medium risk of bias and hence 7 usable reports (Appendix 2.4)

4.2.2 Data extraction and synthesis

The report by DeSmet (2012) contained two distinct studies yielding 8 studies out of 7 usable reports. All the eight studies were observation studies use used perception of teachers regarding the usefulness and ease of use of the technology as a predictor of technology use and other factors as dependent variables and technology use outcome as the dependent variable in regression analyses. The standardized beta coefficients in regression models tells us the effect of each independent variable or predictor on the dependent variable. Standardized beta coefficients were available only for Kim-2009 and Pynoo-2011. Standardized beta coefficients in the other five studies were calculated as described in APPENDIX 2.5.

The effect sizes for perceived ease of use (ES1) ranged from low of -0.28 to 1.24 and those for perceived usefulness (ES2) ranged from a low -0.13 to 2.45 (APPENDIX XX) .This range is not surprising given the diverse nature of technologies and technology use measures used.

4.2.3 Usefulness v. Ease-of-use

In technology use in business settings it is observed that the perceptions of usefulness is the strongest predictor of intention to use technology (Venkatesh et al., 2003, p. 447).[4] To our knowledge no such generalization has been made in regard to technology use in educational settings. In fact, The standardized beta coefficient for perceptions of usefulness of a particular technology (or Effect size 1 or ES1) were found to 2.43 times (with a confidence interval or 0.40) larger than the as the standardized beta coefficient for the perception of the ease of use of that technology (or Effect size1 or ES1) on average, in predicting the use of technology by teachers in five of the studies. The ratio was reduced to 1.23 when the three studies concerned with learning management systems (LMS) or digital learning environments (DLE) were added to the set. LMSs or DLEs are different from subject-specifics tools such e-books, Algebra software or GIS use in class that they involve more administrative and communication feature that go beyond the subject matter. For example in Pynoo-2011, teachers in the target group used the Smartschool DLE which in turn consists of 3 different modules (digital learning, communication and administration). The use measures do not distinguish among those. In De Smet-2012, measures of use distinguish between informational use and communication use, but, the target group uses one of three commercial LMSs known as Dokeos, Blackboard and Smartschool. In future studies LMSs should be not be included in 'specific applications' category since a LMS has multiple uses of a highly diverse nature.

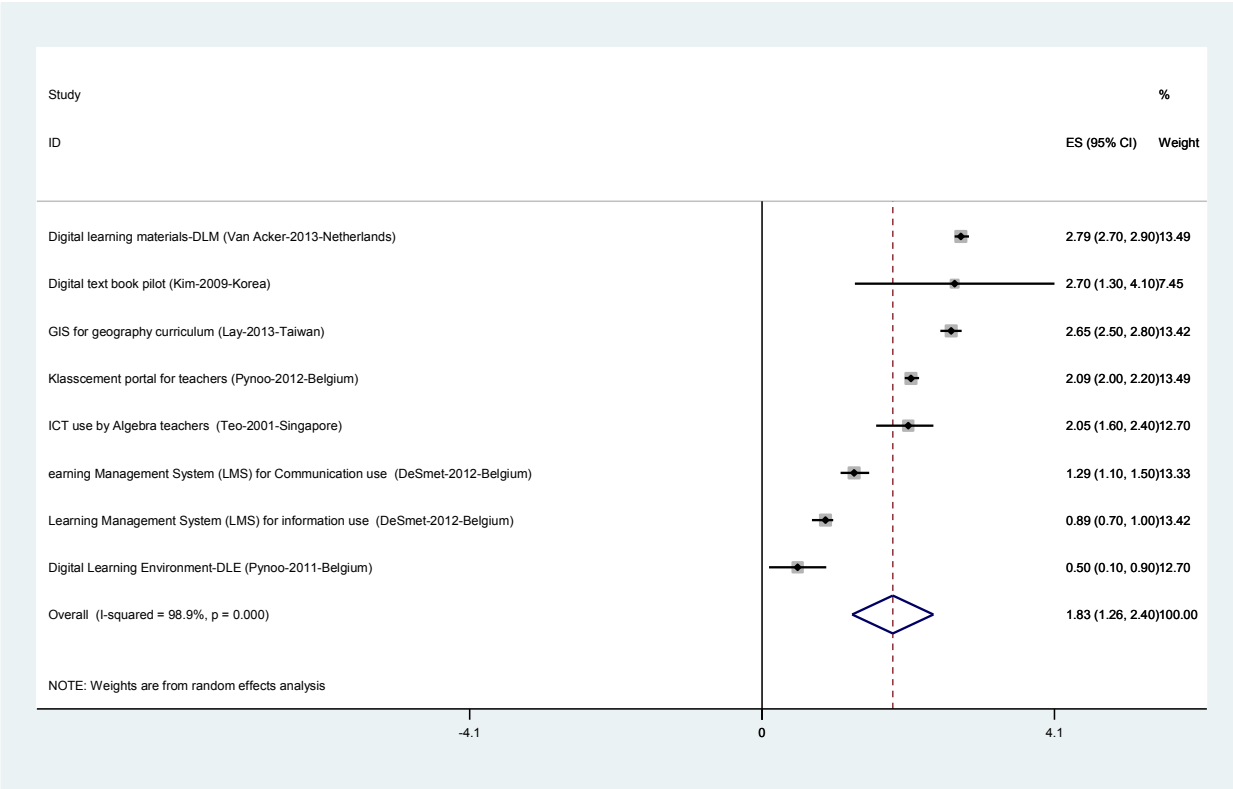
Table 4-2 Ratio of perceived usefulness to perceived ease of use

Paper	Intervention (data source)	RoB	Mean *(Std Error)	Range
Van Acker-2013-Netherland	Digital learning materials (DLM)	Low	2.79 (0.05)	2.7-2.9
Kim-2009-Korea	Digital text book pilot	Med	2.70 (0.70)	1.3-4.1

[4] Venkatesh et l. use the term Performance expetacy.

