



**REVIEW**

**January 2006**

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**The effectiveness of different  
ICTs in the teaching and  
learning of English (written  
composition), 5–16**

This review is supported by the Training and Development Agency for Schools (TDA) to promote the use of research and evidence to improve teaching and learning

*Review conducted by the TDA-supported Information and Communication Technology (ICT) Review Group*

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The EPPI-Centre is part of the Social Science Research Unit, Institute of Education, University of London

## **AUTHORS**

Richard Andrews, University of York  
Hou Dan, University of York  
Allison Freeman, University of York  
Nick McGuinn, University of York  
Alison Robinson, University of York  
Die Zhu, University of York

### **Contact details**

Alison Robinson  
Information Officer  
Department of Educational Studies  
University of York  
York YO10 5DD

Tel: 01904 433462  
Fax: 01904 433459  
Email: [ar31@york.ac.uk](mailto:ar31@york.ac.uk)

## **REVIEW GROUP MEMBERSHIP**

As above.

## **CONFLICTS OF INTEREST**

There are no conflicts of interest for any members of the Review Team.

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# LIST OF ABBREVIATIONS

BECTa	British Educational Communications and Technology Agency
CAI/CAL	Computer-assisted instruction/Computer-assisted learning
CD-Rom	Compact disc, read-only memory
CT	Controlled trial
DfES	Department for Education and Skills (previously DfEE: Department for Education and Employment) (England and Wales)
EPPI-Centre	Evidence for Policy and Practice Information and Co-ordinating Centre
ERIC	Educational Resources Information Center
ICT	Information and communication technology
NOF	New Opportunities Fund
OECD	Organization for Economic and Collaborative Development
OfSTED	Office for Standards in Education (UK)
PGCE	Post-Graduate Certificate in Education
QA	Quality assurance
QCA	Qualifications and Curriculum Authority (England and Wales)
RCT	Randomised controlled trial
REEL	Research Evidence in Education Library
R-WISE	Reading and Writing in a Supportive Environment
SSCI	Social Science Citation Index
TDA	Training and Development Agency for Schools (England and Wales)
UK	United Kingdom
USA	United States of America

# GLOSSARY

## CAI/CAL

'Computer-assisted instruction' and 'computer-assisted learning'. The former tends to be associated with self-supporting computer programs which replace the teacher, rather than complement him/her.

## Chat room

A 'place' on the internet where people can converse in writing synchronously, as if they were talking to each other.

## Composition

Composition is literally 'putting together' words (and sometimes other media) to convey meaning, usually reserved for writing in English classes in schools or in further and higher education.

## **Comprehension**

Understanding print. Understood by psychologists as a key activity in learning to read, and complementing 'decoding' of printed text. Understood by English teachers as a now outmoded form of textual analysis and appreciation in which text is subjected to a series of questions to elicit understanding.

## **Databases**

Files in which information is arranged for access and use by readers.

## **Decoding**

The process, in reading, of converting print-based symbols into meaningful sounds.

## **Drama**

The subject on the school curriculum concerned with a combination of movement, acting, the performance of scripts, improvisation, etc.

## **Email**

Electronic mail, conveyed via the internet.

## **Games**

Computer games are the equivalent of conventional games, but with sophisticated graphics and interactive features.

## **Genre**

Basically, a type or category of text. In the Australian tradition, it means 'text-type'. In the North American sociological tradition, it means identifiable patterns of 'social action' grounded in texts.

## **Grammar**

Descriptions of, and prescriptions for, word order in sentences. Sometimes used to account for how whole texts are put together.

## **Hypertext**

Computer-readable text which allows for extensive cross-referencing, particularly 'vertically': that is, it is possible to conceive of and present text in vertical layers rather than conventionally, in a horizontal plane.

## **ICT**

ICT is taken to include stand-alone computers, networked technologies with a multimodal interface, mobile phones with the capacity for a range of types of communication, and other technologies which allow multimodal and interactive communication.

## **Interaction**

A dialogic relationship between the screen and the user of a computer. Usually involving the writer/user having *to do* something, rather than just passively *observe*.

## **Internet**

The facility by which email, the web and other forms of communication can be transmitted via computer and other ICT devices.

## **Language**

For the purposes of the reviews, language simply refers to any study that specifically focuses on aspects of speech, listening, reading and/or writing.

## **Language Arts**

This is the phrase used, particularly in the USA, to describe the language curriculum K–12 (Kindergarten to Year 12); it is often used to apply to the subject of English in the primary years

## **Learning**

The transformation from one state of personal knowledge to another.

## **Listening**

Hearing speech and interpreting it.

## **Literacies**

Literacy can be defined narrowly, as the ability to understand and create written language. It is, however, frequently defined in two broader senses, and both are included in the present review. Firstly, the scope can be expanded so that written language becomes written language and graphical or pictorial representation. Secondly, the skill can be treated as social, rather than psychological; in this view, literacy is the ability to operate a series of social or cultural representations. Both these expansions of the narrow term 'literacy' can be termed 'literacies'.

## **Literacy**

The ability to read and write.

## **Literature**

Fictional, dramatic or poetic texts.

## **Mobile phone**

Hand-held device for making spoken calls without having to be wired in to a network; also used for texting and sending images.

## **Motivation**

The impulse and/or desire to learn.

## **Moving image**

Film, video, animation.

## **Multimedia**

The use of more than one medium of communication to convey information. Whereas multimodality refers to the combination of more than one mode of communication (e.g. the verbal and visual), multimedia is a more technical term referring to a range of media which can convey such modes of communication.

## **Multimodality**

The use of more than one mode of communication to convey 'information'. All texts, in a sense, are multimodal in that printed writing is both visual and verbal. Multimodality is usually reserved for the combination of word and image, and/or sound conveyed via the computer screen.

## **Reading**

The act of bringing meaning to print.

## **Software**

Commercially created material for use on computers; it is the equivalent of a textbook or manual which can be used as an intervention in computer use.

## **Speaking**

In the National Curriculum in England and Wales, speaking is one of the four main capabilities required for the subject of English.

## **Spelling**

Orthographic representation of phonemes, morphemes and words.

## **Teaching**

Teacher-centred strategies for encouraging, eliciting and developing learning in pupils and students.

## **Vocabulary**

Words that make up a particular field; the lexicon.

## **Web-logging**

A form of communication via the internet in which a log is built up – sometimes individually, sometimes in collaboration – to create a running record. Known as 'blogging' in an abbreviation.

## **Word-processing**

The composition of verbal language on screen, usually on computer and in substantial form – as opposed to 'texting'.

## **Writing**

This term should be reserved for papers which study the impact of ICT on general writing skills and capabilities: for example, the structure and expression of compositions.

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# SUMMARY

## Background

The last few years have seen an increase in research studies on the impact and effectiveness of information and communication technologies in the teaching and learning of English as a school subject. Andrews (2004) provides an overview of such studies and contains chapters on five systematic reviews of research published between 1990 and 2003 on the impact of information and communication technology (ICT) on literacy learning in English for 5- to 16-year-olds. It is against that research background, and recent developments in policy and practice in the UK, that the present systematic review of the effectiveness of different ICTs in the teaching and learning of English has been undertaken.

## Aims

The aim of the present review is to shed light on whether ICTs are effective in the teaching and learning of English for 5- to 16-year-olds.

## Review questions

The review is in two parts. The first asks about what research has been published since 1998 on the topic of effectiveness of different ICTs in the teaching and learning of English, 5–16, and draws a systematic map of the field as a result. The second question is one that is answered in an in-depth review: what is the evidence for the effectiveness of different ICTs in the teaching and learning of English (written composition), 5–16?

## Methods

The systematic review (both the map and the in-depth study) used the methodology set out in guidelines and tools devised by the EEPI-Centre (EPPI-Centre 2002a, 2002b and 2002c). In short, a protocol or plan for the research was drafted, including a provisional research question for the initial map of research in the field. Exclusion and inclusion criteria for the literature search were written. The protocol was peer reviewed, revised and then published on the Research Evidence in Education website (<http://eppi.ioe.ac.uk/reel>). Research papers were searched for, identified, screened for relevance and then keyworded to create an initial database. A map of research studies in the field was generated. From the map, one area of research was identified for in-depth review: written composition. Papers in this area were data-extracted and assessed for quality and weight of evidence with respect to the research question. A narrative synthesis of the results was produced.

## Results

A total of 2,103 papers were found in the initial search of studies published between 1998 and 2003 on the topic of the review. Of these, 56 met the inclusion criteria for the review. Of the 56 papers, 14 were reviews of research and 42 reported primary research. Because four of the primary research papers contained more than one study, a total of 14 reviews and 53 studies were examined.

Nine of the 14 reviews were systematic reviews, and the countries of origin of the 14 reviews were the UK (seven) and the USA (seven). They also divided equally between a focus on reading, writing and other aspects of literacy. The general consensus of the reviews with regard to written composition was that computer-assisted instruction or learning and word-processing appeared to have a beneficial effect on student's written composition, but only when combined with strategic instruction.

Of the 53 primary studies, 36 were from the USA, 15 from the UK, and one each from Australia and Canada. The majority of the studies focused on learners between the ages of 5 and 10 in a primary or elementary school setting; and two-thirds involved learners of both sexes. Again, these studies were evenly divided between an emphasis on reading, writing or other aspects of literacy. The principal focus in terms of ICT across the 53 primary studies was on computer-assisted instruction or computer-aided learning, and on software. Almost two-thirds of the studies on writing focused on composition. More specifically, in terms of those 20 studies that focused on written composition, CAI/CAL<sup>1</sup>, software and multimedia were the most popular ICT interventions, each with six studies; five studies investigated word-processing.

The in-depth review on the effectiveness of ICT in the teaching and learning of written composition in English concentrated on nine studies. A meta-analysis was not conducted as the samples, intervention measures and outcomes were considered too heterogeneous; so a narrative synthesis was undertaken. As eight of the nine studies were judged to be of medium weight of evidence and also different from each other in nature, it was not possible to arrive at a clear answer to our in-depth research question. Rather, we wish to report that the field is in a pre-paradigmatic state where definitions of English, literacy and ICT are still relatively unclear and where the causal and/or symbiotic relationship between them have yet to be fully theorised. The most authoritative study in terms of the present review is that by Lewis *et al.* (1999) which showed that ICT made little difference to an experimental group of 'learning disabled' students in terms of writing quality, but that, for lower-order writing skills, improvements happened at a faster rate for such students as well as there being an increase in self-esteem for these students.

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<sup>1</sup> CAI/CAL as computer-assisted instruction and computer-assisted learning are often difficult to unravel in studies on ICT's effect on written composition. When we refer to them separately, we mean them as separate concepts; but when we splice them together, it is because there is no clear distinction between 'instruction' ('teaching') and 'learning' in the research we have reviewed.

## Conclusions

Such results can provide neither clear answers to our research questions nor firm conclusions. Despite a rigorous searching and screening exercise and a systematic, explicit and replicable process of distillation that involved inter-rater reliability and peer review on three occasions, the results are non-conclusive. The review suggests that there is insufficient research of high quality to answer the specific research questions we set ourselves. It is fully acknowledged that the research questions are about effectiveness, and therefore require studies of a particular kind to answer them. It does not mean that this is the only kind of question that can be asked in the field, but our results (which are consistent with previous reviews in the field) suggest that researchers, practitioners and policy-makers need to accept that questions about effectiveness or impact with regard to ICT and literacy/English in schools have yet to be answered; and that other questions also need to be asked.

Implications for policy, practice and research are set out in detail in the report. Essentially, from the individual studies we have examined (rather than through a synthesis of the studies for in-depth review) policy-makers might think about ICT as a range of technologies that can have particular effects on particular parts of the English syllabus under particular circumstances, rather than as a main tool for literacy development. The next version of the National Curriculum for England could view ICT as less peripheral, but more limited and specific in its contribution to learning and teaching. Procurement policies should follow from curricular needs, rather than driving them.

In practice terms, ICT is best seen as another tool in the repertoire available to learners and teachers for expression and communication. Custom-made word-processing and other software programs should be considered by teachers, as some of these prove to be more attuned to the writing process than others. Teachers also need to be aware that there are times when the use of ICT is appropriate for a particular writing task (or part of that task), and other times when different media are more appropriate. Continued and prolonged exposure to ICT can be demotivating.

Further research needs to undertake some large-scale, well-designed randomised controlled trials if it is to answer the questions set in the present review. Ethical issues need to be considered, and the limitations of controlled trials and pre- and post-test studies acknowledged. In substantial terms, research needs to look at the symbiotic relationship between ICT and literacy; the role of teachers in mediating between ICT and learning; and the use of curriculum time with regard to technologies. Further work also needs to be done on the theoretical foundations of research in the field: in particular, building on the work of the New London Group (Cope and Kalantzis, 2000). Finally, one of the implications of the present (and previous) reviews on the topic is that a new kind of research is needed in the field: one that is at the cutting edge of interface design and pedagogical application, and which adopts a research and development approach.

# 1. BACKGROUND

The present review aims to answer the question ‘What is the effectiveness of different information and communication technologies (ICTs) in the teaching and learning of English, 5–16?’ It does so by collecting and appraising existing research literature in the field, some of it the result of systematic research reviews by the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) English Review Group, which has looked at the impact of ICT on literacy learning in English. There is also a policy background, represented in a range of papers from the Department for Education and Skills (DfES), the Office for Standards in Education (Ofsted), the British Educational Communications and Technology Agency (BECTa) and the Organization for Economic and Collaborative Development (OECD).

## 1.1 Aims and rationale for current review

The Training and Development Agency for Schools (TDA) has identified a number of key areas in which systematic reviews of the research literature should be carried out over a three-year period from the autumn of 2003 to the autumn of 2006. One of these is the effectiveness of ICT applications in teaching and learning in the core curriculum subjects of English, Science and Mathematics. The present review looks at the first of these subjects: English.

There is a growing concern internationally that the investment in ICT in schools is not impacting on learning development. This concern counters a belief held by many – including governments, as well as schools – that ICT *is* beneficial to learning (see, for example, OECD, 2001, p 11). This concern arises because the claims for and against the effectiveness of ICT in core curriculum subjects are not evidence-based. The issue is an important one, and has to be seen within a wider political, social and technological context in which the symbiosis between new technologies and new forms of learning are acknowledged.

There have been a number of systematic reviews published since 2002 on the impact of ICT on literacy learning (see Andrews, 2004). The purpose of the present review is to focus specifically on the *effectiveness* of ICT on teaching and learning in English, 5–16. To date, one systematic review (Torgerson and Zhu, 2003) has focused on this topic, but without specific attention on the significance of the results for teacher educators and trainee teachers. Also this review did not look at the evidence for the effectiveness of different pedagogies in the use of ICT in English, and it did not explore the effectiveness of different ICTs. Among the value-added elements that the present review provides are:

- comparison between different ICT applications
- effectiveness of different pedagogies
- a focus on English as a school subject as defined by the National Curriculum in England, as opposed to ‘literacy’, which is more international and more focused on language development

- specific applicability for teachers, teachers trainees and teacher educators

The objectives are as follows:

- to map the field of research published in the last five years on the effects of different ICTs in the teaching and learning of English for pupils aged between 5 and 16
- to undertake an in-depth review on one aspect of the field: the effects of different ICTs on the teaching and learning of *written composition* for pupils aged between 5 and 16

## 1.2 Definitional and conceptual issues

**Literacy**, as used in the overarching protocol for this project, has two meanings. First, it refers to the ability to read and write. More broadly, it includes social as well as cognitive aspects of literacy on the one hand; and texts where written language has been complemented by a graphic or pictorial dimension on the other.

**ICT** has been defined as including stand-alone computers, networked technologies with a multimodal interface, mobile phones with the capacity for a range of types of communication, and other technologies that allow multimodal and interactive communication.

**English** refers to the school subject on the core curriculum as well as to the language to which the review limits its scope. For definitional purposes, the review will use 'English' as the subject defined in the National Curriculum for England (DfEE/QCA, 1999). The four skills of English are defined as speaking and listening, reading and writing. The latter two cover fictional, poetic and dramatic literature as well as non-fiction; drama and media studies are included where they come within the subject 'English'.

**Pedagogy** is the art of teaching. In other words, it includes teaching methods and strategies.

**Effectiveness** is a concept in research methodology that describes and analyses the effect of an intervention upon an existing state of affairs. It is best measured via randomised controlled trials (RCTs). It can be distinguished from the broader term 'impact' in that it operates within a causal, scientific paradigm.

## 1.3 Policy and practice background

The use of ICT in schools to support literacy learning is pervasive. Successive governments, across a range of English-speaking countries, have, since the mid-1990s, invested large amounts of resources to develop ICT in schools. What appears to have been lacking has been the articulation of a rationale for ICT integration into the English programme.

There is a requirement in the National Curriculum for England, for example, that ICT is incorporated in the teaching of all subjects. Between 1992 and 2002, all primary and secondary teachers in England were required to undertake training under a New Opportunities Fund (NOF) initiative to improve their ICT capabilities and competence.

In England, Ofsted (2001, 2002) has published reviews on the impact of government initiatives on standards and on literacy. It concluded (2001, p 2) that there is 'emerging evidence of a link between high standards across the curriculum and good ICT provision' but that the 'contribution of ICT to the raising of standards in individual subjects remains variable'.