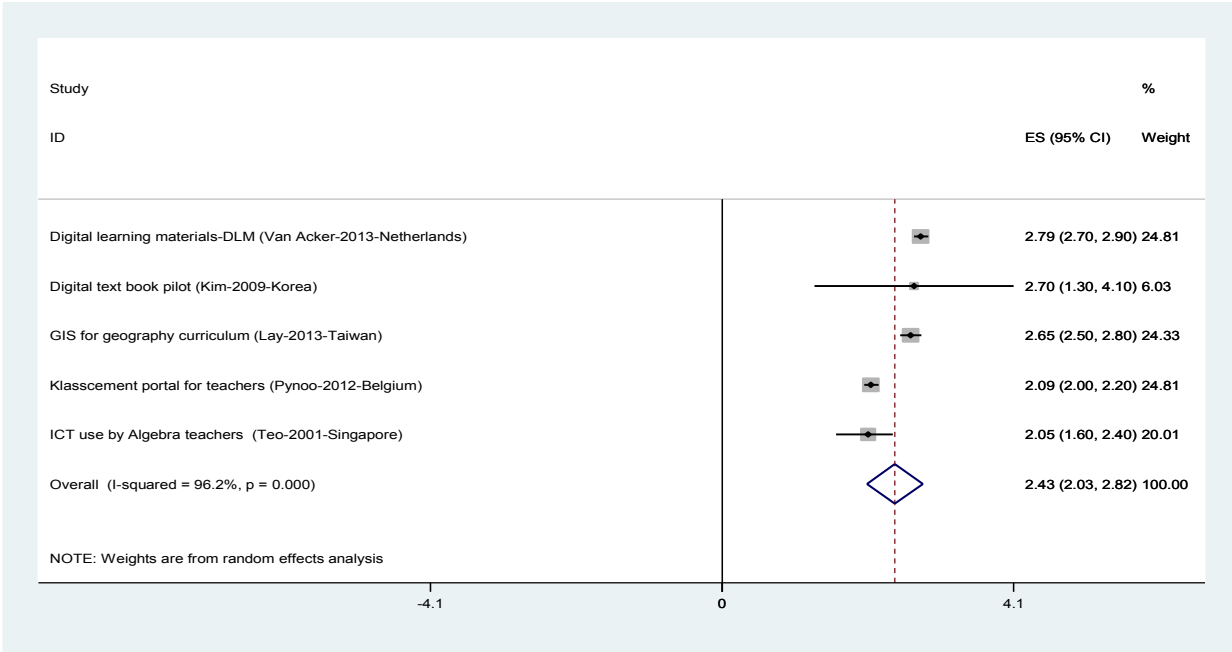
Lay-2013-Taiwan	GIS for geography curriculum	Low	2.65 (0.07)	2.5-2.8
Pynoo-2012-Belgium	'KlasCement' proprietary portal for sharing teaching resources	Med	2.09 (0.06)	2.0-2.2
Teo-2001-Singapore	ICT use by Algebra teachers	Low	2.05 (0.20)	1.6-2.4
DeSmet-2012-Belgium	Learning management system (LMS) for Communication use	Low	1.29 (0.09)	1.1-1.5
DeSmet-2012-Belgium	Learning management system (LMS) for information use	Low	0.89 (0.08)	0.7-1.0
Pynoo-2011-Belgium	Digital learning environment (DLE)	Low	0.50 (0.21)	0.1-0.9

Figure 4-2 Forest plot for ratios of perceived usefulness to perceived ease of use



The set of five studies that deal with specific applications show and average effect size of 2.03-2.83 providing evidence that effect size of perceived usefulness is greater than effect size for perceived ease of use when the outcomes measured is directly related to the technology used.

Figure 4-3 Forest plot for a sub-set of ratios of perceived usefulness to perceived ease of use


Study
ID
ES (95% CI)
%
Weight
Digital learning materials-DLM (Van Acker-2013-Netherlands)
2.79 (2.70, 2.90) 24.81
Digital text book pilot (Kim-2009-Korea)
2.70 (1.30, 4.10) 6.03
GIS for geography curriculum (Lay-2013-Taiwan)
2.65 (2.50, 2.80) 24.33
Klasscement portal for teachers (Pynoo-2012-Belgium)
2.09 (2.00, 2.20) 24.81
ICT use by Algebra teachers (Teo-2001-Singapore)
2.05 (1.60, 2.40) 20.01
Overall (I-squared = 96.2%, p = 0.000)
2.43 (2.03, 2.82) 100.00
NOTE: Weights are from random effects analysis
-4.1
0
4.1

CHAPTER FIVE

IMPLICATIONS

Outline of Chapter

The observational studies show that the effect of perceptions of usefulness on technology use is twice as important as the effect of perceptions of the ease of use on technology use, implying that in selecting ICT applications for K-12 classrooms policymakers both perceptions are important but it is particularly important to get teacher feedback in selecting and purchasing technology for school systems.

The Experimental studies show that teacher training along with facilitating conditions, increase technology use by effect sizes of +0.49 to +1.31 as compared to the control situations with no such facilitation. The two facilitating conditions are one laptop per child and on-site coaches. While adding those two conditions to the repertoire of strategies for training teachers, more experimental studies should be carried out to identify and quantify other interventions such as peer-to-peer learning by teachers or structured long-distance assistance (Orr, 2014) and the costs of such. In all such interventions teachers perceptions regarding the usefulness and ease of use of the technology with particular attention paid to perceptions of usefulness.

5.1 Strengths and limitations of this systematic review

The present systematic set out to determine the effect of different types of teacher training and support programs on the use of technology in the classroom by teachers. Only two such reports and 3 studies therein were revealed in the process. This is unfortunate but not totally surprising. As we said in the introduction, the focus of most of the research on ICT in education is on technology interventions for learning outcomes in students, by-passing the critical intervening step of acceptance and use of the technology by the teacher in the classroom. Easing out teacher factors in a field where student learning outcomes are prioritized proved to be a difficult endeavor. All three studies found in the present review show that if teachers are given sufficient post-training support in the form of better access to computers by students and in-house technical support they will use technology in the classroom, but we may have missed some studies where the focus was on learning outcomes, but teacher use measures were reported in passing.

Additional limitations of the study is that the search for literature were limited to citations with title and/or abstracts given in English. The complexity of review question with a range of strategies for training teachers and ways of measuring technology, was a limitation, but we managed to overcome it by using a mapping study to screen out studies that were not comparable.

The strength of this systematic review is in establishing relative importance of the effect of teachers' perceptions of the usefulness compared to effect of teachers' perceptions of the ease of use. Although the relationship has been established in corporate settings, to our knowledge, the present review is the first time the relationship has been established in educational setting. The other strength of the review is the reporting of effect size of two interventions on teachers' use of technology in the classroom.

5.2 Implications for research

5.2.1 Specificity of technology used

The present systematic review brings to the fore the importance of the technologies assessed in educational settings being directly linked to the teaching learning process.

Van Acker (2013) observes as follows:

"We believe that studies focusing on general ICT use might miss certain effects because the behavior lacks sufficient specificity. Teachers may, for example, have a positive attitude towards using e-mail to communicate with their students, but might feel quite anxious when using an electronic blackboard. As a consequence, measures of a general attitude towards ICT or of the intention to use ICT might include a lot of variability due to the different ICT applications teachers consider when completing these instruments."

These concerns are supported by theories of behavioral psychology. Fishbein and Ajzen (1985) identifies three major factors that determine the correspondence between intention and behavior – (1) specificity of the behavior (2) stability of the intention and (3) volitional control, and goes on to highlight the more important role played by specificity.

“Perhaps the most important factor influencing the size of intention-behavior relation is the degree to which the intention is measured at the same level of specificity as the behavior to be predicted" (Fishbein & Ajzen, 1985, Ch8, p. 369-372).

In the future, any research on ICT use should be about specific ICT tools with the surveys designed to elicit responses regarding that specific tool. For example, if the technology is specified as, say “one e-book per student provided to all students by the school board” and the survey instrument designed as such, it is possible to make meaning out of the responses by the teacher to questions on their attitude, acceptance, intention and use in relation to the particular technology intervention.

5.2.2 Theory of technology use

ICT in education researchers may explore the effect of different variables on technology acceptance and use, but, they need to be encouraged situate their findings in the unified theory of technology acceptance (UTTAU) or other well established theory of change to make their studies more comparable. We were not able to use the bulk of exploratory observational studies we uncovered because the independent variables used were not consistent across the studies. In contrast, where TAM theory was used, the variables were always clustered within the four major variables of Perceived Ease of Use, Perceived usefulness, Social influence and Facilitating conditions.

5.2.3 System-wide surveys of ICT use

The descriptive studies were excluded in the "Title and Abstract Screening II" step of screening process. Such studies may be useful in each specific context, but, not, useful beyond. In contrast, system-wide surveys of ICT use patterns and learning outcomes can help flesh out the findings from experimental or observational studies. For example, the PISA survey by OECD provides comparable information on ICT use and learning outcomes for 29 out of 34 OECD countries and 13 out of 30 partner countries. A synthesis of results from such surveys and the present systematic review will be detailed elsewhere.

5.2.4 Search strategies

Searches for grey literature on Scholar.google.com was time consuming, but, did not yield a single publication which we could not uncover through a search of electronic databases

5.3 Implications for policy and practice

Understanding the relative importance of factors affecting technology use is important for leaders of schools or school systems as they try to introduce a certain new technology or decide between one or more technologies. Often teachers are provided training to use the technology, but, they may not be consulted as to the usefulness of the technology.

Eight observational studies from Belgium (4), Netherlands (1), Singapore (1), South Korea (1) and Taiwan point to the importance of the perceptions of teachers regarding the usefulness and the ease of use of a technology, with perceptions usefulness being as twice as important as perceptions of ease of use, underscoring the importance understanding and responding to 'teacher factors' in the effective use of ICT in improving student learning outcomes.

Three experimental studies, all from the US, are seemingly more concerned with the ease of use aspects. They show that teachers use ICT in increased if professional development on ICT use is accompanied by adequate follow-up support for the teachers or provision of one laptop per child in the classroom. While more attention should be paid to teachers' perceptions of usefulness in introducing ICTs in system-wide initiatives, such initiatives should be planned and executed as experiments to evaluate the effect of ICT on teacher perceptions and effect of perceptions and/or use on student learning outcomes.

CHAPTER SIX

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APPENDIX 1.1: Authorship of this report

Advisory Group membership

None

Review Group membership

To be completed by EPPI

Acknowledgements

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Chivoin Peou, Cambodia

Achala Abeykoon, Deakin University, Australia

Conflicts of interest

None

APPENDIX 1.2: Review-specific keywords and definitions

Review-specific keywords

ICT integration; ICT use; ICT in education; ICT in school education; ICT in K-12; In-service training; Professional development; Teacher training, Teacher training and support; Technology integration; Technology integration in the classroom; Technology use; Technology use in the classroom

Glossary

Citation: Citation is a reference to a report containing the author, title and source information for the report; a report may contain one or more studies.

Digital learning environments (DLEs): Digital learning environments is a term that refers to the total of digital resources (computers, software, storage, software, and systems) used to manage an academic enterprise and support, enable or manage learning.

Experimental designs: The purpose is to assess impact of an intervention or a phenomenon. Allocation or exposure of subjects/participants is controlled or manipulated fully or partly by investigators. Includes (1) Randomized controlled trials (RCTs) which are 'true' experimental designs and (2) quasi-experimental designs.

Observational studies: The purpose is to assess causality or factors affecting an outcome. Allocation or exposure of subjects/participants is not controlled or manipulated by investigators. Data collection can be through cohort, case control or cross-sectional methods. Statistical methods are used to control for bias and derive conclusions.

Learning management systems (LMSs): A learning management system (LMS) is a software application for the administration, documentation, tracking, reporting and delivery of electronic educational technology (also called e-learning) courses or training programs.

Quasi experimental designs: The purpose is to assess the impact of an intervention or a phenomenon. Allocation or exposure of subjects/participants is not random but done by investigator using known allocation rule such as regression discontinuity, or natural experiment, or using some methods to control for confounding such as difference-in-differences estimation, instrumental variables estimation, statistical matching, Interrupted time series etc.

Randomized controlled trials (RCTS): The purpose is to assess the impact of an intervention or a phenomenon. The investigator randomly assigns people to groups that will receive (intervention group) or not receive (control group) one or more interventions. The outcomes measured are then compared between the groups.

APPENDIX 1.3: User Inputs

Participants at the user group consultation

(November 26, 2015, Colombo, Sri Lanka)

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Anir Chowdhury, Access to Information (a2i), Prime Minister's Office, Bangladesh

Anoja Obeysekera, IT consultant

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Dhamitu Kirtisinghe, Mobitel

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Hasitha Dela, Headstart, dialog Axialata

Ishara Madushanka, Infogate, Kantale

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APPENDIX 2.1: Inclusion and exclusion criteria

TITLE & ABSTRACT SCREENING I

INCLUDE: Any studies that (1) concern integration of technology in a classroom, school or school system (2) published in 1990 or after and (3) focus on primary, secondary education.

EXCLUDE: studies consist of an entirely secondary source only (i.e. book review or textbook) or deals with theoretical issues only; studies concerning technology use in tertiary institutions including the technology use by pre-service teachers or technology use in special education

TITLE & ABSTRACT SCREENING II

INCLUDE: Reports that include one or more empirical studies that measure technology use in K-12 classrooms

EXCLUDE: All other reports

FULL TEXT SCREENING

We first coded all reports according to the type of studies (Experimental/Observational/Other) included in them, the Specificity of technology (Specific/Generic), and the Theory of change used (TAM-based/Other)

INCLUDE: All Experimental[5] or Quasi-Experimental[6] studies, or all Observational studies that specified the technology and used TAM or related theory of change

EXCLUDE: All other studies

[5] Experimental studies are studies using randomized control trials (RCTs).