That variability is not generally recognised in many policy and practice publications, which extol the virtues of ICT. The OECD report on schools and ICT is a case in point (OECD, 2001). BECTa, too, suggests that 'ICT has fundamentally altered the way we communicate with each other and how we think about reading and writing' (BECTa, 2002, p 1) and that it 'has unique potential to extend and enhance pupils' learning in English'. Much of the policy writing is couched in such *future potential* terms.

The writing becomes more interesting when it comes down to more specific levels, and it is at the levels of different ICT, different pedagogies and different aspects of English as a school subject that less hyped and more useful distinctions are drawn. For example, word-processing is generally seen as one of the facilities afforded by computers that have revolutionised writing and composition. However, much practice is still concerned with 'secretarial' or surface features, rather than with structural or more deeply compositional aspects of writing.

Word-processing is not the only way in which ICT has affected composition and an increasing number of teachers are frustrated by the fact that their colleagues might see word-processing in such terms. Multimedia reading – and less commonly, multimedia composition – are recognised as adding a new dimension to reading and 'writing'. Hypertext is a multi-layered form of textuality that has been recognised since the early 1990s as altering conventional ways of reading, particularly with regard to its non-linearity. The use of multimedia CD-Roms is another aspect of ICT use in the classroom that has changed research projects by pupils, and especially the relationship between information and analysis. And, last but not least, *networked* ICT in the form of email, chat rooms, the internet, threaded discussions (both synchronous and asynchronous), texting and other uses of mobile phones have blurred the distinction between speech and writing, and brought into the foreground the relationship between word and image.

A further aspect of the policy and practice background to take into account (and which was not addressed in the previous systematic reviews) is that English as an *additional language* must be included, following government reports on its importance in future planning for schools.

## 1.4 Research background

The present review follows hard on the heels of a series of five systematic reviews on the impact of ICT on literacy learning for 5- to 16-year-olds (Andrews *et al.*, 2002; Burn and Leach, 2004; Locke and Andrews, 2004; Low and Beverton, 2004; Torgerson and Zhu, 2003). These focused respectively on the impact of networked ICT on literacy; the impact of ICT on moving image literacies; the impact of ICT on literature-based literacies; the impact of ICT on literacy for those for whom English is an additional language; and on the effectiveness of ICT in literacy learning. The five reviews, plus methodological considerations, were distilled into a book published early in 2004, *The Impact of ICT on Literacy Education* (Andrews, 2004).

The review by Torgerson and Zhu (2003) is particularly relevant to the present review. Their review focused on the effectiveness of ICT on literacy learning for 5- to 16-years-olds in English (as a language, not as a school subject).

Torgerson and Zhu (2003) identified two RCTs that investigated the effect of word-processing on writing (Jones, 1994; Zhang *et al.*, 1995).

Jones (1994) presented two main outcomes: in one outcome (writing quality), there was a large positive benefit, which was statistically significant; for the second outcome (writing quantity), there was a modest benefit, which was not statistically significant. In the other study (Zhang *et al.*, 1995), the positive effect for the word-processing condition was not statistically significant.

'There was a pooled effect size of 0.890 (C.I. 0.245 to 1.535). This was quite a large positive effect for the word-processing intervention and was statistically significant.'

The results of the review were neither clearly supportive of the benefits of ICT on literacy outcomes, nor supportive of a harmful effect. One of the problems identified in that review was that, until there are larger-scale randomised controlled trials undertaken in the field, it will not be possible to state with any confidence that the effect of ICT on literacy learning is significant. Most of the studies reviewed, although judged to be of medium to high quality, were small in scale, and provided a narrow basis on which to make any conclusions.

However, ICTs are widely used in schools in the UK and their use varies in terms of type of pedagogies and ICTs used. Therefore it is important to investigate which pedagogies and which ICTs are the most effective on English teaching.

The key differences between Torgerson and Zhu (2003), also reported in Andrews (2004), and the present review are that the present review focuses on different pedagogies in the use of ICT to support *English* for 5- to 16-year-olds. For example, the present review looks at word-processing packages as well as at multimedia interfaces, comparing the effectiveness of different technologies where possible. It also explores the evidence for the effectiveness of different ICTs. These questions were not addressed by the previous review.

The boundaries between different pedagogies and different ICTs were hard to map and to study in-depth in the present review, because the studies examined for in-depth review did not take into account different pedagogies. Different ICTs

ranged from CAI/CAL, software packages to multimedia and word-processing. Again, it proved hard to distinguish between these (imperfect) categories, as a particular ICT intervention might have elements of all of these types. Rather than generalise, we have preferred to be specific about the kinds of ICT used and the degree to which, in particular circumstances, they can be said to be effective.

## 1.5 Authors, funders and other users of the review

The particular individuals involved in the present review all have an interest in either the substance of the review – the effectiveness of ICT in the teaching and learning of English (Andrews, McGuinn, Freeman) – or the methodological approach of systematic reviewing (Hou, Robinson), or both. McGuinn has a working interest in teacher education, and is actively involved in the training of English teachers.

The project is funded by the Training and Development Agency for Schools, which is concerned with bringing reviews of research literature to bear on the training of teachers. It is hoped that the results of this review will inform beginning and continuing teachers more fully about an important part of their subject. It is undertaken at this time as ICT has impacted considerably on the teaching and learning of school subjects in the last fifteen years. It is time to take stock of developments in the field.

The principal audiences for the review are likely to be teacher educators, trainee teachers and in-practice teachers. The review will also be of interest to teachers interested in research, policy-makers, researchers, pupils/students and parents. As is usual with EPPI-Centre reviews, user summaries will be written by representatives of the constituencies above.

## 1.6 Review questions

The research question for the systematic map is as follows:

***What is the evidence from research published since 1998 for the effectiveness of different ICTs in the teaching and learning of English, 5–16?***

The research question for the in-depth review is as follows:

***What is the evidence from research published since 1998 for the effectiveness of different ICTs in the teaching and learning of English (written composition), 5–16?***

We have limited our review to the years 1998 to the present for two reasons: one, because the field of research into ICT and pedagogies is changing fast; two, in order to provide an up-to-date review of the field. Although the last 15 years have seen the extensive use of computers and the internet in English classrooms, our focus is on recent developments for the reasons set out above.

Conceptually, such a question is ostensibly narrow in focus. It assumes, in seeking evidence for effectiveness, that it will look principally at randomised controlled trials and at other researcher manipulated or naturally occurring evaluations that might shed light on the question. It does not attempt to explore issues of symbiosis in the relationship between ICT and the teaching and learning of English; rather, it is interested in learning outcomes as a result of teaching with ICT interventions.

For both the mapping and in-depth stages, we looked at empirical research published between 1998 and the present.

Because the review question has close links with those used in the previous systematic reviews undertaken by the English Review Group, these completed reviews served as research background to the present study.

## 2. METHODS USED IN THE REVIEW

Systematic review methods were used throughout the review, using the EPPI-Centre guidelines and tools for conducting a systematic review (EPPI-Centre, 2002a, 2002b and 2002c).

### 2.1 User involvement

Since this review is sponsored by the TDA, the main audiences for it are teachers, trainee teachers and teacher educators. Accordingly, we will use the Post-Graduate Certificate in Education (PGCE) English cohort at the University of York in 2004/05 for the development and dissemination of the report. There are already projects underway in the department on the translation of research findings into teaching plans. There are parent governors, teachers and teacher-educators on the steering group for the English Review Group who commented on the protocol and on the final draft of the report. They will also be involved in dissemination: for example, in writing user summaries or in recommending how the report should be disseminated.

Policy-makers were apprised of the results and methods in a seminar at the DfES (Policy/research interchange, 8 June 2004). The results were further disseminated in seminars held by the TDA in December 2004 and January 2005 aimed at examining ways of engaging parishioners in systematic review outcomes. Members of the review team are presently working with the TDA to produce an effective user summary. The review was presented at an EPPI-Centre conference in May 2005

### 2.2 Identifying and describing studies

#### 2.2.1 Defining relevant studies: inclusion and exclusion criteria

For a study to be included in the systematic map, it had to be a study looking at the effectiveness of different ICTs in the teaching and learning of English, 5–16. It had to be published or unpublished (but in the public domain) between 1998 and 2003. As the focus of the study is on the *effects* of different ICTs, papers using methods to identify any such effects were required. This implied the following study types, classified according to the EPPI-Centre taxonomy of study type contained in its core keywording strategy (EPPI-Centre, 2002a):

- C: Evaluation (naturally occurring or researcher-manipulated)
- E: Review (systematic or other review) containing at least one evaluation

The full inclusion/exclusion criteria are contained in Appendix 2.1.

### **2.2.2 Identification of potential studies: search strategy**

Papers were identified from the following sources:

- searching of electronic bibliographic databases: Educational Resources Information Center (ERIC), PsycINFO, Social Science Citation Index (SSCI)
- searching of references cited in systematic reviews included in the map

Search strings for the electronic databases were constructed by combining the core foci of teaching, learning, pedagogy and ICT with terms describing the types and ages of learners, educational settings and required curriculum area, as set out in the review protocol. The full search strategy is contained in Appendix 2.2.

### **2.2.3 Screening studies: applying inclusion and exclusion criteria**

The Review Group set up a database system, using EndNote bibliographic software, for keeping track of, and coding, studies found during the review. Titles and abstracts were imported and entered manually into the database. Inclusion and exclusion criteria were applied successively to (a) titles and abstracts, and (b) full reports. Full papers were obtained for those studies that appeared to meet the criteria or where we had insufficient information to be sure. The inclusion and exclusion criteria were re-applied to the full papers and those that did not meet these initial criteria were excluded. At both stages of screening, the inclusion and exclusion criteria were applied hierarchically, such that, for instance, exclusion on criterion 6 implies that the study would have been included on criteria 1–5. The database was fully annotated with reviewer decisions on inclusion and exclusion and reasons for exclusion.

### **2.2.4 Characterising included studies**

The studies remaining after application of the inclusion/exclusion criteria were keyworded, using the EPPI-Centre core keywording strategy (EPPI-Centre, 2002a) and online software, EPPI-Reviewer (EPPI-Centre, 2002b). Additional keywords specific to the present review were added. The EPPI-Centre generic and the review-specific keywords are contained in Appendix 2.3. All the keyworded studies were uploaded to the larger EPPI-Centre database, Research Evidence in Education Library (REEL), for others to access via the website.

### **2.2.5 Identifying and describing studies: quality-assurance process**

Quality assurance was undertaken at each stage of the screening process:

#### ***Screening of titles and abstracts***

The inclusion and exclusion criteria were initially applied by four Review Group members (RA, HD, NM and DZ) and by CT to a random sample of 20 titles and abstracts as a training exercise in screening at first stage. This was done

independently in the first instance, and the team members then met to compare the codes allocated, discuss discrepancies, and reach a consensus on how criteria were to be interpreted and applied. A second random sample of 20 titles and abstracts was then created and independently screened by four members of the team and by CT. Agreement between all reviewers was discussed for internal quality assurance purposes. The full database created by the electronic searches of ERIC, PsycINFO and SSCI (2000 references) was then divided into five sections, with each reviewer (RA, HD, NM, CT and DZ) responsible for screening a proportion of the titles and abstracts. For external quality-assurance purposes, a third sample of 20 papers was generated by selecting the first four references from each of the five segments of the database. This sample was independently screened by a representative of the EPPI-Centre (KS). As a further quality-assurance check, the included references from each of the five database segments were merged and independently screened again by the most experienced Review Group member (RA) and by CT who then met and compared their decisions to include.

### **Screening of full papers**

One Review Group member screened all of the papers sent for as a result of the first stage screening of titles and abstracts (AF). CT screened a sample of approximately 25% (23 papers). A further sample of 10 papers was screened by a representative of the EPPI-Centre.

### **Keywording**

Quality assurance of keywording began with a moderation exercise. Four members of the Review Group independently keyworded five papers, using the EPPI-Centre keywording strategy (EPPI-Centre, 2002a) and a draft version of keywords designed specifically for this review. The results of the moderation exercise were analysed by a fifth member and used as a basis for discussion about generic and review-specific keywording procedures. In addition, the review-specific keywords were redrafted and additional information was provided for the glossary.

Subsequently, keywording of all the studies included in the systematic map were conducted by pairs of Review Group members, working first independently and then comparing their decisions before coming to a consensus. A member of the EPPI-Centre also helped in applying criteria and keywording a sample of studies.

## **2.3 In-depth review**

### **2.3.1 Moving from broad characterisation (mapping) to in-depth review**

After the mapping of all the included studies, the research question and inclusion/exclusion criteria were narrowed and refined for the in-depth review.

### **Research question for in-depth review**

What is the evidence from research published since 1998 for the effectiveness of different ICTs in the teaching and learning of English (written composition), 5–16?

To be included in the in-depth review, a study had to focus on ICT and written composition. The reasons for focusing on written composition were partly pragmatic and partly related to policy, research and practice. Pragmatically, we needed to concentrate on an aspect of English that had not been heavily researched (reading) and which might give us evidence of different outcomes according to the kind of ICT used. In terms of policy, research and practice, we felt that a focus on written composition would provide clear evidence of outcome and of the effectiveness of ICT interventions. It was a less heavily researched area of enquiry than reading, with important implications for literacy. In seeking good quality evidence for effectiveness, the inclusion criteria were further refined by the addition of a filter that limited included studies to RCTs and controlled trials (CTs) with adequate sample size and quantified outcome measures. Sample size is relevant because, even where there is a control group, if the total sample is fewer than 10, the study cannot be regarded as sufficiently rigorous for the results to be reliable, *because all the covariates cannot be balanced*. We restricted our attention to quantified outcome measures as these are acknowledged as the best measures of effectiveness.

Full criteria for the in-depth review are as follows:

#### **Inclusion criteria**

- Must focus on ICT and written composition
- Must be a RCT or CT
- Must have adequate sample size to balance all the covariates
- Must have quantified outcome measures

#### **Exclusion criteria**

Exclusion 1: Not focused on ICT and written composition

Exclusion 2: Not RCT or CT

Exclusion 3: Insufficient sample size

Exclusion 4: No quantified outcome measures

### **2.3.2 Detailed description of studies in the in-depth review**

Studies identified as meeting the inclusion criteria were analysed in-depth, using the EPPI-Centre's detailed data extraction guidelines (EPPI-Centre, 2002c) together with its online software, EPPI-Reviewer (EPPI-Centre, 2002b).

### 2.3.3 Assessing quality of studies and weight of evidence for the review question

Three components were identified to help in making explicit the process of apportioning different weights to the findings and conclusions of different studies. Such weights of evidence are based on the following:

- A Soundness of studies (internal methodological coherence), based upon the study only
- B Appropriateness of the research design and analysis used for answering the review question
- C Relevance of the study topic focus (from the sample, measures, scenario, or other indicator of the focus of the study) to the review question
- D An overall weight taking into account A, B and C

EPPI-Centre Guidelines were used to gauge the weight of evidence (WoE) an individual study brings to the review. On the basis of judgements about A, B and C, an overall weight (D) was ascribed to each study. This was done on the basis of an approximate average of the three weights A, B and C, although WoE B was given greater importance given the research question, which focuses on effectiveness. A study could only be given an overall WoE of 'high' if it had at least two 'high' judgements, including 'high' for WoE B, and no 'low' judgements. Similarly a study could only be given an overall WoE 'medium' if it had at least two 'medium' (or 'high') WoE judgements, including WoE B. The weight of evidence assessments were taken into consideration in the narrative synthesis.

### 2.3.4 Synthesis of evidence

The data were then synthesised to bring together the studies which answer the review question and which meet the quality criteria relating to appropriateness and methodology. A narrative synthesis was undertaken.

### 2.3.5 In-depth review: quality-assurance process

Data-extraction and assessment of the weight of evidence brought by the study to address the review question was conducted by pairs of Review Group members, working first independently and then comparing their decisions before coming to a consensus. Members of the EPPI-Centre helped in data-extraction and quality appraisal of a sample of studies.

### 3. IDENTIFYING AND DESCRIBING STUDIES: RESULTS

As outlined in Chapter 2, this systematic review included study types C and E (evaluations and literature reviews) as defined in the EPPI-Centre taxonomy of study types (EPPI-Centre, 2002a). The term ‘study’ is taken to mean one complete piece of work, whether evaluation or review. The term ‘paper’ is taken to mean the research report or article in which the study is reported. Research papers may sometimes report on more than one study. The initial review stages of searching and screening focused on research papers. Where papers identified for inclusion in the map were found to contain more than one study, each individual study was included and keyworded. The map is therefore presented as an overview of characteristics of included studies.

Table 3.1 gives the origin of all papers found and those subsequently included in the systematic map. Table 3.2 describes the identification of papers that reported on more than one study. Figure 3.1 illustrates the process of filtering papers from searching to mapping and finally to synthesis.

#### 3.1 Studies included from searching and screening

**Table 3.1:** Origin of included papers

	Found	Included
PsycINFO	616	20
ERIC	1,217	14
SSCI	242	6
Citation	23	11
Contact	5	5
<b>TOTAL</b>	<b>2,103</b>	<b>56</b>

Table 3.1 shows the origin of papers included in the systematic map following the application of inclusion/exclusion criteria as described in section 2.2.3.