[6] Quasi-experimental designs include: Difference in difference design (DiD); Interrupted time series (ITS); Instrumental variable design (IV); Propensity score matching designs (PSM); Regression discontinuity design (RDD); Single differences designs (SDD) and other designs that evaluate the effect sizes experimentally without the use of randomized controls for comparison.

APPENDIX 2.2: Search strategy for electronic databases

Per data scientist advice we limited our search to the ERIC, EBSCO, SCOPUS, SSCI and Proquest databases. These databases included or overlapped the Australian Education Index, British Education Index, Canadian Business and Current Affairs (CBCA) - Education, Education Abstracts (Wilson), Psych INFO, JSTOR, Sociological Abstracts, Dissertation and Theses (UK, USA/Canada and Australia) which were of interest as education research sources.

1. ERIC (Ovid) - 1965 to June 2014

1. educational technology/ or computer assisted instruction/ or internet/ or computer uses in education/ or technology integration/ or exp computers/ or information technology/ or multimedia materials/ or handheld devices/ or multimedia instruction/ or technology uses in education/ or influence of technology/ or electronic learning/ or access to computers/

2. (ict or "information and communication* technology" or "information technology" or computer* or laptop* or tablet* or pc or pcs or i-pad* or ipad* or "digital literacy" or software or internet or (integrat* adj3 technolog*)).ti,ab.

3. 1 or 2 [140493]

4. exp elementary secondary education/ or elementary schools/ or elementary education/ or primary education/ or high schools/ or secondary education/

5. (((elementary or primary or secondary) adj (school* or education)) or "high school*").ti,ab.

6. 4 or 5 [468127]

7. exp teachers/

8. (teach* or pedagog* or instruct*).ti,ab.

9. 7 or 8 [542943]

10. 3 and 6 and 9 [24626]

11. teacher attitudes/ or teacher behavior/ or teacher competencies/ or teacher effectiveness/ or teacher motivation/ or teaching methods/ or computer attitudes/ or beliefs/ or instructional innovation/

12. (efficacy or self-efficacy or belief* or attitud* or motivat*).ti,ab.

13. 11 or 12 [318042]

14. 3 and 6 and 13 [11309]

15. teacher education/ or teacher education programs/ or teacher improvement/

16. ((train* or performance or competenc* or support* or mentor*) adj3 teacher*).ti,ab.

17. 15 or 16 [77256]

18. 3 and 6 and 17 [3776]

19. 3 and 6 and 7 and 13 [1696]

20. 18 or 20 [5010]

21. limit 21 to yr="1990 -Current" [3679 hits]

Revised ERIC search – 17th July 2014

1. educational technology/ or computer assisted instruction/ or internet/ or exp computers/ or information technology/ or multimedia materials/ or handheld devices/ or influence of technology/ or electronic learning/ or access to computers/

2. (ict or "information and communication* technology" or "information technology" or computer* or laptop* or tablet* or pc or pcs or i-pad* or ipad* or "digital literacy" or software or internet or (integrat* adj3 technolog*)).ti,ab.

3. 1 or 2

4. exp elementary secondary education/ or elementary schools/ or elementary education/ or primary education/ or high schools/ or secondary education/

5. (((elementary or primary or secondary) adj (school* or education)) or "high school*").ti,ab.

6. 4 or 5

7. technology integration/ or computer uses in education/ or multimedia instruction/ or technology uses in education/ or electronic learning/

8. (integrat* or adopt* or inclu* or use* or utili* or incorporat* or using or choos* or select* or exploit* or apply* or application or harness*).ti,ab.

9. 7 or 8

10. exp Elementary School Teachers/ or exp Experienced Teachers/ or exp Middle School Teachers/ or exp Beginning Teachers/ or exp Secondary School Teachers/

11. (teacher* adj3 (elementary or primary or secondary or "high school*")).ti,ab.

12. 10 or 11

13. teacher education/ or teacher education programs/ or teacher improvement/

14. ((train* or performance or competenc* or support* or mentor*) adj3 teacher*).ti,ab.

15. 13 or 14

16. 3 and 6 and 9 and 12

17. limit 16 to yr="1990 -Current"

18. 3 and 6 and 12 and 15

19. limit 18 to yr="1990 -Current"

20. 17 or 19 [1862 hits]

ERIC 1965 to June 2014 Further Revision – 22nd July 2014

1. educational technology/ or computer assisted instruction/ or internet/ or computer uses in education/ or technology integration/ or exp computers/ or information technology/ or multimedia materials/ or handheld devices/ or multimedia instruction/ or technology uses in education/ or influence of technology/ or electronic learning/ or access to computers/

2. (ict or "information and communication* technology" or "information technology" or computer* or laptop* or tablet* or pc or pcs or i-pad* or ipad* or "digital literacy" or software or internet or ((integrat* or adopt* or inclu* or use* or utili* or incorporat* or using or choos* or select* or exploit* or apply* or application or harness*) adj3 technolog*)).ti,ab.

3. 1 or 2

4. exp elementary secondary education/ or elementary schools/ or elementary education/ or primary education/ or high schools/ or secondary education/

5. (((elementary or primary or secondary) adj (school* or education)) or "high school*").ti,ab.

6. 4 or 5

7. exp teachers/

8. (teach* or pedagog* or instruct*).ti,ab.

9. 7 or 8

10. teacher attitudes/ or teacher behavior/ or teacher competencies/ or teacher effectiveness/ or teacher motivation/ or teaching methods/ or computer attitudes/ or beliefs/ or instructional innovation/

11. (efficacy or self-efficacy or belief* or attitud* or motivat*).ti,ab.

12. 10 or 11

13. teacher education/ or teacher education programs/ or teacher improvement/

14. ((train* or performance or competenc* or support* or mentor*) adj3 teacher*).ti,ab.

15. 13 or 14

16. 3 and 6 and 15

17. 3 and 6 and 7

18. 16 or 17

19. limit 18 to yr="1990 -Current"

20. exp Elementary School Teachers/ or exp Experienced Teachers/ or exp Middle School Teachers/ or exp Beginning Teachers/ or exp Secondary School Teachers/

21. (teacher* adj3 (elementary or primary or secondary or "high school*")).ti,ab.