Papers found on PsycINFO, ERIC and SSCI were imported into the review database and the duplicates removed sequentially in the order shown in Table 3.1. A number of studies were identified from citation searching of included systematic reviews. Any potentially relevant studies identified through this process were sent for and then screened using the inclusion/exclusion criteria. Citation searching enables reviewers to focus on more relevant studies than is possible through broad electronic database searching and this is reflected in the proportionately high number of citations included in the map. Any studies that met our inclusion criteria were keyworded and included in the descriptive map (N=11).

The series of systematic reviews by the EPPI English Review Group on the impact of ICT and literacy learning in English for 5- to 16-year-olds (Andrews *et al.*, 2002; Burn and Leach, 2004; Locke and Andrews, 2004; Low and Beverton, 2004; Torgerson and Zhu, 2003) were included and coded as papers identified through contacts (N=5).

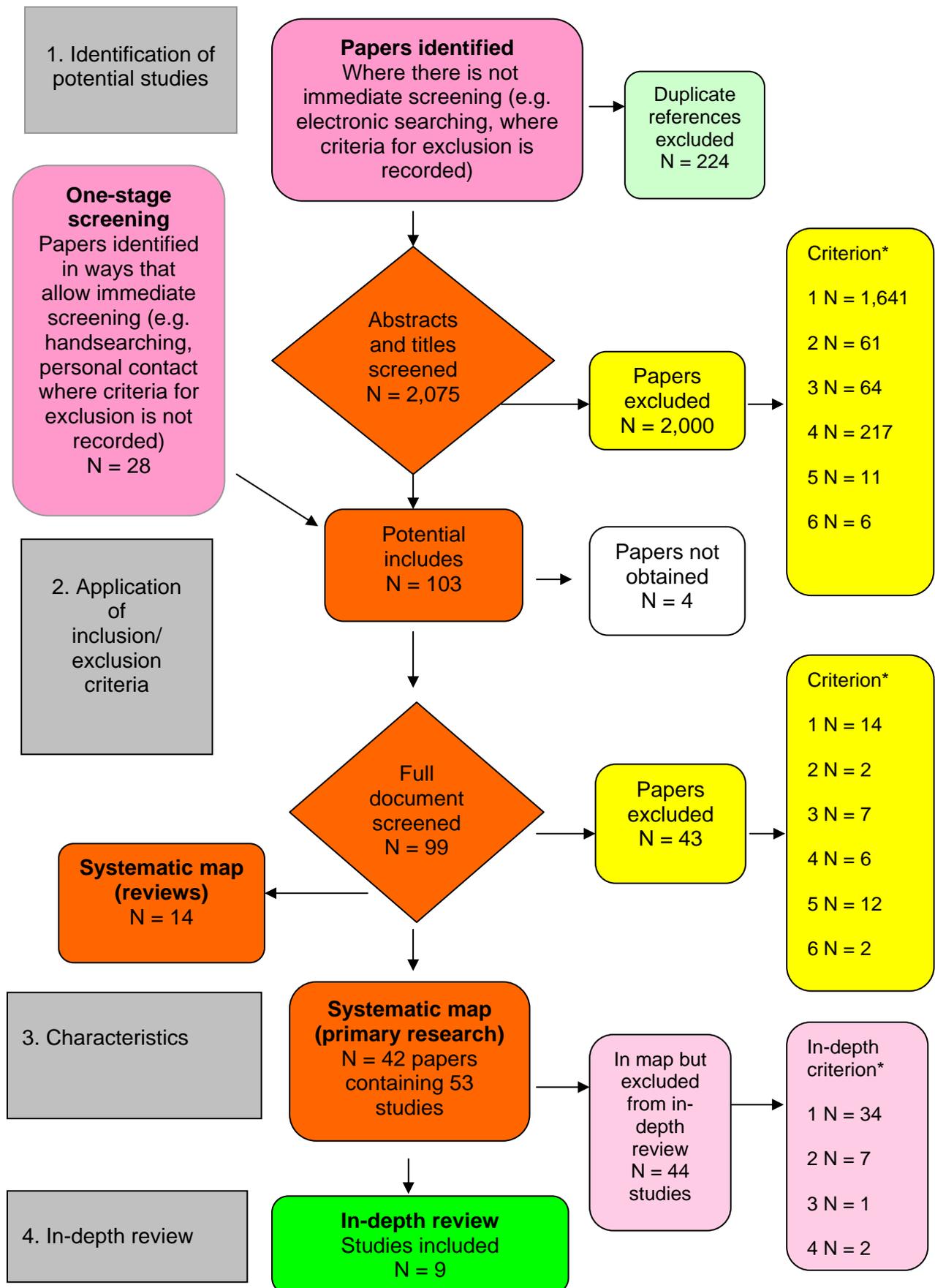
**Table 3.2:** Type of research and number of studies reported by included papers

Research type	Number of papers
Primary research	42 (on 53 studies)
Reviews	14
Total	56

The screening process identified 56 papers that met the inclusion criteria. Table 3.2 shows that 14 papers reported reviews and 42 reported primary research. Four papers (Fan and Orey, 2001; Moseley, 1999; Rowley *et al.*, 1998; Underwood, 2000) reported on two, seven, four and two studies respectively.

The map therefore describes 14 literature reviews and 53 primary studies.

**Figure 3.1:** Filtering of papers from searching to map to synthesis (\*Exclusion criteria were applied hierarchically)



## 3.2 Characteristics of the included studies

### 3.2.1 Research reviews

The majority (64%) of the reviews included in the map were systematic. All were published and were conducted either in the UK or the USA.

**Table 3.3:** Type of review (N = 14, mutually exclusive)

Type of review	Number of reviews
Systematic	9
Non-systematic	5
<b>Total</b>	<b>14</b>

In Table 3.3, we see that nine of the 14 reviews included in the map were systematic.

**Table 3.4:** Country of origin in which the reviews were carried out (N = 14, mutually exclusive)

Country	Number of reviews
UK	7
USA	7
<b>Total</b>	<b>14</b>

Table 3.4 shows that the country of origin of the included reviews was equally split between the UK and the USA.

**Table 3.5:** Aspect of English/Language Arts on which the reviews focused (N = 14, not mutually exclusive)

Aspect of English/Language Arts	Number of reviews
Reading	6
Comprehension	4
Decoding	6
Writing	6
Composition	5
Grammar	4
Spelling	5
Vocabulary	2
Other aspects	6
Literacy	6
Other	3

Included reviews were evenly, but not exclusively, divided in focus between reading, writing and other aspects of English/Language Arts.

Within the group of six reviews that focused on reading, two focused exclusively on decoding and four investigated on both comprehension and decoding.

Within the group of six reviews that focused on writing, four investigated composition, grammar and spelling and two also included vocabulary. One review focused exclusively on spelling and one on written composition.

Of the other aspects of English/Language Arts, six reviews focused on literacy. One review also looked at media (film, TV, video) and one review investigated literacies and literature.

Further details of the characteristics of all reviews included in the systematic map are given in Appendix 3.1

The in-depth review focuses on the effectiveness of different ICTs in the teaching and learning of written composition. The conclusions of the five reviews that include a focus on written composition are presented below.

**Table 3.6:** Summary of conclusions of reviews that focused on written composition

Author, year	ICT intervention(s)	Conclusions in relation to written composition
<b>Systematic reviews</b>		
MacArthur <i>et al.</i> (2001)	CAI/CAL hypertext word-processing software	'Research in writing provides qualified support for the beneficial effects of assistive technology' (p 297). 'Instruction that takes advantage of the capabilities of technology can help students... improve their writing overall' (p 297/298).
Torgerson and Zhu (2003) (EPPI English RG review)	CAI/CAL multimedia word-processing	A meta-analysis for the effect of word-processing on writing produced 'weak evidence for a positive effect' (summary, p 7).
<b>Non-systematic reviews</b>		
Fisher <i>et al.</i> (1999)	CAI/CAL word-processing internet email	The results of studies that explored the use of CAI/CAL and word-processing in writing instruction indicated that technology 'helps children to focus on content rather than mechanics' and 'encourages the production of more and better developed essays' (p 3). Also, accessing electronic literacy environments (internet and email) 'increased specialized vocabulary and coherence' (p 3) and 'improved mechanics of writing' (p 4).
MacArthur (1999)	word-processing software	'Strategy instruction in combination with word processing resulted in...improvement in overall quality of compositions' (p 174).

MacArthur (2000)	hypertext word-processing software	'Word processing, in combination with instruction, can help students learn to revise and improve their writing overall' (p 98). '...practitioners and researchers need to work together to develop instructional methods for using technology in writing' (p 98).
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The general consensus of the reviews that included a focus on written composition was that computer-assisted instruction or learning (CAI/CAL) and word-processing in particular appeared to have some beneficial effect of students' writing, but only when combined with strategic instruction.

The conclusions in these reviews are used to contextualise our results in the discussion section of Chapter 5.

### 3.2.2 Primary research

In seeking evidence for the *effectiveness* of ICT in the teaching and learning of English, searching for and screening of primary research for the systematic map was limited to study type C (i.e. evaluations).

**Table 3.7:** Type of evaluation (N = 53, mutually exclusive)

Study type	Number of studies
Researcher-manipulated	52
Naturally occurring	1
<b>Total</b>	<b>53</b>

Almost all the evaluations included in the map were found to be researcher-manipulated; that is, the researcher(s) determined the process by which participants did or did not receive an intervention. Only one study reported a naturally occurring evaluation. In this study the researchers made no attempt to control who did or did not receive an intervention but rather observed the phenomena that would have occurred without their presence. The definitions of researcher-manipulated and naturally occurring evaluation applied in this review are contained in full in the EPPI-Centre's core keywording strategy (EPPI-Centre, 2002a).

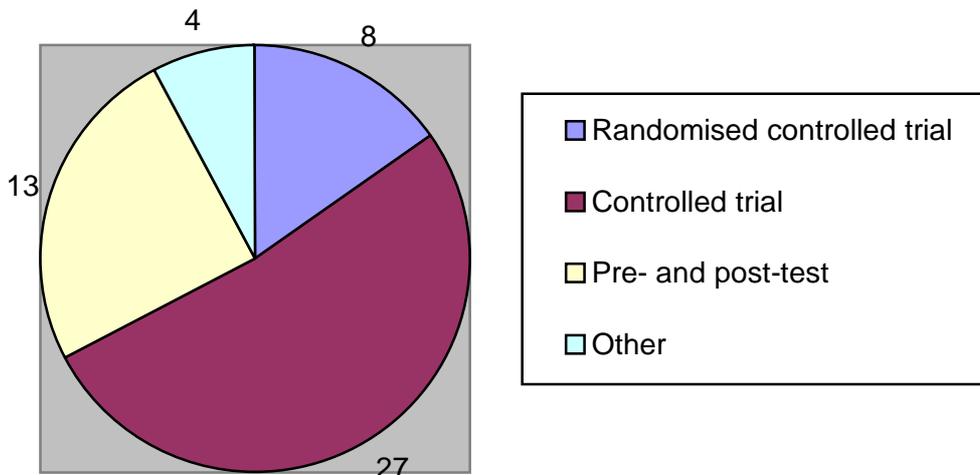
**Figure 3.2:** Type of researcher-manipulated evaluation (N = 52, mutually exclusive)

Figure 3.2 shows that 52% (N=27) of included studies reported controlled trials (researcher manipulated evaluations with non-randomised control group). 15% (N=8) reported randomised controlled trials (researcher manipulated evaluations with randomised control group), 25% (N=13) reported pre- and post-tests (researcher manipulated evaluations with no control group) and 8% (N=4) reported other types of researcher-manipulated evaluation.

**Table 3.8:** Country of origin (N = 53, mutually exclusive)

Country	Number of studies
USA	36
UK	15
Australia	1
Canada	1
<b>Total</b>	<b>53</b>

Two-thirds (N=36) of included studies were carried out in the USA. Less than one-third (N=15) were conducted in the UK. The two remaining included studies originated in Australia and Canada respectively.

**Table 3.9:** Publication status (N = 53, mutually exclusive)

Status	Number of studies
Published	51
Unpublished	2
<b>Total</b>	<b>53</b>

Almost all (96%) of the studies included in the map were published. Two were in the form of unpublished research reports originating in the USA.

**Table 3.10:** Types of learners (N = 53, not mutually exclusive)

<b>Age of learners</b>	
5–10	43
11–16	22
<b>Educational setting</b>	<b>Number of studies</b>
Home	1
Nursery school	2
Primary school	43
Secondary school	14
Other	1
<b>Sex of learners (mutually exclusive)</b>	
Mixed sex	34
Not stated	19

Table 3.10 describes the age and sex of learners, and the educational setting(s) in which the included studies were conducted. The majority of studies (N=43) involved learners aged between 5 and 10 in a primary school setting. Seven studies were conducted in more than one educational setting and 11 studies involved learners in both primary and secondary school age groups. Two-thirds (N=34) of included studies involved learners of mixed sex. The sex of learners was not stated in the remaining 19 studies.

**Table 3.11:** Aspect of English/Language Arts (N = 53, not mutually exclusive)

<b>Aspect of English/Language Arts</b>	<b>Number of studies</b>
<b>Reading</b>	<b>31</b>
Comprehension	20
Decoding	8
Phonological awareness	2
Other aspects of reading	7
<b>Writing</b>	<b>32</b>
Composition	20
Grammar	3
Spelling	13
Vocabulary	2
Other aspects of writing	3
<b>Other aspects</b>	<b>31</b>
Literacy	24
Multimodality	2
Speaking or listening	3
Media (film, TV, video)	1
Genre	1

Reading and writing were the aspects of English/Language Arts most frequently investigated by the included studies with numbers of studies divided almost

equally between these two aspects. Ten studies investigated both reading and writing.

Within the group of 31 studies that looked at reading, almost two-thirds (N=20) focused on comprehension. Eight studies focused on decoding, two investigated phonological awareness and seven looked at other aspects of reading. Six studies investigated both comprehension and decoding.

Within the group of 32 studies that looked at writing, almost two-thirds (N=20) focused on composition. Thirteen studies focused on spelling, three on grammar, two on vocabulary and three on other aspects of writing. Seven studies investigated two or more aspects of writing.

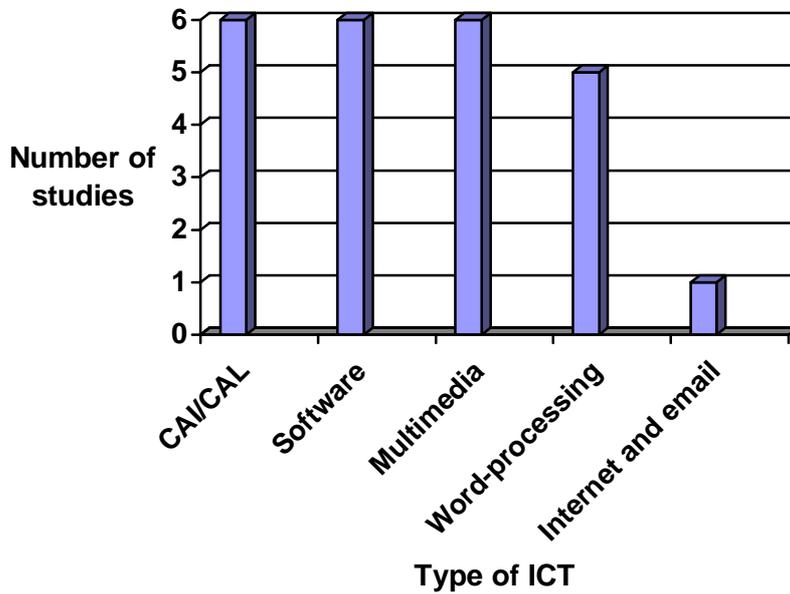
Of the 31 studies that investigated other aspects of English/Language Arts, the majority (N=24) focused on literacy.

**Table 3.12:** Type of ICT (N = 53, not mutually exclusive)

Type of ICT	Number of studies
CAI/CAL	24
Software	21
Multimedia	12
Word-processing	8
Email	1
Internet	1
Games	1
Moving image	1

Studies often included more than one type of ICT per study. CAI/CAL was used in just under half (N=24) of the included studies and exclusively so in 16 studies. Seven studies involved the use of CAI/CAL with specific software, and one used CAI/CAL exclusively with multimedia and word-processing technologies. Specific software was used exclusively in 10 studies and in combination with CAI/CAL and/or other technologies in 11 studies. Multimedia and word-processing technologies featured in 12 and 8 studies respectively, and other technologies were used in four studies.

**Figure 3.3:** Type of ICT used in studies that focused on written composition (N = 20, not mutually exclusive)



The cross-tabulation in Figure 3.3 shows that, for the 20 studies that focused on written composition, CAI/CAL, software and multimedia technologies were the most popular ICT interventions, each featuring in six studies. Five studies investigated word-processing. Two studies included two types of ICT and one study included three.

**Table 3.13:** Aspect of pedagogy (N = 53, not mutually exclusive)

Aspect of pedagogy	Number of studies
Learning	53
Teaching	8
Individual/autonomous learning	10
Interaction	4
Drafting	2
Whole class	5
Small group	2

It is interesting to note that all (N=53) of the included studies focused on learning. Eight studies investigated both learning and teaching. Almost one in five (N=10) of the studies that focused on learning looked at individual/autonomous learning. Thirteen studies focused (not exclusively) on other aspects of pedagogy.

**Table 3.14** Outcomes reported (N = 53, not mutually exclusive)

Outcomes reported	Number of studies
Test results	45
Quality	21
Motivation/engagement	16
Other	12

The outcomes reported in the studies often included more than one measure per study. The majority (N = 45) of the included studies reported outcomes in terms of test results, although fewer than half of these (N = 21) relied exclusively on test results. Quality and motivation/engagement were reported as outcome measures in 21 and 16 studies respectively, and 12 studies reported other outcomes. Of the eight studies that did not report test results, three measured outcomes exclusively in terms of quality and four measured outcomes in terms of quality and motivation/engagement. One study reported exclusively on writing quantity.

Further details of the study type and review-specific characteristics of each included study are given in Appendix 3.2

### 3.3 Identifying and describing studies: quality-assurance results

#### *Quality assurance of the two stages of screening papers retrieved from the electronic searches*

##### *Screening of titles and abstracts*

*Internal quality assurance (QA) of a random sample of 20 titles and abstracts:* Agreement between the four reviewers and CT was high. Full agreement to include or exclude was established on 19 out of 20 titles and abstracts. Two reviewers (NM and DZ) were slightly more inclusive and included one study that CT, RA and DH excluded.

*External QA of a further random sample of 20 titles and abstracts:* Full agreement about whether to include or exclude was established between KS and the Review Group on all 20 titles and abstracts.

On the basis of internal and external QA for first stage screening, it was felt that, because agreement was high on both counts, there was no need to take the QA process further.

##### *Screening of full papers*

*Internal QA of a random sample of 25% of the papers received for second-stage screening (23 papers):* Agreement was high; AF and CT agreed to include or exclude 22 out of the 23 papers. This agreement was felt to be high enough for the Review Group to have confidence in the main reviewer's second-stage screening decisions.

External QA of a random sample of 10 papers: Agreement between the EPPI-Centre link person (KS) and the Review Group was 8 out of 10 papers. KS was more inclusive than the Review Group reviewer and included two papers that were excluded by AF. Again, on the basis of internal and external QA for second stage screening it was felt that because agreement was high on both counts there was no need to take the QA process further.

#### **Quality assurance of keywording**

All of the studies that were included in the map were independently double keyworded by pairs of reviewers. Agreement was generally high on both the generic and the review-specific keywords, although there was some disagreement on study type. This was resolved through discussion and through internal QA provided by CT.

### **3.4 Summary of results of map**

Fourteen reviews and 53 primary research studies met the inclusion criteria developed for the overall research review. These reviews and studies were keyworded and formed the basis of the systematic map. The map revealed a number of characteristics of research on different ICTs in the teaching and learning of English, as summarised below.

#### **Research reviews**

- Nine of the reviews were systematic and five were non-systematic.
- All the reviews reported work that had taken place in either the USA or the UK.
- The reviews were evenly, but not exclusively, divided in focus between reading, writing and other aspects of English/Language Arts.
- The most frequently reported ICT intervention was CAI/CAL.

#### **Primary research**

- Almost all the studies reported researcher-manipulated evaluations. Only one reported a naturally occurring evaluation.
- Thirty-five of the studies reported trials, of which eight reported randomised controlled trials.
- The majority of the studies were published and reported work that had taken place in the USA or UK.
- ICT was used with all ages of student in the primary and secondary school age ranges.
- All the studies focused on learning, with only a small proportion having the additional focus of teaching.

- CAI/CAL and/or specialist software were the most frequently used ICT interventions.
- The majority of ICT interventions were used in relation to effect on reading and/or writing.
- Most studies reported outcomes in terms of test results.

## 4. IN-DEPTH REVIEW: RESULTS

### 4.1 Selecting studies for the in-depth review

The systematic map yielded 20 studies that met the inclusion criterion of written composition. The application of the full inclusion/exclusion criteria specified in section 2.3.1 identified nine studies for in-depth review, as shown in Table 4.1.

**Table 4.1:** Studies included in in-depth review

<b>Author(s), year, title</b>
Barrera MT, Rule AC, Diemart A (2001) The effect of writing with computers versus handwriting on the writing achievement of first-graders
Cramer S, Smith A (2002) Technology's impact on student writing at the middle school level
Fan H, Orey M (2001) Multimedia in the classroom: its effect on student writing ability (Study B)
Lewis RB, Ashton TM, Haapa B, Kieley CL, Fielden C (1999) Improving the writing skills of students with learning disabilities: are word processors with spelling and grammar checkers useful?
Lowther DL, Ross SM, Morrison GM (2003) When each one has one: the influences on teaching strategies and student achievement of using laptops in the classroom
Rowley K, Carlson P, Miller T (1998) A cognitive technology to teach composition skills: Four studies with the R-WISE writing tutor (Study A)
Rowley K, Carlson P, Miller T (1998) A cognitive technology to teach composition skills: four studies with the R-WISE writing tutor (Study B)
Rowley K, Carlson P, Miller T (1998) A cognitive technology to teach composition skills: four studies with the R-WISE writing tutor (Study C)
Rowley K, Carlson P, Miller T (1998) A cognitive technology to teach composition skills: four studies with the R-WISE writing tutor (Study D)

The exclusion criteria for the 11 studies that focused on written composition but were not included in the in-depth review are given in Table 4.2.

**Table 4.2:** Studies included in the systematic map that focused on written composition but were excluded from in-depth review

Author(s), year, title	Exclusion criterion
Casey JM (2001) A path to literacy: empowering students in your Classroom	Exclusion 4
Fan H, Orey M (2001) Multimedia in the classroom: its effect on student writing ability (Study A)	Exclusion 2
Holdich CE, Chung PWH (2003) A 'computer tutor' to assist children develop their narrative writing skills: conferencing with HARRY	Exclusion 3
Jones I (1998) The effect of computer-generated spoken feedback on kindergarten students' written narratives	Exclusion 2
Moseley D (1999) Ways forward with ICT: effective pedagogy using information and communications technology for literacy and numeracy in primary schools (Study A)	Exclusion 2
Moseley D (1999) Ways forward with ICT: effective pedagogy using information and communications technology for literacy and numeracy in primary schools (Study D)	Exclusion 2
Moseley D (1999) Ways forward with ICT: effective pedagogy using information and communications technology for literacy and numeracy in primary schools (Study G)	Exclusion 2
Vincent J (2001) The role of visually rich technology in facilitating children's writing	Exclusion 2
Watts M, Lloyd C (2001) Evaluating a classroom multimedia programme in the teaching of literacy	Exclusion 4
Yekovich FR, Yekovich CW, Nagy-Rado A (1999) A formative evaluation of the TRALE (technology-rich authentic learning environments) project	Exclusion 2
Zhang Y (2000) Technology and the writing skills of students with learning disabilities	Exclusion 2

Key to in-depth exclusion criteria:

Exclusion 2: not RCT or CT

Exclusion 3: insufficient sample size

Exclusion 4: no quantified outcome measures

Eight studies (Fan and Orey, 2001, Study A; Jones, 1998; Moseley, 1999, Studies A, D and G; Vincent, 2001; Yekovich *et al.*, 1999; Zhang, 2000) were excluded as they were not of a randomised controlled trial or controlled trial design. These studies could not be reliably used when addressing the research question, which concentrated on effectiveness, as their design did not allow for temporal effects and regression to the mean. Two studies (Casey, 2001; Watts and Lloyd, 2001) reported controlled trials but were excluded as they contained no quantified outcome measures and thus could not be reliably used to provide evidence of improvement in writing.

One study focusing on written composition reported a randomised controlled trial (Holdich and Chung, 2003). This was the most appropriate study design to address the question of effectiveness of an ICT in teaching written composition. However, although Holdich and Chung's research confirmed 'the hypothesis that a computer tool can change the way children approach the task of writing and improve writing performance' (p 631), this study was excluded from the in-depth review because the sample size was inadequate with too few participants to balance any covariate.

None of the studies in the in-depth review focused on different pedagogies as part of its research design. We found that it was difficult to separate teaching from learning on our reading of the studies. Although some of the studies referred to learning style, they did not relate such styles to pedagogical approaches. Discussion of self-esteem and motivation in relation to work with ICT was not connected to classroom approach and/or the influence of the teacher.

## 4.2 Comparing the studies selected for in-depth review with the total studies in systematic map

All nine studies selected for in-depth review were carried out or were assumed by implication to have been carried out in the USA. In each study, the main pedagogical focus was learning.

### *Ages of learners*

As summarised in Table 4.1 below, the majority of studies (N=8) involved learners between the ages of 11 and 16. Three studies involved learners aged between 5 and 10, and two included both age groups. This differs significantly from the systematic map, in which the proportion of studies involving learners of primary school age was much higher.

**Table 4.1:** Ages of learners in studies selected for in-depth review

Age range	Number of studies	Study
5–10	3	Barrera <i>et al.</i> (2001) Lewis <i>et al.</i> (1999) Lowther <i>et al.</i> (2003)
11–16	8	Cramer and Smith (2002) Fan and Orey (2001) (Study B) Lewis <i>et al.</i> (1999) Lowther <i>et al.</i> (2003) Rowley <i>et al.</i> (1998) (Studies A, B, C and D)

### *Type of ICT*

Three types of ICT intervention were used in the studies selected for in-depth review; CAI/CAL, word-processing and multimedia. As shown in Table 4.2, each study focused exclusively on one type of ICT. The proportion of studies that used word-processing is high by comparison with the proportion of studies in the map,

but this is not surprising given that the focus of the in-depth review is written composition.

**Table 4.2:** Type of ICT used in studies selected for in-depth review

Type of ICT	Study
CAI/CAL	Rowley <i>et al.</i> (1998) (Studies A, B, C and D)
Word-processing	Barrera <i>et al.</i> (2001) Lewis <i>et al.</i> (1999) Lowther <i>et al.</i> (2003)
Multimedia	Cramer and Smith (2002) Fan and Orey (2001) (Study B)

### 4.3 Further details of studies included in the in-depth review

Appendix 4.1 provides summary tables of the nine studies included in the in-depth review. These tables are based on the information gathered and judgements reached in the data extraction of the studies.

### 4.4 Synthesis of evidence

All the studies in the in-depth review were examined in order to determine the nature of the synthesis (syntheses) to be conducted for the review. It was not felt to be appropriate to conduct a meta-analysis, because the samples (ages, learner characteristics, etc.), interventions and outcome measures were too heterogeneous. Therefore a narrative synthesis was undertaken.

Of the nine studies included in the in-depth review, eight were judged to be of medium weight of evidence in answering the research question for this particular review. All nine studies were controlled trials in one form or another, but only in one of the studies (Lewis *et al.*, 1999) was there an element of randomisation. These will be discussed later in the present section. The synthesis will start with a discussion of Lewis *et al.* (1999) which was rated as providing the highest weight of evidence, as set out in Table 4.3.

**Table 4.3:** Individual weights of evidence of studies selected for in-depth review

Paper	Weight of evidence A (trustworthiness in relation to study's own research question)	Weight of evidence B (appropriateness of research design and analysis)	Weight of evidence C (relevance of focus of study to review)	Weight of evidence D (overall weight of evidence)
Lewis <i>et al.</i> (1999)	High to medium	High to medium	High	High to medium
Barrera <i>et al.</i> (2001)	Medium	Medium	Medium	Medium
Cramer and Smith (2002)	Medium	Medium	Medium	Medium
Fan and Orey (2001) Study B	Medium	Medium	Medium	Medium
Lowther <i>et al.</i> (2003)	Medium	Medium	Medium	Medium
Rowley <i>et al.</i> (1998) Study A	Medium	Medium	Medium	Medium
Rowley <i>et al.</i> (1998) Study B	Medium	Medium	Medium	Medium
Rowley <i>et al.</i> (1998) Study C	Medium	Medium	Medium	Medium
Rowley <i>et al.</i> (1998) Study D	Medium	Medium	Medium	Medium

As Lewis *et al.* (1999) state, 'the primary goal of [their] study was to examine the impact of word-processing tools combined with effective instruction on editing and revising performance' in English (p 87), specifically on the effectiveness of spelling and grammar checkers as tools for improving the quality and accuracy of the writing of students with learning disabilities. The study type is that of a randomised controlled trial within a controlled trial, with A, B and C teacher groups randomly allocated. This is an unusual study type in that randomisation is used in a particular way: not to increase reliability between the control and experimental groups, but to minimise the potential influence of teachers upon the learners in the conduct of the study. As part of the pre-test and post-test control group design, 106 students with learning disabilities made up three experimental groups and one control group. A further control group with no disabilities was established. Both control groups worked with only paper and pencil, as opposed to the experimental groups who worked with a Write This Way word-processing program. The study was rated high to medium in terms of weight of evidence in that there was a tight focus on quantifiable outcomes in terms of writing (such as the number of 'mechanic' errors); use of control and comparison groups; and an application of established data-collection procedures. However, the number of teachers in each of the A, B and C groups was not stated.

The results of the Lewis *et al.* study show little difference between the treatment/experimental groups of 'learning disabled' students in terms of writing quality. There were differences, however, in those groups that used spelling and grammar checkers, in that the number of errors decreased from pre-test to post-test for all experimental groups. Significantly, the decrease happened at a faster rate for students with learning disabilities who were using the software. Furthermore, the software gave those students who used it more self-esteem in themselves as writers; 86% of students agreed that Write This Way was a helpful

tool for writing; and 64% said they were better writers on the computer than with paper and a pencil.

The remaining studies, for various reasons set out in the appendices, were afforded medium weight of evidence overall. This means that only Lewis *et al.* (1999) can be depended on for a relatively authoritative answer to the research question we set ourselves (with the caveats stated above), and that the following studies, while shedding light on the problem from various angles, are neither robust enough nor dependable enough to provide solid evidence.

Barrera *et al.* (2001) sought to build on recent investigations of computer use by pre-school children by investigating a mixed ability class of first-grade students in a semi-rural elementary school. A relatively small sample of students (18) was given alternating interventions and activities over a six-month period, and their performance measured to assess the differential effects of computer word-processing and handwriting of assignments. The measures included number of words and sentences written, and also on- and off-task behaviour during writing periods (to test concentration on the task in hand). Computer use resulted in significantly more writing: on average, there were more sentences written per assignment and more words per assignment when using a computer than when assignments were handwritten. Off-task behaviour differences were not significant.

In the study by Cramer and Smith (2002), the aim was to find out how student writing in the areas of organisation, voice and/or ideas improve(s) with involvement in technology-rich instruction. In a quasi-experimental study, with pre- and post-test design, a sample of 139 students was used, with 88 in the experimental group and 51 in the control group. The results were that changes in achievement did occur but not in predicted directions. 'By the end of the year, there was no statistically significant differences in student writing abilities ( $p > .05$ )...'. The median score was the same for both schools, and no different from the pre-test scores in general. The 'only differences in scores on the post-test were for sixth graders in the areas of organization and voice ( $p > 0.5$ )' (p 8). There are other small effects reported, but nothing of note for this review. The authors conclude that the research 'does not provide evidence to support a yes vote' (p 8) in respect of its research question.

The purpose of Fan and Orey's (2001) study 'was to examine the constructivist use of multimedia technology to improve students' writing performance' (p 2) with a controlled trial, pre- and post-test writing samples, and a sample of 47 seventh-grade advanced language arts students. The six-week experimental project did not improve compositional skills in pencil and paper essays; rather, 'its power lay in its motivational effects rather than its effects on learning writing' (p 11). The authors conclude that more systematic investigation of motivational effects would be needed to gauge the extent to which motivation has been affected – and, we would add, sustained.

The principal aim of Lowther *et al.* (2003) was 'to provide further insight into the degree to which school laptop programs can influence students' educational experiences and learning'. Two primary research questions were asked: is teaching and student behaviour different in laptop compared with control classrooms? And do students achieve differently in laptop classrooms? The study focused on fifth-, sixth- and seventh-grade students, and a number of evaluation

measurement strategies were used. Results were highly significant with regard to the effect of using laptops on writing, particularly on content, organisation and style; the fourth aspect of writing capability that was measured (conventions) showed a slightly lower significance. However, the *ex post facto* design of the study, despite the presence of a control and experimental groups over 21 classrooms (the exact sample is unclear), reduces the overall reliability of the results.

Rowley *et al.* (1998) undertook a linked series of four studies, the broad aim of which as a group was 'to evaluate and adapt the writing software Reading and Writing in a Supportive Environment (R-WISE) in an attempt to improve prose composition as a cognitive act with the help of computers' (p 260). R-WISE is a word-processing package based on an understanding that composing in writing is a cognitive, socially-informed act that might go through a number of stages. It therefore tries to reflect contemporary understanding of the writing process, rather than be a drill-based tool. The four separate studies took place sequentially, developing the software, as well as measuring outcomes in composition along the way. A large sample was used for each of the studies.

The first study revealed that R-WISE helped most ninth-grade students in the sample to improve their compositional skills, but helped students with lower pre-test scores the most. Specifically, 'holistic score trends...suggest that the use of R-WISE effectively supplemented and extended classroom instruction in writing. Introducing R-WISE into ninth-grade English classes produced significant gains over and above traditional instruction' (p 272).

The second study showed similar results, in that on all measures, the treatment/experimental group gained about twice as much progress on compositional skills as the control group (again with a large sample). This time, higher-end students seemed to gain more than lower-end students, a contrast from the findings of the first study. The interesting difference between the two studies was that the second one compared the use of R-WISE with straightforward word-processing, rather than with handwritten composition. The novelty factor of the computer was thus reduced.