22. 20 or 21

23. 3 and 6 and 22

24. 17 or 23

25. 3 and 12 and 22

26. 24 or 25

27. limit 26 to yr="1990 -Current" [4256 hits]

ERIC1	3679	I have been working on a draft strategy for your SR on IT uptake by teachers in elementary/secondary education, and have started on the education database ERIC on the Ovid platform. This is probably going to be the most important database and it has the advantage of being both a textword- and thesaurus-searchable database. I attach the strategy which I ran on ERIC and also attach the results (3679 hits from 1990 onwards, in 4 files (RIS text format)). There is no study methods filter or LMICs limit as the protocol states. Can you look through the strategy (the individual set results are given in brackets) and assess whether I have got the combinations right. I have two separate sets - one on the ICT element+primary/secondary education+Teacher education/training; and the other is ICT+primary/secondary education+Teachers attitudes/self-efficacy etc. These two sets have been added together and limited to 1990 onwards, so that overlaps/duplicates between the two are eliminated.
ERIC2	4256	I have adjusted the original strategy to enhance the integration part and attach the results (4256 hits in 5 files in RIS format) and attach the strategies document so you can see how it compares with previous strategies. I shall now start to look at the other databases on the list
EBSCO	5194	Combined databases search - Academic Search Complete, British Education Index, Educational Administration Abstracts, PsycInfo;
SCOPUS	3787	Scopus results of 3787 hits after duplicates were removed in Endnote - file is in RIS format. Scopus is a big database (26,000 journal titles) and I would expect a fair degree of overlap between this file and the other results.
FIRSTSEARCH	-	Few SRs use Firstsearch as its essentially a large combined library catalogue. Ive looked at it and it appears to be a subscription-based service with some databases tacked on - most not important. The key question is whether it indexes individual articles from journals as do good databases, or is it just a catalogue of journal titles and books and not of content. Without trying it I cant tell, but I think we are covered with the databases we have.
SSCI	430	
Proquest	1393	Proquest search on Sociological Abstracts and also the Proquest Education Journals and got 1393 hits
Inst Education, UK		You might want to look at the small Database of Education Research from the UK Institute of Education - http://eppi.ioe.ac.uk/cms/Default.aspx?tabid=185

APPENDIX 2.3: Additional sources

Scholar.google.com

The internet search carried out during July 2014 using the search terms "Teacher AND [ICT OR Technology] AND [Integration OR Adoption] AND [Training OR Development]" published between 1990 and the day of the search in 2014, yielded 900+ hits of which 400+ were screened out as not meeting inclusion criteria. In order to further reduce the number of studies we focused on the selection bias and explanatory power of the models. Applying these two criteria we were able to identify 7 studies for in depth review (Fordham_2004; Hastings_2009; Hong_2009; Johnson_2006; Pynoo_2011; Rickman_2009 and Sang_2010), but, all were found to within the 64 studies included from title and abstract screening of reports from electronic database search.

Institutional Databases

- 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)
- World Bank

ICT for Education Projects

Salto para o Futuro	Brazil
New School Program	Egypt
Fundamental Quality and Equity Levels	Guinea
Mental Arithmetic: The Numbers Family	Honduras
Telesecundaria	Mexico
Basic Education ; Support 2	Namibia
Kids on the Block, SchoolNet	Namibia
Learn Link	Namibia
Conflict-prevention Project	Rwanda
G. S. Soeurs de la assumption	Rwanda
DEEP-South Africa, Handheld Computers	South Africa

Intel Teach to the Future	South Africa
Relief International-Schools Online	Tajikistan
Basic education Project	Turkey
Intel Teach to the Future	Turkey
Connect ED ; Project	Uganda
Active learning with Technology	United states
Applying technology to Restructuring ; Learning	United states
EdTech; Leaders Online	United States

APPENDIX 2.4: Quality Appraisal Tools

Risk of Bias assessment tool (Waddington and Homrados, 2014)

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 differences in covariates between groups?
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 program implementation and, or monitoring?
4. Spill-overs and Cross-overs	Performance bias	Is the program 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 heteroskedasticity not accounted for? Is the study not taking into account possible heterogeneity in effects?

APPENDIX 2.5: Methods of synthesis

In development research there are two major methods of calculating effect size – (1) response ratio (RR) and (2) standardized mean difference (SMD).

For binary outcomes, the response ratio is used as the effect measure. For continuous outcomes, SMD is used. 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 there was 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 program being evaluated.

	SMD	RR
Formulae for regression-based studies	SMD = β/Sp ; Sp =f(SDy, β, nt, nc)[7]	RR=Ys+ β/ Ys
SE	SMD/t	ln(RR)/t
Parameters needed	SDy, β, nt, nc and t[8]	β, t, Ys

SMD can be calculated from correlation coefficients through the following procedure:

$$SMD = \frac{2\,r}{\sqrt{1-r^2}}$$

Where r is the correlation coefficient and n is the whole sample size. The Standard Error (SE) of the SMD would be:

$$SE_{smd} = \sqrt{\frac{4\left(\frac{(1-r^2)^2}{n-1}\right)}{(1-r^2)^3}}$$

---

[7] $$S_p = \sqrt{\frac{(SD_y^2 \cdot (n_t + n_c - 1)) - \left(\frac{\beta^2 \cdot (n_t \cdot n_c)}{n_t + n_c}\right)}{n_t + n_c}}$$

[8] □ is the coefficient or impact effect of interest; nt and nc are the sample sizes for the treatment group and control group; Sp is the standard deviation of the regression model; SDp is standard deviation of the regression residulas; SDy is the sample standard deviation of the dependent variable; t is the t statistics of the regression coefficient or of the relevant treatment impact (t-test for equality of means); Yt, Yc and Ys, are the mean outcome in the treatment group, control group and total sample;

APPENDIX 3.1: Details of studies included in the systematic map

Five experimental study reports and the 59 observational study reports are detailed here.

EXPERIMENTAL STUDY REPORTS

	CITATION	Abstract
1	Lowther-2003 Lowther, Deborah L.; Steven M. Ross; Gary M. Morrison (2003). When Each One Has One: The Influences on Teaching Strategies and Student Achievement of Using Laptops in the Classroom. ETR&D, Vol. 51, No. 3, 2003, pp. 23–44 ISSN 1042–1629	In this study, we examined the educational effects of providing fifth-, sixth-, and seventh-grade students with 24-hour access to laptop computers. Specifically we examined the impact of laptops on classroom activities, and on student use of technology and their writing and problem-solving skills. Participating teachers received computer integration training using the iNtegrating Technology for inQuiry (NTeQ) model to develop problem-based lessons that engage students in critically examining authentic issues, and strengthen research and writing skills. A matched treatment-control group design was employed, in which classes taught at the same grade levels in five participating schools served as the laptop (1 computer per student) and control (5+ computers per class) contexts. Participants included students, teachers, and parents from the two groups. Although systematic observations revealed relatively few differences in teaching methods between laptop and control classrooms, laptop students used computers more frequently, extensively, and independently. Writing assessment results showed substantial and significant advantages for laptop over control students, with six of eight effect sizes exceeding +0.80. Results also showed significant advantages for the laptop group on five of the seven components of the problem-solving task.
2	Lowther-2008 Lowther, Deborah; J. Dan Strahl, Fethi A. Inan, and Steven M. Ross (2008). Does Technology Integration "Work" When Key Barriers are Removed? Paper presented at the annual meeting of the American Educational Research Association in New York, NY March 2008.	The effectiveness of Tennessee EdTech Launch (TnETL), a statewide technology program designed to meet the NCLB mandate was investigated in this mixed-methods study. The goal of the program was to provide full-time, on-site technology coaches to prepare teachers to create lessons that engage students in critical thinking and use of computers as tools in order to increase learning. The study examined TnETL impact on student achievement, teachers' skills and attitudes toward technology integration; use of research-based practices; and students' skills in using technology as a tool. The study was implemented as "Launch" 1 and 2 cohorts that collectively involved 54 schools, 28,735 students and 1,746 teachers. Program effectiveness was measured via direct classroom observations, surveys, student performance assessments, focus groups, and student achievement analysis. A matched treatment-control quasi-experimental mixed methods research design was used for Launch 1, while a randomized control trial was used for Launch-2. Survey results showed that program teachers had significantly higher confidence to integrate technology and in using technology for learning. Observation results revealed that program as compared to control students more frequently used computers as tools, worked in centers, and engaged in research and project-based learning. Although the TnETL program