Whereas the focus of the first two studies was on comparing tools, that of the third study was more instructional in focus, in that a comparison was made of 'guided' with 'open' modes of composition was made. The sample was 1,122 students and 21 teachers. Using the same six-point holistic scoring rubric as in the first two studies, the authors revealed that 'groups using R-WISE in guided mode during the first semester, then open mode during the second semester, showed significant gains over groups using only guided for both semesters' (p 280). Importantly, 'the teacher's instructional style appeared to play some role in the effectiveness of R-WISE, with the students of those teachers who prefer social, independent, and neutral instructional styles receiving less benefit from R-WISE than students of teachers who prefer a conceptual instructional style' (pp 280–281). The authors conclude that, as 'the level of prior knowledge that a student has of a domain has been demonstrated to be a critical factor in the effectiveness of learner-control in computer-based instructional systems', then the fact that students in the sample did best when moving from guided mode into open mode seems to confirm such findings.

The fourth and last of the Rowley *et al.* studies was a replication of previous studies, using R-WISE version 3.0. In other words, it attempted to see if results of previous studies held up to sustained enquiry. The results revealed that they did: that is, there was superior performance by ninth-grade students using R-WISE on all measures, but the size of the difference remained small – as in earlier studies – and the students' pre-test scores remained more predictive of post-test performance than the effect of the experiment. The authors also conclude that 'to some degree the application of cognitive science to the development of an adaptive learning environment for writing skills is viable' (p 291) but they note that several unanswered questions remain, including the context of student aptitudes and the support of teachers' preferred instructional styles.

In summary, this was a heterogeneous set of studies with no possibility of meta-analysis. In arriving at a narrative synthesis in answer to our research question, we have judged all the studies (with the exception of Lewis *et al.*, 1999) to be of medium weight of evidence in answering the question. All the studies suggest, rather than conclusively prove, the beginnings of an answer to the research question we set ourselves. Part of the difficulty in attempting a synthesis is that the studies are so different. Barrera *et al.* (2001) concentrate on length of composition and on attitudes to writing; Cramer and Smith (2002) on organisation, 'voice' and ideas; Lowther *et al.* (2003) on content, organisation, style and convention; and Rowley *et al.*'s (1998) four studies focus on the impact of a developing word-processing program on student composition. At least all these studies, and that of Lewis *et al.* (1999), take ICT to be word-processing on a computer, whereas Fan and Orey (2001) look at multimedia technology more broadly. In short, there is no consistent view across the set of studies on the nature of the written composing process, nor on information and communication technologies themselves. We are thus dealing with two variables – ICT and written composition – which require further definition. While there have been at least four decades of research on writing processes and perhaps two on ICT, the field is still in a pre-paradigmatic state where researchers pay too little attention to defining the (shifting) terms with which they are operating. In such a stage of development in research in a particular field, syntheses remain largely heterogeneous; we are thus unable to make confident comparisons between the effectiveness of different ICTs on learning in English for 5- to 16-year-olds.

## 4.5 In-depth review: quality-assurance results

There were nine studies in the in-depth review for this research question. All nine studies were independently double data-extracted by Richard Andrews, Allison Freeman and Nick McGuinn, and by Katy Sutcliffe from the EPPI-Centre. The data extractions were compared and all disagreements resolved. The data-extraction for each of the nine studies was then uploaded to the EPPI-Centre's REEL database.

## 4.6 Nature of actual involvement of users in the review and its impact

The protocol for the present review was designed by ex-English teachers (Andrews, McGuinn, Torgerson), vetted by the English Review Group's steering group (which consists of teachers, advisory teachers for literacy, a parent governor, parents of school-age children) and independently peer-reviewed by a teacher. Members of the Review Group include three former teachers of English, two postgraduate research students, and two teacher educators. Dissemination and application of the review will involve PGCE students.

## 4.7 Summary of results of synthesis

Our findings in the present review are principally that our initial hesitation, as set out in the Background section of this report, was confirmed: there is little research that shows a clear positive effect of different ICTs in the teaching and learning of English for 5- to 16-year-olds. Our answer to the research question that we set ourselves – 'What is the evidence for the effectiveness of different ICTs in the teaching and learning of English (written composition), 5–16?' – has to be 'Not much'.

First, there is only one study that we could find that is sound enough to accept its conclusions with some confidence, *viz* Lewis *et al.* (1999). This study used two control groups and revealed that there was a positive effect of the use of a word-processing program to assist students in composition, particularly those who had problems in learning. However, the study is not a randomised controlled trial and therefore cannot answer questions of the *effectiveness* of the intervention. It can, at best, suggest that there might be such an effect.

The other studies in the in-depth review were not afforded sufficient weight of evidence for us to be confident that their results contribute much to answering our research question. Most showed a positive effect for ICT, but these effects vary: one study showed weaker students, and then stronger students benefiting more from engagement with ICT in written composition; one suggested that motivation was likely to be the biggest gain; and another showed greater advances in some aspects of written composition than in others.

## 5. IMPLICATIONS

### 5.1 Strengths and limitations of this systematic review

The main strength of this review is that it is rigorous. Although covering only a five-year period from 1998 to 2003, initial searching identified 2,299 studies that might be relevant. Of these, 2,075 were screened by abstract, and title where there was no abstract. In addition, two existing systematic reviews and three non-systematic reviews were drawn on. A subsequent 103 papers were sent for, of which 99 arrived. These were distilled down to a systematic map of 53 studies that were highly relevant to our initial research question for the review as a whole. In selecting written composition as a sub-set of the map for in-depth review, we identified nine studies on which to focus.

The degree of distillation is due to the fact that our research question was very tightly focused. The search strategy was designed to be sensitive as well as specific and many studies initially identified by the searching mechanisms turned out, on closer examination, not to be relevant to the review question. Attrition can also be attributed to a lack of quality in the abstracts by which most of the studies were initially identified, meaning that some studies which, on abstract alone, appear pertinent to the topic, proved not to be when the full text was screened.

The other strengths of the review were as follows:

- The review was transparent.
- All stages of the review were subject to inter-rater reliability; peer review was used on three occasions (blind and independent on one occasion) to check the validity and scope of the review.

Limitations are fully acknowledged. They include the fact that the research question itself asks about 'effectiveness'; therefore the kind of study we were drawing on had to be a controlled trial at the very least, with randomised controlled trials, if they existed. Such a question requires a particular kind of methodology. It does not mean to say that this is the only kind of question that might be appropriate in the field. On the contrary, questions about broader impact; about the symbiotic relationship between ICT and English teaching and learning; and about pedagogical applications of ICT within the classroom might well be asked.

We were also working to a tight timetable (six months) that did not allow for much consultation with teachers, students, trainee teachers or other interested parties along the way. Such consultation will follow the review, rather than work alongside it.

We are aware, too, that we are highly dependent on research databases and the quality of abstracts for the searching and screening parts of the process of systematic reviewing. There may be a bias toward American research in these databases. Certainly we acknowledge that results from research carried out in the

USA might not have a direct bearing on the classroom in England, or in other parts of the world.

## 5.2 Implications

### 5.2.1 Policy

As in previous reviews in the field (see Andrews, 2004, for an account of reviews undertaken by the English Review Group between 2001 and 2003), one of the main implications for policy is that we must move away from a belief that ICT will act as a panacea for the successful learning of literacy. It is clear from the present review, and from previous reviews, that ICT should be seen as a range of technologies that can have particular effects on particular parts of the English syllabus. These effects vary according to the age and ability of learners, and very much in relation to the readiness of teachers to incorporate ICT into their understanding of the subject and thus into their lessons.

In the 1999 version of the National Curriculum for England, ICT had a cross-curricular, but largely peripheral, add-on role. In the next version of the curriculum, its strengths, limitations and scope should be properly debated prior to the writing the curriculum.

There are also clear implications for governors, local education authorities and government in the procurement of ICT for schools. While this has been a specific study on the effectiveness of different ICTs on English (written composition), it would seem clear from the synthesised results that ICT benefits students at either end of the ability spectrum for independent learning that has been well guided in its early stages (Rowley *et al.*, 1998). In other words, perhaps the best use of ICT in a school is not as an automatic means of communication for everyone for all kinds of composition, but for specific occasions when independent research is called for, when additional dimensions of the curriculum need to be explored, and for particular groups who need curricular support and encouragement.

### 5.2.2 Practice

If it were possible, the ideal outcome would be for schools to have easy access to ICT, and rapid deployment of it in support of teaching and learning English. All too often, teachers have to book computer suites well in advance, thus formalising the occasions on which computers are used and limiting the spontaneity with which they might be deployed. The opportunities for hybrid use are few. It is clear from both theories and accounts of written composition that the 'putting together' of ideas, texts and voices that composition implies requires a flexibility about the means of communication and an understanding of the multimodal nature of communication.

There are other implications for practice arising from the present review. One or two of the studies compare carefully designed composition programmes with standard word-processing. The custom-designed programmes come out on top, because they take account of the writing process at the macro- and meso-levels

(structure, arrangement, etc.), as well as at the micro-level at which grammar and spelling checkers operate.

Since the improvements gained from using ICT to aid composition are not universal, teachers need to develop a sense of when it is appropriate to use and when composition might be better undertaken with other tools, such as pen and paper. Providing such a variety of means of expression will prevent the demotivating aspect of prolonged and inappropriate exposure to one medium that can occur.

### 5.2.3 Research

The quality and variability of these results suggest that further research is needed to answer the specific question we set ourselves. There has yet to be a high-quality, large-scale randomised controlled trial in the field that would answer the question about the effectiveness of ICT in assisting written composition for 5- to 16-year-olds. In this sense, the review has come to the same conclusion as Torgerson and Zhu (in Andrews 2004), a more extensive in-depth review on evidence for the effectiveness of ICT on literacy learning. As indicated in the earlier chapters of the present review, Torgerson and Zhu systematically reviewed studies from 1990 to 2002 (rather than the more recent five-year span of the present review), and they were also able to conduct a meta-analysis of the results of two studies (which the present review has been unable to undertake because of the nature of the studies examined). They had found that previous systematic reviews were equivocal on the effectiveness of ICT on literacy learning in English for 5- to 16-year-olds, and their own review confirmed the inconclusive nature of studies on this topic. They found that research had suggested that ICT was neither beneficial nor harmful in respect of its impact on literacy learning; and they recommend that large-scale randomised trials be undertaken in the field to work towards a clearer answer to the question of effectiveness. As far as we know, no such study has yet been undertaken.

One of the clearest implications for further research that emerges from the present review is that there needs to be some large-scale randomised control trials (RCTs) in order to answer the question of the effectiveness of different ICTs in relation to English, and specifically in relation to composition. Many of the studies we have looked at in the present review are large-scale; but in relation to the specific research question of the in-depth review, not a single one was an RCT.

Although questions of effectiveness are not the only questions that need to be asked about ICT and English, they are valid questions. In answering such questions, ethical issues and feasibility are some of the factors that have prevented researchers from undertaking fully-fledged RCTs. Further research is required into the ethics and feasibility of RCTs in the educational context in order to make the option of undertaking a RCT a reasonable one. Limitations of CTs and pre- and post-test studies need to be acknowledged.

Even when a particular study type is selected for a research study, there is not always sufficient rigour and comprehensiveness in the undertaking of the study and/or its reporting to provide the reader with confidence that the study has covered all necessary points. A checklist of what should be included for research

grant writers, research designers and writers of research reports and articles would be helpful.

Moving away from methodological issues, there are implications for the substance of research arising from the present review. These include a need to look at the changing nature of literacy in its symbiotic relationship with technologies; the impact of teachers in mediating between technologies and learners in the classroom; and the use of curriculum time with regard to technologies. Furthermore, the role that ICT can play in assisting independent learning needs further research.

Perhaps one of the most exciting implications to emerge from the attempted synthesis of studies in the in-depth review is that the field of research in ICT and literacy/English is still in its infancy; it is in a pre-paradigmatic state. That is to say, we have had a number of studies that purport to try to answer the question of the effectiveness or impact of ICT on literacy development; and fewer that try to explore the symbiotic relationship between the two. What we are yet to see is a coherent theoretical account of the field that builds on the work of the New London Group in the mid-1990s (see Cope and Kalantzis, 2000) and that provides a clear and workable framework for further research, with particular emphasis on the use of ICT.

Finally, it may be the case that no amount of prospective or *ex post facto* research is going to solve the problem of how best to bring research, policy and practice together to improve student learning in English. Rather than more and better studies (which is a laudable aim in itself), one of the implications of the recent studies in the impact and effectiveness of ICT on literacy learning in English is that we also need a new kind of research: one that is at the cutting edge of interface design in the service of learning. Such research will look more like research and development. We hope that in the present study we have contributed to a firmer foundation for such advances in human knowledge and pedagogical practice.

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## Appendix 2.1: Inclusion and exclusion criteria

For a paper to be included in the systematic map, it had to be a study looking at the effectiveness of different ICTs in the teaching and learning of English, 5-16. It had to be published or unpublished (but in the public domain) between 1998 and 2003.

As the focus of the study is on the *effects* of different ICTs, papers using methods to identify any such effects were required. This implied the following study types, classified according to the EPPI-Centre taxonomy of study type contained in its core keywording strategy (EPPI-Centre, 2002a):

C: Evaluation (naturally occurring or researcher-manipulated)

E: Review (systematic or other review) containing at least one study exploring relationships or one evaluation

### ***Inclusion criteria***

- Must be a study of ICT or English
- Must be a study of the effects on teaching and learning strategies (pedagogies)
- Must focus exclusively on children and young people aged 5 to 16
- Must be one of the following study types: C (evaluation) or E (review)
- Must be in a mainstream school setting
- Must be teaching of English as first language or an additional language

### ***Exclusion criteria***

#### *Exclusion on scope*

One: Not ICT or English

Two: Not effects on teaching and learning strategies (pedagogies)

Three: Not children or young people aged between 5 and 16

#### *Exclusion on study type*

- Four:
- (a) A (description)
  - (b) B (exploration of relationships)
  - (c) D (methodology)
  - (d) Editorial, commentary, book review
  - (e) Policy document
  - (f) Resource, text book
  - (g) Bibliography
  - (h) Dissertation abstract
  - (i) Theoretical paper

*Exclusion on setting in which study was carried out*

Five: Not mainstream school setting

Six: Not English as a first or additional language

## Appendix 2.2: Search strategy for electronic databases

### 1. Electronic databases

#### **ERIC**

1. teach? or learn? or pedagog?
2. child? or teenage? or adolescent?
3. (student? or learner?) not (adult or medical)
4. (primary or elementary or secondary) and education?
5. (primary or elementary or junior or middle or secondary or public or state or high) and school?
6. 2 or 3 or 4 or 5
7. read? or writing or write or written or spell? or literac?
8. (oral English) or (spoken English) or (language arts)
9. (literature) or (drama) or (media studies)
10. 7 or 8 or 9
11. ICT or CAI or CAL or computer? or software
12. (information and communication technolog?) or (information technolog?) or (networked technolog?) or (digital media) or (digital technolog?) or (moving image)
13. email or internet or conferencing or multimedia or multimodal? or CD-Rom or hypertext or video
14. (wide web) or (worldwide web)
15. (word process?) or (wordprocess?) or (spell check?)
16. 11 or 12 or 13 or 14 or 15
17. 1 and 6 and 10 and 16
18. Limit 17 to ("Reports--Evaluative (142)" or "Collected Works--Proceedings (021)" or "Journal Articles (080)") and (LA=("English")) and (PY="1998" or "1999" or "2000" or "2001" or "2002" or "2003")

#### **PsycINFO**

1. teach\* or learn\* or pedagog\*
2. child\* or teenage\* or adolescent\*
3. (student\* or learner\*) not (adult or medical)
4. (primary or elementary or secondary) and education\*
5. (primary or elementary or junior or middle or secondary or public or state or high) and school\*
6. 2 or 3 or 4 or 5
7. read\* or writing or write or written or spell\* or literac\*
8. (oral English) or (spoken English) or (language arts)
9. (literature) or (drama) or (media studies)
10. 7 or 8 or 9
11. ICT or CAI or CAL or computer\* or software
12. (information and communication technolog\*) or (information technolog\*) or (networked technolog\*) or (digital media) or (digital technolog\*) or (moving image)

13. email or internet or conferencing or multimedia or multimodal\* or CD-Rom or hypertext or video
14. (wide web) or (worldwide web)
15. (word process\*) or (wordprocess\*) or (spell check\*)
16. 11 or 12 or 13 or 14 or 15
17. 1 and 6 and 10 and 16
18. Limit 17 to (DT:PY = Book) or (DT:PY = Chapter) or (DT:PY = Journal-Article) or (DT:PY = Report)) and (LA:PY = English) and (PY:PY = 1998-2004)

### **SSCI**

1. teach\* or learn\* or pedagog\*
2. child\* or teenage\* or adolescent\*
3. (student\* or learner\*) not (adult or medical)
4. (primary or elementary or secondary) and education\*
5. (primary or elementary or junior or middle or secondary or public or state or high) and school\*
6. 2 or 3 or 4 or 5
7. read\* or writing or write or written or spell\* or literac\*
8. (oral English) or (spoken English) or (language arts)
9. (literature) or (drama) or (media studies)
10. 7 or 8 or 9
11. ICT or CAI or CAL or computer\* or software
12. (information and communication technolog\*) or (information technolog\*) or (networked technolog\*) or (digital media) or (digital technolog\*) or (moving image)
13. email or internet or conferencing or multimedia or multimodal\* or CD-Rom or hypertext or video
14. (wide web) or (worldwide web)
15. (word process\*) or (wordprocess\*) or (spell check\*)
16. 11 or 12 or 13 or 14 or 15
17. 1 and 6 and 10 and 16
18. Limit 17 to Doc Type = All document types; Language = English; Database(s) = SCI-Expanded, SSCI; Timespan = 1998-2004)

## **2. Citations**

An EndNote library of references cited in the 2002–2004 series of systematic reviews on the impact of ICT on literacy learning in English for 5- to 16-year-olds was searched for evaluations and reviews published between 1998 and 2004.