		demonstrated progress in changing school culture to benefit students through the use of technology, student gains on high-stakes tests were mixed. The implications of the results are discussed relative to implementation successes and barriers, sustainability prospects, and the observed impacts of technology integration on teaching and student learning.
3	Mayo-2005 Mayo, N. B., Lawrence, T. K. (2005). Longitudinal Study of Technology Training to Prepare Future Teachers. Educational Research Quarterly.	This three year study examined a program designed to prepare Pre-k toGrade 12 teacher candidates (TCs) to develop and deliver lessons that effectively incorporate technology that enable their students to use technology to achieve lesson plan objectives. Three variables were used: (1) comfort level with technology, (2) frequency of technology use, and (3) efficacy. The project evalaution showed positive pre-test/post-test gains on all three variables with statistically significant differences for comfort and frequency of use. Follow-up studies compared TCs as first-year teachers and first-year alternative certification teachers (ACTs) who did not participate in the technology training. TCs average scores were more positive than ACTs with a significant difference for teaching efficacy and number of hours students use technology.
4	Pass-2008 Pass, Delia Raymos (2005). Effects of a Professional Development Initiative on Technology Innovation in the Elementary School, UNF Theses and Dissertations. http://digitalcommons.unf.edu/etd/273	This non-equivalent group study explored the impact of teacher participation in the development and use of a web-based instructional resource on computer utilization by students. The effects of participation in the technology initiative on teacher attitudes toward computers, technology proficiency, and stages of adoption of technology were also investigated. Teacher volunteers participated in a treatment group that received a professional development intervention and a comparison or web access group (WAG)that received no professional development. The treatment, or Professional Development Group (PDG), received instruction that modeled a constructivist hands-on approach to creating technology-rich lessons based on classroom curricula and Intermediate technologies to encourage technology integration in the classroom. The lessons were posted online using identical web sites for both groups and accessed by students of the PDG and WAG teachers promoting the school-wide use of technology as a tool for active, directed learning. Use of the online resource was analyzed descriptively through computer lab usage logs, teacher-reported weekly logs, and number of hits on the websites. Utilization of the online resource by students of the professional development group of teachers was slightly higher than by students of the comparison group of teachers. The findings also indicated that exposure to the professional development intervention increased reported use of integrated applications and encouraged higher stages of adoption by the experimental group of teachers (PDG) than the comparison group of teachers (WAG).
5	Skoertz-2001 Skoretz, Yvonne M. (2011). A Study of the Impact of a School-Based, Job-Embedded Professional Development Program on Elementary and Middle School Teacher Efficacy for Technology Integration" (2011). PhD dissertation.	'The purpose of this study was to determine the impact of a school-based, job-embedded professional development program on elementary and middle school teacher efficacy for technology integration. Teacher efficacy has been identified as a strong predictor of whether the content of professional development will transfer to classroom practice (Bandura, 1997). Using a conversion mixed methods quasi-experiment research design, qualitative data were collected from the experimental groups' journal postings. Grappling's Technology and Learning Spectrum (Porter, 2002) was used to convert this qualitative data into quantitative data to determine the change in levels of technology integration in classroom practice. The Computer Technology Integration Survey (Wang, 2004) was used to determine

	differences in efficacy levels for technology integration between the experimental and comparison groups. Study findings indicated there was no statistically significant change in teachers' levels of technology integration after participation in a school-based, job-embedded professional development program. However, statistically significant differences in levels of efficacy for technology integration between teachers who participated in aschool-based, job-embedded professional development program and those who had not were found. Additionally, study findings indicated statistically significant differences in the experimental group's levels of efficacy for technology integration based on whether teachers taught in an elementary or middle school and whether teachers taught multisubjects or a single subject. Finally, there was no statistically significant relationship between efficacy for technology integration and technology integration in classroom practice for those teachers who participated in the professional development program.

OBSERVATIONAL STUDY REPORTS

	CITATION-SHORT	CITATION	THEORY	TECHNOLOGY
1	Abdullah-2013	Abdullah, Zalinawati, Mansor,Norudin, Hassanuddin, Noor Aini (2013). School Teachers Acceptance of E-book. World Applied Sciences Journal, 23,	Study specific	S-E-Book
2	Askar-2006	Askar, P., Usluel, Y. K. & Mumcu, F. K. (2006). Logistic Regression Modeling for Predicting Task-Related ICT Use in Teaching. Educational Technology & Society, 9 (2), 141-151.	Innovation Diffusion	Generic
3	Baldwin-2011	Baldwin, K. L. (2011). The influence of teacher professional development on technology integration at the secondary level. A PhD Dissertation	Study specific	Generic
4	Booth-2009	Booth, Jennifer (2008). The influence of professional development in technology integration on teacher pedagogy and student engagement in fourth and fifth grade elementary classrooms in an urban elementary school in the Northeast. Dissertation & Theses Collection. Paper AAI3315153. http://scholarsarchive.jwu.edu/dissertations/AAI3315153	Study specific	Generic
5	Brunk-2008	Brunk, J. D. (2008). Factors Affecting The Level Of Technology Implementation By Teachers In Elementary Schools. Phd Dissertation.	Study specific	Generic
6	Cartas-1998	Rodolfo Abreu Cartas (1998). The relationship between technology use by classroom teachers and factors which promote innovation adoption, PhD dissertation, University of Southern California, United States	Study specific	Generic
7	Cerveró-2011	Almerich Cerveró, Gonzalo;Suárez Rodríguez, Jesús M.;Jornet Meliá, Jesús M.;Orellana Alonso, María Natividad (2011). Las competencias y el uso de las Tecnologías de Información y Comunicación (TIC) por el profesorado: estructura dimensional,Revista electrónica de investigación educativa , 2011,	Study specific	Generic
8	Chang-2012	Chang, I.-H. (2012). The Effect of Principals' Technological Leadership on Teachers' Technological Literacy and Teaching Effectiveness in Taiwanese Elementary Schools. Educational Technology & Society, 15 (2), 328–340.	Study specific	Generic
9	Cobbs-1990	Cobbs, Henry L., Jr.; Wilmoth, Noel, J. (1990). Computing Potential Assessment in Atlanta Public Schools Education. Report Number 2.	Study specific	Generic
10	Coffland-2004	Coffland, DAVID A. and Strickland, ALBERT W (2004). Factors Related to Teacher Use of Technology in	Study specific	Technology in Geometry

		Secondary Geometry Instruction. Jl. of Computers in Mathematics and Science Teaching (2004) 23(4), 347-365		instruction
11	DeSmet-2012*	De Smet C., Bourgonjon J., De Wever, B., Schellens, T., Valcke, M. (2012). Researching instructional use and the technology acceptation of learning management systems by secondary school teachers. Computers & Education 58 (2012) 688–696	TAM or related	S-LMS-Informationuse
12	Dolgos-1991	Dolgos, Kathleen Ann (1991). A study of the relationship between attitude, computer use, and teacher training at the secondary level. PhD dissertation, Lehigh University.	Study specific	Generic
13	Fordham-2004	Rachel A. Vannatta Nancy Fordham. (2004). Teacher Dispositions as Predictors of Classroom Technology Use	Study specific	Generic
14	Friedrich-2011	Friedrich, H. F., Hron, A. (2011) Factors affecting teachers' student-centered classroom computer use, Educational Media International, 48:4, 273-285	Study specific	Generic
15	Gargallo-2006	Gargallo, B., Suárez, J. y Almerich, G. (2006). La influencia de las actitudes de los profesores en el uso de las nuevas tecnologías. Revista Espa-ola de Pedagogía, 223, pp. 45-66.	Study specific	Generic
16	Green-2006	Green, Jerilyn Denise (2006). The impact of teacher self efficacy and attitudes toward classroom computers(s) on the use of classroom technology. PhD dissertation, Wayne State University	Study specific	
17	Hall-2008	Hall, Valerie (2008). The effects of technology resources, school administration, and teacher expertise on the relationship between teachers' pedagogical beliefs and classroom computer use. PhD dissertation, University of California, Los Angeles.	Study specific	Generic
18	Hastings-2009	Hastings, T. A. (2009). Factors That Predict Quality Classroom Technology Use. PhD Dissertation.	Study specific	Generic
19	Hermans-2008	Hermans, R; Tondeur, J.; van Braak, J.; Valcke, M. (2008). The Impact of Primary School Teachers' Educational Beliefs on the Classroom Use of Computers. Computers & Education 51 1499–1509	Study specific	Generic
20	Himsworth-2007	Himsworth (2007). Why Resistance? Elementary Teachers' Use of Technology in the Classroom. PhD dissertation,Teachers College, Columbia University.	Study specific	Generic
21	Hong-Table8-p.62	Hong, K. H. (2009). L2 Teachers' Experience Of Call Technology Education And The Use Of Computer Technology In The Classroom: The Case Of Franklin County, Ohio Dissertation Table8-p.62	Study specific	Generic
22	Howley-2011	Howley, A., Wood, L., & Hough, B. (2011). Rural elementary school teachers' technology integration. Journal of Research in Rural Education, 26(9).	Study specific	Generic

		Retrieved from http://jrre.psu.edu/articles/26-9.pdf.		
23	Hsu-2010	Hsu, S. (2010). The Relationship Between Teacher's Technology Integration Ability And Usage. Journal of Educational Computing Research, 43(3), 309-325.	Study specific	Generic
24	Hua-2012	Chang, I.-H. (2012). The Effect of Principals' Technological Leadership on Teachers' Technological Literacy and Teaching	Study specific	Generic
25	Johnson-2006	Johnson, Pamel M. (2006). Change in classroom practices of technology use by K-12 teachers. PhD Dissertation. North Carolina State University.	Study specific	
26	Kessler-2011	Kessler (2011). Effectiveness in Taiwanese Elementary Schools. Educational Technology & Society, 15 (2), 328–340.	Study specific	Generic
27	Kim-2009*	Kim, M-R., Choi, M-A., Kim, Jayhyoun (2012). Factrsinfluencing the usage and acceptance of multi-mediabased digitaltextbooks in pilot schools. KSII Transactions on Intermet and Information Systems,	TAM or related	S-digital text book pilot
28	Konstantin-2014	"Konstantina, K. (2014). The Integration of Information and Communication Technologies (ICTs) in the Teaching of Mathematics in Secondary Schools: an Ecosystemic Approach. Journal of Educational and Social Research MCSER Publishing, Rome-Italy.	Study specific	Generic
29	Latio-2010	Latio, G. W. (2009). Examination of Factors that Influence Computer Technology Use for Classroom Instruction by Teachers in Ohio Public High Schools. A dissertation presented to the faculty of the College of Education of Ohio University.	Study specific	Generic
30	Lay-2013*	Lay, Jinn-Guey Lay, Yu-Lin Chi, Yeu-Sheng Hsieh, Yu-Wen Chen (2013). What influences geography teachers' usage of geographic information systems? A structural equation analysis, Computers & Education 62 (2013) 191–195	TAM or related	S-GIS
31	Marcinkiewicz-1993	Marcinkiewicz Henryk R (1994). Practicing vs Future Teachers: Comparisons and Correlates of Computer Use. Proceedings of Selected Research and Development Presentations at the 1994 National Convention of the Association for Educational Communications and Technology Sponsored by the Research and Theory Division, Nashville, TN, February 16-20.	Study specific	Generic
32		Marion, J. M. (2011). Assessing In-Kind Middle School Teachers' Concern About & Use Of Soars: School Online Assessment Reporting System. Phd Dissertation.	Study Specific	Specific
33	Marnella-2008	Marnella, molly (2008). A Study of Beginning Teachers' Use of Communication Technology.VDM Pulblishing, Saarbrücken, Germany.	Study specific	Generic