## Appendix 2.3: EPPI-Centre keyword sheet, including review-specific keywords

### V0.9.7 Bibliographic details and/or unique identifier

<p><b>A1. Identification of report</b>                  Citation                  Contact                  Handsearch                  Unknown                  Electronic database                  (Please specify.) .....</p> <p><b>A2. Status</b>                  Published                  In press                  Unpublished</p> <p><b>A3. Linked reports</b>  <i>Is this report linked to one or more other reports in such a way that they also report the same study?</i></p> <p>Not linked                  Linked (Please provide bibliographical details and/or unique identifier.)                  .....                  .....                  .....                  .....</p> <p><b>A4. Language</b> (Please specify.)                  .....</p> <p><b>A5. In which country/countries was the study carried out?</b> (Please specify.)                  .....                  .....                  .....</p>	<p><b>A6. What is/are the topic focus/foci of the study?</b>                  Assessment                  Classroom management                  Curriculum*                  Equal opportunities                  Methodology                  Organisation and management                  Policy                  Teacher careers                  Teaching and learning                  Other (Please specify.) .....</p> <p><b>A7. Curriculum</b>                  Art                  Business studies                  Citizenship                  Cross-curricular                  Design and technology                  Environment                  General                  Geography                  Hidden                  History                  ICT                  Literacy – first language                  Literacy further languages                  Literature                  Maths                  Music                  PSE                  Physical education                  Religious education                  Science                  Vocational                  Other (Please specify.) .....</p>	<p><b>A8. Programme name</b> (Please specify.)                  .....</p> <p><b>A9. What is/are the population focus/foci of the study?</b>                  Learners                  Senior management                  Teaching staff                  Non-teaching staff                  Other education practitioners                  Government                  Local education authority officers                  Parents                  Governors                  Other (Please specify.) .....</p> <p><b>A10. Age of learners</b> (years)                  0–4                  5–10                  11–16                  17–20                  21 and over</p> <p><b>A11. Sex of learners</b>                  Female only                  Male only                  Mixed sex</p>	<p><b>A12. What is/are the educational setting(s) of the study?</b>                  Community centre                  Correctional institution                  Government department                  Higher education institution                  Home                  Independent school                  Local education authority                  Nursery school                  Post-compulsory education institution                  Primary school                  Pupil referral unit                  Residential school                  Secondary school                  Special needs school                  Workplace                  Other educational setting (Please specify.) .....</p> <p><b>A13. Which type(s) of study does this report describe?</b>                  A. Description                  B. Exploration of relationships                  C. Evaluation                      a. naturally-occurring                      b. researcher-manipulated                  D. Development of methodology                  E. Review                      a. Systematic review                      b. Other review</p>
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## Appendix 3.1: Further characteristics of reviews included in the systematic map

Author, year	English/Language Arts focus	Pedagogical focus	Type of ICT
<b>Systematic reviews</b>			
Andrews <i>et al.</i> (2002)	Literacy	learning	internet email
Bryant <i>et al.</i> (2003)	Literacy reading: comprehension reading: decoding	learning	CAI/CAL
Burn and Leach (2004)	Literacy media (film, TV, video)	learning	moving image
Hall <i>et al.</i> (2000)	reading: comprehension reading: decoding	learning teaching	CAI/CAL
Locke and Andrews (2004)	Literacies literature	learning teaching	CAI/CAL hypertext word-processing databases internet email software
Low and Beverton (2004)	Literacy	learning	CAI/CAL hypertext email software
MacArthur <i>et al.</i> (2001)	Literacy reading: comprehension reading: decoding writing: composition writing: grammar writing: spelling writing: vocabulary	learning	CAI/CAL hypertext word-processing software

Torgerson and Elbourne (2002)	writing: spelling	teaching	CAI/CAL
Torgerson and Zhu (2003)	reading: comprehension reading: decoding writing: composition writing: grammar writing: spelling writing: vocabulary	learning	CAI/CAL multimedia word-processing

<b>Non-systematic reviews</b>			
Fisher <i>et al.</i> (1999)	literacy writing: composition	learning assessment	CAI/CAL word-processing internet email
Lewis (1999)	reading: decoding	learning	CAI/CAL
MacArthur (1999)	writing: composition writing: grammar writing: spelling	learning	word-processing software
MacArthur (2000)	writing: composition writing: grammar writing: spelling	learning	hypertext multimedia word-processing
Mastropieri <i>et al.</i> (1999)	reading: decoding	learning small group	CAI/CAL

## Appendix 3.2: Further characteristics of primary research studies included in the systematic map

Author, year	English/Language Arts focus	Pedagogical focus	Type of ICT	Outcomes reported
<b>Randomised controlled trials (researcher-manipulated evaluations with randomised control group)</b>				
Berninger <i>et al.</i> (1998)	writing: spelling	teaching learning	CAI/CAL	test results: writing
Din and Calao (2001)	reading: other writing: spelling	learning	games	test results: reading test results: writing
Handley-More <i>et al.</i> (2003)	writing: spelling writing: other	learning	word-processing	quality of writing
Holdich and Chung (2003)	literacy writing: composition	learning individual/autonomous learning	CAI/CAL software	test results: writing
Lewin (2000)	reading: other	learning	CAI/CAL	test results: reading motivation/engagement
Mathes <i>et al.</i> (2001)	reading: phonological awareness	teaching	CAI/CAL	test results: reading
Mitchell and Fox (2001)	reading: phonological awareness	learning	CAI/CAL	test results: reading
Ross <i>et al.</i> (2001)	literacy writing: other	learning interaction individual/autonomous learning	software	test results: writing motivation/engagement
<b>Controlled trials (researcher-manipulated evaluations with non-randomised control group)</b>				
Barrera <i>et al.</i> (2001)	writing: composition	learning	word-processing	other: writing quantity
Brush <i>et al.</i> (1999)	reading: comprehension	learning	CAI/CAL software	test results: reading motivation/engagement
Butzin (2001)	reading: comprehension	learning	CAI/CAL	test results: reading
Casey (2001)	reading: other writing: composition	learning	internet email software	motivation/engagement quality of writing

Appendix 3.2: Further characteristics of primary research studies included in the systematic map

Author, year	English/Language Arts focus	Pedagogical focus	Type of ICT	Outcomes reported
Cramer and Smith (2002)	writing: composition	learning	multimedia	test results: writing quality of writing
Erdner <i>et al.</i> (1998)	reading: comprehension reading: decoding	learning	CAI/CAL	test results: reading
Fan and Orey (2001) (Study B)	writing: composition	learning	multimedia	test results: writing quality of writing
Howell <i>et al.</i> (2000)	reading: comprehension reading: decoding writing: spelling	learning	CAI/CAL software	test results: reading test results: writing
Ignatz (2000)	reading: decoding writing: spelling	learning	software	test results: reading test results: writing
The Institute of Academic Excellence (1999)	literacy reading: comprehension	learning whole class individual/autonomous learning	software	test results: reading quality of reading
Lewis <i>et al.</i> (1999)	writing: composition writing: grammar writing: spelling	learning	word-processing	quality of writing
Ligas (2002)	literacy reading: comprehension	learning	CAI/CAL	test results: reading
Lowther <i>et al.</i> (2003)	writing: composition	learning	word-processing	test results: writing quality of writing
Nicolson <i>et al.</i> (2000)	literacy reading: other writing: spelling	learning teaching	CAI/CAL	test results: reading test results: writing motivation/engagement other: cost-effectiveness of programme
Parker (1999)	literacy media (film, TV, video)	learning teaching	moving image	test results: reading test results: writing quality of writing

Appendix 3.2: Further characteristics of primary research studies included in the systematic map

Author, year	English/Language Arts focus	Pedagogical focus	Type of ICT	Outcomes reported
Paterson <i>et al.</i> (2003)	literacy reading: comprehension reading: decoding	learning teaching	CAI/CAL software	test results: reading self-esteem/attitude classroom behaviour/social skills quality of reading
Reinking and Watkins (2000)	literacy reading: comprehension	learning	multimedia	test results: reading motivation/engagement self-esteem/attitude classroom behaviour/social skills quality of reading
Rogier <i>et al.</i> (1999)	literacy reading: decoding writing: spelling writing: vocabulary	teaching learning	CAI/CAL multimedia word-processing	test results: reading test results: writing
Rowley <i>et al.</i> (1998) (Study A)	writing: composition	learning	CAI/CAL	test results: writing quality of writing
Rowley <i>et al.</i> (1998) (Study B)	writing: composition	learning	CAI/CAL	test results: writing quality of writing
Rowley <i>et al.</i> (1998) (Study C)	writing: composition	learning	CAI/CAL	test results: writing quality of writing
Rowley <i>et al.</i> (1998) (Study D)	writing: composition	learning	CAI/CAL	test results: writing quality of writing
Troia and Whitney (2003)	reading: comprehension speaking listening: comprehension	learning	CAI/CAL	test results: reading test results: speaking test results: listening classroom behaviour/social skills
Underwood (2000) (Study A)	literacy reading: comprehension reading: decoding	learning interaction individual/autonomous learning	CAI/CAL multimedia software	test results: reading motivation/engagement
Watts and Lloyd (2001)	literacy writing: composition genre	learning whole class	multimedia	test results: writing motivation/engagement quality of writing

Appendix 3.2: Further characteristics of primary research studies included in the systematic map

Author, year	English/Language Arts focus	Pedagogical focus	Type of ICT	Outcomes reported
Weller <i>et al.</i> (1998)	Literacy reading: comprehension	learning whole class	CAI/CAL	test results: reading
Wise <i>et al.</i> (1998)	literacy reading: comprehension reading: decoding other : dyslexia	learning interaction	software	test results: reading
<b>Naturally occurring evaluation</b>				
Potter and Small (1998)	reading: comprehension	learning	CAI/CAL	test results: reading test results: writing
<b>Pre- and post-tests (researcher-manipulated evaluations with no control group)</b>				
Blasewitz and Taylor (1999)	reading: comprehension	learning	multimedia	test results: reading motivation/engagement other: attendance and discipline
Fan and Orey (2001) (Study A)	writing: composition	learning	multimedia	test results: writing quality of writing
Isernhagen (1999)	literacy reading: other	learning individual/autonomous learning	CAI/CAL software	test results: reading
Lynch <i>et al.</i> (2000)	reading: comprehension reading: decoding writing: spelling	learning	CAI/CAL	test results: reading test results: writing
Moseley (1999) (Study A)	literacy reading: comprehension writing: composition writing: grammar writing: spelling	learning teaching whole class	CAI/CAL word-processing software	test results: reading test results: speaking motivation/engagement self-esteem/attitude quality of reading quality of speaking
Moseley (1999) (Study B)	literacy reading: other writing: spelling	learning	software	test results: reading test results: writing
Moseley (1999) (Study C)	writing: other	learning drafting	software	test results: writing

Appendix 3.2: Further characteristics of primary research studies included in the systematic map

Author, year	English/Language Arts focus	Pedagogical focus	Type of ICT	Outcomes reported
Moseley (1999) (Study D)	literacy writing: composition	learning drafting	word-processing	test results: reading test results: writing motivation/engagement
Moseley (1999) (Study E)	literacy writing: grammar	learning small group	multimedia	test results: writing
Moseley (1999) (Study F)	literacy reading: comprehension speaking	learning small group	word-processing software	test results: reading test results: writing
Moseley (1999) (Study G)	literacy reading: comprehension writing: composition writing: spelling	learning whole class individual/autonomous learning	multimedia	test results: reading test results: writing
Underwood (2000) (Study B)	literacy reading: comprehension multimodality	learning interaction individual/autonomous learning	multimedia software	test results: reading motivation/engagement
Yekovich <i>et al.</i> (1999)	literacy reading: comprehension writing: composition	learning teaching individual/autonomous learning	software	test results: reading test results: writing motivation/engagement
<b>Other types of researcher-manipulated evaluation</b>				
Chambers <i>et al.</i> (2001)	literacy reading: other	learning individual/autonomous learning	software	motivation/engagement quality of reading
Jones (1998)	writing: composition	learning	software	quality of writing
Vincent (2001)	literacy writing: composition writing: spelling multimodality	learning individual/autonomous learning	multimedia	motivation/engagement classroom behaviour/social skills quality of writing
Zhang (2000)	writing: composition writing: vocabulary	learning	software	motivation/engagement self-esteem/attitude classroom behaviour/social skills quality of writing

## Appendix 4.1: Details of studies included in the in-depth review

<b>Barrera et al. (2001)</b> The effect of writing with computers versus handwriting on the writing achievements of first-graders. <i>Information Technology in Childhood Education Annual 13</i> : 215–228	
Country of study	USA
Age of learners	5–6: first-grade students
Type of study	Researcher-manipulated evaluation: controlled trial
Aims of study	To determine ‘the effects of writing on the computer vs writing by hand across the same students in a first-grade classroom’ (p 217)
Summary of study design, including details of sample	This is ‘an equivalent time samples design’ (Campbell and Stanley, 1973, p 218). In other words, a single sample of students (N=18) was given alternating interventions/activities over a six-month period. Their performance, against a series of three measures, was recorded during that period.
Data-collection instruments, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Data were collected from weekly writing assignments.</li> <li>• Students used three different programs for writing at the computer.</li> <li>• An anecdotal journal was kept by the teacher.</li> </ul> <p><i>Details of reliability and validity</i></p> <ul style="list-style-type: none"> <li>• Matched pairs of computer-generated and handwritten assignments.</li> <li>• Random sample of compositions scored by a second person independent of the study.</li> <li>• Inter-rater reliability coefficients (Pearson’s r) were analysed.</li> </ul>
Methods used to analyse data, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Students’ writing scores were used to assess differential effects of computer word-processing and handwriting of assignments.</li> <li>• Measures of writing included number of words and sentences written, and event-recording of on and off-task behaviour during writing periods.</li> <li>• The number of words written by hand or keyboard was counted on each student composition. The number of sentences was also tabulated.</li> <li>• The teacher kept a tally during each lesson of the number of times she interacted with the students about off-task behaviour.</li> <li>• Statistical methods included mean, standard error, mean square and significance measures.</li> </ul> <p><i>Details of reliability and validity</i></p> <ul style="list-style-type: none"> <li>• Inter-rater reliability coefficients were used to check the reliability of the analysis.</li> <li>• More than one researcher was used to analyse data.</li> </ul>
Summary of results	<ul style="list-style-type: none"> <li>• Computer use resulted in significantly more writing. On average, there are more sentences written per</li> </ul>

	<p>assignment by computer, and more words per assignment when using a computer than when assignments are handwritten.</p> <ul style="list-style-type: none"> <li>• Off-task behaviour differences were not significant.</li> <li>• There was no significant difference in the amount of on and off-task behaviour exhibited by students when writing by hand or on the computer (pp 223–224).</li> </ul>
Conclusions	<p>The authors conclude that their first hypothesis – that computer use would result in significantly more writing – was confirmed in this study. The second hypothesis – whether student use of computers would produce more on-task behaviour - was not supported by results of this study. They add that this latter result ‘raises important conclusions both about the validity of this study and about the nature of student activity while using computers’ (p 224) and they suggest that ‘additional work is needed ... to verify and reinforce the results of the current study’ (p 226).</p>
Weight of evidence A (trustworthiness in relation to study questions)	<p>Medium</p> <ul style="list-style-type: none"> <li>• The children acted as their own controls because they wrote alternately using computers and by hand.</li> <li>• The sample is small; significant variables like group writing or the nature of the writing assignments are not taken into account; important methodological issues are not addressed in sufficient detail.</li> </ul>
Weight of evidence B (appropriateness of research design and analysis)	<p>Medium</p> <p>This is a controlled trial which is appropriate for an effectiveness question, but there is no random allocation of use of computers and paper and pencil.</p>
Weight of evidence C (relevance of focus of study to review)	<p>Medium</p> <p>The study of the influence of computers upon motivation and production of written material is relevant.</p>
Weight of evidence D (overall weight of evidence)	<p>Medium</p>