34	Miranda-2007	Miranda, H., Russell, M. (2011). Predictors of Teacher-Directed Student Use of Technology in Elementary Classrooms: A Multilevel SEM Approach Using Data from the USEIT Study JRTE | Vol. 43, No. 4, pp. 301–323	Study specific	Generic
35	Norris-2003	Norris, C. , Sullivan, T., Poirot, J. (2003). No Access, No Use, No Impact: Snapshot Surveys of Educational Technology In K-12.	Study specific	Generic
36	Oberbay-2010	Overbaya, A., Patterson, A. S., Vasua, E. S., and Grable, L. L. (2010). Constructivism and technology use: findings from the IMPACTing Leadership project. Educational Media International Vol. 47, No. 2, June 2010, 103–120	Study specific	Generic
37	Odwyer-2004-p390	O'dwyer, L. M., Russell, M., Bebell, D. (2004). Identifying Teacher, School, And District Characteristics Associated With Middle Andhigh School Teachers' Use Of Technology: A Multilevel Perspective	Study specific	Generic
38	Pelgrum-2009	Pelgrum, W. J., Voogt, J. (2009). School and teacher factors associated with frequency of ICT use by mathematics teachers: Country comparisons. Educ Inf Technol (2009) 14:293–308	Study specific	Generic
39	Polly-2011	Polly, Drew (2011). Examining Teachers' Enactment of Technological Pedagogical and Content Knowledge (TPACK) in Their Mathematics Teaching after Technology Integration Professional Development, Journal of Computers in Mathematics and Science Teaching, v30 n1 p37-59.	TPCK-Efficacy	Generic
40	Pynoo-2011*	Pynoo, B. , Devolder, P., Tondeur, J., van Braak, J., Duyck, W., Duyck, P. (2011). Computers in Human Behavior 27 (2011) 568–575	TAM or related	S-DLE
41	Pynoo-2012*	Pynoo, B., Jo Tondeur, J., van Braak ,J., Duyck, W., Sijnave ,B. , Duyck, P. (2012). Teachers' acceptance and use of an educational portal. Computers & Education 58 (2012) 1308–1317	TAM or related	S-Education Portal
42	Rickman-2009	Rickman-Rogers, T. P. (2009). Analysis Of Factors That Influence A Teacher's Use Of Computer Technology In The K-5 Classroom. PhD Dissertation.	Study specific	Generic
43	Russell-2007	Russell, Michael; Damian Bebell, Laura O'Dwyer and Kathleen O'Connor (2003). Examining Teacher Technology Use: Implications for Preservice and Inservice Teacher Preparation. Journal of Teacher Education September 2003 vol. 54 no. 4 297-310.	Study specific	Generic
44	Sang-2011	Sang, G., Valcke, M., van Braak, J. , Tondeur ,J. & Zhu, C. (2011). Predicting ICT integration into classroom teaching in Chinese primary schools: exploring the complex interplay of teacher-related variables.	Study specific	Generic

45	Simonsson-2005	Simonsson, Marie (2004). Technology Use of Hispanic Bilingual Teachers: A Function of Their Beliefs, Attitudes and Perceptions on Peer Technology Use in the Classroom. Journal of Instructional Psychology, v31 n3 p257-266.	Study specific	Generic
46	Stols-2011*	Stols, Gerrit and Jeanne Kriek, Jeanee (2011). Why don't all maths teachers use dynamic geometry software in their classrooms? Australasian Journal of Educational Technology, 27(1), 137-151	TAM or related	S-Dynamic Mathematics software
47	Teo-2001*	Toe, Hock-Hai and Kwok-Kee Wei (2001). J. Educational Computing Research, Vol. 25(4) 385-415, 2001 Effective use of computer aided instruction in secondary schools: a causal model of institutional factors and teachers' roles	TAM or related	S-Algebra Explanation by Holt Rhine Hart, 1997 and Maths Heads by Theatrix, 1997
48	Tondeur-2008	J Tondeur,J., van Braak, J. and Valcke, M. & (2010). ICT integration in the classroom: Challenging the potential of a school policy. Computers & Education, 51, 212-223	Study specific	Generic
49	Tondeur-2010	Tondeur,J. , Valcke, M. & van Braak, J. (2010). A multidimensional approach to determinants of computer use in primary education: teacher and school characteristics.	Study specific	Generic
50	Van Acker*	Van Acker, F., van Buuren, H., Kreijns, K., Vermeulen, M. (2013). Education and Information Technologies , Volume 18, Issue 3	TAM or related	S-DLM or digital leanring materials
51	Van Braak-2004	van Braak, J., Tondeur, J., Valcke, M. (2004). Explaining different types of computer use among primary school teachers. European Journal of Psychology of Education 2004. Vul. XIX. «"-/, 407-422	Study specific	Generic
52	VanderLinde	Vanderlinde, R, Aesaert, van Braak, J. (2014). Institutionalised ICT use in primary education: A multilevel analysis. Computers & Education, 72:1–10.	TAM or related	S-Integrate ICT attainment targets into the curriculum with concrete teaching/learnin g activities.
53	Waight-2014	Waight, Noemi Waight; Chiu, Ming Ming; Whitford, Melinda (2014). Factors that Influence Science Teachers' Selection and Usage of Technologies in High School Science Classrooms. ournal of Science Education and Technology, Volume 23, Issue 5, pp 668-681.	Study specific	Tools for science
54	Ward-2010	Ward, Lorrae and Parr, J. M. (2009). Revisiting and reframing use: Implications for the integration of ICT. Computers & Education, v54 n1 p113-122.	Study specific	Generic
55	Wisenmayer-1999	Wiesenmayer, R. L., Koul, R. (1999). Level of Internet Use Among Science Teachers Involved in a	Study specific	Integration of Internet-based

		Professional Development Project. Journal of Science Education and Technology, Vol. 8, No. 2, 1999		resources into science curriculum and peer critique of ind. efforts
56	Wozney-2006	Wozney, L., Venkatesh, V., And Abrami, P. C. (2006). Implementing Computer Technologies: Teachers' Perceptions and Practices. Jl. of Technology and Teacher Education (2006) 14(1), 173-207	Expectancy -value theory	Generic
57	Wu-2007	Hsin-Kai Wu, Ying-Shao Hsu And Fu-Kwun Hwang. (2007). Factors Affecting Teachers' Adoption Of Technology In Classrooms: Does School Size Matter? International Journal Of Science And Mathematics Education (2007) 6: 63y85	Study specific	Generic
58	Ying-Shao-2007	Hsu, Y.-S., Wu, H.-K., & Hwang, F.-K. (2007). Factors Influencing Junior High School Teachers' Computer-Based Instructional Practices Regarding Their Instructional Evolution Stages. Educational Technology & Society, 10 (4), 118-130.	Study specific	Generic
59	Yucel	Yücel, C., Acun, I. , Tarman, B. (2010). A Model To Explore Turkish Teachers' Ict Integration Stages. Tojet: The Turkish Online Journal Of Educational Technology – October 2010, Volume 9 Issue 4	Study specific	Generic