<b>Cramer and Smith (2002)</b> Technology's impact on student writing at the middle school level. <i>Journal of Instructional Psychology</i> 29: 3–14	
Country of study	USA
Age of learners	11–14: specifically, sixth-, seventh- and eighth-grade students
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	To find out how student writing in the areas of organisation, voice and/or ideas improve(s) with involvement in technology-rich instruction
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>• A quasi-experimental pre-test/post-test design</li> <li>• N = 139 (experimental = 88; control = 51)</li> </ul>
Data-collection instruments, including details of checks on reliability and validity	<p>The school district adopted the Six Trait Writing Model, as defined by the Northwest Regional Education Laboratory and modified slightly by the movie project school. This was used for scoring each paper in the areas of (1) organisation, (2) voice and (3) ideas.</p> <p><i>Details of reliability:</i> Eight of the writing samples were used to establish consistency in scoring. After coding, student papers were then separated thoroughly mixed and divided into two equal piles. Each researcher was responsible for scoring half the papers. After all papers had been scored, 10% of the papers were then rescored by the other researcher to ensure that scoring remained constant across the papers.</p> <p><i>Details of validity:</i> Use of Northwest Regional Educational Laboratory Six Trait Writing Assessment Model Scoring Guide</p>
Methods used to analyse data, including details of checks on reliability and validity	<p>Student writing scores were examined as an aggregate for each grade level. Beginning of the year, end of the year and change between the two scores were calculated for each writing area – ideas, organisation, voice. Statistically significant differences were found in some areas. Significance frequency distribution was used.</p> <p><i>Details of reliability:</i> Use of standard statistical procedures</p> <p><i>Details of validity:</i> Validity addressed by using standard statistical procedures..</p>
Summary of results	<ul style="list-style-type: none"> <li>• Changes in achievement did occur but not in predicted directions. 'By the end of the year, there was no statistically significant differences in student writing abilities (<math>p &gt; 0.05</math>)...' (p 8).</li> <li>• The median score was the same for both schools, and no different from the pre-test scores in general.</li> <li>• The 'only differences in scores on the post-test were for sixth graders in the areas of organization and voice (<math>p &gt; 0.5</math>)' (p 8).</li> <li>• There are other small effects reported, but nothing of note.</li> </ul>
Conclusions	<ul style="list-style-type: none"> <li>• The research 'does not provide evidence to support a yes vote' (p 8) in respect of its research question.</li> <li>• The results are complicated by the fact that the researchers discovered that 'based on teacher interview data, students in the traditional [control] school used technology more often than did those in the Movie Project [experimental] school' (p 8).</li> </ul>

	<ul style="list-style-type: none"> <li>• They further conclude that ‘other factors must be held constant if one is to look at this type of variable’ (p 9), i.e. the research question; and ‘the questions around which research studies are designed may need to be radically different than the one posed in this study’ (p 9). More appropriate questions might seek to explore higher level thinking skills.</li> </ul>
Weight of evidence A (trustworthiness in relation to study questions)	<p>Medium</p> <p>This study is a controlled trial design, so it can provide results in answer to the specific research question. However, as this is not a randomised control trial, we cannot be sure the experimental and control groups are comparable; also, there is only one cluster in each arm.</p>
Weight of evidence B (appropriateness of research design and analysis)	<p>Medium</p> <p>The research design is of medium appropriateness, as it is a controlled trial.</p>
Weight of evidence C (relevance of focus of study to review)	<p>Medium</p> <p>Potentially, the particular focus is highly relevant, but it does focus on moving image as opposed to computer use.</p>
Weight of evidence D (overall weight of evidence)	<p>Medium</p>

<b>Fan and Orey (2001)</b> Multimedia in the classroom: Its effect on student writing ability. <i>Journal of Research on Technology in Education</i> 33: 1–13	
Country of study	USA
Age of learners	12–13: seventh-grade students
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	'The purpose of this study was to examine the constructivist use of multimedia technology to improve students' writing performance' (p 2)
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>• Non-randomised controlled trial</li> <li>• Pre-test and post-test writing samples</li> <li>• N = 47 seventh grade advanced language arts students</li> </ul>
Data-collection instruments, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Pre- and post-test essays were examined by two raters according to the five domain criteria of the Rater Training Manual for Grade 8, Georgia Writing Assessment: content and organization, sentence formation, mechanics, usage and style. The scores were then averaged (p 7).</li> <li>• T-test procedure was used to judge the reliability of the scores evaluated by the two raters.</li> <li>• Validity was established by use of established test.</li> </ul>
Methods used to analyse data, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• 'the basic model of this method was a true experimental design with a pre-test and post-test, we did an unpaired t-test on the gain scores using an alpha level of 0.05' (p 7).</li> <li>• Reliability and validity addressed by use of standard statistical procedures.</li> </ul>
Summary of results	'...the participation for six weeks in a project based learning environment does not improve writing performance on paper and pencil essays' (p 11).
Conclusions	The authors conclude that 'participation for six weeks in a project-based learning environment does not improve writing performance on paper-and-pencil essays' (p 11) but that it might have an effect on student motivation. 'In the future we will examine the motivational aspects more systematically' (p 11).
Weight of evidence A (trustworthiness in relation to study questions)	Medium Reliability and validity addressed, but only one cluster in each arm of the trial.
Weight of evidence B (appropriateness of research design and analysis)	Medium Use of controlled trial is appropriate but only of medium weight as trial is non-randomised.
Weight of evidence C (relevance of focus of study to review)	Medium Research focus falls within the focus of this review.

Weight of evidence D (overall weight of evidence)	Medium
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<b>Lewis et al. (1999)</b> Improving the writing skills of students with learning disabilities: are word processors with spelling and grammar checkers useful? <i>Learning Disabilities: A Multidisciplinary Journal</i> 9: 87–98	
Country of study	Assumed USA
Age of learners	Average age of sample is 12 years and 0 months. Selection criteria indicate that students must be enrolled in grades 4 to 12.
Type of study	Researcher-manipulated evaluation: controlled trial containing randomised controlled trial (A, B and C teachers randomly allocated)
Aims of study	<ul style="list-style-type: none"> <li>• 'The primary goal of this study was to examine the impact of word processing tools combined with effective instruction on editing and revising performance' (p 87).</li> <li>• Specifically, the study was designed 'to investigate the effectiveness of spelling and grammar checkers as tools for improving the accuracy and quality of the writing of students with learning disabilities' (p 88).</li> </ul>
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>• This study employed a pre-test and post-test control group design.</li> <li>• Students with learning disabilities made up three experimental groups and a control group. The experimental groups were given various degrees of access to the Write This Way word-processing program. The control group worked only with paper and pencil. A comparison group of general education students without learning disabilities received no interventions. Like the control group, they wrote the pre- and post-test samples of writing by hand.</li> <li>• All the students with learning disabilities received two six-week periods of writing instruction from their special educational needs teachers. The three experimental groups were granted degrees of access to Write This Way (as described above). Pre- and post-testing was carried out to investigate the effectiveness of two types of technology-based editing tools, spelling and grammar checkers, in improving the writing performance of students with learning disabilities.</li> <li>• The sample included 118 students with learning disabilities served by 30 special education teachers and the comparison group contained 115 general education students (p 89).</li> </ul>
Data-collection instruments, including details of checks on reliability and validity	<p>Two procedures were used to gather data from students with learning disabilities and general education comparison students at both pre-test and post-test: collection of writing samples and administration of a scale assessing attitude toward writing.</p> <ul style="list-style-type: none"> <li>• The writing attitude measure was an adaptation of the reading subscales of the Estes Attitude Scales (Estes, Estes, Richards and Roettger, 1981).</li> <li>• Writing samples were collected from students using the Test of Written Language-2 (TOWL-2) (Hammill and Larsen, 1988) with modified administration procedure.</li> <li>• The changes students made from first to final drafts at pre-test and post-test were evaluated for a subsample of 16 students with learning disabilities.</li> </ul>

	<ul style="list-style-type: none"> <li>• Project staff conducted structured observations of students in the technology groups when they wrote their first and final drafts of the writing samples and conducted classroom observations at least monthly to monitor treatment implementation.</li> <li>• The teachers involved kept weekly teaching logs.</li> <li>• Special education teachers and the students with learning disabilities were interviewed at post-test.</li> </ul> <p><i>Data-collection instruments: reliability and validity</i></p> <ul style="list-style-type: none"> <li>• Information from the observations (made by project staff) and teaching logs was used to monitor treatment fidelity.</li> <li>• Staff provided assistance and training when discrepancies with the treatment protocol were noted.</li> <li>• Writing attitude: use of a published and previously used scale (an adaptation of the Estes Attitude Scales – see above). ‘An earlier study (Lewis, Graves, Ashton and Kieley, 1998) found the reliability of this adapted scale to be adequate’ (p 90).</li> <li>• Writing samples were collected using a published test (TOWL-2).</li> <li>• Quality of writing: Use of a scale adapted from a published tool Test of Written English (1992). Two experienced raters read and evaluated each sample, compared and reconciled ratings if necessary.</li> <li>• Accuracy of writing: Not stated</li> <li>• Changes to drafts: Ratings were based on a published procedure by Stoddard and MacArthur (1993).</li> <li>• Qualitative analysis was based on published procedures Ashton (1997).</li> </ul>
<p>Methods used to analyse data, including details of checks on reliability and validity</p>	<ul style="list-style-type: none"> <li>• Reliability and validity of quantitative data were addressed by use of established statistical tests.</li> <li>• These were not stated for qualitative data.</li> </ul>
<p>Summary of results</p>	<ul style="list-style-type: none"> <li>• Writing quality: There was no difference between treatments for treatment groups of learning disabled students. General education peers were superior to students with learning disabilities at both pre-test and post-test, although both groups showed improvement in writing overtime.</li> <li>• Writing accuracy: All groups reduced their overall error rates and made fewer errors at post-test than pre-test. All groups showed decreases in the number of mechanics errors from pre-test to post-test. Those decreases appear most pronounced in the groups using spelling and grammar checkers.</li> <li>• Syntax I errors were found to increase over time for all groups, whereas syntax II errors decreased.</li> <li>• Overall, general education students made fewer total errors than students with learning disabilities and error rates of both groups decreased from pre-test to post-test. Students with learning disabilities experienced a sizeable decrease.</li> <li>• Editing skills of students with learning disabilities: At post-test, students in the traditional and general education groups experienced about the same rate of success as at pre-test, while the students in the</li> </ul>

	<p>technology group almost doubled their accuracy rate.</p> <ul style="list-style-type: none"> <li>• Attitude towards writing: A small decline was observed for the four treatment groups from pre-test to post-test. General education peers achieved higher attitude scores than students with learning disabilities at both pre-test and post-test, although scores of both groups decreased slightly over time.</li> <li>• Views of students with learning disabilities: Students and teachers were generally positive about the word processor. However, both groups identified drawbacks including problems with the spelling and grammar checkers.</li> </ul>
Conclusions	<p>The authors make a number of tentative conclusions:</p> <ul style="list-style-type: none"> <li>• Spelling checkers appear to be valuable tools to support students with learning disabilities in the editing and revising stages of the writing process.</li> <li>• The limitation of spelling checkers can be lessened by adding 'local' words to the dictionary and providing students with strategies for the use of these tools.</li> <li>• Synthesised speech appears to be a useful addition to word-processors because it can provide assistance in the error-correction process.</li> <li>• Grammar checkers: At least the one under study in this investigation, should be used with caution.</li> </ul>
Weight of evidence A (trustworthiness in relation to study questions)	<p>High to medium</p> <ul style="list-style-type: none"> <li>• Tight focus upon quantifiable outcomes in terms of writing (such as number of 'mechanic' errors); use of control and comparison groups; application of established data-collection procedures.</li> <li>• Number of teachers in A, B and C is not stated.</li> </ul>
Weight of evidence B (appropriateness of research design and analysis)	<p>High to medium</p> <p>Comparatively large sample included control and comparison group; raters analysed the writing samples for both pre and post-tests; data collected from a range of sources and by means of a variety of procedures; research questions tightly-focused (see above) and findings appropriately modest and tentative.</p>
Weight of evidence C (relevance of focus of study to review)	<p>High</p> <p>The study of the impact of word-processing tools combined with effective instruction on editing and revising performance is relevant.</p>
Weight of evidence D (overall weight of evidence)	<p>High to medium</p>

<b>Lowther et al. (2003)</b> When each one has one: the influences on teaching strategies and student achievement of using laptops in the classroom. <i>Educational Technology Research and Development</i> 51: 23–44	
Country of study	Assumed USA
Age of learners	10–13 years: fifth-, sixth- and seventh-grade students
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	<ul style="list-style-type: none"> <li>To provide further insight into the degree to which school laptop programs can influence students' educational experiences and learning.</li> <li>Two primary research questions were: <ul style="list-style-type: none"> <li>Is teaching and student behaviour different in laptop compared with control classrooms?</li> <li>Do students achieve differently in laptop classrooms?</li> </ul> </li> <li>Also of interest for explaining student classroom outcomes were the reactions and interests of key stakeholder groups (i.e. teachers, students and parents.)</li> </ul>
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>This study employed a matched treatment-control group design.</li> <li>Intervention group students were given 24-hour access to laptop computers in order to examine their impact on students' classroom activities, use of technology, writing and problem-solving skills.</li> <li>Eight quantitative or qualitative evaluation measurement strategies were employed (see below).</li> <li>The study only specifies the number of classes explicitly, not the total number of participants. The resultant sample consisted of 21 classrooms (12 laptop; 9 control) distributed across grade levels 5, 6 and 7.</li> </ul>
Data-collection instruments, including details of checks on reliability and validity	<p><b>School observation measure (SOM):</b> Structured prescheduled 60-minute observations of teaching and learning practices in 10-12 randomly selected classrooms.</p> <p><b>Survey of computer use (SCU):</b> Completed as part of the 60-minute SOM observation and designed to capture student access to, ability with, and use of computers.</p> <p><b>Writing assessment:</b> Students completed a common prompted written task at the end of the academic year.</p> <p><b>Problem-solving assessment:</b> Students were given 45 minutes in which to solve a problem and report their answers via computer.</p> <p><b>Student survey:</b> Students completed a 36-item laptop survey consisting of Likert-type items and open-ended questions.</p> <p><b>Student focus group:</b> This was targeted towards four major areas: (a) overall impressions of the laptop, (b) classroom level changes, (c) students results and (d) parental support.</p> <p><b>Teacher interview:</b> This was grouped into same four areas as the student focus group.</p> <p><b>District parent survey:</b> This survey items addressed the best and the worst aspects of the laptop program.</p> <p><i>Details of reliability</i></p> <p><b>School observation measure (SOM) and survey of computer use (SCU):</b> Observers were involved in</p>

	<p>training and moderating procedures. High rates of consistency were recorded.</p> <p><b>Writing assessment:</b> Experienced reviewers used the district's four-point rubric to conduct a blind assessment of the writing samples.</p> <p><b>Problem-solving assessment:</b> Laptop and control teachers received same written instructions for administering the problem-solving task. Trained reviewers judged student responses. Raters independently evaluated 15 sets of randomly selected responses. All reviews were done blind.</p> <p><b>Student survey:</b> This was developed and field-tested during the pilot study (Ross <i>et al.</i>, 2000). Internal consistency reliability computed for the two sections of the Laptop Student Survey.</p> <p><b>Student focus group and teacher interview:</b> These were conducted by university researchers.</p> <p><b>District parent survey:</b> Not stated</p> <p><i>Details of validity</i></p> <p><b>School observation measure (SOM):</b> The SOM schedule was slightly modified from an observation instrument which had been developed and tested for several years (Ross, Smith and Alberg, 1999).</p> <p><b>Survey of computer use (SCU):</b> The SCU items were compiled through examination of research, existing instruments (e.g. Apple Classrooms of Tomorrow) focus groups and a series of formal evaluation strategies.</p> <p><b>Writing assessment:</b> The writing samples were assessed according to the rubric of an established, school-district Writing Scoring Guide.</p> <p><b>Problem-solving assessment:</b> This was devised with the assistance of a group of sixth-grade teachers.</p> <p><b>Student survey:</b> The student survey had been developed and field-tested during the pilot study and reported on in Ross <i>et al.</i> (2000).</p> <p><b>Student focus group and teacher interview:</b> Not stated.</p> <p><b>District parent survey:</b> This only involved parents of students in the sample group.</p>
Methods used to analyse data, including details of checks on reliability and validity	<p>Quantitative results were analysed via appropriate nonparametric tests, analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA), for the dependent measures of concern.</p> <p>Qualitative analyses, guided by Miles and Huberman's (1994) analysis model, were performed on open-ended survey and interview responses.</p> <p>Reliability and validity were checked by use of standard statistical procedures and tests.</p>
Summary of results	<p><b>School observation measure:</b> In Grade 5, results strongly favoured the laptop classes on using technology as a learning tool (ES = +1.25) and on level of student attention or interest (ES = +0.89). The control group, however, was favoured on use of higher-level questioning (ES = -1.08) and integration of subject areas (ES = -0.98). In Grade 6, laptop classes made more extensive use of technology as a learning tool than did control classes (ES = +1.31). None of the comparisons was significant in Grade 7.</p> <p><b>Survey of computer use:</b> Meaningfulness of computer usage (1 = low level 4 = very meaningful use) results showed the laptop classes (mean = 2.12) to have a non-significant advantage (<math>p &lt; 0.10</math>) over control classes (mean = 1.78). Analyses conducted separately by grade showed comparable outcomes. However, in Grade 6</p>

	<p>only, laptop students were rated significantly higher than control students on the overall rubric (<math>p &lt; 0.001</math>, <math>ES = +1.43</math>)</p> <p><b>Writing test (sixth grade):</b> The MANOVA test performed on the four writing dimensions indicated a highly significant program effect favouring the laptop group (<math>p &lt; 0.001</math>). The ANOVAs were highly significant (<math>p &lt; 0.001</math>) on three of the four ratings: (a) ideas and content, (b) organisation and (c) style. The fourth (conventions) approached significance (<math>p = 0.053</math>). Effect sizes ranged from +0.53 to +1.47. Effects of this magnitude represent strong and educationally important influences.</p> <p><b>Seventh grade:</b> A MANOVA test again indicated a highly significant (<math>p &lt; 0.005</math>) program effect. Univariate analyses yielded significant differences, favouring the laptop students on each of the four dimensions. Effect sizes were moderate to strong in magnitude, ranging from +0.59 on conventions to +0.94 on style.</p> <p><b>Problem-solving test:</b> A MANOVA test, comparing the means of laptop and control sixth-grade students on the seven problem-solving components, yielded a highly significant difference (<math>p = 0.003</math>). Follow-up analyses showed significant advantages for the laptop group on five of the seven components.</p> <p><b>Student survey:</b> The laptop students were highly positive in their attitude towards laptop computers and felt that their computer skills had increased. Students were less committal that having a laptop increased their interest in learning. Most of the control students (54%) but significantly fewer (<math>p &lt; 0.001</math>) than the laptop group (75%) felt that their computer skills had increased as a result of having access to classroom computers.</p> <p><b>Student focus group:</b> Laptop students were very positive about having a laptop. Responses were mixed with regard to the impact on student-to-student or student-to-teacher communication. Control students in general liked having computers in their classroom but were mixed with regard to the impact of computers on classroom level changes or individual student learning.</p> <p><b>Teacher interview:</b> Laptop group teachers were very positive about the overall laptop program. Control group teachers were, overall, supportive about the use of computers.</p> <p><b>District parent survey:</b> 31% thought the laptop had helped their child with school-related work.</p>
Conclusions	<p>While acknowledging the tentative nature of their findings, the writers conclude that laptop students:</p> <ul style="list-style-type: none"> <li>• engaged in more extensive student-centred learning in laptop than students in control classes</li> <li>• made more frequent usage of the computer as a learning tool rather than to deliver instruction</li> <li>• were more attentive and interested in learning relative to control students</li> <li>• demonstrated superior writing skills</li> <li>• displayed significantly higher confidence compared to control students for using all the basic software applications and internet searches</li> </ul> <p>Results on the problem-solving test were further suggestive of the laptop program's positive impact on student achievement.</p>
Weight of evidence A (trustworthiness in relation to)	Medium

study questions)	
Weight of evidence B (appropriateness of research design and analysis)	Medium Experimental and control groups are self-selected and prone to bias
Weight of evidence C (relevance of focus of study to review)	Medium <ul style="list-style-type: none"> <li>• Not entirely focused on English – also concerned with problem-solving; however, it is school-based student sample and writing measures are appropriate.</li> <li>• A range of types of ‘witness’ was called upon to give ‘evidence’: students, teachers and parents</li> <li>• The word ‘achievement’ in the second research question is a little problematic, particularly in the case of the writing sample analysis which tended to focus upon ‘surface’ rather than ‘deep’ structural features.</li> </ul>
Weight of evidence D (overall weight of evidence)	Medium

<b>Rowley et al. (1998)</b> A cognitive technology to teach composition skills: Four studies with the R-WISE writing tutor. <i>Journal of Educational Computing Research</i> 18: 259–296 (Study A)	
Country of study	USA
Age of learners	14–15: ninth-grade students
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	The broad aim of the study as a whole (i.e. all four particular studies) was ‘to evaluate and adapt the writing software Reading and Writing in a Supportive Environment (R-WISE)’ (p 260) in an attempt to improve prose composition as a cognitive act with the help of computers.
Summary of study design, including details of sample	This is a ‘quasi-experimental contrasted groups design’ with a large sample (p 268). N = 852 students: 429 in the experimental group, and 423 in the control group
Data collection instruments, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• A one- to six-point holistic scoring rubric which ‘directed general impression scoring for the professional raters’ (p 268) was used, plus a secondary analytical rubric ‘designed to assess more specific cognitive operations specifically taught in R-WISE’ (p 268). Details of the rubric are given on page 268.</li> <li>• Reliability was addressed in detail. ‘Trained proctors provided students with standardised instructions and were present in the classroom at all times during testing. The writing samples were scored by Psychological Corporation’s Writing Assessment Center. Each paper was read at least ten times...’ (p 269).</li> <li>• Validity is not so carefully described. There is little discussion of the validity of the writing activities used.</li> </ul>
Methods used to analyse data, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Statistical data analysis methods include percentages, repeated measures ANCOVA, significance, mean square, etc.</li> <li>• Details of validity are not given.</li> </ul>
Summary of results	<ul style="list-style-type: none"> <li>• Scores revealed that ‘as a whole, treatment group scores rose during the study while control group scores dropped over the same period’ (p 270). Students with lower pre-test scores made the more extensive gains: in the order of 27 to 34%, as opposed to 9 to 11% for those in the upper segment of the treatment group.</li> <li>• Overall, ‘R-WISE 1.0 helped most ninth-graders in the sample to improve, but it appeared slightly more effective for those needing more improvement’. However, regression to the mean could not be discounted, nor could a ceiling effect. It is also possible that the pre-test was inaccurate.</li> <li>• Cognitive growth was more substantial: ‘The descriptive statistics for the analytical assessments for abstraction, elaboration, focus and sequence showed greater overall improvements than the holistic assessments, but with less significant interactions with ability as measured by the pre-test’ (p 271).</li> </ul>
Conclusions	The conclusions follow closely from the results, in that ‘holistic score trends...suggest that the use of R-WISE effectively supplemented and extended classroom instruction in writing. Introducing R-WISE into ninth-grade

	English classes produced significant gains over and above traditional instruction on all four analytical measurements' (p 272).
Weight of evidence A (trustworthiness in relation to study questions)	Medium Uncertainty about the comparability of the two groups, lack of randomization, and possible ceiling effects and/or regression to the mean.
Weight of evidence B (appropriateness of research design and analysis)	Medium The research design - a quasi-experimental contrasted groups design - is only of medium weight in the light of the research question. There are too many sources of bias or error likely in such a design to be sure that the results are totally reliable.
Weight of evidence C (relevance of focus of study to review)	Medium This topic is squarely within the focus of the review.
Weight of evidence D (overall weight of evidence)	Medium Overall, the study is a valuable one in that it directly compares word-processing approaches to composition with R-WISE cognitive computer-mediated ones, based on a sound theory of writing composition processes. The sample is large.

<b>Rowley et al. (1998)</b> A cognitive technology to teach composition skills: Four studies with the R-WISE writing tutor. <i>Journal of Educational Computing Research</i> 18: 259 – 296 (Study B)	
Country of study	USA
Age of learners	13–15: eighth- and ninth-grade students
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	The broad aims of the study as a whole (i.e. all four individual studies) was to 'evaluate and adapt the writing software Reading and Writing in a Supportive Environment (R-WISE)' (p 260) in an attempt to improve prose composition as a cognitive act with the help of computers.
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>• 'A quasi-experimental contrasted groups design was used to guide data collection. It was not possible to randomly assign classes within schools to treatment or control conditions or to randomly assign students within these groups' (p 274).</li> <li>• N = 1,151 in total</li> </ul>
Data-collection instruments, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• 'The writing sample was subjected to the same scoring techniques used in the Year 1 study: a holistic reading to determine achievement and an analytical reading using the analytical rubric' (p 274). Specifically, a one- to six-point holistic scoring rubric which 'directed general impression scoring for the professional raters' (p 268) was used, plus a secondary analytical rubric 'designed to assess more specific cognitive operations specifically taught in R-WISE' (p 268). Details of the rubric are given on page 268.</li> </ul>
Methods used to analyse data, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Statistical data-collection methods include type III sum of squares, ANCOVA, percentages, mean squares and significance.</li> <li>• The reliability measures taken to ensure the data are well described, but no details of validity are given.</li> </ul>
Summary of results	<ul style="list-style-type: none"> <li>• Having controlled for the novelty factor (computers versus handwriting) in the present study by comparing word-processing with the R-WISE software, the authors found that R-WISE was more effective: R-WISE students gained about 13% on holistic and analytical measures, whereas they gained about 7% with word-processing over the same period. On all measures, indeed, the treatment group gained about twice as much as the control group. Higher-end students seemed to gain more than lower-end students, in contrast to the findings of the first study.</li> <li>• 'the findings of the second year illustrated that initial aptitude appeared to result in higher ability students gaining more from the use of either R-WISE or the word-processor control than average students' (pp 276–277).</li> <li>• Overall, the effectiveness of R-WISE was again demonstrated. 'The superior performance of the R-WISE group over the word processor control group demonstrates that there were likely factors in the active pedagogy and in the adaptive and supportive environment of R-WISE that helped improve student writing...' (p 277).</li> </ul>

Conclusions	Conclusions are no different to the results
Weight of evidence A (trustworthiness in relation to study questions)	Medium Because the study is a quasi-experimental one, it cannot be fully relied on to give us a clear answer to the research question for the review as a whole.
Weight of evidence B (appropriateness of research design and analysis)	Medium The research design – a quasi-experimental contrasted groups design – is only of medium weight in the light of the research question. There are too many sources of bias or error likely in such a design to be sure that the results are totally reliable.
Weight of evidence C (relevance of focus of study to review)	Medium This topic is squarely within the focus of the review.
Weight of evidence D (overall weight of evidence)	Medium Overall, the study is a valuable one in that it directly compares traditional pedagogical approaches to composition with computer-mediated ones, based on a sound theory of writing composition processes. The sample is large.

<b>Rowley et al. (1998)</b> A cognitive technology to teach composition skills: Four studies with the R-WISE writing tutor. <i>Journal of Educational Computing Research</i> 18: 259 – 296 (Study C)	
Country of study	USA
Age of learners	11–16: specific grade not stated
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	The broad aims of the study as a whole (i.e. all four individual studies) was to 'evaluate and adapt the writing software Reading and Writing in a Supportive Environment (R-WISE)' (p 260) in an attempt to improve prose composition as a cognitive act with the help of computers.
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>• 'The year 3 R-WISE study was designed to first provide all students with basic competence in R-WISE using guided mode, then to perform a comparison of guided vs. open modes, providing a large-scale test of the general findings of learner-control research. A secondary design of the study was to measure the effects of instructional design on student performance' (p 279).</li> <li>• N = 1,122 students and 21 teachers</li> </ul>
Data-collection instruments, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Curriculum-based assessment was used, but we do not have any more detail on the nature of the writing assignments.</li> <li>• Sense of reliability was given by the use of a tried and tested inventory for the instructional styles.</li> <li>• No details of validity are given.</li> </ul>
Methods used to analyse data, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• 'The scoring of the samples followed the methods of previous studies' (p 280); that is a one- to six-point holistic scoring rubric which 'directed general impression scoring for the professional raters' (p 268) was used, plus a secondary analytical rubric 'designed to assess more specific cognitive operations specifically taught in R-WISE' (p 268). Details of the rubric are given on page 268.</li> <li>• Statistical data-collection methods include ANCOVA, percentages, mean squares and significance.</li> <li>• The reliability measures taken to ensure the data are well described, but no details of validity are given.</li> </ul>
Summary of results	<ul style="list-style-type: none"> <li>• The results were that 'groups using R-WISE in guided mode during the first semester then open mode during the second semester showed significant gains over groups using only guided for both semesters' (p 280).</li> <li>• 'The teacher's instructional style appeared to play some role in the effectiveness of R-WISE, with the students of those teachers who prefer social, independent, and neutral instructional styles receiving less benefit from R-WISE than students of teachers who prefer a conceptual instructional style' (pp 280–281).</li> </ul>
Conclusions	<ul style="list-style-type: none"> <li>• The first conclusion is that as 'the level of prior knowledge that a student has of a domain has been demonstrated to be a critical factor in the effectiveness of learner-control in computer-based instructional systems', then the fact that students in the sample did best when moving from guided mode into open mode seems to confirm such findings.</li> </ul>

	<ul style="list-style-type: none"> <li>Secondly, teachers who prefer social, independent and neutral instructional styles may not help their students in computer-based R-WISE instruction as well as teachers who adopt a conceptual mode of operation.</li> </ul>
Weight of evidence A (trustworthiness in relation to study questions)	<p>Medium</p> <p>The findings can be trusted within the confines of the study.</p>
Weight of evidence B (appropriateness of research design and analysis)	<p>Medium</p> <p>The research design is, in the light of the research question, a valid one.</p>
Weight of evidence C (relevance of focus of study to review)	<p>Medium</p> <p>This topic is squarely within the focus of the review.</p>
Weight of evidence D (overall weight of evidence)	<p>Medium</p> <p>Overall, the weight of evidence is still medium, due to the lack of validity in the sampling, data-collection and analysis – despite measures of reliability and a large sample, plus a generally appropriate study design.</p>

<b>Rowley et al. (1998)</b> A cognitive technology to teach composition skills: Four studies with the R-WISE writing tutor. <i>Journal of Educational Computing Research</i> 18: 259 – 296. (Study D)	
Country of study	USA
Age of learners	14–15: ninth grade students enrolled in English classes in Texas and New Mexico schools that had participated in previous studies
Type of study	Researcher-manipulated evaluation: controlled trial (cluster)
Aims of study	The broad aims of the study as a whole (i.e. all four individual studies) was to ‘evaluate and adapt the writing software Reading and Writing in a Supportive Environment (R-WISE)’ (p 260) in an attempt to improve prose composition as a cognitive act with the help of computers.
Summary of study design, including details of sample	<ul style="list-style-type: none"> <li>• This was ‘a quasi-experimental contrasted groups design featuring a treatment-control comparison’ (p 286).</li> <li>• N = 617, of which 356 were in the treatment group and 261 in the control group</li> </ul>
Data collection instruments, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• ‘A set of five scores were calculated for each paper: a holistic score (0–6 point scale) and four analytic measures (0–4 point scale). The holistic score was meant to capture the overall quality of the writing sample while the analytics were intended to capture specific qualities of the final writing product. The analytical score categories, although fundamentally the same as in the first year study, were renamed to more closely reflect the aspects of writing being taught through the R-WISE software design...’ (p 287).</li> <li>• The writing prompt responses were ‘scored by trained readers using standardized procedures described for the year 1 study’ (p 287).</li> </ul>
Methods used to analyse data, including details of checks on reliability and validity	<ul style="list-style-type: none"> <li>• Statistical data-collection methods include ANCOVA, sum of squares, mean squares, significance, etc.</li> <li>• Authors mention that, although the analytical score categories were fundamentally the same as in the year 1 study, they ‘were renamed to more closely reflect the aspects of writing being taught through the R-WISE software design (“abstraction” remained unchanged, “development” instead of “elaboration”, “purpose” instead of “focus”, and “organization” instead of “sequence”)’ (p 287).</li> </ul>
Summary of results	<ul style="list-style-type: none"> <li>• ‘...the finding for the year 4 replication study using R-WISE 3.0 was that there was a significant main effect of treatment across all dependent measures. This included significantly superior performance of the R-WISE treatment group on both the analytic measures and holistic measures. However, the size of the performance difference remained small as in earlier studies, and the students’ pre-test scores remained more predicative of post-test performance than the conditions’ (p 287).</li> <li>• Specifically, ‘holistic score gains, after adjustments for initial aptitude, were 8 percent for R-WISE users and 4 percent for control group students...as in the other studies, initial aptitude was most predictive of post-test score [but] the observed difference between conditions is likely to be reliable and valid’ (p 288).</li> </ul>
Conclusions	<ul style="list-style-type: none"> <li>• Conclusions are brief: simply that ‘the results of the year 4 study demonstrated that the findings of</li> </ul>

	<p>previous studies with regard to the efficacy of the R-WISE software in improving student outcomes can be replicated. The students who used R-WISE outperformed those who did not use R-WISE' (p 288). It is important to note here the conclusions to the four studies, of which this is the fourth and last:</p> <ul style="list-style-type: none"> <li>• The authors conclude that 'students using R-WISE augmented instruction consistently out-perform students receiving classroom instruction alone. Although the size of the effect of R-WISE was small for the studies, it is important given the nature of writing and the long time-frames typically required for improvement in writing skill.' (pp 288–289) There is a useful table showing summary results of all four studies on p 290.</li> <li>• The authors also conclude that 'to some degree the application of cognitive science to the development of an adaptive learning environment for writing skills is viable' (p 291) They note that several unanswered questions remain, including the context of student aptitudes and support of teachers' preferred instructional style.</li> </ul>
<p>Weight of evidence A (trustworthiness in relation to study questions)</p>	<p>Medium In many ways, the quality of the methodological approach is impressive, particularly with regard to the reliability of the analytical procedures.</p>
<p>Weight of evidence B (appropriateness of research design and analysis)</p>	<p>Medium The research design – a quasi-experimental contrasted groups design – is only of medium weight in the light of the research question. There are too many sources of bias or error likely in such a design to be sure that the results are totally reliable.</p>
<p>Weight of evidence C (relevance of focus of study to review)</p>	<p>Medium This topic is squarely within the focus of the review.</p>
<p>Weight of evidence D (overall weight of evidence)</p>	<p>Medium Overall, the study is a valuable one in that it directly compares word-processing approaches to composition with R-WISE cognitive computer-mediated ones, based on a sound theory of writing composition processes. The sample is large.</p>